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Report to Congressional Committees

May 2023

ZOONOTIC DISEASES

Federal Actions Needed to Improve Surveillance and Better Assess Human Health Risks Posed by Wildlife

Accessible Version

GAO-23-105238

GAO Highlights

Highlights of GAO-23-105238, a report to congressional committees

May 2023

ZOONOTIC DISEASES

Federal Actions Needed to Improve Surveillance and Better Assess Human Health Risks Posed by Wildlife

Why GAO Did This Study

Major outbreaks of zoonotic diseases have caused millions of human deaths and cost billions of dollars. Zoonotic diseases can spread to people from U.S. wildlife or animals imported from other countries.

A congressional report directed GAO to review issues related to the emergence of zoonotic diseases. This report examines (1) settings where zoonotic pathogens can spread and risk factors for outbreaks; (2) federal efforts to conduct and coordinate surveillance for zoonotic diseases in U.S. wildlife; and (3) federal regulation of imported wildlife to prevent introduction of zoonotic diseases into the U.S. GAO reviewed scientific articles and regulations; reviewed agency strategies and agreements; analyzed data; and interviewed federal officials and other experts. GAO also assessed agency collaboration against GAO's leading practices identified in prior work.

What GAO Recommends

GAO is making five recommendations: two each to APHIS and USGS and one to CDC. The recommendations include that APHIS and USGS improve collaboration to establish a national wildlife disease surveillance system and that CDC comprehensively assess zoonotic disease risks for imported wildlife. Regarding the recommendations, APHIS did not comment, USGS concurred, and

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What GAO Found

Zoonotic diseases, which are transmitted between animals and humans, can spread in any setting where people and animals interact—including forests, farms, or live animal markets. Zoonotic pathogens, such as coronaviruses and avian influenza viruses, are more likely to infect people in crowded, unsanitary settings, where multiple animal species from a wide geographic area intermingle. In general, the risks of a human outbreak increase when zoonotic pathogens are novel—because of a lack of immunity in humans—and when they can spread rapidly from person to person.

Zoonotic Diseases Can Be Transmitted by Animals such as White-Tailed Deer, Nonhuman Primates, and Rodents

Sources (left to right): Paul/pe3check/Alexey Kuznetsov/stock.adobe.com. | GAO-23-105238

Federal agencies conduct some surveillance for zoonotic diseases in U.S. wildlife but have not fully coordinated certain efforts. For example, the Animal and Plant Health Inspection Service (APHIS) and the U.S. Geological Survey (USGS) have taken initial steps to establish a national surveillance system that would better position the U.S. to address emerging wildlife diseases. As they work to establish this system, more fully following GAO's leading collaboration practices would enhance their efforts. These practices include clearly defining common outcomes and involving relevant participants. In addition, USGS is leading the development of a national wildlife disease database. The 2022 National Biodefense Strategy calls for agencies to develop the ability to rapidly detect and share information on emerging animal pathogens that pose a significant biological threat. However, obstacles related to interoperability and privacy currently prevent the incorporation of APHIS data into the national wildlife disease database. By working together to address these obstacles, the agencies could better support early detection of zoonotic disease outbreaks.

The Centers for Disease Control and Prevention (CDC) and other agencies regulate the importation of certain wildlife species, in part to mitigate the risk of introducing zoonotic diseases to the U.S. In some cases, CDC has issued regulations after outbreaks have occurred, such as banning rodents from Africa after they were linked to a 2003 monkeypox outbreak in the U.S. However, some species of imported wildlife known to be capable of carrying zoonotic diseases, such as rodents not from Africa, are allowed to enter the U.S. without CDC restrictions. Further, CDC has not comprehensively identified and characterized risks related to imported wildlife. As a result, CDC's current approach may not be sufficient to prevent outbreaks. If CDC comprehensively assessed disease risks to inform decisions about regulating imported wildlife, it could help prevent the introduction of zoonotic diseases into the U.S.

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Abbreviations

APHIS	Animal and Plant Health Inspection Service
ARPA	American Rescue Plan Act of 2021
CDC	Centers for Disease Control and Prevention
FWS	U.S. Fish and Wildlife Service
HHS	Department of Health and Human Services
Interior	U.S. Department of the Interior
MERS	Middle East respiratory syndrome
Mpox	monkeypox
SARS	severe acute respiratory syndrome
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WHISPers	Wildlife Health Information Sharing Partnership Event Reporting System

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May 31, 2023

The Honorable Tammy Baldwin
Chair
The Honorable Shelley Moore Capito
Ranking Member
Subcommittee on Labor, Health and Human Services, Education, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Robert Aderholt
Chair
The Honorable Rosa DeLauro
Ranking Member
Subcommittee on Labor, Health and Human Services, Education, and Related Agencies
Committee on Appropriations
House of Representatives

Zoonotic diseases, or diseases that can spread between animals and people, account for an estimated 75 percent of new and emerging infectious diseases and are a serious public health concern around the world.[1] Emerging infectious diseases, primarily zoonotic diseases, have been increasing in frequency over the past 5 decades.[2] According to the World Health Organization, there are more than 200 known zoonotic diseases. In recent decades, zoonotic pathogens have caused numerous outbreaks, epidemics, and pandemics in people[3]—including HIV/AIDS,

[1]For the purposes of this report, the term "animal" refers to nonhuman animals, including insects. According to the World Health Organization, an emerging infectious disease is one that has appeared and affected a human population for the first time or has existed previously but is rapidly spreading to more people or new geographical areas.

[2]For example, see Y. Alimi et al., "Report of the Scientific Task Force on Preventing Pandemics," *Harvard Global Health Institute and the Center for Climate, Health, and the Global Environment at Harvard T.H. Chan School of Public Health* (Aug. 2021).

[3]The Centers for Disease Control and Prevention (CDC) defines an epidemic as an increase in the number of cases of a disease above what is normally expected in an area; an outbreak as an epidemic, but in a more limited geographic area; and a pandemic as an epidemic that has spread over several countries or continents. However, these terms are not always used consistently. For example, while some researchers describe Middle East respiratory syndrome as a pandemic, others describe it as an epidemic or outbreak.

severe acute respiratory syndrome (SARS), 2009 H1N1 influenza, Middle East respiratory syndrome (MERS), and Ebola. These pathogens have collectively resulted in tens of millions of deaths and hundreds of billions of dollars in economic costs worldwide.

Zoonotic pathogens can be carried by agricultural animals, pets, and wildlife, including wildlife in the U.S. and animals imported to the U.S. from other countries. For example, the pathogens that cause brucellosis and COVID-19 have been detected in U.S. wildlife, while Ebola and monkeypox (mpox) have been detected in imported wildlife.[4] Transmission of zoonotic diseases from animals to people, called spillover, can occur when people interact with infected animals. Researchers estimate that hundreds of thousands of zoonotic viruses might still be undiscovered in mammals and birds and could cause spillover. Bacteria, fungi, and parasites can also cause spillover events.

Multiple federal agencies share responsibilities for mitigating disease threats from U.S. and imported wildlife. These responsibilities include conducting surveillance of U.S. wildlife and regulating imported wildlife.[5] Federal agencies responsible for conducting surveillance of U.S. wildlife include the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) and the Department of the Interior's (Interior) U.S. Fish and Wildlife Service (FWS) and U.S. Geological Survey (USGS).[6] Federal agencies responsible for issuing and enforcing regulations for imported wildlife, including quarantine or permit requirements, include APHIS, the Department of Health and Human

[4]For the purposes of this report, "U.S. wildlife" refers to native and nonnative wildlife located in the U.S. CDC has called the virus that causes COVID-19 a zoonotic virus because it can spread between animals and humans. Researchers have detected evidence of the COVID-19 virus in U.S. wildlife, including in white-tailed deer and mink, likely as a result of human-to-animal spread (called "spillback"). Mink-to-human spread of the COVID-19 virus has been reported in Europe, and CDC stated that data suggest that this may have also occurred in the U.S., https://www.cdc.gov/importation/bringing-an-animal-into-the-united-states/mink.html, accessed February 17, 2023.

As of November 28, 2022, the World Health Organization has recommended that "mpox" be the new name for monkeypox, and CDC is updating its materials accordingly.

[5]Federal agencies also conduct other activities—such as research and wildlife population monitoring—that are related to surveillance but are outside the scope of this report.

[6]Other federal agencies also conduct surveillance of U.S. wildlife. For example, Interior's National Park Service is responsible for conducting surveillance of U.S. wildlife within its boundaries. In addition, the Department of Commerce's National Oceanic and Atmospheric Administration is the lead federal agency for surveillance of wild marine mammals, which are outside the scope of our review.

Services' Centers for Disease Control and Prevention (CDC); FWS; and the Department of Homeland Security's U.S. Customs and Border Protection.

In response to multiple zoonotic disease outbreaks in recent years, federal agencies have begun new efforts to jointly address zoonotic disease threats, including those from wildlife. In 2017, CDC, Interior, and USDA held an intragovernmental workshop and identified priority zoonotic diseases of greatest national concern.[7] In 2020, APHIS and USGS established an ad hoc interagency committee to recommend ways to address the threat of zoonotic diseases emerging from U.S. wildlife. Among other things, the committee identified the need for a coordinated national wildlife surveillance system to rapidly detect and diagnose zoonotic diseases in wildlife, and a common database to integrate wildlife disease data. In 2021, Congress provided funding for federal agencies to conduct disease surveillance of U.S. wildlife and develop a national wildlife disease database, among other things.[8] In 2018, the White House issued the National Biodefense Strategy, which was designed to strengthen federal capabilities to address biological threats from accidental, deliberate, and naturally occurring sources, including zoonotic diseases.[9] In 2022, the White House updated the National Biodefense Strategy.[10]

The explanatory statement accompanying the Departments of Labor, Health and Human Services, and Education, and the Related Agencies Appropriations Act, 2021, contains a provision for GAO to review issues related to the emergence of zoonotic diseases.[11] This report (1) describes what is known about the settings where zoonotic disease spillover occurs

[7]See Centers for Disease Control and Prevention, U.S. Department of the Interior, and U.S. Department of Agriculture, *Prioritizing Zoonotic Diseases for Multisectoral, One Health Collaboration in the United States, Workshop Summary*, CS29887A (Washington, D.C.: 2019).

[8]American Rescue Plan Act of 2021, Pub. L. No. 117-2, 135 Stat. 4.

[9]The White House, *2018 National Biodefense Strategy* (Washington, D.C.: Sept. 2018).

[10]The White House, *National Biodefense Strategy and Implementation Plan For Countering Biological Threats, Enhancing Pandemic Preparedness, and Achieving Global Health Security* (Washington, D.C.: Oct. 2022). The 2022 strategy reflects the administration's plan for a whole-of-government effort across 20 federal agencies, including agencies within the Departments of Health and Human Services, Interior, and Agriculture, among others.

[11]*Explanatory Statement: Division H—Departments of Labor, Health and Human Services, and Education*, *and Related Agencies Appropriations Act, 2021*, Congressional Record, 116th Cong. (Dec. 21, 2020): pp. H8619, H8633.

and what factors increase the risks of an outbreak; (2) examines the efforts that federal agencies currently undertake to conduct surveillance for zoonotic diseases in U.S. wildlife, and the extent to which federal agencies have coordinated efforts to develop a national surveillance system and a national database; and (3) examines the extent to which federal agencies regulate imported wildlife to mitigate the risks that they could introduce zoonotic diseases to the U.S.

To describe the settings where zoonotic disease spillover occurs and the factors that increase the risks of outbreaks, we conducted a literature search and reviewed selected journal articles from 2012 through 2021, as well as related government reports. We interviewed officials from CDC and FWS, as well as five zoonotic and infectious disease experts from universities or nongovernmental organizations. We identified experts to interview through our review of literature, online sources from relevant organizations, and prior GAO work on related topics. We sought to include a range of specific expertise in zoonotic diseases, spillover, and associated risks.

To examine the types of surveillance that federal agencies are conducting for zoonotic diseases in U.S. wildlife, we reviewed relevant legislation, as well as strategies, plans, and interagency agreements from APHIS, FWS, and USGS. We interviewed officials from these agencies, as well as officials from three state wildlife departments and representatives of three nongovernmental organizations.[12] We also visited APHIS's National Wildlife Research Center and USGS's National Wildlife Health Center to observe their operations and talk to officials. To assess the agencies' coordination of efforts to develop a national wildlife surveillance system, we compared the agencies' actions with leading practices for collaboration.[13] To assess agencies' coordination of efforts to develop a national wildlife disease database, we compared their efforts with relevant objectives in the 2018 and 2022 national biodefense strategies.

[12]Specifically, we interviewed representatives from the Association of Fish and Wildlife Agencies, the Association of State and Territorial Health Officials, and the Southwestern Cooperative Wildlife Disease Study. We interviewed officials from Colorado Parks and Wildlife and two representatives of the Association of Fish and Wildlife Agencies who also spoke to their own state experiences with the Oregon Department of Fish and Wildlife and the West Virginia Division of Natural Resources. We identified these entities to interview through our review of online sources from relevant organizations, GAO work on related topics, and by asking interviewees for suggestions. We sought to include perspectives on zoonotic disease surveillance from a range of entities.

[13]For more information on the leading practices for collaboration, see app. II. GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms,* GAO-12-1022 (Washington, D.C.: Sept. 27, 2012).

Specifically, in its objective on data integration for early warning, the 2022 strategy calls for agencies to share data on animal health surveillance.

To examine the extent to which federal agencies regulate imported wildlife to mitigate the risks that they could introduce zoonotic diseases to the U.S., we reviewed relevant legislation and regulations, and agency documentation about the rationale for regulations. We interviewed officials from APHIS, CDC, FWS, and the Department of Homeland Security. We obtained and analyzed FWS animal import data from 2013 through 2022, from FWS's Law Enforcement Management Information System, to describe the number of imports by categories of wildlife. These were the most recent data available at the time of our analysis. We assessed the reliability of FWS animal import data, which included screening for omissions and anomalies, interviewing agency officials about the reliability, and reviewing technical documentation. We determined that the data were sufficiently reliable for providing contextual information about the general trends in certain categories of wildlife imported to the U.S. from 2013 through 2022.[14] We compared CDC's actions for restricting imported wildlife with relevant goals and objectives in the 2018 and 2022 national biodefense strategies, which call for agencies to ensure that decision-making is informed by risk assessment, among other things. We also compared CDC's actions with relevant standards for internal control, which call for management to comprehensively identify risks that affect defined objectives.

We conducted this performance audit from June 2021 to May 2023 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[14]From 2013 through 2022, some imported fish were recorded in categories such as "freshwater tropical fish" without a species name. Because we did not analyze fish by species, we determined that this was acceptable for reporting general trends for fish imported during the period. In addition, we found that about 4 percent of the wildlife imports that we analyzed either had a missing species name or had a species name that was not relevant for our analysis (e.g., nematodes). We determined that this was an acceptable level for providing contextual information. We did not verify FWS animal import data against FWS source documents.

Background

Zoonotic Disease Transmission

Zoonotic diseases are caused by pathogens—such as viruses, bacteria, fungi, or parasites—that spread between animals and people. Table 1 shows examples of zoonotic pathogen types, diseases, and possible animal hosts.

Table 1: Examples of Zoonotic Pathogen Types, Diseases, and Possible Animal Hosts

Zoonotic pathogen type	Examples of zoonotic diseases that the pathogens can cause	Examples of animal hosts that can carry or transmit the pathogens
Viruses	Coronavirus diseases (e.g., severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and COVID-19)[a]	• Wild mammals (e.g., white-tailed deer, mule deer, civets, and black-tailed marmoset) • Agricultural mammals (e.g., minks and camels) • Pet mammals (e.g., cats, dogs, and hamsters)
	Ebola	• Wild mammals (e.g., bats and nonhuman primates)
	Mpox[b]	• Wild mammals (e.g., nonhuman primates, hedgehogs, prairie dogs, squirrels, and shrews)
	Rabies	• Wild mammals (e.g., bats, raccoons, and foxes) • Agricultural mammals (e.g., cattle and horses) • Pet mammals (e.g., cats, dogs, and ferrets)
	West Nile	• Wild birds (e.g., crows, ravens, and jays)
	Zoonotic influenzas (e.g., swine influenza or avian influenza)	• Wild birds (e.g., ducks, geese, and swans) • Agricultural mammals and birds (e.g., pigs and poultry)
Bacteria	Anthrax	• Wild mammals (e.g., deer and antelope) • Agricultural mammals (e.g., cattle, goats, and sheep)
	Brucellosis	• Wild mammals (e.g., bison, elk, and feral swine) • Agricultural mammals (e.g., cows, goats, and sheep)
	Lyme	• Wild mammals (e.g., rodents)
	Plague	• Wild mammals (e.g., ground squirrels, prairie dogs, mice, and rabbits)
	Salmonellosis	• Wild birds (e.g., songbirds) • Agricultural mammals and birds (e.g., pigs, cows, and chickens) • Pets (e.g., cats, dogs, and reptiles)

Zoonotic pathogen type	Examples of zoonotic diseases that the pathogens can cause	Examples of animal hosts that can carry or transmit the pathogens
Fungus	Histoplasmosis	• Wild mammals and birds (e.g., bats, pigeons, and blackbirds) • Agricultural birds (e.g., poultry)
	Ringworm	• Agricultural mammals (e.g., pigs, cows, and goats) • Pet mammals (e.g., dogs and cats)
Parasite	Giardiasis	• Wild mammals (e.g., nonhuman primates, opossums, and chinchillas) • Pet mammals (e.g., dogs and cats)

Source: GAO analysis of information from the Centers for Disease Control and Prevention (CDC). | GAO 23 105238

Note: This table is not intended to be a comprehensive list of all zoonotic diseases and the animal hosts that can carry the pathogens.

[a]CDC has called the virus that causes COVID-19 a zoonotic virus because it can spread between animals and humans.

[b]As of November 28, 2022, the World Health Organization recommended that "mpox" should be the name for monkeypox, and CDC is updating its materials accordingly.

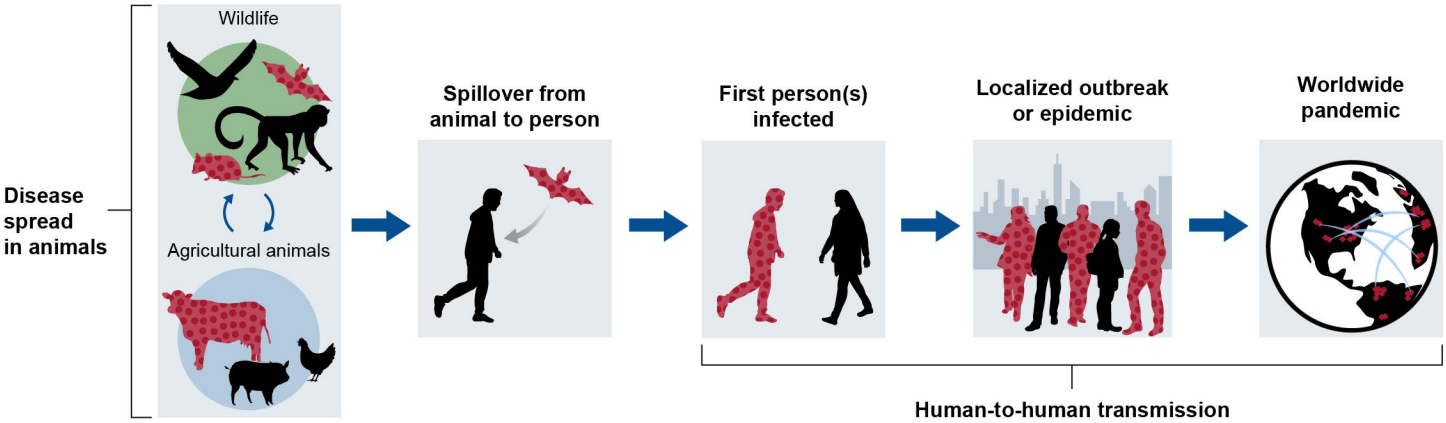
Zoonotic disease spillover occurs when an infected animal transmits a pathogen to a person.[15] Spillover can occur through the following mechanisms:

- **Direct contact.** Spillover via direct contact may occur when a person touches, or gets bitten or scratched by, an infected animal. For example, rabies can spread to a person who is bitten or scratched by a rabid bat, dog, or raccoon.
- **Indirect contact.** Spillover via indirect contact may occur when a person comes into contact with an infected animal's environment or an area or object contaminated by an infected animal. For example, salmonellosis can spread to a person from environmental sources, such as surface water, contaminated by animal feces.
- **Vector-borne.** Spillover may occur when a person is bitten by a vector, such as a mosquito, tick, or flea that is carrying a zoonotic disease. For example, West Nile virus can spread to people from mosquitos that have fed on infected birds, and Lyme disease can spread to people from ticks that have fed on infected rodents.

[15]According to CDC's website, a zoonotic disease can also pass from people back to animals (called spillback), mutate into a new strain, and spread back to people.

Spillover may result in outbreaks, epidemics, or pandemics, or a disease may become endemic in the human population (see fig.1).[16]

Figure 1: Zoonotic Disease Spillover Can Lead to an Outbreak, Epidemic, or Pandemic



Sources: GAO analysis of information from the Centers for Disease Control and Prevention and other scientific literature; Dzmitry/stock.adobe.com. | GAO-23-105238

Text for Figure 1: Zoonotic Disease Spillover Can Lead to an Outbreak, Epidemic, or Pandemic

1) Disease spread in animals
    a) Wildlife (e.g. birds, bats, mice, monkeys)
    b) Agricultural animals (e.g. cows, pigs, chickens)
2) Spillover from animal to person
3) Human-to-human transmission
    a) First person(s) infected
    b) Localized outbreak or epidemic
    c) Worldwide pandemic

Source: GAO analysis of information from the Centers for Disease Control and Prevention and other scientific literature; Dzmitry/stock.adobe.com. | GAO-23-105238

[16]According to CDC's website, an endemic disease is the constant presence or the usual prevalence of a disease or infectious agent in a population within a geographic area. For example, one of the types of human immunodeficiency virus, type 2 (HIV-2), likely originated from nonhuman primates and is now endemic in human populations in parts of West Africa.

Note: Red patterned animals and people indicate the presence of a zoonotic disease. Not all zoonotic diseases will spread beyond the first person(s) infected.

Laws Governing U.S. Animal Surveillance and Live Animal Imports

The following laws provide federal agencies with authorities related to disease surveillance of U.S. wildlife and importation of wildlife:

- **Animal Health Protection Act.**[17] USDA takes measures to detect, control, or eradicate any pest or disease of livestock and enhance surveillance for diseases in animals. APHIS prohibits imports of particular animals to prevent the introduction of any pest or disease affecting agricultural animals, such as cattle, horses, poultry, and swine.
- **Lacey Act.**[18] FWS administers the prohibition against the import of animals that have been individually listed in the statute or prescribed in FWS regulation to be "injurious to human beings, to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the U.S."
- **The Endangered Species Act of 1973.**[19] FWS administers the prohibition against the import of animals that have been listed as threatened or endangered species and implements other international agreements related to these species.
- **Public Health Service Act.**[20] CDC issues regulations to prevent the introduction, transmission, and spread of communicable diseases, including zoonotic diseases.

Types of Wildlife Disease Surveillance

Federal agencies generally use two approaches for wildlife disease surveillance: active and passive. According to the World Organisation for

[17]Pub. L. No. 107-171, tit. X, subtit. E, 116 Stat. 134, 494 (2002) (codified as amended at 7 U.S.C. §§ 8301-8318).

[18]18 U.S.C. § 42.

[19]Pub. L. No. 93-205, 87 Stat. 884 (codified as amended at 16 U.S.C. §§ 1531-1544).

[20]Act July 1, 1944, ch. 373, 58 Stat. 682 (codified as amended at 42 U.S.C. §§ 201 through 300mm-61).

Animal Health, these approaches use different methods to help identify wildlife carrying infectious diseases.

- **Active surveillance.** This approach (sometimes referred to by agencies as “targeted” surveillance) involves actively testing certain wildlife populations for specific pathogens, even in the absence of signs of disease. Agencies use active surveillance to estimate the prevalence of a specific pathogen, trends over time, and other statistical information. For example, a federal agency might use active surveillance to determine whether avian influenza is present in migratory birds in the northeastern U.S. at different times throughout the year.
- **Passive surveillance.** This approach (sometimes referred to by agencies as “general” surveillance) seeks to detect sick or dead wildlife and determine what pathogens, if any, may have caused the wildlife to sicken or die. Passive surveillance may identify wildlife carrying infectious diseases, including diseases caused by pathogens that are new or emerging. For example, a land manager might notice a cluster of dead raccoons, then send the dead raccoons to a lab that determines whether a pathogen new to the area likely killed the animals.

Spillover Can Occur in Various Settings Where People and Animals Interact, and Factors such as Ease of a Pathogen’s Transmission Increase the Risks of an Outbreak

Zoonotic disease spillover can occur wherever people interact with animals. The likelihood of spillover increases in crowded settings, such as live animal markets, where people have more frequent interactions with animals and may not wear adequate personal protective equipment. Novel pathogens—either newly discovered or emerging in new areas—and pathogens that are capable of rapid human-to-human transmission increase the risks of an outbreak.

Crowded Settings Increase the Likelihood of Spillover, but Quantifying the Likelihood of Spillover Is Difficult

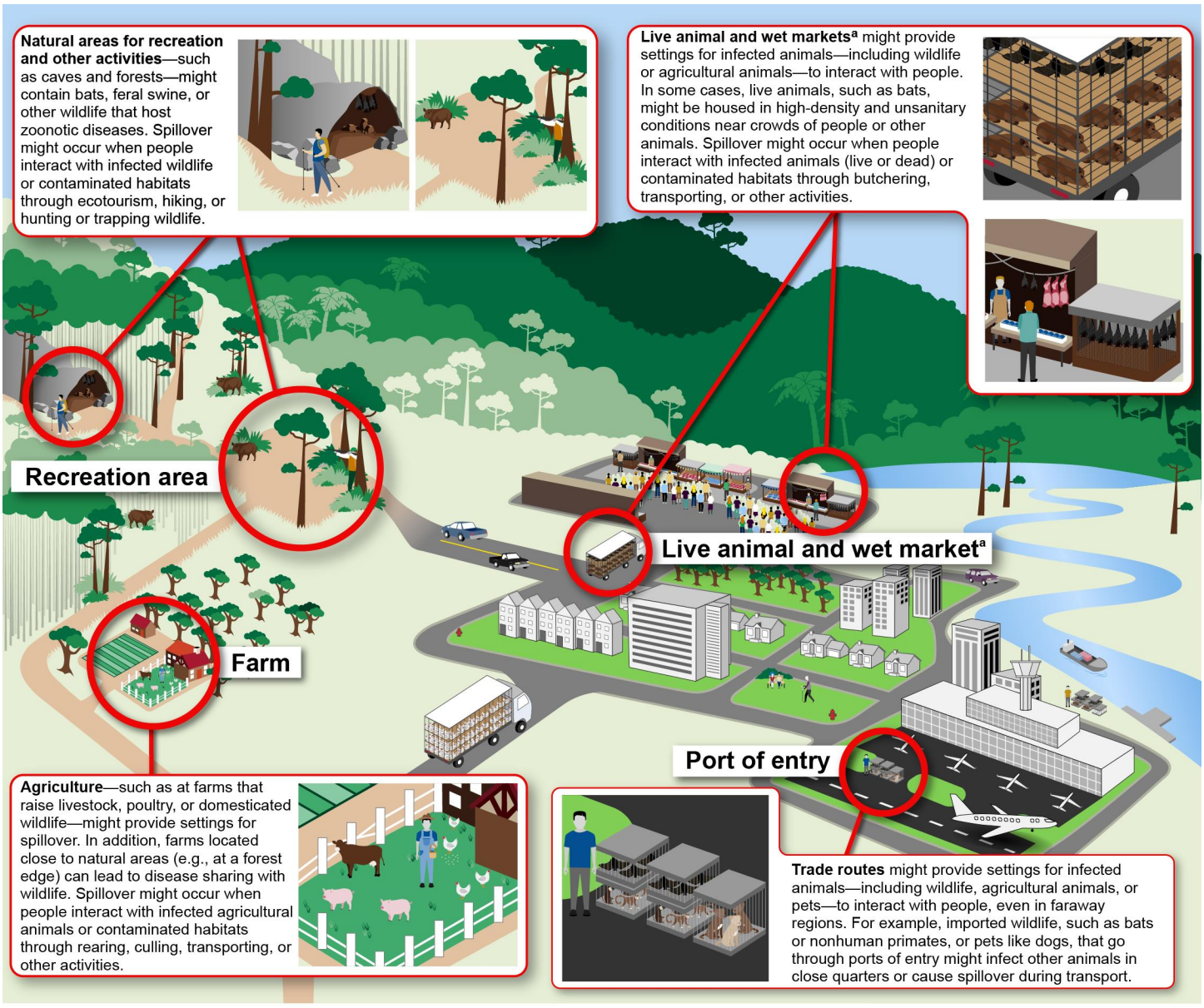
Spillover can occur in settings where people interact directly or indirectly with infected animals—including wildlife, agricultural animals, or pets—as

well as their habitats or the pathogens they carry. According to the literature we reviewed and the experts we interviewed, including agency officials, known settings where spillover can occur include natural areas for recreation and other activities, agricultural settings, live animal and wet markets, and along animal trade routes (see fig. 2).[21] Other settings where spillover can occur include zoos, residential areas (e.g., households with rodent infestations or pets), and research laboratories or field sites. For example, in 2004, a scientist in a Russian laboratory died after accidentally infecting herself with Ebola virus, which is a zoonotic pathogen.[22] Additionally, spillover can occur in settings with contamination from infected animals (e.g., via agricultural runoff) or with a prevalence of vectors, such as mosquitos, ticks, or fleas.

[21]Live animal and wet markets sell perishable items—such as fresh meat and produce—and sometimes live animals that are often slaughtered on-site.

[22]See University of Minnesota Center for Infectious Disease Research and Policy, "Russian scientist dies of Ebola after lab accident" (May 25, 2004), https://www.cidrap.umn.edu/ebola/russian-scientist-dies-ebola-after-lab-accident, accessed February 22, 2023. Spillover may also occur when a researcher collects a sample containing a zoonotic pathogen and transfers it to a laboratory. A sample may be obtained from animal sources (e.g., blood, feces, saliva, other body fluids, or tissues), the environment (e.g., water, soil, or air), or other sources. One expert told us that the laboratory groups working on zoonotic disease research represent a relatively small number of human-animal interactions (compared with the wildlife trade, for example), and many researchers wear personal protective equipment (e.g., gloves and face masks) when doing field research.

Figure 2: Examples of Settings Where Spillover of Zoonotic Diseases Can Occur



Sources: GAO analysis of scientific literature; adapted from figure by Headwaters Economics. | GAO-23-105238

Text for Figure 2: Examples of Settings Where Spillover of Zoonotic Diseases Can Occur

- **Illustration of a natural recreation area and cave**
  - Natural areas for recreation and other activities—such as caves and forests—might contain bats, feral swine, or other wildlife that

host zoonotic diseases. Spillover might occur when people interact with infected wildlife or contaminated habitats through ecotourism, hiking, or hunting or trapping wildlife.

- **Illustration of a farm with cows and chickens**
  - Agriculture—such as at farms that raise livestock, poultry, or domesticated wildlife—might provide settings for spillover. In addition, farms located close to natural areas (e.g., at a forest edge) can lead to disease sharing with wildlife. Spillover might occur when people interact with infected agricultural animals or contaminated habitats through rearing, culling, transporting, or other activities.
- **Illustration of a supply truck driving in the direction of a wet market**
  - Live animal and wet marketsa might provide settings for infected animals—including wildlife or agricultural animals—to interact with people. In some cases, live animals, such as bats, might be housed in high-density and unsanitary conditions near crowds of people or other animals. Spillover might occur when people interact with infected animals (live or dead) or contaminated habitats through butchering, transporting, or other activities.
- **Illustration of port of entry**
  - Trade routes might provide settings for infected animals—including wildlife, agricultural animals, or pets—to interact with people, even in faraway regions. For example, imported wildlife, such as bats or nonhuman primates that go through ports of entry might infect other animals in close quarters or cause spillover during transport.

Source: GAO analysis of scientific literature; adapted from figure by Headwaters Economics. | GAO-23-105238

[a]Live animal and wet markets sell perishable items—such as fresh meat and produce—and sometimes live animals that are often slaughtered on-site.

For the settings we identified, some activities and examples associated with spillover include the following:

- **Natural areas for recreation and other activities.** Spillover can occur in natural recreation areas—including caves and forests—through activities such as ecotourism, hiking, or hunting or trapping wildlife. Natural recreation areas might contain animal “reservoirs” where a zoonotic pathogen persists and circulates between outbreaks. In caves, bats can host or transmit zoonotic diseases, such as histoplasmosis, which has spread to people in the U.S. through

contact with soil contaminated with bat feces and can cause chronic lung infection or death. In forests, feral swine host dozens of zoonotic diseases, such as brucellosis, which has spread to hunters in the U.S. through contact with carcasses and, though it is usually not fatal if treated, it can cause fever and other severe symptoms.

- **Agriculture.** Spillover can occur in agricultural settings—including farms that raise livestock, poultry, or domesticated wildlife—through activities such as rearing, culling, or transporting animals. Agricultural animals have spread many zoonotic diseases to people, such as salmonellosis (e.g., from dairy cows or poultry) and zoonotic influenzas (e.g., from pigs or poultry). In addition, wildlife can spread zoonotic diseases to agricultural animals, which can then lead to spillover. For example, according to FWS's website, wild bird migration in 2021 and 2022 likely contributed to the spread of avian influenza among poultry farms in the U.S.,[23] and one U.S. poultry worker tested positive for the disease as a result.[24]
- **Live animal and wet markets.** Spillover can occur in live animal and wet markets through activities such as butchering or transporting animals. Certain live animal and wet markets might provide opportunities for animals that do not normally interact with people—including bats and other exotic wildlife that can carry novel pathogens—to come into contact with people who are not using adequate personal protective equipment, such as gloves or face masks. For example, researchers determined that civets reportedly sold at a live animal market in China were likely the source of two cases of SARS, a novel coronavirus disease that killed 774 people worldwide between 2002 and 2003.[25]

[23]See U.S. Fish and Wildlife Service, "Avian Influenza," https://www.fws.gov/avian-influenza, accessed February 26, 2023.

[24]On April 28, 2022, CDC confirmed a single human case of avian influenza virus infection in the U.S. The patient reported fatigue for a few days and recovered. As of February 22, 2023, CDC reported on its website that nearly 60 million poultry in 47 states had been affected as a result of the 2022 avian influenza outbreak.

[25]See M. Wang et al., "SARS-CoV Infection in a Restaurant from Palm Civet," *Emerging Infectious Diseases*, vol. 11 (2005):1860-1865. Civets are meat-eating mammals with small heads, long bodies, and long tails (somewhat like a cat). Some researchers originally theorized that civets were the primary animal origin of SARS. Later studies have suggested that Chinese horseshoe bats were natural reservoirs—where the pathogen is maintained between outbreaks—and that civets most likely served as an intermediate host.

- **Trade routes.** Spillover can occur along animal trade routes—including from the point where an animal first comes under human control (e.g., in forests) to where it enters a new region or country (e.g., ports of entry)—through activities such as trapping or transporting animals.[26] In the U.S., millions of animals (live and dead) move through ports of entry each year, many of which have the potential to carry zoonotic diseases. For example, in 2015 a rabid dog was imported to the U.S. from Egypt, and 18 people initiated postexposure treatment for rabies in case they were exposed.[27]

According to literature we reviewed and interviews with experts, including agency officials, spillover is more likely when mammals or birds are involved. Mammals host many zoonotic diseases, in part because these animals have physiological and genetic similarities to humans that make them more likely to host viruses that will also be able to infect people. Mammals can transmit many diseases to people, including Ebola, MERS, mpox, SARS, and zoonotic influenzas. In addition, birds can host and transmit multiple avian influenzas that can cause human fatalities. For example, countries around the world have reported 868 cases and 457 deaths from avian influenza H5N1 to the World Health Organization between 2003 and 2022.[28]

Though the risk of spillover generally increases with duration or repetition of exposure to animals, it is challenging for researchers to quantify the likelihood of spillover in each setting. The likelihood of spillover can vary based on factors such as the density of animals and people, the types of animals present, and the levels of sanitation and hygiene. For example, CDC officials told us that crowded, unsanitary markets with the intermingling of multiple animal species from a wide geographic area would be more concerning than spacious, clean markets selling local

[26]Among other things, trade provides animals for scientific research, exhibition, the aquarium and pet industries, and products such as foods, furs, and medicines.

[27]According to CDC, if a person does not receive appropriate medical care after a potential rabies exposure, the virus is almost always fatal. Approximately 59,000 people die every year from rabies worldwide, and more than 99 percent of deaths are due to exposure to rabid dogs.

[28]See World Health Organization, “Cumulative number of confirmed human cases for avian influenza A(H5N1) reported to WHO, 2003-2023” (Jan. 26, 2023), https://www.who.int/publications/m/item/cumulative-number-of-confirmed-human-cases-for-avian-influenza-a(h5n1)-reported-to-who-2003-2022-26-jan-2023, accessed March 15, 2023. According to the World Health Organization, almost all cases of H5N1 infection in people have been associated with close contact with infected live or dead birds or H5N1-contaminated environments. The avian influenza H5N1 is one of several known types of avian influenzas that can infect people.

species that are kept separate from dissimilar animals. In addition, the likelihood of spillover increases when people interact with animals without using personal protective equipment, such as gloves and face masks, and these practices can vary with socioeconomic factors, such as education and training. Thus, the likelihood of spillover occurring in a specific setting, such as live animal markets, in one country may not equal the likelihood in another country.

The following issues also affect the likelihood of spillover, according to our review of literature and interviews with experts:

- **Land-use change.** Globally, activities such as deforestation, agricultural expansion, and urbanization can increase the likelihood of spillover. These activities change the frequency of interactions between people, animals, and each other's habitats. When forest habitats are disturbed, for example, bats that carry zoonotic pathogens—including the viruses that cause Ebola, SARS, and other diseases—might move into human settlements, including cities or farms. Additionally, as human populations grow and expand into new geographic areas, more people live in close contact with wildlife that can carry zoonotic pathogens, including viruses that cause rabies, mpox, and other diseases. For example, land-use change was reported as a key contributor to zoonotic disease emergence in West Africa, Malaysia, Bangladesh, and Australia;[29]
- **Changes in weather and climate patterns.** Compared with historical data, some geographic areas in the 21st century are experiencing milder winters, warmer summers, increased flooding, and more numerous forest fires that may affect migration patterns of wildlife, vectors (e.g., mosquitos and ticks), and people. As a result, many zoonotic diseases—including West Nile, plague, rabies, Lyme, and others—may expand into new geographic areas and lead to spillover. For example, CDC stated on its website that a mild winter, early spring, and hot summer in 2012 were partly to blame for an outbreak of West Nile in the U.S., which caused more than 5,600 illnesses and 286 deaths;[30] and
- **Trends in the global wildlife trade.** Each year, billions of wild animals are traded globally—both legally and illegally—and this can

[29]See A. Dobson et al., "Ecology and economics for pandemic prevention," *Science*, vol. 369 (2020): 379-381.

[30]See Centers for Disease Control and Prevention, "Climate change and infectious diseases," https://www.cdc.gov/ncezid/what-we-do/climate-change-and-infectious-diseases/index.html, accessed March 17, 2023.

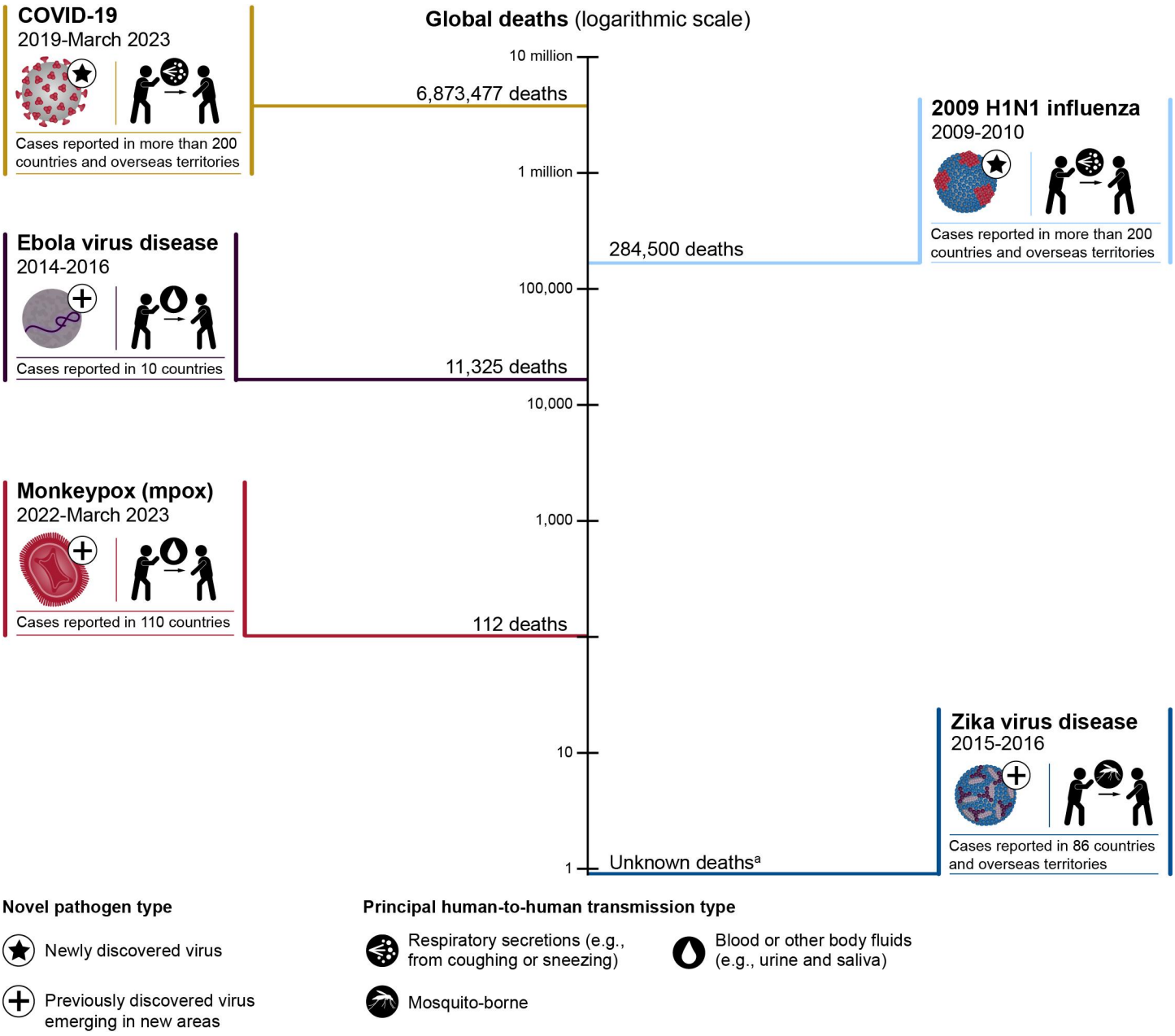
increase the likelihood of spillover. The wildlife trade can vary from year to year in terms of the amount, type, and origin of animals, which can affect the likelihood of spillover. For example, countries of origin for U.S. imports of nonhuman primates changed from mostly China to mostly countries in Southeast Asia and Southern Africa in early 2020 with the onset of the COVID-19 pandemic, according to our analysis of FWS animal import data. Following the time of these changing import patterns, CDC became aware of six cases of melioidosis—a zoonotic bacterial disease that can be fatal in up to 90 percent of human cases without treatment—in nonhuman primates being imported into the U.S. Although, according to CDC, these cases did not result in any reported human infections, the risk of spillover increases when infected animals are traded.

Pathogens That Are Novel or Capable of Rapid Human-to-Human Transmission Can Increase the Risks of an Outbreak

According to the literature we reviewed and the experts we interviewed, factors that increase the risks of an outbreak, such as those caused by a zoonotic pathogen, include whether a pathogen is novel or capable of rapid human-to-human transmission. In the past 2 decades, multiple global outbreaks have been caused by novel viruses—either newly discovered or emerging in new areas—that are transmitted from person to person (see fig. 3). These outbreaks have caused significant impacts to human populations—including sickness, death, and social disruptions—as the pathogens spread around the world.[31]

[31]Social disruptions may include personal costs, such as the costs of medical countermeasures (e.g., vaccines, diagnostics, and therapeutics); effects on gross domestic product, such as lost productivity and tourism; and tolls on government agencies due to increased public health planning, outreach, and implementation.

Figure 3: Selected International Outbreaks, Epidemics, or Pandemics, 2009-2023



Sources: GAO analysis of information from the Centers for Disease Control and Prevention (CDC) and World Health Organization. | GAO-23-105238

Text for Figure 3: Selected International Outbreaks, Epidemics, or Pandemics, 2009-2023

- **COVID-19**

- 2019- March 2023
- Newly discovered virus
- Respiratory secretions (e.g., from coughing or sneezing)
- Cases reported in more than 200 countries and overseas territories
- 6,873,477 deaths

- **2009 H1N1 influenza**
  - 2009-2010
  - Newly discovered virus
  - Respiratory secretions (e.g., from coughing or sneezing)
  - More than 200 countries and overseas territories
  - 284,500 deaths
- **Ebola virus disease**
  - 2014-2016
  - Previously discovered virus emerging in new areas
  - Blood or other body fluids (e.g., urine and saliva)
  - Cases reported in 10 countries
  - 11,325 deaths
- **Monkeypox (mpox)**
  - 2022- March 2023
  - Previously discovered virus emerging in new areas
  - Blood or other body fluids (e.g., urine and saliva)
  - Cases reported in 110 countries
  - 112 deaths
- **Zika virus disease**
  - 2015-2016
  - Previously discovered virus emerging in new areas
  - Mosquito-borne
  - Cases reported in 86 countries and overseas territories
  - Unknown deaths[a]

Source: GAO analysis of information from the Centers for Disease Control and Prevention (CDC) and World Health Organization. | GAO-23-105238

Notes: Selected outbreaks, epidemics, or pandemics were designated by the World Health Organization as Public Health Emergencies of International Concern, affected more than one country, and can spread between animals and people. Global deaths from 2009 H1N1 influenza are based on CDC estimates; all others are based on deaths as reported to CDC or the World Health Organization (last accessed on Mar. 17, 2023).

Due to underreporting and other factors, the actual numbers of global cases and deaths are likely greater than what is reported.

[a]Zika virus infection rarely causes death of the infected person directly but can cause Guillain-Barré syndrome (a rare sickness of the nervous system) and adverse pregnancy outcomes, including increased risk of fetal death, stillbirth, and congenital malformations. The World Health Organization stated that accurate and up-to-date Zika virus-related epidemiological data are limited in many areas of the world. Because of this, the number of deaths is not known.

The following factors can increase the risks of an outbreak because they may determine whether a pathogen spreads rapidly among people:

- **Novelty of pathogen.** The risks of an outbreak can increase when an infectious disease is caused by a novel pathogen that can readily infect people—either new or emerging, or a new variant of an existing pathogen[32]—for two reasons that we identified. First, a sufficient supply of effective countermeasures—such as diagnostics, vaccines, and treatments—is rarely immediately available for novel pathogens, particularly for viruses.[33] Second, individuals often lack immunity to novel pathogens. This might allow a pathogen to spread until effective countermeasures are developed and sufficiently distributed. For example, the coronavirus that causes COVID-19 has mutated into new variants that often have different properties (e.g., higher transmissibility), which affected the performance of approved vaccine regimens.[34] Novel pathogens can also result in major social disruptions, even when they cause relatively small outbreaks. For example, the SARS pandemic of 2002-2003 resulted in relatively few

[32]Variants might be caused by one or more mutations in the genome (genetic code) of a pathogen. RNA viruses—including coronaviruses (e.g., the viruses that cause SARS, MERS, and COVID-19) and influenzas (e.g., 2009 H1N1 influenza)—are more likely to mutate than other pathogens, such as DNA viruses. New variants might have different characteristics, such as being more transmissible or more deadly.

[33]There are few available broad-spectrum treatments (treatments that are effective against a large variety of organisms) for viral diseases. Experts are also concerned that existing broad-spectrum antibiotics will become increasingly ineffective for novel bacterial strains (e.g., antimicrobial-resistant bacteria). CDC officials told us that antifungal resistance is also becoming a concern.

[34]See Centers for Disease Control and Prevention, “New COVID-19 Vaccine Effectiveness Data Showcase Protection Gained by 3rd and 4th Doses” (July 15, 2022), https://www.cdc.gov/media/releases/2022/s0715-COVID-VE.html#print, accessed February 14, 2023.

deaths (774 across nine countries) but still cost an estimated $40 billion in economic losses worldwide, in part due to the uncertainties about the novel coronavirus disease and how it might spread.[35]

- **Ease of human-to-human transmission.** Human-to-human transmission can cause pathogens to spread far beyond where the initial spillover event occurred. For example, experts determined that COVID-19 spreads through short- and long-range contact with respiratory secretions—including from asymptomatic individuals—which has contributed to the pandemic's large reach. In contrast, experts have determined that people infected with SARS can likely transmit the disease only through close contact and if they are symptomatic, which helped to limit spread. Pathogens capable of human-to-human transmission may spread more easily and be more challenging to control in the absence of timely and effective mitigation measures (e.g., case identification, quarantines, or personal protective equipment), or when spread occurs in crowded settings or areas readily connected to other geographic areas (e.g., via roads or airports).

Federal Agencies Conduct Some Surveillance for Zoonotic Diseases in U.S. Wildlife but Have Not Fully Collaborated on National Efforts

APHIS, FWS, and USGS each conduct some surveillance for zoonotic diseases in U.S. wildlife. APHIS and USGS have begun collaborating to establish a national wildlife disease surveillance system. However, their efforts are fragmented and do not fully follow leading practices for collaboration.[36] Finally, USGS has taken steps to establish a national wildlife disease database, but APHIS and USGS have not resolved issues related to sharing key information.

[35]See J.W. Lee and W.J. McKibbin, "Estimating the Global Economic Costs of SARS," in *Learning from SARS: preparing for the next disease outbreak: workshop summary* (Washington, D.C.: National Academies Press, 2004): 92-109.

[36]Fragmentation refers to those circumstances in which more than one federal agency (or more than one organization within an agency) is involved in the same broad area of national need and opportunities exist to improve service delivery. GAO, *Fragmentation, Overlap, and Duplication: An Evaluation and Management Guide*, GAO-15-49SP (Washington, D.C.: Apr. 14, 2015).

Federal Agencies Conduct Some Surveillance for Priority Zoonotic Diseases

APHIS, FWS, and USGS each conduct some surveillance for zoonotic diseases in U.S. wildlife.[37] The types of surveillance the federal agencies conduct, and the diseases for which they conduct surveillance, vary by agency. APHIS conducts surveillance for diseases that could affect agricultural animals. FWS and USGS conduct surveillance for diseases that could affect wildlife. In addition, multiple agencies sometimes conduct surveillance for the same zoonotic pathogen, such as the COVID-19 virus because of its risk to people. For example, APHIS and USGS both conduct surveillance for the COVID-19 virus in wildlife.[38] According to agency officials we interviewed and agency documents, to determine which diseases and animals to target, the agencies rely on congressional direction; agency priorities; and requests for assistance from state, tribal, and local jurisdictions. According to APHIS and USGS officials, from 2020 to 2022, the agencies shifted some resources away from normal operations to the federal response to outbreaks of diseases such as COVID-19 and highly pathogenic avian influenza (see sidebar).

APHIS, FWS, and USGS conduct surveillance for seven of the eight priority diseases that they jointly identified during an interagency workshop in 2017 (see app. I for a full listing), with support from CDC.[39] CDC conducts surveillance for the eighth priority disease, Lyme disease.[40] The types of surveillance can include (1) active, which focuses on obtaining information about a specific pathogen in certain wildlife populations; (2) passive, which focuses on detecting sick or dead wildlife

[37]In addition, the National Park Service conducts surveillance of wildlife within its boundaries, according to agency officials, and some CDC efforts include surveillance of wildlife, although the agency's focus is on human health. In addition to federal agency efforts, other entities, such as state agencies, universities, and other wildlife health-related organizations—in some cases operating under cooperative agreements with federal agencies—are also involved in U.S. wildlife disease surveillance but are outside of the scope of our review.

[38]CDC has also conducted surveillance for the COVID-19 virus in wildlife, according to agency officials.

[39]APHIS, FWS, and USGS conduct surveillance for seven of the eight priority diseases, which include zoonotic influenzas, salmonellosis, West Nile virus, plague, emerging coronaviruses (e.g., COVID-19), rabies, and brucellosis.

[40]CDC collects surveillance data on ticks that cause Lyme disease in people through its data system called ArboNET. Among other things, the data system includes information on cases of Lyme disease in wildlife. CDC also conducts surveillance for rabies, according to agency officials.

and determining what pathogens, if any, may have caused the wildlife to sicken or die; or (3) both.

Federal Agencies' Surveillance for COVID-19 in Wildlife and Related Activities

In response to the COVID-19 pandemic, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) and the Department of the Interior's U.S. Geological Survey (USGS) began conducting surveillance for the COVID-19 virus in wildlife and initiated related research projects. The following are examples of such activities during 2021 and 2022:

- Under an agreement with the Centers for Disease Control and Prevention (CDC), USGS conducted passive surveillance of deceased animals to determine the prevalence of the COVID-19 virus and other coronaviruses in U.S. wildlife. As of April 2023, USGS is also developing a risk assessment to identify high-risk human-wildlife interfaces for the COVID-19 virus. USGS told us that they plan to use the results of this risk assessment to optimize future surveillance efforts.
- APHIS partnered with the Agricultural Research Service to begin developing easy field tests to quickly identify the COVID-19 virus in wildlife. The two agencies also began studies on how long the COVID-19 virus persists in deer and whether deer or elk can serve as a reservoir where the virus could mutate into new variants.

Sources: APHIS, CDC, and USGS documentation; Paul/stock.adobe.com (photo). I GAO-23-105238

Active surveillance. For five of the eight priority zoonotic diseases, agencies conduct active surveillance to estimate the prevalence or

spread of a particular pathogen in a selected population.[41] Table 2 provides an overview of federal agencies' active surveillance for the five priority zoonotic diseases in wildlife and shows affected locations and examples of species sampled.

Table 2: Animal and Plant Health Inspection Service (APHIS), U.S. Fish and Wildlife Service (FWS), and U.S. Geological Survey's (USGS) Active Disease Surveillance Activities for Five Priority Zoonotic Diseases in Wildlife, 2021-2022

Priority zoonotic disease	Agency	Location of surveillance	Examples of species included in active surveillance activities
Brucellosis	APHIS	41 states and Guam	Feral swine
	FWS	Certain FWS land and National Park Service land in Colorado, Iowa, Nebraska, North Dakota, Oklahoma, and Wyoming[a]	Bison
COVID-19[b]	APHIS	36 states, the District of Columbia, and the U.S. Virgin Islands	White-tailed deer
	USGS	18 states and Guam	Mule deer and other cervids (e.g., moose, elk)
		1-3 states	Badgers, coyotes, minks, rabbits, raccoons, rodents (e.g., mice, squirrels, woodchucks), shrews, skunks, opossums
		14 states	Bats, canids (e.g., coyotes), felids (e.g., bobcats, lynx), mustelids (e.g., ferrets), ungulates (e.g., bison, moose), rodents, and marine mammals
Plague	APHIS	Western U.S.	Coyotes, bobcats, rodents (e.g., black rats, ground squirrels, prairie dogs), and other mammals
Rabies	APHIS	17 states	Raccoons, skunks, coyotes, and other mammals
Zoonotic influenzas, including highly pathogenic avian influenza	APHIS	Continental U.S. and Alaska	Migratory birds (e.g., dabbling ducks)
	USGS	Continental U.S., Alaska, Hawaii, and Pacific Insular Territories	Migratory birds (e.g., dabbling ducks)

Source: GAO summary of agency documents, including U.S. Department of Health and Human Services' Centers for Disease Control and Prevention, U.S. Department of the Interior, and U.S. Department of Agriculture, "Prioritizing Zoonotic Diseases for Multisectoral, One Health Collaboration in the United States," Workshop Summary, CS29887A (Washington, D.C.: 2019). | GAO-23-105238

[41]The five diseases covered by active surveillance are zoonotic influenzas (including highly pathogenic avian influenza), plague, emerging coronavirus diseases (including COVID-19), rabies, and brucellosis. Because West Nile virus and Lyme disease are established in the U.S., and there are limited resources for surveillance, USGS did not conduct active surveillance in 2021 or 2022. In addition, APHIS officials told us that they did not conduct active surveillance for West Nile virus and Lyme disease due to limited funding and resources. USGS officials told us that they did not conduct active surveillance for salmonellosis because of lack of funding. APHIS officials explained that they did not conduct active surveillance for salmonellosis because its source pathogen is ubiquitous and impractical to mitigate in wild animals. APHIS assigned higher priority to other, higher-risk pathogens.

Notes: Because West Nile virus and Lyme disease are established in the U.S., and there are limited resources for surveillance, USGS did not conduct active surveillance in 2021 or 2022. In addition, APHIS officials told us that they did not conduct active surveillance for West Nile virus and Lyme disease due to limited funding and resources. USGS officials told us that they did not conduct active surveillance for salmonellosis because of lack of funding. APHIS officials explained that they did not conduct active surveillance for salmonellosis because its source pathogen is ubiquitous and impractical to mitigate in wild animals. APHIS assigned higher priority to other, higher-risk pathogens.

[a]Rocky Mountain Arsenal National Wildlife Refuge, Neal Smith National Wildlife Refuge, Fort Niobrara National Wildlife Refuge, White Horse Hill National Game Preserve, Wichita Mountains Wildlife Refuge, National Elk Refuge, and Grand Teton National Park.

[b]COVID-19 is a type of emerging coronavirus disease, and emerging coronavirus diseases were identified as one of the eight priority zoonotic diseases.

Agencies also conduct active surveillance for pathogens that are not among the eight priority zoonotic diseases. For example, APHIS has conducted active surveillance for several zoonotic pathogens, including *Coccidioides* in feral swine in Arizona, California, Guam, and Texas, which can cause Valley fever in people, and *Pasteurella* in feral swine in Texas, which can cause pasteurellosis in people.

Passive surveillance. The agencies also conduct passive surveillance by tracking events in which land managers or other partners (such as federal agencies, states, and other wildlife diagnostic labs) find sick or dead wildlife. When agency officials receive a report of such an event, they test the sick or dead wildlife to detect and identify the wildlife disease. For example, FWS officials told us that they determine which diseases to test for based on the type of animal, visible signs and symptoms, location, and other indications about possible diseases the animals may have. The diseases found in this way may include those on the priority list or others.

Passive surveillance activities have contributed to enhancing the federal government's situational awareness of wildlife diseases. For example, in 2020, USGS passive surveillance efforts, in coordination with APHIS, provided situational awareness during an outbreak of rabbit hemorrhagic disease (while this is not a zoonotic disease, it is a reportable transboundary viral disease fatal to rabbits, hares, and pikas).[42] Partners in the wildlife health community reported outbreaks in wild rabbits in 11 western U.S. states and in Mexico. USGS's passive surveillance capabilities allowed partners to quickly identify affected counties,

[42]A transboundary disease means a plant or animal disease or pest that is within one or more countries outside of the U.S. 7 U.S.C. § 8914(a)(8)(A). The federal government, including APHIS and USGS, works with diagnostic labs to track all wild rabbit, hare, and pika samples submitted for testing, reports test results back to state wildlife agencies, and provides crucial data used in World Organisation for Animal Health reporting, disease mapping, and genetic sequencing.

coordinate responses, and contribute to the national understanding of the outbreak, according to USGS documentation.

APHIS and USGS Are Working to Establish a National Wildlife Disease Surveillance System but Have Not Fully Followed Leading Practices for Collaboration

APHIS and USGS have taken initial steps to jointly establish a national wildlife disease surveillance system.[43] In May 2020, an APHIS and USGS ad hoc committee authored a concept paper identifying strategies to enhance readiness and address emerging and zoonotic disease in wildlife.[44] The concept paper outlines capabilities within APHIS and USGS and identifies opportunities to enhance collaboration and reduce fragmentation. The paper also states that there are significant gaps in the nation's capabilities to address emerging wildlife disease and highlights the need for a comprehensive national wildlife disease surveillance system. Such a system would be consistent with 2019 international guidance that states that nations should establish a coordinated national surveillance system for early detection of zoonotic disease events and timely, routine data sharing among all relevant sectors responsible for zoonotic diseases.[45]

Following the issuance of the concept paper, APHIS and USGS signed a memorandum of agreement in February 2021 in which they agreed to take several steps toward establishing a national wildlife disease surveillance system.[46] One such step, for example, is the establishment of

[43]According to APHIS and USGS officials, they have made FWS and CDC aware of their efforts and intend to invite them to formally participate in the development of a national wildlife disease surveillance system.

[44]U.S. Geological Survey and Animal and Plant Health Inspection Service, *Concept Paper Outline: Strategies to Enhance Readiness and Address Emerging and Zoonotic Diseases in Wildlife*, internal interagency white paper (2020).

[45]Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, and World Health Organization, *Taking a Multisectoral, One Health Approach: A Tripartite Guide to Addressing Zoonotic Diseases in Countries* (2019). See also World Organisation for Animal Health, *Guidelines for Wildlife Disease Surveillance: An Overview* (Paris, France).

[46]Memorandum of Agreement between the U.S. Geological Survey and the U.S. Department of Agriculture Animal and Plant Health Inspection Service - Wildlife Services, APHIS Agreement #: 21-7100-0461-MU (Feb. 24, 2021). The agreement is in effect through February 2026.

the permanent standing committee, which will be charged with overseeing the agencies' collaborative efforts using information in the concept paper. To do so, the permanent standing committee is to develop an implementation plan, in coordination with regional and state natural resource organizations. As of February 2023, APHIS and USGS signed a charter to establish the committee, but APHIS and USGS officials told us that the committee had not yet set target dates for the implementation plan.

In our prior work, we have identified leading practices to enhance and sustain collaboration between federal agencies.[47] These practices include defining outcomes and monitoring accountability, identifying or sharing leadership, including relevant participants, identifying and leveraging resources, and developing written guidance and agreements.[48] (For additional information on these leading practices for collaboration, see app. II.) Actions that APHIS and USGS have taken since 2020 to collaborate are consistent with aspects of some of these leading practices, including leadership and written guidance and agreements, as discussed below:

- **Leadership.** Given the importance of leadership to any collaborative effort, consistent leadership can help ensure the effectiveness of collaborative mechanisms. In the concept paper, APHIS and USGS identified themselves as the agencies that will share leadership over developing a national wildlife disease surveillance system. Both APHIS and USGS officials told us that they will likely address issues of long-term shared leadership through the permanent standing committee that they will co-lead.[49]
- **Written guidance and agreements.** Agencies that articulate their agreements in formal documents can strengthen their commitment to working collaboratively. The February 2021 memorandum between APHIS and USGS establishes an agreement to facilitate collaboration,

[47]GAO-12-1022.

[48]Given the early stages of the development of the national wildlife disease surveillance system, we did not compare APHIS and USGS's actions to two of the seven leading practices for collaboration—bridging organizational cultures and clarifying roles and responsibilities—because agency officials told us that they will likely address these areas after the establishment of the permanent standing committee.

[49]According to USGS and APHIS's Emerging and Zoonotic Disease Leadership Group Charter, signed in February 2023, the committee will comprise APHIS and USGS staff. The committee will include participation from additional stakeholders, such as other federal, regional, and state natural resource organizations and agencies.

create efficiencies, integrate capabilities, and enhance readiness in addressing diseases at the human-animal-wildlife interface.[50]

As APHIS and USGS progress through the remaining steps to establish a national wildlife disease surveillance system, they have opportunities to more fully follow leading practices for collaboration. For example:

- **Outcomes and accountability.** Clearly defining common outcomes can help agencies shape the purpose of their collaborative efforts, and tracking progress toward the outcomes can help them better identify areas for improvement. In the concept paper, APHIS and USGS jointly identified the common outcome of a national wildlife disease surveillance system but, to date, agency officials told us that they have not clearly defined what will make up the surveillance system. Specifically, some officials described the system as a communication network to facilitate interagency coordination, while others described it as a nationwide plan that would target high-risk species, locations, and pathogens for surveillance. Also, APHIS and USGS could benefit from establishing a way to track progress toward establishing a national surveillance system, consistent with the leading practices for collaboration.
- **Participants.** It is important to ensure that the relevant participants are included in a collaborative effort. This can include other federal agencies, state and local entities, and organizations from the private and nonprofit sectors. As APHIS and USGS continue their collaborative effort to establish a national wildlife disease surveillance system, they could benefit from including other relevant agencies. Officials we interviewed from both APHIS and USGS have told us that other agencies, including FWS and CDC, will be more actively involved at some point, but they have not yet included these or other agencies as members of the national wildlife disease surveillance system efforts.
- **Resources.** As the permanent standing committee develops an implementation plan for the national wildlife disease surveillance system, key issues to consider include how to fund and staff these collaborative mechanisms. In their concept paper, APHIS and USGS have identified existing capabilities and resources available for both agencies. As the agencies move forward, it will continue to be important for them to address questions about funding and staffing.

[50]Memorandum of Agreement between USGS and APHIS - Wildlife Services (Feb. 24, 2021). The agreement is in effect through February 2026.

In sum, APHIS and USGS could more fully follow leading practices for collaboration, including clearly defining common outcomes, involving relevant participants, and identifying resources and staffing. Doing so could improve the effectiveness of the permanent standing committee, help to develop an effective implementation plan, and lead to the successful implementation of a national wildlife disease surveillance system. Such a system, if implemented effectively, would better position the U.S. to address emerging wildlife diseases.

USGS Is Beginning to Develop a National Wildlife Disease Database, but APHIS and USGS Have Not Resolved Issues Related to Sharing Key Information

Currently, APHIS and USGS each maintain their own databases. According to APHIS and USGS officials, the existing databases are designed to meet the agencies' respective mission requirements. Specifically:

- APHIS tracks data on diseases in wildlife that could affect agricultural animals, and agency officials told us that they maintain over 20 databases that are generally disease specific. For example, an entry in an APHIS database might show an individual animal in a specific county with test results for brucellosis; and
- USGS, the lead federal agency for wildlife disease research and surveillance, tracks passive surveillance data about wildlife morbidity and mortality events through its database, the Wildlife Health Information Sharing Partnership Event Reporting System (WHISPers).[51] For example, an entry in the WHISPers database might show an event in which a certain number of wild birds were found dead in a specific county and that some were diagnosed with highly pathogenic avian influenza.

[51]U.S. Geological Survey, "WHISPers" (Washington, D.C.: 2022), https://whispers.usgs.gov/home, accessed March 8, 2023. The records in WHISPers can be searched by species, event diagnosis, location (county level), and event starting and ending date. In addition, WHISPers is the portal for requests for diagnostic and epidemiologic assistance from USGS. According to USGS, as of October 2021, 100 partner organizations had users registered in WHISPers, including 37 state agencies, 18 FWS offices, 17 National Park Service parks, 11 other federal agencies, eight nongovernmental organizations, three tribal/foreign entities, and two other wildlife diagnostic labs.

In 2021, Congress passed the American Rescue Plan Act of 2021 (ARPA), which dedicated $45 million to strengthen federal capacity for wildlife health monitoring to enhance early detection of diseases that have the capacity to jump the species barrier and pose a risk in the U.S.[52] Among other things, this funding is meant to cover the development of a national wildlife disease database. Within Interior, USGS has taken the lead in developing a national wildlife disease database, using WHISPers as the foundation. To become an effective national wildlife disease database, WHISPers will need to be able to incorporate data from other agencies, including APHIS.

In a 2021 memorandum of agreement, APHIS and USGS agreed to use WHISPers as the wildlife disease situational awareness data system. Officials from both agencies told us that they have recognized USGS's WHISPers as a tool to begin discussions on how to share wildlife disease data and improve APHIS and USGS coordination. However, a number of obstacles currently prevent USGS's WHISPers from incorporating APHIS wildlife disease data and databases, including the following:

- **Interoperability.** According to USGS officials, the current structure of WHISPers does not accommodate active surveillance data and is not interoperable with other relevant wildlife disease databases, including the ones administered by APHIS.[53] For example, USGS officials told us that they wait for APHIS officials to release avian influenza data publicly, and USGS officials then enter the data into WHISPers to form a more complete picture of the outbreak. Officials from APHIS and USGS acknowledge that this approach is inefficient. Since receiving ARPA funding, USGS officials told us that they plan to restructure WHISPers to accommodate active surveillance data.
- **Privacy.** Because a provision of the 2008 farm bill generally prohibits disclosing data on the location of agricultural operations, APHIS officials expressed concerns about sharing certain wildlife disease

[52]Pub. L. No. 117-2, § 6003(a)(3), 135 Stat. 4, 94. FWS then signed an interagency agreement with USGS and provided USGS funding to lead the development of the database, according to agency officials.

[53]Interoperability is the ability of data collection systems to exchange information with and process information from other systems. Our prior work describes interoperability challenges among different surveillance databases. See GAO, *Emerging Infectious Diseases: Actions Needed to Address the Challenges of Responding to Zika Virus Disease Outbreaks,* GAO-17-445 (Washington, D.C.: May 23, 2017); and GAO, *COVID-19: Pandemic Lessons Highlight Need for Public Health Situational Awareness Network,* GAO-22-104600 (Washington, D.C.: June 23, 2022).

data with the public.[54] In addition, APHIS officials told us that wildlife disease data can be sensitive and could have negative effects on trade and the domestic livestock and poultry industries. For example, APHIS officials told us that if foreign countries learned about animals in the U.S. carrying diseases, they could ban imports of U.S. livestock or poultry, resulting in significant economic losses for the U.S.[55] APHIS and USGS officials told us that they have not discussed what changes they may need to make to WHISPers to incorporate APHIS data without raising concerns.

For years, USGS and APHIS officials have recognized the importance of working together on wildlife disease surveillance. During the interagency zoonotic disease prioritization workshop in 2017, the participating agencies—including APHIS and USGS—determined that improved knowledge and data sharing were needed to address gaps in disease surveillance, prevention, and control.[56] In 2020, APHIS and USGS again highlighted the need to improve wildlife disease data sharing and coordination in their concept paper on enhancing readiness and addressing emerging and zoonotic diseases in wildlife.[57] APHIS and USGS officials also told us that they see opportunities to improve coordination and sharing of wildlife disease data.

As discussed above, APHIS and USGS have agreed to use WHISPers as a tool to begin discussions on how to share wildlife disease data and improve APHIS and USGS coordination. A more coordinated approach between APHIS and USGS would align with the White House's 2018 and 2022 National Biodefense Strategies.[58] These strategies identify data system integration for early warning as an objective and state that agencies should share surveillance data, among other things. Specifically, the 2022 strategy and implementation plan calls for agencies

[54]Food, Conservation, and Energy Act of 2008, Pub. L. No. 110-246, § 1619(b), 122 Stat. 1651, 1750-1751 (codified at 7 U.S.C. § 8791(b)).

[55]Such actions are based on trade agreements between the U.S. and foreign countries.

[56]U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, U.S. Department of the Interior, and U.S. Department of Agriculture, *Prioritizing Zoonotic Diseases for Multisectoral, One Health Collaboration in the United States.*

[57]U.S. Geological Survey and Animal and Plant Health Inspection Service, *Concept Paper Outline: Strategies to Enhance Readiness and Address Emerging and Zoonotic Diseases in Wildlife*, internal interagency white paper.

[58]The White House, *2018 National Biodefense Strategy*; and *National Biodefense Strategy and Implementation Plan For Countering Biological Threats.*

to develop the ability to rapidly detect and share relevant information on pathogens that pose a biological threat of national or international significance soon after they emerge in animals. However, both APHIS and USGS officials told us that they have not fully resolved how to address APHIS's concerns about incorporating its data into WHISPers. Working together to determine how to address APHIS's data-sharing concerns and implement enhancements that would facilitate APHIS's participation in USGS's national wildlife disease database would help support early detection of zoonotic disease outbreaks.

Federal Agencies Regulate Certain Wildlife Imports but Have Not Comprehensively Assessed the Risks of Other Imported Wildlife

CDC, FWS, and APHIS have implemented regulations intended to mitigate the zoonotic disease risks associated with certain imported wildlife. However, CDC—the agency with primary responsibility for protecting public health—has not comprehensively assessed the risk that other imported wildlife could introduce zoonotic diseases.

CDC, FWS, and APHIS Have Implemented Regulations to Mitigate the Risk of Certain Imported Wildlife Introducing Zoonotic Diseases

Currently, CDC, FWS, and APHIS each regulate certain imported wildlife, though for different primary purposes: CDC to prevent the introduction of zoonotic diseases that could affect people, FWS to mitigate threats to the health of U.S. wildlife and to prevent entry of illegally imported animals, and APHIS to mitigate disease risks to agricultural animals. FWS's and APHIS's regulations are not aimed primarily at reducing the risk of zoonotic diseases to people, but they sometimes do so. For example, an FWS regulation restricts the importation of live mitten crabs, in part because of their potential to harm human health.[59] APHIS has regulations that restrict the importation of certain birds because they can carry avian influenza, a zoonotic disease that can infect poultry, as well as people.

[59]Mitten crabs can carry the Oriental lung fluke, a type of parasite that can infect people and cause severe disease and death, according to the FWS regulation.

Examples of restrictions on imported wildlife imposed by these agencies include limiting the allowable purposes for import, requiring quarantine, and requiring health certificates.[60] The restrictions established in agencies' regulations vary by type of imported wildlife and agency, and some animals are regulated by multiple agencies. For example, CDC, APHIS, and FWS all have regulations for live nonhuman primates. CDC's regulation allows nonhuman primates to be imported only for educational, exhibition, or scientific purposes, or for breeding colonies, provided that offspring will be used for educational, exhibition, or scientific purposes, or to replace breeding stock. The regulations include other requirements, such as quarantine for 31 days upon entry to the U.S., monitoring for signs of any zoonotic diseases, and testing for tuberculosis before leaving quarantine. APHIS's and FWS's regulations for nonhuman primates have standards for transport, including specifications for enclosures, food and water, and care in transit. In addition, APHIS regulates certain other wildlife. For example, APHIS regulations for hedgehogs allow them to be imported only from regions designated as free of foot-and-mouth disease. The hedgehogs must be accompanied by a veterinary health certificate from the exporting country and inspected for signs of disease upon entry to the U.S.

The agencies' approaches to regulating imported wildlife differ, partly because of their different purposes for doing so. In particular,

- CDC regulations apply primarily to animals that have been linked to previous outbreaks of zoonotic diseases in humans, such as rodents from Africa, whose importation into the U.S. led to a 2003 outbreak of mpox in people.[61] CDC regulations also require permits for imported live bats. In most cases, the regulations apply to live animals. CDC also prohibits the importation of certain animal products that could carry zoonotic disease risks and requires other products derived from

[60]Health certificates from exporting countries may document negative tests for certain diseases, such as tuberculosis, or veterinary assessments that animals are healthy.

[61]In April 2003, a shipment of rodents imported from West Africa led to 47 confirmed and probable cases of mpox in people in the U.S., according to CDC. See Mary G. Reynolds et al., Centers for Disease Control and Prevention, "Clinical Manifestations of Human Monkeypox Influenced by Route of Infection," *Journal of Infectious Diseases*, vol. 194 (2006): 773-880. For CDC's regulation, see *Control of Communicable Diseases; Restrictions on African Rodents, Prairie Dogs, and Certain Other Animals*, 68 Fed. Reg. 62,353 (Nov. 4, 2003).

animals to be rendered noninfectious, such as by placing them in boiling water;[62]

- APHIS regulations apply mainly to imported agricultural animals, such as cattle, horses, swine, and poultry. In addition, APHIS regulates some wildlife and pets—such as wild boars, dogs, hedgehogs, and certain birds—because they can carry diseases that could affect agriculture. For example, wild pigs can carry African swine fever, and hedgehogs can carry foot-and-mouth disease (neither of which are zoonotic diseases). If these diseases spread to the agriculture industry, they could result in significant loss of agricultural animals and economic impacts resulting from disease control measures and trade repercussions;[63] and
- FWS regulations apply to thousands of species of imported wildlife that are protected in legislation and by international agreements.[64] For example, FWS regulations restrict the entry of certain species of monkeys and wild cats because they are listed as endangered under the Endangered Species Act regulations. In addition, FWS regulations require all shipments of wildlife to be accompanied by declaration forms with information such as the quantity and species of animal and their country of origin.

FWS also has the authority to prohibit the importation of wildlife that the agency finds to be injurious to humans; to the interests of agriculture, horticulture, or forestry; or to wildlife or the wildlife resources of the U.S.[65]

[62]Specifically, CDC directs staff to deny entry of goatskin drums from Haiti because they have been linked to anthrax, and bushmeat—raw or minimally processed meat from wild animals—because it could be infected with pathogens, such as Ebola virus.

[63]African swine fever is a highly contagious viral disease of domesticated and wild pigs. It kills most pigs that it infects but is not a danger to human health. The disease can result in massive losses in pig populations and drastic economic consequences, according to the World Organisation for Animal Health. Foot-and-mouth disease is a highly contagious viral disease that can infect livestock but generally does not infect humans and is not a public health threat. For information about federal agencies' efforts to prepare for a foot-and-mouth disease outbreak, see GAO, *Foot-and-Mouth Disease: USDA's Efforts to Prepare for a Potential Outbreak Could Be Strengthened*, GAO-19-103 (Washington, D.C.: Mar. 12, 2019).

[64]For example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora requires parties to the convention, including the U.S., not to trade in listed species other than in accordance with the convention. The agreement regulates international trade in animals and plants that may be endangered by trade, including some animals that may be linked to zoonotic diseases.

[65]42 U.S.C. § 42(a)(1).

In the past, FWS rarely prohibited the importation of wildlife species on the basis of their disease risk to human health. However, in 2021, Congress provided funding to FWS, and the Chairmen of the House Committee on Natural Resources and the Senate Committee on Environment and Public Works, referencing that funding, recommended that FWS use its authority to issue regulations prohibiting the importation of wildlife species that pose a risk to human health.[66] FWS contracted with the Smithsonian Institution to conduct a risk assessment that will evaluate the risks of imported wildlife species associated with zoonotic pathogens. FWS plans to use the results to inform its future regulations prohibiting the entry of wildlife species that pose a risk to human health, according to agency officials.

CDC Has Not Comprehensively Assessed the Disease Risks of Imported Wildlife to Inform Its Regulatory Decisions

Although CDC, FWS, and APHIS have import regulations in place for some wildlife species, many wildlife species are allowed to enter the U.S. without restrictions that could mitigate zoonotic disease risk. In addition, for many species, the agencies do not require imported animals to be screened for diseases prior to shipment or tested after arrival in the U.S. Consequently, imported wildlife that present a zoonotic disease risk could be allowed to enter the U.S. Imported wildlife poses a particular risk of carrying zoonotic diseases because most shipments contain a high volume of animals. Also, many include different species co-mingled or kept in close proximity in confined spaces, which are favorable conditions for the transmission of zoonotic diseases between animals, according to CDC.

From 2013 through 2022, FWS tracked 3.7 million live mammals and 7.5 million live reptiles imported to the U.S. overall, according to our analysis of FWS animal import data. As the agency with primary responsibility for protecting public health, CDC regulates some of these animals, consistent with its legislative authority. Specifically, under the Public Health Service Act, CDC is authorized to implement regulations needed

[66]In the American Rescue Plan Act of 2021, Congress provided $10 million to FWS to carry out provisions of the Lacey Act. See Pub. L. No. 117-2, § 6003(b), 135 Stat. 4, 94. In a subsequent letter to Interior, Members of Congress recommended that FWS use the funds to conduct risk analyses and issue regulations prohibiting the entry of species that pose a risk to human health.

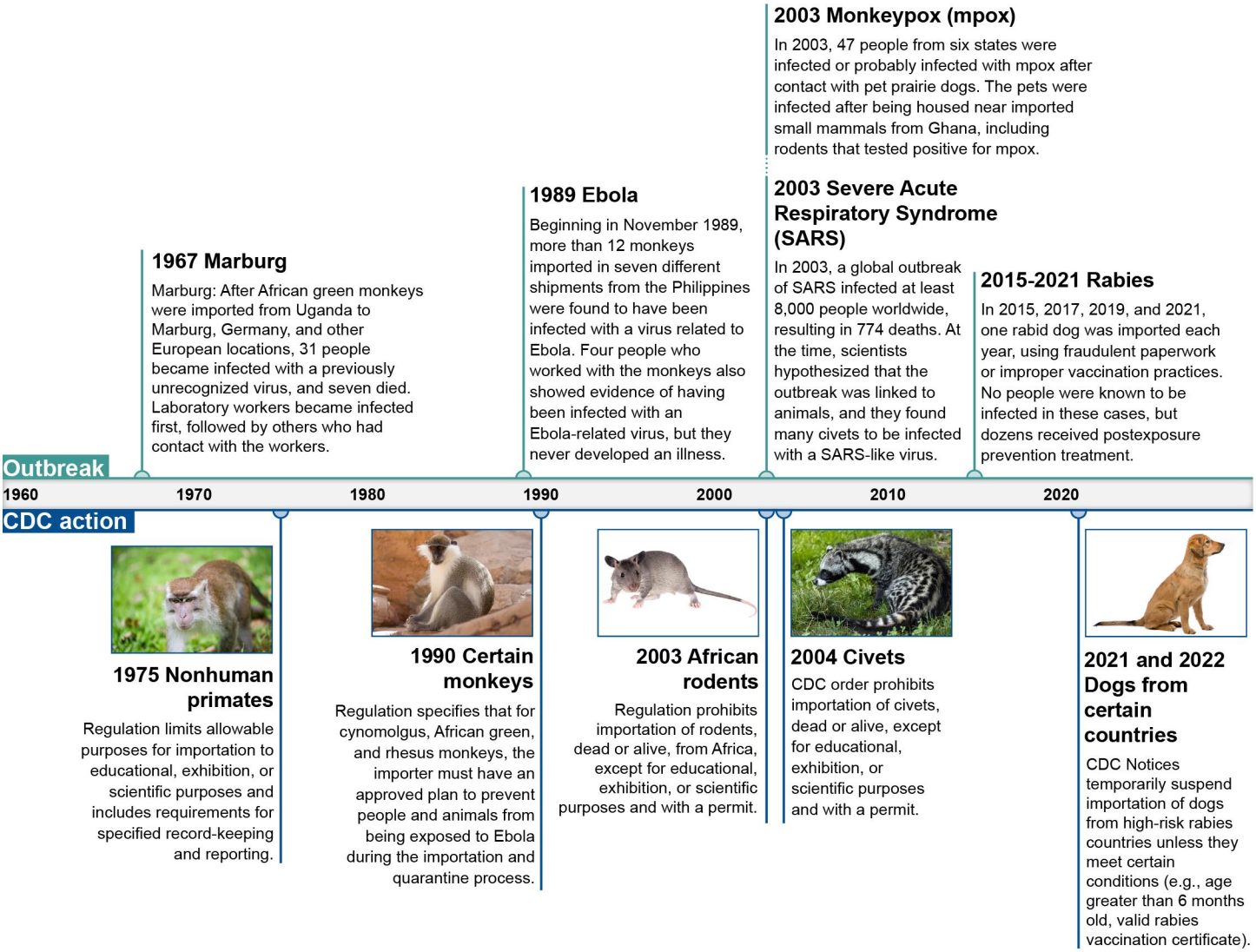
to prevent the introduction or transmission of communicable diseases from foreign countries into the U.S.[67] CDC may suspend the entry of animals from designated places whenever the agency determines that doing so is necessary to protect public health.[68]

CDC has implemented import restrictions for wildlife primarily in response to outbreaks that have occurred in the U.S. or other countries, according to agency officials (see fig. 4).

[67]Act July 1, 1944, ch. 373, § 361, 58 Stat. 682, 703 (codified as amended at 42 U.S.C. § 264).

[68]42 C.F.R. § 71.63.

Figure 4: Outbreaks of Zoonotic Diseases and Centers for Disease Control and Prevention (CDC) Corresponding Actions to Restrict Entry of Imported Animals, 1960-2022



Sources: GAO summary of CDC regulations and related information; (photos left to right) pe3check/Sweet Lana/Farinoza/vladislav333222/Erik Lam/stock.adobe.com. | GAO-23-105238

Text for Figure 4: Outbreaks of Zoonotic Diseases and Centers for Disease Control and Prevention (CDC) Corresponding Actions to Restrict Entry of Imported Animals, 1960-2022

- **Outbreaks**
  - 1967 Marburg: After African green monkeys were imported from Uganda to Marburg, Germany, and other European locations, 31 people became infected with a previously unrecognized virus, and

seven died. Laboratory workers became infected first, followed by others who had contact with the workers.

- 1989 Ebola: Beginning in November 1989, more than 12 monkeys imported in seven different shipments from the Philippines were found to have been infected with a virus related to Ebola. Four people who worked with the monkeys also showed evidence of having been infected with an Ebola-related virus, but they never developed an illness.
- 2003 Monkeypox (mpox): In 2003, 47 people from six states were infected or probably infected with mpox after contact with pet prairie dogs. The pets were infected after being housed near imported small mammals from Ghana, including rodents that tested positive for mpox.
- 2003 Severe Acute Respiratory Syndrome (SARS): In 2003, a global outbreak of SARS infected at least 8,000 people worldwide, resulting in 774 deaths. At the time, scientists hypothesized that the outbreak was linked to animals, and they found many civets to be infected with a SARS-like virus.
- 2015-2021 Rabies: In 2015, 2017, 2019, and 2021, one rabid dog was imported each year, using fraudulent paperwork or improper vaccination practices. No people were known to be infected in these cases, but dozens received postexposure prevention treatment.

- **CDC action**
  - 1975 Nonhuman primates: Regulation limits allowable purposes for importation to educational, exhibition, or scientific purposes and includes requirements for specified record-keeping and reporting.
  - 1990 Certain monkeys: Regulation specifies that for cynomolgus, African green, and rhesus monkeys, the importer must have an approved plan to prevent people and animals from being exposed to Ebola during the importation and quarantine process.
  - 2003 African rodents: Regulation prohibits importation of rodents, dead or alive, from Africa, except for educational, exhibition, or scientific purposes and with a permit.
  - 2004 Civets: CDC order prohibits importation of civets, dead or alive, except for educational, exhibition, or scientific purposes and with a permit.

- 2021 and 2022 Dogs from certain countries: CDC Notices temporarily suspend importation of dogs from high-risk rabies countries unless they meet certain conditions (e.g., age greater than 6 months old, valid rabies vaccination certificate).

Sources: GAO summary of CDC regulations and related information; (photos left to right) pe3check/Sweet Lana/Farinoza/vladislav333222/Erik Lam/stock.adobe.com. | GAO-23-105238

However, CDC does not have specific import regulations for other types of wildlife—including some that can harbor zoonotic diseases.[69] Table 3 shows selected types of wildlife with and without CDC import restrictions, examples of zoonotic diseases that they can carry, and the number imported from 2013 through 2022, according to our analysis of FWS animal import data.[70] Some of the diseases are among the eight priority diseases in the U.S. However, some diseases present in foreign countries, such as Ebola, are not priority diseases in the U.S., partly because they are not prevalent in the U.S. Additional information on the numbers of wildlife imported, according to FWS animal import data, is provided in appendix III.

Table 3: Information about Selected Live Wildlife Imports with and without Centers for Disease Control and Prevention (CDC) Restrictions, and Examples of Zoonotic Diseases They Can Carry

			U.S. Fish and Wildlife Service (FWS) data on imported wildlife	
	Type of wildlife	**Examples of zoonotic diseases that can be carried by this type of wildlife[a]**	**Number imported, 2013-2022**	**Primary countries last shipped from, 2013-2022[b]**
Importation restricted by CDC	Turtles[c]	Salmonellosis	1,247,514	Thailand

[69]CDC has authority to suspend the entry of animals or animal products entering the U.S. if CDC determines that such action is necessary to protect public health, regardless of whether CDC has a specific import regulation related to that animal or animal product.

[70]From 2013 through 2022, we found that about 1 percent of the wildlife imports that we analyzed in FWS's animal import data were recorded as other or missing, rather than with a species name. We determined that this was an acceptable level for describing the general trends for certain categories of wildlife imported to the U.S. during that period.

			U.S. Fish and Wildlife Service (FWS) data on imported wildlife	
	Type of wildlife	**Examples of zoonotic diseases that can be carried by this type of wildlife**[a]	**Number imported, 2013-2022**	**Primary countries last shipped from, 2013-2022**[b]
	Nonhuman primates	Viral hemorrhagic diseases (e.g., Ebola, Marburg, and yellow fever), herpes B virus infection, monkeypox (mpox), gastrointestinal diseases (e.g., salmonellosis), simian immunodeficiency virus, tuberculosis, hepatitis	271,123	China, Cambodia
	Bats	Rabies, Nipah virus infection, coronavirus diseases, pegivirus infection	652	Israel, Canada
	Rodents from Africa	Lassa fever, Leptospirosis, viral hemorrhagic fevers (e.g., Lujo), gastrointestinal diseases (e.g., salmonellosis), lymphocytic choriomeningitis, mpox, plague, rickettsial diseases (e.g., murine typhus)	644	Egypt, Tanzania
	Civets	Severe acute respiratory syndrome	21	South Africa, Great Britain
Importation not restricted by CDC	Reptiles other than turtles	Salmonellosis, mycobacterium infection, *Aeromonas* infection	6,233,695	Vietnam, El Salvador
	Rodents not from Africa	Hantaviral diseases (e.g., Sin Nombre), Leptospirosis, viral hemorrhagic fevers (e.g., Omsk), gastrointestinal diseases (e.g., salmonellosis), lymphocytic choriomeningitis, plague, rickettsial diseases (e.g., murine typhus), tularemia	2,979,207	Czech Republic
	Minks	COVID-19	19,240	Canada, Denmark

		U.S. Fish and Wildlife Service (FWS) data on imported wildlife	
Type of wildlife	Examples of zoonotic diseases that can be carried by this type of wildlife[a]	Number imported, 2013-2022	Primary countries last shipped from, 2013-2022[b]
Shrews	Human bornavirus encephalitis, rabies-related infections (e.g., Mokola virus), Kyasanur Forest disease	5,309	China
Hedgehogs	Salmonellosis, dermatophytosis (e.g., ringworm), Crimean Congo hemorrhagic fever, Tahyna fever	3,311	Czech Republic, Thailand
Sugar gliders	Salmonellosis, giardiasis, leptospirosis, clostridiosis, toxoplasmosis	1,813	Thailand

Source: GAO analysis of CDC regulations and reports, the online Merck Veterinary Manual, and FWS animal import data. | GAO-23-105238

Note: We selected imported categories of wildlife tracked in FWS's animal import data system that could carry a variety of known zoonotic diseases, that were among those imported to the U.S. in the greatest numbers, or that had CDC restrictions on importation.

[a]This list includes some examples of zoonotic diseases that the listed types of wildlife are known to carry. These diseases are not all currently present in the primary countries that the animals are imported from, and disease prevalence in the primary countries could change. The list is not all inclusive, and wildlife shown here may harbor additional zoonotic diseases not listed.

[b]The country last shipped from is the country that the wildlife shipment left immediately before arriving in the U.S., and it may not be the country of origin. To identify the primary countries last shipped from, we identified those countries that individually accounted for 20 percent or more of the number imported for the type of wildlife, from 2013 through 2022, based on our analysis of FWS animal import data.

[c]CDC restricts the entry of live turtles, tortoises, and terrapins with shell length less than 4 inches. The number of turtles imported from 2013 through 2022 includes those that are restricted by CDC, as well as those that are not.

The following are examples of wildlife that may generally enter the U.S. without CDC restrictions related to risk of disease. Each example also includes the quantity imported, based on our analysis of FWS animal import data:[71]

[71]In FWS's animal import data, the country last shipped from is the country that the wildlife shipment left immediately before arriving in the U.S., and it may not be the country of origin.

- **Rodents that are not from Africa.**[72] From 2013 through 2022, about 2.9 million live rodents that were not from Africa were imported to the U.S. These rodents include hamsters, chinchillas, and others and were shipped primarily from the Czech Republic (see fig. 5). Such rodents can harbor one or more zoonotic diseases, including plague and salmonellosis, which were both identified as priority diseases of greatest concern in the U.S. during the 2017 interagency workshop on zoonotic diseases. Rodents present a particular risk for zoonotic diseases because people sometimes keep them as pets and interact with them closely and because they reproduce rapidly, leading to more spillover risks.

Figure 5: Image of a Chinchilla

Source: Alexey Kuzentsov/stock.adobe.com. | GAO-23-105238

- **Shrews.**[73] From 2013 through 2022, about 5,300 live shrews were imported into the U.S., mainly shipped from China. Shrews can harbor hepatitis B and diseases caused by hantaviruses. Some diseases caused by hantaviruses have not been found in the U.S. but are found in Asia and can be particularly severe and sometimes fatal to

[72]Some species of rodents, such as certain chinchillas found in South America, are protected under the Endangered Species Act, and their entry into the U.S. is consequently restricted by FWS.

[73]One species of shrew, the Buena Vista Lake shrew, is listed as endangered under the Endangered Species Act, and their entry into the U.S. is consequently restricted by FWS.

people.[74] Also, in August 2022, shrews were linked to an outbreak of illness in 35 people in China caused by the novel Langya virus, which resulted in respiratory symptoms such as fever, cough, and fatigue.[75]

- **Minks.** From 2013 through 2022, more than 19,000 live minks were imported into the U.S., primarily shipped from Canada and Denmark. Minks can harbor the COVID-19 virus, and COVID-19 is a priority disease in the U.S. Mink-to-human spread of the COVID-19 virus has been reported in the Netherlands, Denmark, and Poland, and data suggest that it might have occurred in the U.S., according to CDC's website.[76] The risk of susceptible animals, such as minks, becoming a COVID-19 reservoir is a worldwide concern, as it could pose a continued public health risk and lead to future spillover events, according to a statement published by the World Organisation for Animal Health.[77]
- **Reptiles other than turtles.** From 2013 through 2022, about 6.2 million reptiles other than turtles were imported, primarily shipped from Vietnam and El Salvador. Reptiles, including various types of lizards and snakes, can harbor zoonotic diseases, such as the priority disease salmonellosis (including strains that are resistant to antibiotics) and ticks that can carry zoonotic diseases. For example, in 2022 and 2023, CDC reported that at least 88 people were infected

[74]Hantaviruses are a family of viruses spread mainly by rodents and can cause varied diseases in people worldwide. For example, hantavirus pulmonary syndrome is a severe, sometimes fatal, respiratory disease in humans caused by infection with hantaviruses. A group of clinically similar illnesses caused by hantaviruses, known as hemorrhagic fever with renal syndrome, is not known to be present in the U.S. but is widely distributed in eastern Asia, particularly in China, Russia, and Korea, according to CDC documents.

[75]Xiao-Ai Zhang, et al., "A Zoonotic Henipavirus in Febrile Patients in China," *New England Journal of Medicine*, vol. 387, no. 5 (2022).

[76]To confirm the spread of the COVID-19 virus from minks to people in the U.S., public health officials would need more information, according to CDC's website. https://www.cdc.gov/importation/bringing-an-animal-into-the-united-states/mink.html, accessed February 14, 2023; and https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/animals.html, accessed February 22, 2023.

[77]World Organisation for Animal Health, "OIE Statement on COVID-19 and Mink" (Nov. 12, 2020), https://www.woah.org/en/oie-statement-on-covid-19-and-mink/, accessed February 16, 2022.

and 29 hospitalized during three multistate outbreaks of salmonellosis linked to pet bearded dragons, a type of lizard.[78]

CDC does not regulate these animals, partly because the agency's approach is generally to regulate animals in response to outbreaks, and these animals have not been linked to significant human outbreaks in the U.S. or elsewhere, according to agency officials. Also, when implementing regulations, CDC seeks to protect public health while minimizing effects on trade and the personal freedoms of importers, according to agency officials.

CDC has not assessed disease risks generally for imported wildlife, but it has conducted individual risk assessments to inform decisions about the regulations that it has implemented since approximately 2000, according

[78]CDC's investigations did not determine whether any of the bearded dragons had been imported. See Centers for Disease Control and Prevention, *Salmonella Investigation Details* (June 16, 2022), https://www.cdc.gov/salmonella/uganda-01-22/details.html, accessed November 28, 2022 and *Salmonella Investigation Details* (March 3, 2023), https://www.cdc.gov/salmonella/beardeddragon-10-22/details.html, accessed April 28, 2023.

The Centers for Disease Control and Prevention (CDC) Conducted a Risk Assessment for Imported Minks in 2020

After minks were found to be infected with the COVID-19 virus, CDC conducted a risk assessment in December 2020 to consider whether to regulate imported minks. The agency decided not to do so, partly because few people—other than workers on mink farms—have direct contact with minks, according to CDC's briefing slides about the risk assessment. Also, some of the strains carried by minks were already widespread in people, according to the briefing slides. Instead of issuing new regulations, CDC posted on its website guidance for importing minks safely to prevent COVID-19. CDC officials said that they did not conduct any other risk assessments related to the COVID-19 virus in imported animals.

Sources: CDC documents and interviews with agency officials; Eric Isselée/stock.adobe.com (photo). | GAO-23-105238

to CDC officials. Specifically, CDC reviews risks related to the particular wildlife species and pathogens involved in past outbreaks. CDC officials said that they use professional judgment to determine when or for which animals to conduct such risk assessments. Generally, the officials said that they conduct risk assessments after there is an outbreak in humans linked to wildlife or when agency officials determine that one is needed, based on information in scientific literature. For example, CDC led interagency discussions and conducted a risk assessment for imported minks in 2020 (see sidebar).

CDC officials said that they also use professional judgment to decide how to conduct the individual risk assessments, what to include in them, and how to document results. Agency officials said that they generally use certain questions to guide the assessments. For example, they consider the likelihood of human exposure to the pathogen, its potential to cause severe illness in humans and spread from human to human, and the existence of effective treatments. CDC also considers factors such as the quantity imported of the relevant wildlife species and whether there are known cases of spillover. CDC then considers the advantages and disadvantages of implementing regulations, using information about disease risk, as well as potential economic effects and trade implications, and whether there are options for mitigating risk without implementing regulations. CDC officials said that they document these considerations in decision memos or briefing slides that they share with agency leadership.

Between 2007 and 2017, CDC expressed concerns that its regulations might not be sufficient to prevent the introduction of zoonotic diseases to the U.S. and considered, but ultimately rejected, two proposals for additional, more proactive regulations covering imported wildlife. In 2007, CDC issued an advance notice of proposed rulemaking and announced its intent to revise its animal import regulations. The notice said that the importation of wild animals represented a risk to human health and that existing regulations may not be sufficient to fully prevent the introduction of zoonotic diseases into the U.S. because they are limited to specific species and regions.[79] It also said that CDC's approach was to take action after an outbreak occurred, rather than to proactively prevent outbreaks from known high-risk animals. CDC asked for public input on whether it should maintain a list of high-risk categories of animals for

[79]*Foreign Quarantine Regulations, Proposed Revision of HHS/CDC Animal-Importation Regulations*, 72 Fed. Reg. 41,676 (July 31, 2007).

which importation is restricted. In 2008 testimony, a CDC official said that CDC's approach of taking actions after outbreaks occurred could not fully prevent the introduction of zoonotic diseases.[80] In 2014, CDC again considered issuing regulations to mitigate zoonotic disease risks but decided not to, according to agency officials, partly because of competing priorities at the time. In 2017, CDC withdrew its 2007 advance notice of proposed rulemaking, stating that it believed the public interest was best served by doing so.[81]

The first goal in the 2022 National Biodefense Strategy states that the U.S. will build risk awareness at the strategic level through analyses and research efforts to characterize risks, including natural biological risks, such as the introduction of zoonotic diseases from imported animals.[82] The first objective for this goal is to ensure that decision-making is informed by intelligence, forecasting, and risk assessment. In addition, federal standards for internal control state that agencies should identify, analyze, and respond to risks related to achieving defined objectives. Specifically, the standards state that management should comprehensively identify risks that affect defined objectives.[83]

However, CDC has not comprehensively identified and characterized risks related to imported wildlife. Also, its current approach—to act after an outbreak occurs, rather than proactively—may not suffice to ensure that reasonable steps are being taken to prevent the introduction of zoonotic diseases into the U.S. Comprehensively assessing risk for imported wildlife—including animals that have not been linked to past outbreaks—would help inform the agency's decisions about issuing regulations to mitigate zoonotic disease risks. CDC officials said that the agency has not comprehensively assessed risks because its current approach has not resulted in any significant outbreaks from imported

[80]Nina Marano, D.V.M., M.P.H., Branch Chief, Division of Global Migration and Quarantine, CDC, *CDC's Role in the Importation and Movement of Animals*, testimony before the House Natural Resources Subcommittee on Fisheries, Wildlife, and Oceans, 110th Cong., 2nd sess., June 26, 2008.

[81]*Foreign Quarantine Regulations, Proposed Revision of HHS/CDC Animal-Importation Regulations,* 82 Fed. Reg. 54,314 (Nov. 17, 2017). According to CDC officials, after considering feedback from the public and analyzing the need to amend its regulations, CDC did not issue a final rule because the agency had not obtained any new information that would cause it to implement additional regulations.

[82]The White House, *National Biodefense Strategy and Implementation Plan For Countering Biological Threats*. This goal also appeared in the 2018 version of the strategy.

[83]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: Sept. 10, 2014).

wildlife to people. The officials also said that CDC does not have sufficient resources to conduct risk assessments for thousands of wildlife species. However, a comprehensive approach would not necessarily require thousands of assessments. For example, it could include a risk-based approach, such as identifying high priority categories of wildlife and then conducting risk assessments for those particular categories.

In July 2022, FWS began a project with the Smithsonian Institution that could help CDC comprehensively assess risks from imported wildlife. Specifically, the project plans to develop a risk analysis framework that uses data from multiple sources to evaluate the risks of all imported wildlife species associated with zoonotic pathogens. For example, the framework will use data on the quantity of different species imported, pathogens that can be carried by the species, and the species' countries of origin. The results, which may include a list of high-risk categories of imported wildlife, could be helpful to CDC in reviewing its current policies and determining whether adjustments should be made. CDC has worked with the Smithsonian Institution to provide information and other assistance in support of this project, according to CDC officials. However, CDC officials told us that they could not be sure how helpful the results might be for CDC until the project is complete. If CDC comprehensively assessed risk—in collaboration with other agencies, as appropriate—to inform decisions about regulating imported wildlife, it could help ensure that reasonable, proactive steps were being taken to prevent the introduction or transmission of zoonotic diseases from foreign countries into the U.S.

Conclusions

Zoonotic diseases are a serious public health concern, and federal agencies play an important role in detecting them and mitigating related risks. APHIS and USGS have taken key steps to improve collaboration on a national wildlife disease surveillance system, such as signing a charter for a permanent standing committee that will oversee collaborative efforts related to creating the system. As they continue this work, more fully following leading practices for collaboration, including clearly defining common outcomes, involving relevant participants, and identifying resources and staffing could enhance the agencies' efforts. Following the leading practices for collaboration could also help APHIS and USGS successfully develop a surveillance system and close some gaps in the nation's ability to address emerging wildlife diseases.

In addition, USGS is leading an effort to develop a national wildlife disease database, using its WHISPers database as the foundation. However, APHIS has concerns about sharing certain data with the public and how to incorporate APHIS data into USGS's database. Working together to overcome these concerns would help APHIS and USGS develop more complete data to help support early detection of zoonotic disease outbreaks.

Finally, CDC has issued regulations to mitigate zoonotic disease risks associated with certain types of imported wildlife. For example, after an mpox outbreak was linked to imported rodents from Africa, CDC issued a regulation restricting their entry. However, CDC has not comprehensively assessed the risks that other imported wildlife could introduce zoonotic diseases, which CDC could accomplish with a risk-based approach. Such an assessment would help ensure that the agency can make proactive, informed decisions about regulations intended to prevent the introduction of zoonotic diseases by imported wildlife.

Recommendations for Executive Action

We are making a total of five recommendations, including two to APHIS, two to USGS, and one to CDC. Specifically:

The Administrator of APHIS should more fully follow leading practices for collaboration while coordinating with USGS to develop and implement a national wildlife disease surveillance system. This should include clearly defining common outcomes, involving relevant participants, and identifying resources and staffing. (Recommendation 1)

The Director of USGS should more fully follow leading practices for collaboration while coordinating with APHIS to develop and implement a national wildlife disease surveillance system. This should include clearly defining common outcomes, involving relevant participants, and identifying resources and staffing. (Recommendation 2)

The Administrator of APHIS should work with USGS to resolve data-sharing concerns and implement enhancements that would facilitate APHIS's participation in USGS's national wildlife disease database. (Recommendation 3)

The Director of USGS should work with APHIS to resolve data-sharing concerns and implement enhancements that would facilitate APHIS's participation in USGS's national wildlife disease database. (Recommendation 4)

The Director of CDC, in collaboration with other agencies, as appropriate, should comprehensively assess zoonotic disease risks related to imported wildlife to inform CDC's decisions about regulations. Such an assessment could include identifying high priority categories of wildlife and then conducting risk assessments for those particular categories. (Recommendation 5)

Agency Comments and Our Evaluation

We provided a draft of this report to the Departments of Agriculture, Health and Human Services (HHS), Homeland Security, and the Interior for review and comment. We received comments from HHS, reproduced in appendix IV, stating that HHS did not concur with our recommendation to CDC. Interior provided comments, reproduced in appendix V, stating that USGS concurred with our two recommendations to USGS. HHS's and Interior's comments on the recommendations are discussed further below. USDA did not comment on our recommendations to APHIS. All four departments provided technical comments, which we incorporated as appropriate.

As noted above, HHS did not concur with our recommendation to CDC. CDC requested that we consider an alternative approach and meet to discuss the agency's comments, which we did. CDC raised three main issues. First, CDC stated that it currently regulates the importation of wildlife that it considers "high risk." However, as noted in our report, CDC's approach is to act after an outbreak occurs, which may not suffice to ensure that reasonable steps are being taken to prevent future outbreaks from introduction of zoonotic diseases into the U.S. Second, CDC stated that risk assessments alone are not sufficient when developing wildlife importation regulations, and collaborative interagency practices are needed. We support interagency collaboration to help prevent introduction of diseases from live animal imports, and we modified the recommendation language to explicitly include collaboration. Nevertheless, CDC should play a lead role as the federal agency with primary responsibility for protecting public health.

Finally, CDC stated that it does not have sufficient staffing resources to conduct quantitative public health risk assessments for every potential zoonotic disease threat and that such work would have to be balanced against other CDC priorities and ongoing activities. We modified our report language to clarify that comprehensively assessing zoonotic disease risks related to imported wildlife would not require individual risk

assessments of all species. We also noted that CDC could conduct more focused risk assessments after identifying high-priority categories of wildlife. We agree that CDC would have to balance the work we are recommending against other CDC priorities.

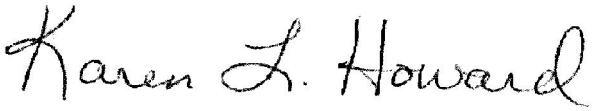
In its comments, Interior stated that USGS concurred with our two recommendations, and it described steps that the agency plans to take to implement them. We will evaluate the responsiveness of the agency's actions once they are completed.

We are sending copies of this report to the appropriate congressional committees, the Secretaries of the Departments of Agriculture, Health and Human Services, Homeland Security, and the Interior, and other interested parties. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact Steve D. Morris at (202) 512-3841 or MorrisS@gao.gov or Karen L. Howard at (202) 512-6888 or HowardK@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VI.

Steve D. Morris

Director, Natural Resources and Environment



Karen L. Howard, PhD

Acting Chief Scientist and Director, Science, Technology Assessment, and Analytics

Appendix I: Eight Priority Zoonotic Diseases Identified by Federal Agencies in 2017, and Descriptions of the Diseases

Table 4: Priority Zoonotic Diseases Identified by Federal Agencies, and Descriptions of the Diseases

Priority disease	Causative pathogen(s)	Examples of animal hosts	Description of disease
1. Zoonotic influenzas	Influenza A viruses (RNA viruses)	• Wildlife (e.g., feral swine and waterfowl) • Agricultural animals (e.g., pigs and poultry)	Zoonotic influenzas (e.g., swine influenza, avian influenza) can occasionally spread from infected animals to people through respiratory secretions or body fluids (e.g., saliva) and from person to person through respiratory secretions. Zoonotic influenzas can vary in their severity, including rates of death, depending on characteristics of the virus. There was one pandemic in the past 20 years under the zoonotic influenza category: 2009 H1N1 influenza.
2. Salmonellosis	*Salmonella* bacteria	• Wild birds (e.g., songbirds) • Agricultural animals (e.g., pigs, cows, poultry)	Salmonellosis is spread to people through food; contaminated environments, such as surface water; and animals, such as pets. Salmonellosis can lead to hospitalization and death, especially when not treated.
3. West Nile virus	*Flavivirus* (RNA virus)	• Wild birds (e.g., crows, ravens, jays)	West Nile virus is spread to people via mosquitos that have fed on infected birds, but only rarely spread from person to person. West Nile virus can cause hospitalization, long-term disability (via neuroinvasive disease), and death.
4. Plague	*Yersinia pestis* bacteria	• Wild mammals (e.g., ground squirrels, prairie dogs, ferrets)	Plague is spread to people via fleas that have fed on infected animals, and from person to person through cough droplets (i.e., pneumonic plague). Plague can vary in its severity, including rates of death, depending on when and whether it is treated.
5. Emerging coronavirus diseases	Coronaviruses (RNA viruses)	• Wild mammals (e.g., minks, civets, raccoon dogs) • Domesticated camels	Emerging coronavirus diseases can occasionally spread to people, and from person to person, through respiratory secretions. Emerging coronavirus diseases can vary in their severity, including rates of death, depending on characteristics of the virus. Three major outbreaks in the past 21 years represent examples of emerging coronavirus diseases: severe acute respiratory syndrome (SARS); Middle East respiratory syndrome (MERS); and COVID-19.

Priority disease	Causative pathogen(s)	Examples of animal hosts	Description of disease
6. Rabies	*Lyssavirus* (RNA virus)	• Wild mammals (e.g., bats, raccoons, foxes) • Agricultural animals (e.g., cattle, horses)	Rabies is spread to people through bites or scratches of rabid mammals. Once clinical signs of rabies appear, the disease is nearly always fatal; however, prompt postexposure treatment effectively prevents disease.
7. Brucellosis	*Brucella* bacteria	• Wild mammals (e.g., bison, elk) • Agricultural animals (e.g., cattle, horses)	Brucellosis is spread to people through contact with infected animals or contaminated animal products. Brucellosis can lead to chronic illness and death in people, though it is rarely fatal if treated with antibiotics.
8. Lyme disease	*Borrelia burgdorferi* bacteria	• Wildlife (e.g., white-footed mouse)	Lyme disease is spread to people via ticks that have fed on infected animals. Lyme disease can cause chronic health conditions (e.g., fatigue, muscle aches), even after treatment, though it is rarely fatal.

Source: GAO analysis of information from the Centers for Disease Control and Prevention and other government sources. | GAO-23-105238

Appendix II: Leading Practices for Collaboration

Table 5: Leading Practices for Collaboration

Leading practice	Key considerations
Outcomes and accountability	➢ Have short-term and long-term outcomes been clearly defined? ➢ Is there a way to track and monitor progress toward the short-term and long-term outcomes? ➢ Do participating agencies have collaboration-related competencies or performance standards against which individual performance can be evaluated? ➢ Do participating agencies have the means to recognize and reward accomplishments related to collaboration?
Bridging organizational cultures	➢ What are the missions and organizational cultures of the participating agencies? ➢ What are the commonalities between the participating agencies' missions and cultures, and what are some potential challenges? ➢ Have participating agencies developed ways for operating across agency boundaries? ➢ Have participating agencies agreed on common terminology and definitions?
Leadership	➢ Has a lead agency or individual been identified? ➢ If leadership will be shared between one or more agencies, have roles and responsibilities been clearly identified and agreed upon? ➢ How will leadership be sustained over the long term?
Clarifying roles and responsibilities	➢ Have participating agencies clarified the roles and responsibilities of the participants? ➢ Have participating agencies articulated and agreed to a process for making and enforcing decisions?
Participants	➢ Have all relevant participants been included? ➢ Do the participants have o full knowledge of the relevant resources in their agency? o the ability to commit these resources? o the ability to regularly attend activities of the collaborative mechanism? o the appropriate knowledge, skills, and abilities to contribute?
Resources	➢ How will the collaborative mechanism be funded? If interagency funding is needed, is it permitted? ➢ If interagency funding is needed and permitted, is there a means to track funds in a standardized manner? ➢ How will the collaborative mechanism be staffed? ➢ Are there incentives available to encourage staff or agencies to participate? ➢ If relevant, do agencies have compatible technological systems? ➢ Have participating agencies developed online tools or other resources that facilitate joint interactions?
Written guidance and agreements	➢ If appropriate, have the participating agencies documented their agreement regarding how they will be collaborating? A written document can incorporate agreements reached in any or all of the following areas: o Leadership o Accountability o Roles and responsibilities

- Resources
- Have participating agencies developed ways to continually update or monitor written agreements?

Source: GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, GAO-12-1022 (Washington, D.C.: Sept. 27, 2012). | GAO-23-105238

Appendix III: Information about Imported Wildlife, 2013-2022

Tables 6 through 9 below provide contextual information about the general trends for certain categories of wildlife imported to the U.S., based on our analysis of U.S. Fish and Wildlife Service animal import data. We determined that the data were sufficiently reliable for describing general trends for certain categories of wildlife imported to the U.S. from 2013 through 2022, but the data have some limitations. For example, from 2013 through 2022, some imported fish were recorded in categories such as “freshwater tropical fish,” without a species name. Because we did not analyze fish by species, we determined that this was acceptable for reporting general trends for fish imported during the period. In addition, we found that about 4 percent of the wildlife imports that we analyzed either had a missing species name or had a species name that was not relevant for our analysis (e.g., nematodes). We determined that this was an acceptable level for providing contextual information.

Table 6: Selected Live Wildlife Imports with and without Centers for Disease Control and Prevention (CDC) Restrictions, and Number Imported Annually, 2013-2017

		U.S. Fish and Wildlife Service (FWS) data on number imported				
	Type of wildlife	**2013**	**2014**	**2015**	**2016**	**2017**
Importation restricted by CDC	Turtles[a]	136,081	138,963	186,442	120,693	100,879
	Nonhuman primates	19,028	26,997	21,300	30,021	22,261
	Bats	60	105	122	90	141
	Rodents from Africa	84	93	5	75	0
	Civets	2	1	2	5	3
Importation not restricted by CDC	Reptiles other than turtles	715,442	573,269	628,734	564,545	635,740
	Rodents not from Africa	185,876	184,070	225,456	325,564	382,766
	Minks	0	0	12,590	6,150	0
	Shrews	4,800	8	0	6	77
	Hedgehogs	83	154	1	351	531

	Sugar gliders	44	16	7	40	55

Source: GAO analysis of CDC regulations and restrictions, and FWS animal import data. | GAO-23-105238

Note: We selected imported categories of wildlife tracked in FWS's animal import data system that could carry a variety of known zoonotic diseases, that were among those imported to the U.S. in the greatest numbers, or that had CDC restrictions on importation.

[a]CDC restricts the entry of live turtles, tortoises, and terrapins with shell length less than 4 inches. The number of turtles imported from 2013 through 2022 includes those that are restricted by CDC, as well as those that are not.

Table 7: Selected Live Wildlife Imports with and without Centers for Disease Control and Prevention (CDC) Restrictions, and Number Imported Annually, 2018-2022

		U.S. Fish and Wildlife Service (FWS) data on number imported					
	Type of wildlife	**2018**	**2019**	**2020**	**2021**	**2022**	**Total, 2013-2022**
Importation restricted by CDC	Turtles[a]	125,024	102,547	107,678	89,566	139,641	1,247,514
	Nonhuman primates	30,006	40,616	23,006	28,048	29,840	271,123
	Bats	133	0	0	0	1	652
	Rodents from Africa	6	372	3	4	2	644
	Civets	5	0	0	0	3	21
Importation not restricted by CDC	Reptiles other than turtles	653,463	698,441	742,380	344,638	677,043	6,233,695
	Rodents not from Africa	363,219	338,435	364,315	245,908	363,598	2,979,207
	Minks	0	0	500	0	0	19,240
	Shrews	180	195	0	43	0	5,309
	Hedgehogs	503	523	549	586	30	3,311
	Sugar gliders	2	35	3	802	809	1,813

Source: GAO analysis of CDC regulations and restrictions, and FWS animal import data. | GAO-23-105238

Note: We selected imported categories of wildlife tracked in FWS's animal import data system that could carry a variety of known zoonotic diseases, that were among those imported to the U.S. in the greatest numbers, or that had CDC restrictions on importation.

[a]CDC restricts the entry of live turtles, tortoises, and terrapins with shell length less than 4 inches. The number of turtles imported from 2013 through 2022 includes those that are restricted by CDC, as well as those that are not

Table 8: Selected Live Wildlife Imports, by Category, and Number Imported Annually, 2013-2018

	U.S. Fish and Wildlife Service (FWS) data on number imported					
Type of wildlife	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Mammals	232,062	235,473	291,695	408,307	447,498	433,626
Birds	90,642	112,206	131,458	90,363	100,779	78,361
Reptiles	851,523	712,232	815,176	685,238	736,619	778,487

Fishes	148,241,127	127,716,711	119,787,597	112,123,908	108,263,894	104,887,888
Amphibians	2,921,342	2,498,030	2,360,459	2,664,079	2,885,790	2,191,589

Source: GAO analysis of FWS animal import data. | GAO-23-105238

Table 9: Selected Live Wildlife Imports, by Category, and Number Imported Annually, 2019-2022

	U.S. Fish and Wildlife Service (FWS) Data on Number Imported				
Type of wildlife	**2019**	**2020**	**2021**	**2022**	**Total, 2013-2022**
Mammals	460,831	456,612	309,185	434,445	3,709,734
Birds	64,087	38,770	31,510	84,253	822,429
Reptiles	800,988	850,058	434,204	816,684	7,481,209
Fishes	100,987,845	325,917,124	107,518,921	103,437,386	1,358,882,402
Amphibians	3,366,762	2,824,345	2,963,436	2,753,938	27,429,770

Source: GAO analysis of FWS animal import data. | GAO-23-105238

Appendix IV: Comments from the Department of Health and Human Services

DEPARTMENT OF HEALTH & HUMAN SERVICES — OFFICE OF THE SECRETARY

Assistant Secretary for Legislation
Washington, DC 20201

April 24, 2023

Karen L. Howard
Acting Chief Scientist and Director, Science,
Technology Assessment, and Analytics
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Steve D. Morris
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Ms. Howard and Mr. Morris:

Attached are comments on the U.S. Government Accountability Office's (GAO) report entitled, **"*Zoonotic Diseases: Federal Actions Needed to Improve Surveillance and Better Assess Human Health Risks Posed by Wildlife*" (GAO-23-105238).**

The Department appreciates the opportunity to review this report prior to publication.

Sincerely,

Melanie Anne Egorin

Melanie Anne Egorin, PhD
Assistant Secretary for Legislation

Attachment

GENERAL COMMENTS FROM THE DEPARTMENT OF HEALTH & HUMAN SERVICES ON THE GOVERNMENT ACCOUNTABILITY OFFICE'S DRAFT REPORT ENTITLED: ZOONOTIC DISEASES: FEDERAL ACTIONS NEEDED TO IMPROVE SURVEILLANCE AND BETTER ASSESS HUMAN HEALTH RISKS POSED BY WILDLIFE (GAO-23-105238)

The U.S. Department of Health & Human Services (HHS) appreciates the opportunity from the Government Accountability Office (GAO) to review and comment on this draft report.

Recommendation 5
The Director of CDC, building on efforts by other agencies as appropriate, should comprehensively assess zoonotic disease risks related to imported wildlife to inform CDC's decisions about regulations. Such an assessment could include proactively identifying a list of high-risk categories of imported wildlife.

HHS Response
HHS non-concurs with GAO's recommendation.

CDC appreciates GAO's attention to the risks of zoonotic disease associated with imported wildlife. However, CDC respectfully requests that GAO consider an alternative approach to this recommendation. The recommendation implies CDC has not identified wildlife that presents a high degree of risk to human health; however, CDC currently regulates the importation of wildlife that it considers "high-risk" such as bats and nonhuman primates. Additionally, while CDC agrees that qualitative and quantitative public health risk assessments are valuable for informing policy decisions, risk assessments alone are not sufficient when developing wildlife importation regulations. Interagency support is necessary to implement regulations; therefore, collaborative interagency practices that incorporate a One Health approach are needed to facilitate the identification and mitigation of zoonotic disease risks posed by wildlife to people. It should also be noted that at present, CDC does not have sufficient staffing resources to conduct quantitative public health risk assessments for every potential zoonotic disease threat. Additionally, any public health risk assessments would have to be balanced against other CDC priorities and ongoing activities.

For these reasons, CDC suggests that GAO rewords its recommendation as follows: *The Director of CDC, in collaboration with other agencies as appropriate and assuming sufficient resources, should assess zoonotic disease threats that pose the highest risk to people from imported wildlife using a One Health approach to inform CDC's regulatory decisions*. CDC would like the opportunity to discuss the reasoning and proposed language with GAO prior to the issuance of the final report.

Text for Appendix IV: Comments from the Department of Health and Human Services

DEPARTMENT OF HEALTH & HUMAN SERVICES
OFFICE OF THE SECRETARY
Assistant Secretary for Legislation
Washington, DC 20201

April 24, 2023

Karen L. Howard
Acting Chief Scientist and Director, Science,
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U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Steve D. Morris
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

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The Department appreciates the opportunity to review this report prior to publication.

Sincerely,

Melanie Anne Egorin, PhD
Assistant Secretary for Legislation

Attachment

GENERAL COMMENTS FROM THE DEPARTMENT OF HEALTH & HUMAN SERVICES ON THE GOVERNMENT ACCOUNTABILITY OFFICE'S DRAFT

REPORT ENTITLED: ZOONOTIC DISEASES: FEDERAL ACTIONS NEEDED TO IMPROVE SURVEILLANCE AND BETTER ASSESS HUMAN HEALTH RISKS POSED BY WILDLIFE (GAO-23-105238)

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HHS Response

HHS non-concurs with GAO's recommendation.

CDC appreciates GAO's attention to the risks of zoonotic disease associated with imported wildlife. However, CDC respectfully requests that GAO consider an alternative approach to this recommendation. The recommendation implies CDC has not identified wildlife that presents a high degree of risk to human health; however, CDC currently regulates the importation of wildlife that it considers "high-risk" such as bats and nonhuman primates. Additionally, while CDC agrees that qualitative and quantitative public health risk assessments are valuable for informing policy decisions, risk assessments alone are not sufficient when developing wildlife importation regulations. Interagency support is necessary to implement regulations; therefore, collaborative interagency practices that incorporate a One Health approach are needed to facilitate the identification and mitigation of zoonotic disease risks posed by wildlife to people. It should also be noted that at present, CDC does not have sufficient staffing resources to conduct quantitative public health risk assessments for every potential zoonotic disease threat. Additionally, any public health risk assessments would have to be balanced against other CDC priorities and ongoing activities.

For these reasons, CDC suggests that GAO rewords its recommendation as follows: The Director of CDC, in collaboration with other agencies as appropriate and assuming sufficient resources, should assess zoonotic disease threats that pose the highest risk to people from imported wildlife using a One Health approach to inform CDC's regulatory decisions. CDC would like the opportunity to discuss the reasoning and proposed language with GAO prior to the issuance of the final report.

Appendix V: Comments from the Department of the Interior

United States Department of the Interior
OFFICE OF THE SECRETARY
Washington, DC 20240

Mr. Steve D. Morris
Director, National Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

Dear Director Morris,

In accordance with 31 U.S.C. § 720, the U.S. Department of the Interior (DOI, Department) is responding to the recommendations in the Government Accountability Office (GAO) report titled, ZOONOTIC DISEASES: Federal Actions Needed to Improve Surveillance and Better Assess Human Health Risks Posed by Wildlife (GAO-23-105238). Thank you for the opportunity to respond to the referenced report. The U.S. Geological Survey (USGS) concurs with the two recommendations directed to the USGS. The USGS also has a few technical comments on the text of the report, as documented in the enclosed file *USGS technical comments on draft report GAO-23-105238*.

The GAO issued two recommendations relevant to the USGS as part of its overall findings. Below is a summary of actions taken or planned to implement the recommendations.

Recommendation 2:

The Director of USGS should more fully follow leading practices for collaboration while coordinating with APHIS to develop and implement a national wildlife disease surveillance system. This should include clearly defining common outcomes, involving relevant participants, and identifying resources and staffing.

USGS response:

The USGS concurs and is collaborating with U.S. Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services (USDA/APHIS/WS) to convene an ad hoc interagency committee comprising the USGS and the USDA/APHIS/WS to develop a white paper regarding a national wildlife disease surveillance system. The white paper will include clearly defined outcomes, involvement of relevant participants, and identification of resource and staffing requirements. The white paper will be developed and submitted to the Director of the USGS by December 31, 2023.

Recommendation 4:

The Director of USGS should work with APHIS to resolve data-sharing concerns and implement enhancements that would facilitate APHIS's participation in USGS's national wildlife disease database.

USGS response:

The USGS concurs and is collaborating with the above-referenced ad hoc committee (or a sub-committee thereof) to prepare a white paper to identify and prioritize specific actions for resolving data-sharing concerns between the USGS and USDA/APHIS/WS. The white paper will outline a plan, where feasible, for implementing enhancements to enable APHIS data sharing with the National Wildlife Disease database. This white paper will also be developed and submitted to the Director of the USGS by December 31, 2023.

Similar letters have been sent to other federal officials and the members of Congress listed below. If you have any questions or need additional information, please contact the PFM AM team at DOI_PFM_AM@ios.doi.gov.

Sincerely,

David Applegate
Director

Text for Appendix V: Comments from the Department of the Interior

United States Department of the Interior
OFFICE OF THE SECRETARY
Washington, DC 20240

Mr. Steve D. Morris
Director, National Resources and Environment
U.S. Government Accountability Office
Washington, DC 20548

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surveillance system. The white paper will include clearly defined outcomes, involvement of relevant participants, and identification of resource and staffing requirements. The white paper will be developed and submitted to the Director of the USGS by December 31, 2023.

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The Director of USGS should work with APHIS to resolve data-sharing concerns and implement enhancements that would facilitate AP HIS' s participation in USGS' s national wildlife disease database.

USGS response:

The USGS concurs and is collaborating with the above-referenced ad hoc committee (or a sub-committee thereof) to prepare a white paper to identify and prioritize specific actions for resolving data-sharing concerns between the USGS and USDA/ APHIS/WS. The white paper will outline a plan, where feasible, for implementing enhancements to enable APHIS data sharing with the National Wildlife Disease database. This white paper will also be developed and submitted to the Director of the USGS by December 31, 2023.

Similar letters have been sent to other federal officials and the members of Congress listed below. If you have any questions or need additional information, please contact the PFM AM team at DOI_PFM_AM@ios.doi.gov.

Sincerely,

David Applegate
Director

Appendix VI: GAO Contacts and Staff Acknowledgments

GAO Contacts:

Steve D. Morris at (202) 512-3841 or MorrisS@gao.gov or Karen L. Howard at (202) 512-6888 or HowardK@gao.gov.

Staff Acknowledgments:

In addition to the contacts named above, Nico Sloss (Assistant Director), Hayden Huang (Assistant Director), Christy Feehan (Analyst in Charge), Sahar Angadjivand, Kevin Bray, Karina Camacho, Lorraine Ettaro, Eliot Fletcher, Steven Flint, Ellen Fried, Cory Gerlach, Matt McLaughlin, Anika McMillon, Amber Sinclair, Andrew Titmus, and Sarah Veale made key contributions to this report.

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