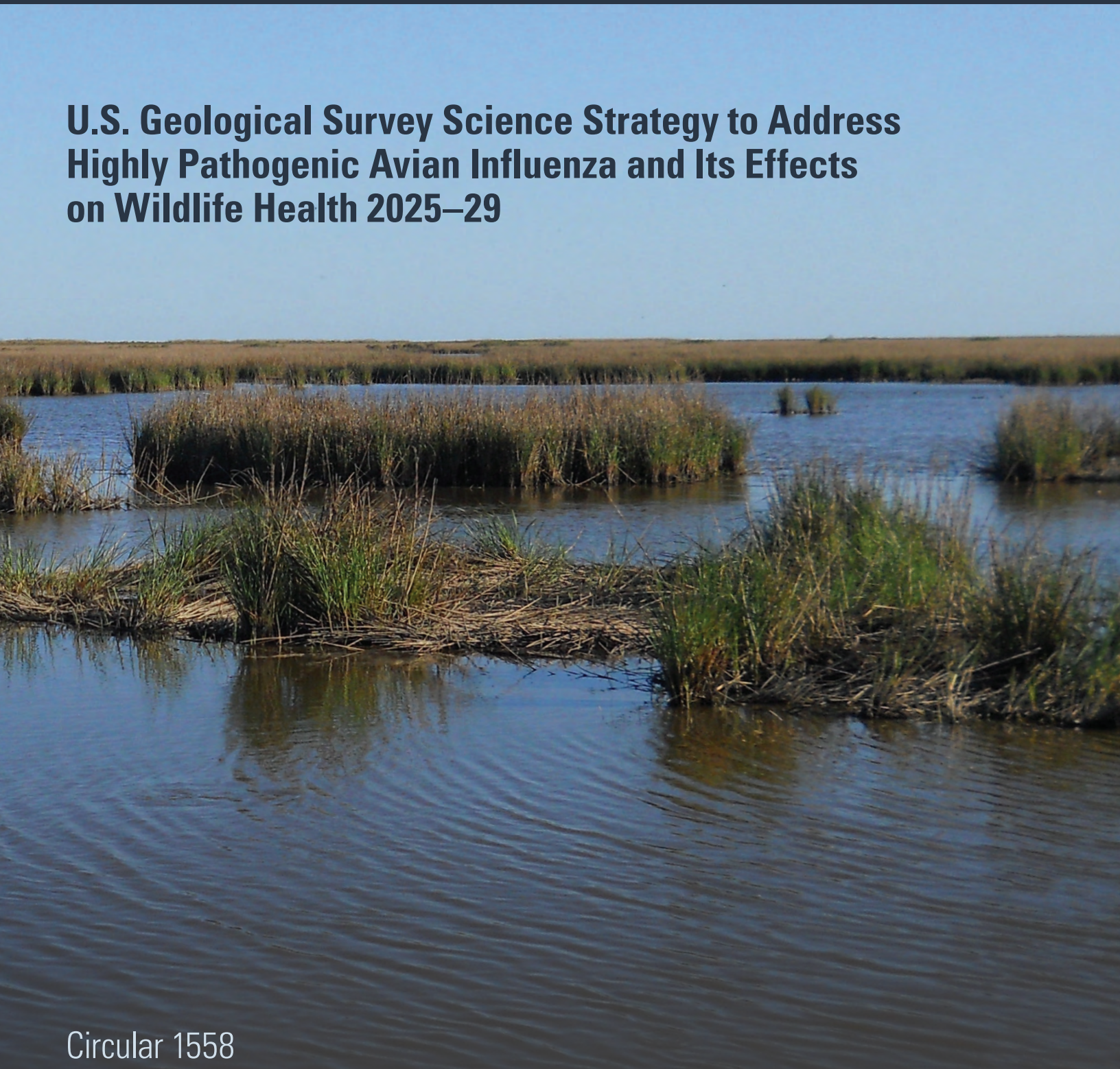
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U.S. Geological Survey Science Strategy to Address Highly Pathogenic Avian Influenza and Its Effects on Wildlife Health 2025–29



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Cover. Previous research led by U.S. Geological Survey scientists has assessed the duration for which avian influenza viruses may remain infectious within environmental surface waters. Photograph by Andrew Ramey, U.S. Geological Survey.

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Abbreviations

AIV	avian influenza virus
CDC	Centers for Disease Control and Prevention
DOI	U.S. Department of the Interior
EMA	Ecosystems Mission Area
ESF	Emergency Support Function
FY	fiscal year
HPAI	highly pathogenic avian influenza
IOC	Interior Operations Center
USGS	U.S. Geological Survey



Previous U.S. Geological Survey-led research has assessed the role waterfowl with intercontinental migratory tendencies, such as *Anas acuta* (Linnaeus, 1758; northern pintail), may play in the dispersal of avian influenza viruses between East Asia and North America. Photograph by Andrew Ramey, U.S. Geological Survey.

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Executive Summary

Highly pathogenic avian influenza (HPAI) is an ecologically and economically important animal disease that can also directly affect humans (a "zoonotic" disease). HPAI was once limited almost exclusively to domestic poultry but has rapidly adapted to diverse animal hosts. Viruses causing HPAI now appear to be maintained and dispersed by wild birds largely independent of poultry, though HPAI continues to cause considerable economic losses and supply chain disruptions in the domestic poultry trade. Coincident with the adaptation of HPAI viruses to wild birds, particularly waterfowl and gulls, increasingly diverse wild bird hosts are becoming exposed to HPAI, often resulting in disease and death. More sporadically, HPAI has caused mass mortality events, particularly among seabirds. Furthermore, viral spillover to wild and domestic mammals has become more common. Spillover to wild mammals has resulted in mortality among diverse terrestrial and marine taxa, including episodic losses of such scale as to represent potential conservation challenges. Since approximately March 2024, HPAI has also affected dairy cows, which represents a new threat to the agricultural economy. Lastly, HPAI has increasingly affected humans through domestic animal exposures, exemplifying the considerable implications of this disease beyond animal health.

Rapid changes in the ecology of HPAI are currently outpacing research efforts. For example, it is not entirely clear which newly established hosts may become reservoirs for HPAI viruses (in other words, capable of maintaining HPAI viruses within a broad population indefinitely) and how this may influence viral evolution and dissemination. As a result, there are considerable information gaps regarding HPAI in wildlife that, if filled, would improve the ability of scientists, managers, agricultural industry representatives, and healthcare professionals to understand and to anticipate the effects of HPAI on wild animal, domestic animal, environmental, and human health ("One Health").

The U.S. Geological Survey (USGS) is the lead Federal agency providing scientific research on avian influenza viruses (AIVs), including HPAI viruses, that affect wildlife for which the Department of the Interior (DOI) has management authority. States have jurisdiction over wildlife on Federal lands within their borders (43 CFR § 24.3), so the USGS Ecosystems Mission Area (EMA) coordinates with State natural resource management agencies. The EMA focuses its research on HPAI through priorities identified by the USGS Avian Influenza Science Team (app. 1). Priorities identified by the USGS Avian Influenza Science Team are based on Administration priorities, Congressional direction, and discussions with State, Federal, and Tribal natural resource management agencies that identify specific scientific gaps that need to be filled to inform sound wildlife management decisions. Notable non-DOI Federal partners include the U.S. Department of Agriculture, the lead for the HPAI regulatory response in poultry and livestock, and the Centers for Disease Control and Prevention (CDC), the lead agency for the HPAI response pertaining to human health.

The USGS offers unique expertise and capacity pertaining to research on diseases affecting free-ranging wildlife populations. This expertise has been critical to interjurisdictional surveillance and capacity-building efforts, including programs administered by the U.S. Department of Agriculture and the CDC. The USGS also provides resources, guidance, and tools to inform surveillance and interventions conducted by natural resource management agencies. More specifically, the USGS EMA provides objective and rigorous scientific data for inferring (1) the utility of new methods to detect and characterize AIVs, including those maintained in wildlife and the environment; (2) effects of HPAI on wildlife; (3) spatiotemporal patterns of wildlife host and AIV dispersal; (4) the presence and persistence of AIVs in the environment; (5) how HPAI in wildlife influences consumptive and nonconsumptive utilization of wildlife; (6) how new tools and scientific methods may promote sound management decisions for HPAI-affected wildlife, particularly species of conservation concern; and (7) the combined effects of HPAI and other stressors on ecosystem health and resiliency.

This science strategy builds upon research outlined in a previous USGS science strategy for HPAI (2016–20) by Harris and others (2016). This strategy also details research priorities identified by the Administration (for example, U.S. Department of Agriculture, 2025) and others based on USGS Avian Influenza Science Team discussions with natural resource management agencies to address HPAI and wildlife health over the next 5 years (2025–29). This strategy presents 7 goals and 26 objectives that focus USGS and partner efforts on priorities that will fill data gaps regarding the effects of HPAI on wildlife managed by or co-managed with the U.S. Department of the Interior such that agencies and partners might anticipate or limit adverse effects on public resources. This strategy also identifies research priorities intended to address HPAI in wildlife and wildlife habitat that are anticipated to support interjurisdictional One Health efforts.

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Branta hutchinsii (Richardson, 1832; cackling geese) have been affected by highly pathogenic avian influenza in North America during 2022–25 and are among the wild birds that have been targeted for sampling through research efforts led by the U.S. Geological Survey. Photograph by Ryan Askren, U.S. Geological Survey.



Introduction

Waterfowl, gulls, and shorebirds have long been recognized as natural reservoir hosts of diverse avian influenza viruses (AIVs) (Webster and others, 1992). Genetically and antigenically diverse AIVs maintained among waterfowl, gulls, and shorebirds have historically not been associated with disease among wild birds; however, sporadic viral spillover into nonreservoir hosts, including marine mammals, various peridomestic animals (those living in and around human habitations or poultry farms), and domestic chickens and turkeys, has more commonly led to adverse animal health outcomes (Webster and others, 1992). In particular, the spillover of AIV subtypes H5 and H7 into domestic poultry has repeatedly led to further viral evolution and adaption, resulting in viruses with a highly pathogenic phenotype (Swayne and Suarez, 2000). The disease caused by such viruses, highly pathogenic avian influenza (HPAI), and the resultant mortality among affected domestic birds have long been recognized as economically costly to the domestic bird trade and therefore have been subject to intensive management to mitigate effects for many years (Lupiani and Reddy, 2009). However, with perhaps only a single exception (Becker, 1966), HPAI was not known to affect wild birds prior to 2002 (Ellis and others, 2004).

Since 2002, HPAI has become increasingly common among wild birds (Ramey and others, 2022a). With few exceptions, confirmed cases of HPAI among wild birds have been associated with a particular H5 subtype viral lineage that was first described as affecting domestic geese in Guangdong, China, in 1996 (Sonnberg and others, 2013). Reports of HPAI among wild birds circa 2002–10 generally appeared to be a function of poultry-adapted viruses repeatedly spreading from domestic birds to susceptible wild bird hosts (Sonnberg and others, 2013). However, the incidence of HPAI among wild birds has become more common since approximately 2010, providing evidence that HPAI viruses were becoming established among wild bird reservoir species (Ramey and others, 2022a).

The first reports of HPAI among wild birds inhabiting North America, which resulted from sampling efforts by U.S. Geological Survey (USGS) scientists and others, began in late 2014 (Ip and others, 2015). Through genomic analysis of viruses led by USGS scientists and others, it became clear that wild migratory birds introduced HPAI viruses from East Asia (Ramey and others, 2016). Viruses causing HPAI quickly spread from wild birds to domestic poultry throughout Canada and the western and midwestern United States, resulting in the largest animal disease outbreak in North America at that time (Lee and others, 2018). Domestic animal management agencies within North America adopted prevention, control, and eradication strategies that included strict biosecurity for domestic bird production, isolation of infected and exposed flocks, and prompt depopulation. These strategies ultimately led to eradication of HPAI within domestic poultry in Canada and the United States in 2015

(Seeger and others, 2021). The last detection of HPAI viruses among wild birds inhabiting North America associated with this outbreak was in 2016 (Lee and others, 2017).

Despite concerted efforts to eradicate HPAI in North America during 2014–15, viruses causing HPAI continued to circulate among wild and domestic birds on other continents (Ramey and others, 2022a). During 2021, HPAI viruses were again introduced by wild birds into North America via both a trans-Atlantic pathway from Europe (Caliendo and others, 2022) and a trans-Pacific pathway from East Asia (Ahlstrom and others, 2024). Since re-introduction in 2021, HPAI has set new disease precedents in the United States, affecting more wild bird species, wild mammal species, domestic animal species, individual animals, and humans than previously reported HPAI-associated disease events (Harvey and others, 2023). The geographic extent of viral detections, levels of occurrence among susceptible hosts, and scale of mortality in wildlife and domestic animals have been large enough to indicate that conservation, food security, and public health may face future challenges on account of HPAI viruses (Garg and others, 2024; Haman and others, 2024; Louis and others, 2024). Therefore, agencies within the United States responsible for the management of wild and domestic animal health, and concerned with human public health, are grappling with how to address data gaps regarding the scope of infection and disease to identify appropriate and efficient ways to respond.

The USGS is the lead Federal agency providing scientific research on AIVs, including HPAI viruses, that affect wildlife for which the Department of the Interior (DOI) has management authority and responsibility, including those HPAI-affected species for which management is coordinated with Local, State, Federal, and Tribal partners (henceforth referred to as DOI trust species). As such, the USGS has been at the forefront of research on HPAI in wild birds and other wildlife since before this disease first affected wild birds in North America. Specifically, long-term and ongoing programs at the USGS have provided critical data for forecasting intercontinental viral introduction pathways through which HPAI viruses arrive in North America and subsequently for assessing ecological impacts following introduction events. These programs include the Bird Banding Laboratory established to align with the Migratory Bird Treaty Act (16 U.S.C. 703–712), Breeding Bird Survey to assess the status and trends of North American bird populations, wild bird cause-of-death investigations at the USGS National Wildlife Health Center, and testing of hunter-harvested birds in western Alaska for AIVs.

USGS scientists were among the first to identify HPAI-affected birds in the United States following viral introductions to North America via migratory birds in 2014 and 2021 (Ip and others, 2015; Youk and others, 2023). USGS scientists have also characterized genomes of introduced HPAI viruses and described the emergence of novel HPAI virus genotypes (Ramey and others, 2016; Ahlstrom and others, 2024). USGS scientists have also led or supported efforts to provide information on the potential effects of HPAI on wild bird health (Prosser and others, 2022; Spackman and others, 2023). Additionally, USGS scientists have led the development of new methods to detect and isolate infectious HPAI viruses in the environment (Hubbard and others, 2023, 2024), understand the duration of AIV persistence in aquatic habitats (Ramey and others, 2022b), and model viral spillover risk between wild birds and poultry (Prosser and others, 2024). Collectively, information and tools generated by USGS scientists and partners on topics pertaining to HPAI in wildlife have informed resource allocation, risk mitigation, and outbreak response by diverse Local, State, Federal, and Tribal partners. Table 1 provides metrics pertaining to the impact of recent USGS products (app. 2) about avian influenza and relevance to partners.

Table 1. Metrics of impact and relevance to partners (as of December 2024) for U.S. Geological Survey (USGS) data products about avian influenza that were published between October 2018 and September 2024.

Fiscal year[1]	Scientific papers[2]		All USGS data products[3]			
	Total published	Proportion cited	Total published or presented	Proportion authored by USGS scientists, only	Proportion authored by USGS and academic scientists, only	Proportion authored by USGS scientists and non-academic potential end users
2019	10	1.00	20	0.45	0.10	0.45
2020	11	0.91	17	0.24	0.12	0.65
2021	5	1.00	13	0.31	0.08	0.62
2022	9	0.89	46	0.57	0.13	0.30
2023	12	0.92	48	0.39	0.17	0.44
2024	10	0.30	51	0.31	0.16	0.52

[1]A fiscal year is the 12-month period from October 1 through September 30 of the following year and is designated by the calendar year in which it ends.

[2]This category includes all papers authored or co-authored by USGS scientists that have been cited as determined through a web search conducted in December 2024.

[3]This category includes papers, abstracts, posters, data releases, preprints, and other data products.

Congressional Mandates

The USGS's role in researching HPAI was established through Public Law 109–148, 119 Stat. 2680, which assigned the USGS the responsibility of conducting "surveys, investigations, and research" aimed at detecting HPAI in wild birds. This mandate includes the investigation of unusual morbidity and mortality events in wild birds with an avian influenza testing protocol (refer to resulting USGS publications in app. 2). Funding associated with this mandate was distributed by Congress in fiscal year (FY) 2006 and FY 2007. Additional funding was also distributed per a request in the FY 2008 President's Budget, which Congress approved (U.S. House of Representatives, 2007, p. 52). Although no additional appropriations have been received, the USGS maintain its HPAI research and surveillance capacity, which is aligned with mandates outlined by Executive Order No. 13186—Responsibilities of Federal Agencies to Protect Migratory Birds (16 U.S.C. 701(3)(11)) and the Migratory Bird Treaty Act (16 U.S.C. 703–712).

U.S. Department of Homeland Security's Federal Emergency Management Agency National Response and Recovery Frameworks

The Department of the Interior is one of the primary agencies for the Department of Homeland Security's National Response Framework Emergency Support Function (ESF) #11 (Federal Emergency Management Agency, 2016). One of the five primary functions for ESF #11 is protecting natural and cultural resources and historic properties. Under this function, the ESF #11 annex identifies the USGS as the Federal lead for wildlife diseases (Federal Emergency Management Agency, 2016, p. 7).

USGS Avian Influenza Science Strategy

The USGS Science Strategy to Address HPAI and Its Effects on Wildlife Health 2025–29 was drafted by six authors who received input from the entire USGS Avian Influenza Science Team (app. 1). Subsequent subsections convey 7 overarching science goals for ongoing and future research, 26 specific objectives pertaining to the goals, and information indicating how performance of the agency on targets identified within the Science Strategy will be reviewed.

Goals and Objectives

Science Goal 1: Develop and Refine Methods for Viral Detection and Characterization of Viruses in Wildlife and the Environment

The USGS has been developing, testing, refining, and applying diverse methods for detecting and characterizing AIVs and antibodies thereto among wildlife and wetland habitats for nearly two decades (Ip and others, 2012; Ramey and others, 2013, 2024; Densmore and others, 2017; Reeves and others, 2020; Hubbard and others, 2023, 2024). Through this science goal, the USGS will continue to serve as a leader among Federal agencies in the development and refinement of such methods to expand research and surveillance capabilities and improve cost efficiencies commensurate with changes in animal and environmental health risk during the ongoing panzootic (that is, the globally widespread animal epidemic) of HPAI. Through the specific objectives for this goal, methods will be validated and transferred to diverse users within scientific and management communities to support research and surveillance efforts, including those led by other DOI bureaus, the U.S. Department of Agriculture, State agencies, and Tribes.

Objective 1.1.—Develop, test, and refine culture-independent pipelines, such as genomic methods, for detecting and characterizing AIVs affecting wildlife.

Objective 1.2.—Develop, test, and refine serologic approaches to evaluate prior exposure of wildlife to AIVs, including HPAI viruses.

Objective 1.3.—Develop, test, and refine approaches for detecting and characterizing AIVs in the environment using water and sediment samples.

Objective 1.4.—Develop, test, and refine approaches for estimating time since infection using diagnostic outputs relative to metrics reported from experimental challenge studies.

Science Goal 2: Assess Effects of HPAI on Wildlife

The USGS has a long history of conducting research to understand the effects of various stressors on wildlife health to support the management of DOI trust species (Samuel and others, 1999; Atkinson and others, 2000; Brand, 2013; Hopkins and Soileau, 2018). The USGS will assess how HPAI is affecting migratory birds and other wildlife inhabiting the United States through this science goal. The specific objectives convey how assessments will be logically designed and applied to meet information needs of management organizations, including other DOI bureaus, State agencies, and Tribes.

Objective 2.1.—Assess the incidence of HPAI and antibodies to antigenically relevant viruses among atypically affected wildlife hosts of avian influenza, such as raptors, seabirds, and wild mammals.

Objective 2.2.—Use information on mortality associated with HPAI to assess its effects on wildlife populations, particularly among species and populations of conservation concern.

Objective 2.3.—Identify transcriptomic markers indicative of avian influenza infection and relate to animal outcomes.

Objective 2.4.—Assess how HPAI may predispose wildlife to predation or hunter harvest.

Objective 2.5.—Assess nonlethal impacts of HPAI to wildlife health, such as decreased movement capacity or increased energetic costs.

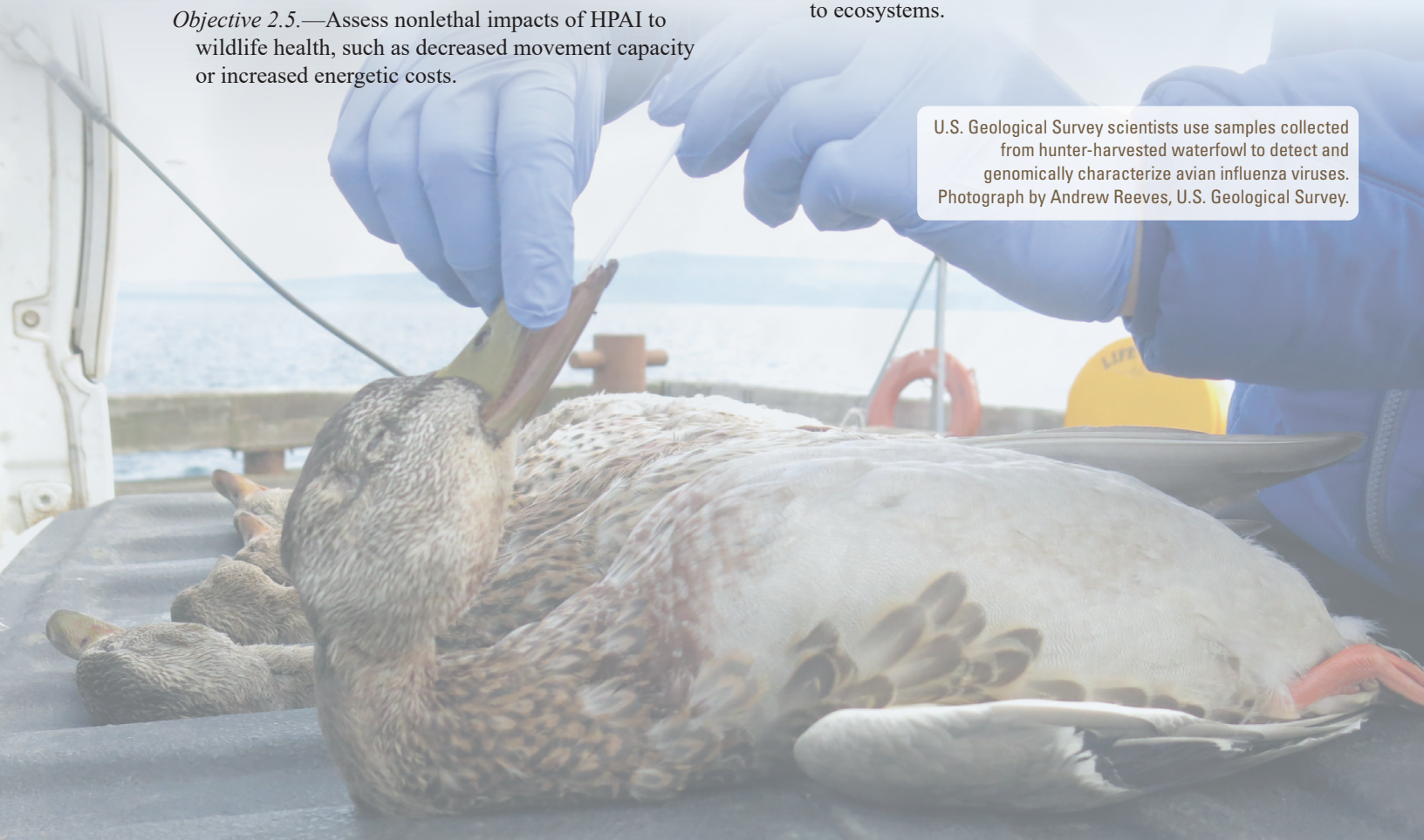
Science Goal 3: Identify Spatiotemporal Patterns of Wildlife Host and HPAI Virus Dispersal

USGS scientists have developed, refined, and applied diverse approaches and tools for inferring patterns of dispersal for wildlife and the potential pathogens they harbor (Prosser and others, 2011, 2022; Ramey and others 2019; Ahlstrom and others, 2021). Through this science goal, the USGS will use its expertise and capacities in molecular methods, bioinformatics, animal tracking, and modeling (Prosser and others, 2011, 2022, 2024; Ramey and others 2019, 2024; Ahlstrom and others, 2021) to hindcast and predict probable future dispersal patterns. Information on wildlife host and HPAI virus dispersal will inform surveillance efforts led by other DOI bureaus, the U.S. Department of Agriculture, State agencies, and Tribes, and support plans to mitigate health risk within wildlife populations and among other sectors (for example, domestic animal and human).

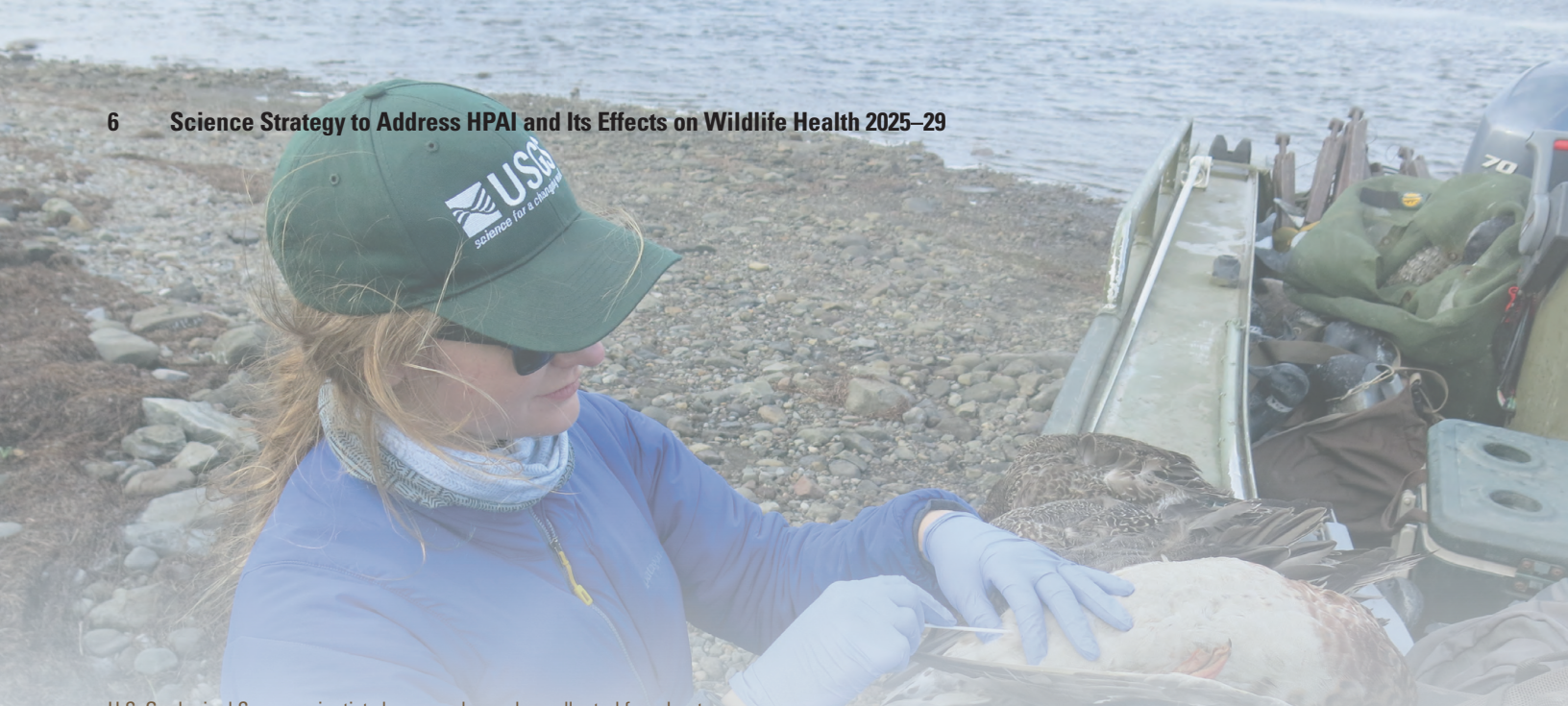
Objective 3.1.—Use molecular diagnostics, genomic sequence information, and serological tools to infer how HPAI viruses are spread across space, through time, and among species.

Objective 3.2.—Identify spatial and temporal dispersal patterns for HPAI viruses and relevant hosts at local, regional, and continental scales.

Objective 3.3.—Develop approaches to understand ecological influences underlying HPAI dissemination and apply models prognostically to anticipate impacts to ecosystems.



U.S. Geological Survey scientists use samples collected from hunter-harvested waterfowl to detect and genomically characterize avian influenza viruses. Photograph by Andrew Reeves, U.S. Geological Survey.



U.S. Geological Survey scientists have used samples collected from hunter-harvested ducks to infer how highly pathogenic avian influenza viruses are dispersed across the landscape, through time, and among species. Photograph by Andrew Reeves, U.S. Geological Survey.

Science Goal 4: Refine Information on the Occurrence and Persistence of HPAI Viruses in the Environment to Inform Management Practices

Within the past 5 years, USGS scientists have developed and applied several novel field-based approaches for assessing the presence and persistence of AIVs in the environment (Ramey and others, 2020, 2022b; Reeves and others, 2020; Hubbard and others, 2023, 2024; Poulson and others, 2024). The USGS will build upon these efforts by refining and applying previously developed approaches (Ramey and others, 2022b; Hubbard and others, 2024) and conducting new research to inform management agencies on the feasibility of efforts to mitigate or deactivate AIVs in the environment.

Objective 4.1.—Assess how removing carcasses associated with HPAI mortality events from the environment influences the subsequent detection of HPAI viruses, or antibodies thereto, in wildlife inhabiting the immediate area.

Objective 4.2.—Assess how physical and chemical characteristics of environmental substrates influence the detection and persistence of AIVs in water and sediment.

Objective 4.3.—Assess how AIVs are dispersed through the water column following deposition.

Objective 4.4.—Assess and describe the deactivation of AIVs by ultraviolet radiation in diverse water and sediment substrates.

Objective 4.5.—Assess the feasibility of mitigation efforts to deactivate AIVs in the environment within relatively small and intensively managed habitats.

Science Goal 5: Incorporate Human Dimensions of HPAI in Scientific Studies

HPAI viruses affecting wild birds during 2022–25 seem to be effectively maintained and dispersed by wild birds independent of poultry. Viral spillover to wild mammals has become increasingly common (Elsmo and others, 2023; Ramey and others, 2025). Wildlife resources that humans utilize may, therefore, be increasingly affected. The USGS intends to respond to emerging data gaps regarding human dimensions and HPAI by developing new lines of inquiry per the specific objectives outlined below.

Objective 5.1.—Assess how HPAI among wildlife has impacted harvest practices among hunters and trappers of waterfowl, upland birds, small mammals, and big game.

Objective 5.2.—Estimate the economic costs of HPAI among wildlife to outdoor recreation industries associated with the consumptive (for example, hunting) and nonconsumptive (for example, birding and other wildlife viewing) utilization of wildlife.

Objective 5.3.—Understand how human behavior, such as recreation, tourism, and animal feeding might affect viral spread in land-management systems (for example, spread to or among critical habitats for DOI trust species).

Objective 5.4.—Assess impacts of HPAI on subsistence harvest practices of wildlife among Tribes.

Science Goal 6: Develop New Tools and Scientific Methods to Inform Management Decisions Regarding HPAI in Wildlife, Particularly for Species of Conservation Concern

The USGS has considerable capacity to support decision science pertaining to public resources (Runge and others, 2013; Stoltz and others, 2023). Given the increasing relevance of HPAI to wildlife health, and specifically to species and populations of conservation concern, the USGS intends to use a portion of its decision science capacity to develop and provide tools to other DOI bureaus, State agencies, and Tribes to inform management decisions regarding DOI trust species in the context of the ongoing HPAI panzootic.

Objective 6.1.—Develop decision support tools for evaluating mortality of wildlife associated with HPAI.

Objective 6.2.—Develop decision support tools for guiding decisions regarding the conservation of threatened or endangered species in the context of HPAI outbreaks.

Objective 6.3.—Advance spatiotemporal transmission risk models at the wild–domestic interface as well as within the expanding host range of wild birds and mammals.

Science Goal 7: Assess Potential Combined Effects of HPAI and Other Stressors on Ecosystem Health and Resiliency

The USGS conducts research on diverse physical and biological resources that comprise ecosystems (U.S. Geological Survey, 2025). The USGS intends to utilize this broad ecological expertise to develop and apply cross-cutting approaches to better understand how HPAI may influence ecosystem health and resiliency. Through the development of projects to meet specific objectives, the USGS intends to help address the effects of HPAI on wildlife and their habitats, which may be influenced by synergistic effects of HPAI viruses and other anthropogenic inputs.

Objective 7.1.—Use information on infection status, disease state or outcome, microbiome, contaminant exposure, and (or) co-infection status to assess cumulative impacts on wildlife health.

Objective 7.2.—Assess correlations between environmental detection of avian influenza viruses and habitat characteristics to predict how management actions may influence viral occurrence and persistence in wetlands.

Objective 7.3.—Investigate effects of weather pattern and land use changes on behavior and overall health of HPAI reservoir wildlife hosts to understand implications for infection, transmission, and manifestation of disease.



Mallards are common hosts of highly pathogenic avian influenza viruses and are frequently harvested by both sport and subsistence hunters. Photograph by Andrew Reeves, U.S. Geological Survey.

Performance Review of the Science Strategy

The USGS Avian Influenza Science Team (app. 1) intends to meet annually to share research, identify synergies and areas for collaboration, and review progress towards achieving objectives defined within this 5-year strategy. USGS Leadership Team members that direct programs overseeing avian influenza research will be invited to meetings to advise on alignment with congressional funding mandates, Administration priorities, and science needs of natural resource management agencies.

Additionally, an annual summary on research conducted by the USGS Avian Influenza Science Team (app. 1) will be prepared for Federal members of the Interagency Steering Committee for Avian Influenza Surveillance in Wild Migratory Birds and other relevant groups to review. Feedback on the Team's effectiveness at addressing priorities and adherence to the strategy will be shared with the USGS Avian Influenza Science Team. This input, along with feedback received from non-governmental organizations of natural resource management agencies (for example, the Association of Fish and Wildlife Agencies and the Native American Fish and Wildlife Society) will be considered for the selection of new projects commensurate with available resources. A revision of the USGS Science Strategy to Address HPAI and Impacts to Wildlife Health is anticipated in 2029 if congressional appropriation language and Administration priorities continue to identify avian influenza in wildlife as an important research priority to meet the information needs of natural resource management agencies.

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Appendix 1. Names and Affiliations of USGS Avian Influenza Science Team Members (in Alphabetical Order by Last Name)

Christina Ahlstrom, Alaska Science Center
Alicia Berlin, Eastern Ecological Science Center
Michael Casazza, Western Ecological Research Center
Susan De La Cruz, Western Ecological Research Center
Robert Dusek, National Wildlife Health Center
Amy George, Columbia Environmental Research Center
Daniel Grear, National Wildlife Health Center
Jeffrey Hall, National Wildlife Health Center
Camille Hopkins, Ecosystems Mission Area
Laura Hubbard, Upper Midwest Water Science Center
Hon Ip, National Wildlife Health Center
Deborah Iwanowicz, Environmental Health Program
Elliott Matchett, Western Ecological Research Center
Christopher Ottinger, Eastern Ecological Science Center
Aaron Pearse, Northern Prairie Wildlife Research Center
Diann Prosser, Eastern Ecological Science Center
Andrew Ramey, Alaska Science Center
Jeffery Sullivan, Eastern Ecological Science Center
Wayne Thogmartin, Upper Midwest Environmental Sciences Center
Forrest Vanderbilt, Eastern Ecological Science Center
Guelaguetza Vazquez-Meves, Ecosystems Mission Area
Daniel Walsh, Montana Cooperative Wildlife Research Unit

Appendix 2. USGS Publications on Avian Influenza

Ahlstrom, C.A., Torchetti, M.K., Lenoch, J., Beckmen, K., Boldenow, M., Buck, E.J., Daniels, B., Dilione, K., Gerlach, R., Lantz, K., Matz, A., Poulson, R.L., Scott, L.C., Sheffield, G., Sinnett, D., Stallknecht, D.E., Stimmelmayr, R., Taylor, E., Williams, A.R., and Ramey, A.M., 2024, Genomic characterization of highly pathogenic H5 avian influenza viruses from Alaska during 2022 provides evidence for genotype-specific trends of spatiotemporal and interspecies dissemination: Emerging Microbes & Infections, v. 13, no. 1, 10 p., https://doi.org/10.1080/22221751.2024.2406291.

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