Prioritizing Zoonotic Diseases for Multisectoral, One Health Collaboration in the United States

Workshop Summary

CS298887A

Photo 1. A brown bear in the forest.

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PARTICIPATING ORGANIZATIONS

United States Department of Health and Human Services (HHS):

- U.S. Centers for Disease Control and Prevention (CDC)
- U.S. Food and Drug Administration (FDA)
- Office of the Assistant Secretary for Preparedness and Response (ASPR)

United States Department of Agriculture (USDA):

- Animal and Plant Health Inspection Service (APHIS)
- Food Safety and Inspection Service (FSIS)
- Agricultural Research Service (ARS)

United States Department of the Interior (DOI):

- U.S. Geological Survey (USGS)
- U.S. National Park Service (NPS)
- U.S. Fish and Wildlife Service (FWS)
- Office of Emergency Management

Environmental Protection Agency (EPA)

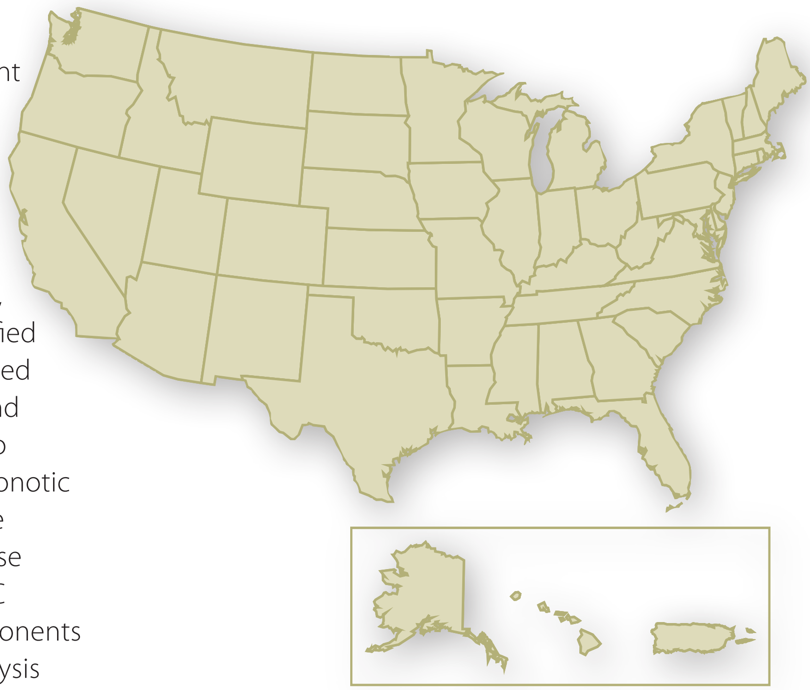
National Oceanic and Atmospheric Association (NOAA)

State Partners:

- Delaware Department of Agriculture
- Virginia Department of Public Health
- Maryland Department of Natural Resources

Photo 2. One Health Zoonotic Disease Prioritization Workshop participants from human, animal, and environmental health sectors in the United States.

EXECUTIVE SUMMARY



The U.S. Centers for Disease Control and Prevention (CDC), the U.S. Department of Agriculture (USDA), and the U.S. Department of the Interior (DOI) organized a One Health Zoonotic Disease Prioritization (OHZDP) workshop to further joint efforts to address zoonotic disease challenges in the United States. The workshop was held December 5-7, 2017, at the Department of Health and Human Services (HHS) Office of the Assistant Secretary for Preparedness and Response (ASPR) headquarters in Washington, DC. During the workshop, participants identified a list of zoonotic diseases relevant for the United States, defined the criteria for prioritization, and determined questions and weights relevant to each criterion. Participants identified eight zoonotic diseases as priorities using a semi-quantitative selection tool, the One Health Zoonotic Disease Prioritization (OHZDP) tool, developed by CDC (Appendix A)[1, 2]. Participants then used components of the One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART™), co-developed by USDA and the University of Minnesota[3, 4], to review and visualize the One Health system currently in place to address the priority zoonoses in the United States among relevant federal agencies. The One Health system includes the procedures and processes for transdisciplinary and multisectoral coordination. Next, participants developed specific steps to address the newly prioritized diseases following the workshop.

The specific workshop goals were:

- To use a multisectoral, One Health approach to identify and prioritize endemic and emerging zoonotic diseases of greatest national concern for the United States that should be jointly addressed by human, animal, and environmental health sectors responsible for federal zoonotic disease programs in HHS/CDC, USDA, and DOI.
- To develop plans for implementing and strengthening multisectoral, One Health approaches to address these diseases in the United States.

This workshop was a critical step towards a unique U.S. approach to One Health, ensuring that all stakeholders have a shared vision and roadmap for implementing One Health strategies for disease surveillance, response, preparedness, workforce, and prevention and control activities in their current and future areas of focus.

Before the workshop, CDC, USDA, and DOI created an initial list of emerging and endemic zoonoses for prioritization using reportable disease lists, reports, and data on zoonotic diseases of concern. The agencies then developed an extensive literature review database for these diseases. Facilitators from each agency were trained in the methods and application of both the OHZDP and OH-SMART™ tools. Three of these trained facilitators, one each from CDC, USDA, and DOI, led the workshop preparation and implementation efforts, in collaboration with a small core planning team of organizers with representatives from each agency.

Workshop participants included voting members and advisors. Voting members represented each of the key federal agencies responsible for zoonotic disease programs in the United States; there were three representatives each from CDC, USDA, and DOI (Appendix B). Organizers also invited 30 government officials from other federal and state agencies who work in the area of zoonotic diseases in the human, animal, and environment sectors (Appendix B). These officials acted as advisors, participating in and informing the One Health Zoonotic Disease Prioritization process. Throughout the workshop, these advisors worked with voting members to develop plans to strengthen multisectoral, One Health zoonotic disease prevention, detection, and response in the United States. Organizers hosted a series of informational webinars in the month before the workshop to familiarize participants with the process, goals, and anticipated outcomes.

The prioritized zoonotic diseases for the United States are zoonotic influenza viruses, salmonellosis, West Nile virus, plague, emerging coronaviruses (e.g., severe acute respiratory syndrome and Middle East respiratory syndrome), rabies virus, brucellosis, and Lyme disease. Please refer to Appendix B for the complete list of diseases considered for prioritization.

The list of priority zoonoses represents a renewed commitment to improved communication, collaboration, and coordination between agencies and departments to use a multisectoral, One Health approach to address these zoonotic diseases. Agreeing to a prioritized zoonotic disease list helps to establish a strong foundation for continued interagency work with a focus on the priority zoonoses. This is in addition to the continuation of existing interagency programs and policies for zoonotic diseases that do not appear on the prioritized list. The list should be reevaluated in 5 years or as often as necessary.

Photo 3. A woman and her pet cat.

This report describes the process used to prioritize the top zoonotic diseases of concern for the United States and the key themes surrounding priority next steps to address these diseases using a multisectoral, One Health approach that includes relevant human, animal, and environmental health sectors and other relevant partners.

Photo 4. A man playing fetch with his dog by a river.

Prioritized Zoonotic Diseases for the United States

Voting members confirmed eight zoonotic diseases for prioritization during the U.S. OHZDP workshop. The information below describes the disease burden or impact of each prioritized disease, as well as examples of previous and ongoing work conducted by each agency around that disease. This information was compiled from the U.S. OHZDP literature review as well as from subject matter experts within each agency (CDC, USDA, and DOI).

1. **Zoonotic influenza (zoonotic influenza A viruses)**
2. **Salmonellosis (*Salmonella* species)**
3. **West Nile virus (Flaviviridae, *Flavivirus*)**
4. **Plague (*Yersinia pestis*)**
5. **Emerging coronaviruses (Coronaviridae; i.e., severe acute respiratory syndrome [SARS-CoV] and Middle East respiratory syndrome [MERS-CoV])**
6. **Rabies (Rhabdoviridae, *Lyssavirus*)**
7. **Brucellosis (*Brucella* species)**
8. **Lyme disease (*Borrelia burgdorferi*)**

1. *Zoonotic Influenza*

Causative Agent

- Influenza A viruses normally maintained in domestic and wild animals but that can be transmitted between animal species, including humans.

Disease Burden and Impacts

- **Human Disease Burden**
  - Some animal influenza viruses are zoonotic and occasionally infect humans, although sustained human-to-human transmission requires host adaptation[5]. This includes certain avian H5, H7, and H9 viruses[6] and swine influenza viruses that may infect humans (referred to as "variant" viruses when infecting humans and designated with letter "v") including H3N2v, H1N1v, and H1N2v[5].
  - In the United States, no human infections with any avian influenza A H5 or H9 viruses have been identified to date[7]. One human infection with avian-origin influenza A (H7N2) virus was reported in 2016, in a person with prolonged unprotected exposure to the respiratory secretions of infected cats at an animal shelter experiencing an outbreak of H7N2 virus in cats. This virus was ultimately characterized to be of avian-origin[8].
  - Influenza viruses that circulate in swine such as H3N2 may cause sporadic human disease, with limited human-to-human transmission. From 2005 to 2017, 468 human infections of variant viruses (mainly H3N2v) were recorded in the United States[9].
  - In the United States, the largest zoonotic disease outbreak of recent years was the 2009 H1N1 pandemic, which led to an estimated 60.8 million human cases and over 12,000 human deaths in the United States[10].

- **Animal Disease Burden**
  - Influenza A viruses are found in many different animals including ducks, chickens, pigs, whales, horses, seals, dogs, and cats.
  - Livestock and Poultry
    - Type A influenza viruses can infect swine and cause a respiratory disease called Influenza A virus in Swine (IAV-S). There are multiple subtypes of type A influenza viruses, including human seasonal type A influenza viruses[11]. IAV infection in swine is not a reportable or regulated animal disease in the United States. The virus is endemic in swine populations in North and South America, Asia, and Europe. Seroprevalence of IAV-S ranges from 20-60% and the mortality rate in swine is estimated to be 2-4%. The USDA's surveillance program for IAV-S identified approximately 8% positive samples from 2010 to 2016.

Photo 5. A group of pigs in a pen.

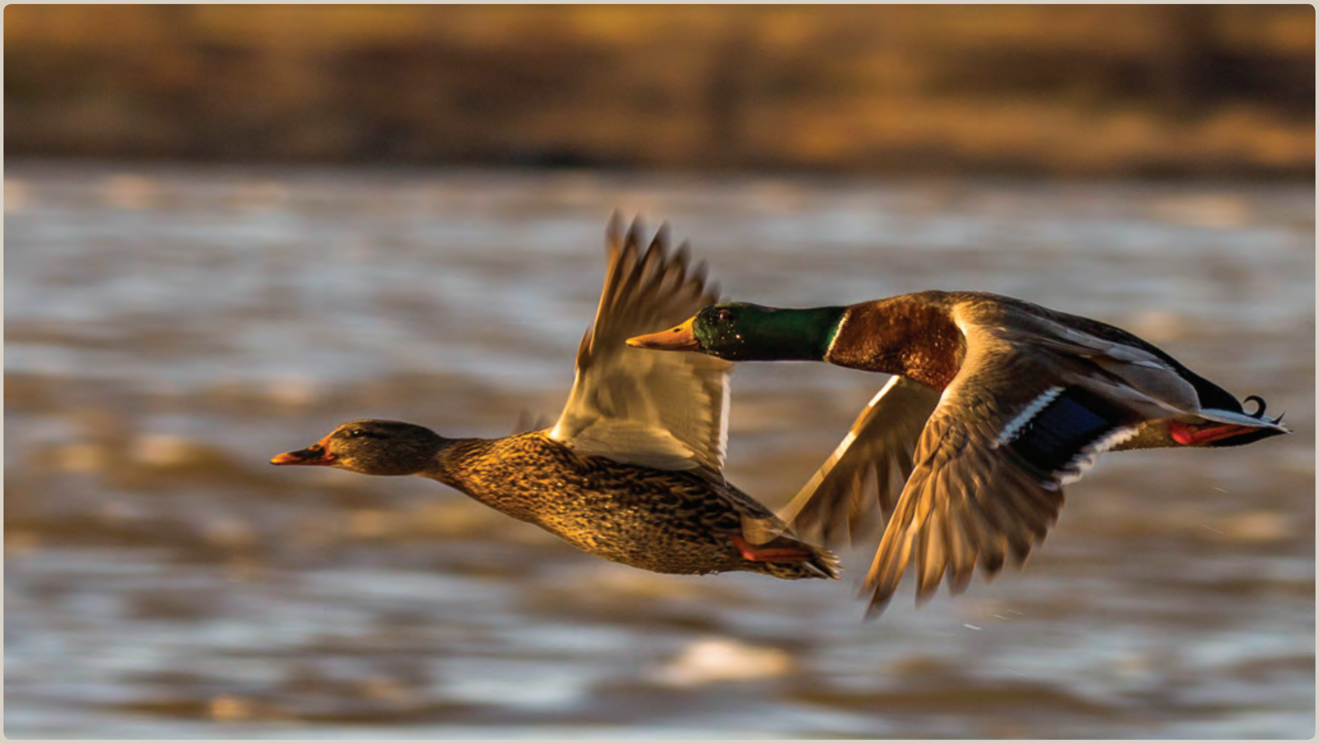


Photo 6. A pair of mallard ducks flying over water.

- In the United States, occasional outbreaks of highly pathogenic avian influenza (HPAI) and low pathogenicity avian influenza (LPAI) in domestic poultry are periodically detected, including North American lineage HPAI and LPAI H7N9 in 2017, North American lineage HPAI and LPAI H7N8 in 2016, and Eurasian lineage HPAI H5N2 and H5N8 in 2014-2015. H5 and H7 subtypes in domestic poultry are reportable to OIE.

› Wildlife

- Feral swine in the United States may be exposed to swine and avian influenza viruses[12-14]. Influenza A viruses occur in feral swine populations; estimates of seropositivity vary from 1% to 14% in one study[13], and approximately 60% seropositive in another study[14]. Morbidity and mortality are unknown.
- Avian influenza viruses cause respiratory and enteric infection in wild waterfowl and other birds, including domestic poultry. Avian Influenza viruses of the H5 and H7 subtypes may develop high pathogenicity in domestic poultry. In domestic poultry, HPAI virus strains are extremely infectious, often fatal to domestic poultry, and can spread rapidly from flock to flock[15]. LPAI virus strains are extremely infectious and can occur naturally in wild migratory waterfowl and shorebirds without causing illness. LPAI can occur in domestic poultry, with little or no signs of illness.
- Leading up to, during, and subsequent to outbreaks of HPAI H5N2 and H5N8 viruses in domestic birds in North America during 2014-2015, wild birds were found to carry HPAI viruses and not appear sick, as identified through United States national surveillance testing on wild birds[16]. From July 2016 to February 2018 (during the post-outbreak period), more than 65,000 wild birds were sampled and 2 (0.003%) were positive for an HPAI virus detection[17, 18]. LPAI viruses, including those of the H5 and H7 subtypes, are endemic in wild waterfowl inhabiting North America, and were also identified as part of this and other national surveillance sampling efforts in the United States.

Photo 7. A young girl walking her dog in the park.

- Pets
  - Zoonotic avian and swine-origin influenza viruses may affect pets, including cats, dogs, and ferrets[19, 20]. Human seasonal influenza viruses also may affect pets[6]. Influenza generally causes mild disease in pets.
  - Canine influenza A (H3N2) virus may affect 60% to 80% of exposed dogs, yet typically with mild symptoms, and rarely more severe illness such as pneumonia[21]. No human infections with canine influenza virus have ever been reported[22].

Environmental Impacts

- USDA and the DOI's U.S. Geological Survey (USGS) actively coordinate with other federal, state, and tribal wildlife, agricultural, and human health agencies to understand avian influenza introductions from foreign sources. They also look at introduction into poultry production operations and distribution across the landscape among host species, including dynamics within and among biotic and abiotic reservoirs. This aids natural resource managers, agricultural officials, and the poultry industry in understanding this disease[23].
- A 2015 USGS groundwater study identified three wells and one lagoon that were positive for the matrix gene indicative of influenza A virus, with one well positive for H5 virus, suggesting that it is possible for avian influenza viruses to be transported to groundwater[24].
- Outbreaks of HPAI can affect wild bird populations, which could have a negative impact on recreational activities related to wildlife resources, such as tourism and hunting.

Current Work

CDC

- The CDC Influenza Division supports domestic and international surveillance and research on both human seasonal and animal influenza viruses, including zoonotic influenza[25].
- The CDC Influenza Division's Influenza Risk Assessment Tool (IRAT) assesses the potential pandemic risk posed by influenza A viruses that currently circulate in animals but not in humans, and highlights zoonotic flu viruses that may pose a risk to human health[26].
- The CDC Influenza Division routinely develops candidate vaccine viruses (CVVs) for zoonotic influenza viruses with pandemic potential as part of its pandemic preparedness activities[27].
- The CDC Influenza Division's International Influenza Program supports activities in more than 50 countries related to surveillance and research of zoonotic influenza viruses at the animal-human interface[28].
- The CDC Influenza Division monitors animal and zoonotic influenza virus outbreaks domestically and internationally. CDC also works with USDA to monitor for possible illness in persons exposed to influenza infected birds or poultry in the United States.

USDA

- USDA's Animal and Plant Health Inspection Service (APHIS) works to keep avian influenza virus, a serious poultry disease, from becoming established in the U.S. poultry population. Avian influenza viruses can infect chickens, turkeys, pheasants, quail, ducks, geese, and guinea fowl, as well as a variety of other birds. Avian influenza viruses findings can negatively impact poultry trade, so APHIS and its partners work together to protect the vitality of this important segment of the country's livestock industry[29].
- The USDA APHIS Veterinary Services' national IAV-S surveillance program monitors genetic changes in endemic, emerging, and novel influenza virus isolates from pigs exhibiting influenza-like illness[11].
- APHIS works with federal and state partners to conduct surveillance testing on wild birds[15].
- USDA develops interventional strategies to control influenza in swine and poultry[29].
- USDA conducts numerous research projects on pathogenesis, epidemiology, and control of zoonotic influenzas.

DOI

- The USGS and other DOI partners conduct surveillance and research related to influenza in wild bird populations, as well as other wild or feral species, and research for understanding how environmental conditions, such as geochemistry, environmental contamination, water quality, hydrology, and climate can affect the distribution, spread, and persistence of pathogens in the environment.
- Specific activities include efforts to detect foreign-origin viruses and identify probable routes of entry; identify sampling efficiencies that may be used to optimize DOI and federal, state, and tribal partner surveillance programs; understand viral transmission, pathogenesis, and epidemiology in wildlife host species; use spatial-temporal modeling to identify high risk populations of poultry and migratory birds in endemic locations; and understand the maintenance of avian influenza virus and IAV-S in wildlife hosts and the environment which may be used in control strategies targeting zoonotic influenzas .
- The USGS Highly Pathogenic Avian Influenza Research Strategy is composed of five main science goals. USGS will augment Federal Interagency Surveillance Plan (Goal #1), improve our understanding of HPAI dynamics in wildlife and the environment (Goals #2–4), and inform managers as we integrate science into HPAI forecasting and decision-making tools (Goal #5)[23].

2. *Salmonellosis*

Causative Agent

- *Salmonella* species (bacteria)

Disease Burden and Impacts

- **Human Disease Burden**
  - Salmonellosis is one of the most important foodborne diseases in the United States. It sickens an estimated 1.2 million people annually, approximately 400 cases per 100,000 persons per year, most of which are not laboratory-confirmed. It also leads to approximately 23,000 hospitalizations and 450 deaths[30].

Photo 8. A chameleon on a woman's hand.

  - In 2017, FoodNet data indicated that *Salmonella* was responsible for an estimated 17 laboratory-confirmed illnesses per 100,000 persons in the United States[31].
  - In 2017, 48 U.S. multistate *Salmonella* outbreaks were linked to contact with backyard poultry, resulting in 1,120 laboratory-confirmed illnesses, 249 hospitalizations, and 1 death[32].That same year, contact with pet turtles resulted in 76 laboratory-confirmed illnesses and 30 hospitalizations[33].
  - Multi-drug resistant (MDR) strains of *Salmonella* have been detected in food, environmental sampling, and human case outbreaks. These are associated with more severe illness and more adverse outcomes[34].
- **Animal Disease Burden**
  - Livestock and Poultry
    - All types of livestock are affected including poultry, ruminants, pigs, and horses. Outbreaks with high morbidity rate and sometimes high case fatality rate are typical in young ruminants, pigs, and poultry. In outbreaks of septicemia, the incidence and mortality rate may approach 100%. In unstressed healthy adults, cases are sporadic [35].

Photo 9. Two backyard chickens.

  - Wildlife
    - Many species of wildlife can be affected by *Salmonella*. The most important are songbirds, which experience mortality events due to contaminated birdfeeders and birdbaths[36]. Salmonellosis outbreaks also can cause relatively large losses in colonial nesting bird populations, such as gulls and terns. Young birds are particularly susceptible to infection and death[36]. *Salmonella* is not usually maintained in wild populations but can be repeatedly acquired from environmental sources such as landfills, sewage wastewater, and agricultural runoff. Outbreaks in wild populations are usually small and linked to birdfeeder use. However, large-scale die-offs in songbirds, shorebirds, and waterfowl have also been recorded[36]. Salmonella strains that cause disease in wildlife can also infect people and domestic pets, so care should be taken when cleaning birdfeeders or disposing of animal carcasses[36].

- Pets
  - Reptiles and amphibians often serve as asymptomatic carriers[37]. Rodents, including pet and feeder rodents, hedgehogs, and other small pets have been linked to outbreaks of human salmonellosis[38]. Dogs and cats experience acute diarrhea, with or without septicemia, and may shed Salmonella for up to 6 weeks[39]. Prevalence may be higher in pets exposed to raw pet foods[39].

Environmental Impacts

- Salmonella has been found in high levels in surface water used for irrigation, which may be connected to produce-related outbreaks[40, 41].

Current Work

CDC

- Laboratory-based Enteric Disease Surveillance: Collects laboratory data from human *Salmonella* cases
- National Notifiable Diseases Surveillance System (NNDSS): Tracks notifiable contagious diseases including *Salmonella*
- Foodborne Disease Active Surveillance Network (FoodNet): Sentinel foodborne surveillance system in 10 states
- National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet): Collects data to connect illnesses and outbreaks across multiple sites
- National Antimicrobial Resistance Monitoring System—enteric bacteria (NARMS): Collaboration between FDA, CDC, and USDA to track antimicrobial resistance
- Foodborne Disease Outbreak Surveillance System (FDOSS): Collects and analyzes data on foodborne disease outbreaks
- CDC Outbreak Response and Prevention Branch (ORPB): Collaborates with epidemiologists and other public health officials who investigate clusters of foodborne, waterborne, zoonotic, and other enteric (gastrointestinal) illnesses in the U.S. ORPB works to ensure rapid and coordinated surveillance, detection, and response to multistate outbreaks caused by enteric bacteria[42].
- Numerous research projects on the burden, sources, and attribution of *Salmonella* using epidemiologic and laboratory data

USDA

- *Salmonella* Action Plan: Comprehensive FSIS plan to reduce *Salmonella* in meat and poultry products in the United States[43]
- *Salmonella* and *Campylobacter* Verification Testing Program: Continuous sampling of poultry establishments to track progress[44]
- National Animal Health Monitoring System: Surveillance of livestock populations for *Salmonella* and other diseases[45]. Numerous research projects on epidemiology, prevention and control measures for *Salmonella*.
- Research on the role of wildlife in transmitting *Salmonella* to livestock and produce at the wildlife-livestock interface[46]

DOI

- National Wildlife Health Center diagnoses and monitors outbreaks of *Salmonella* in wildlife [47]
- USGS water mission area conducts research on the fate and transport of *Salmonella* and other waterborne pathogens in surface water.

3. West Nile Virus (WNV)

Photo 10. Father and daughter on horseback.

Causative Agent

- Flaviviridae, *Flavivirus*

Disease Burden and Impacts

- Human Disease Burden
  - Between 2014 and 2016, incidence has remained around 0.40/100,000 population. Case fatality rate is approximately 6%. In 2017 alone, there were 1,937 cases, 1,293 neuroinvasive cases, and 115 deaths reported to CDC. The disease is most common in mid-to-late summer[48,49]. Neuroinvasive disease can cause long-term disability[50]. Human incidence can vary considerably among years or regions of the United States due to climate and weather conditions that support enzootic transmission (the virus amplifies among birds and mosquitoes)[51]. There is evidence that as many as 70 unreported cases of WNV occur for every reported case[49]. Immunity among avian amplifiers also regulates transmission levels[52].
- Animal Disease Burden
  - Livestock and Poultry
    - Outbreaks have been reported in young domestic geese but other poultry remain asymptomatic. Equids (horses, donkeys, and mules) are the most severely affected mammals[53, 54]. Equids are routinely vaccinated to prevent clinical disease using killed vaccines that have been available and widely used since around 2000-2001. Unvaccinated or under-vaccinated equids are the primary clinical cases identified and the case fatality rate is 38% in horses that show neurologic signs. Of surviving horses, 10-20% will have persistent disability[54, 55].
  - Wildlife
    - Disease is most severe in corvids (crows, ravens, magpies, and jays) but songbirds, raptors, and other birds are also susceptible [56]. Some species of owls and wild grouse are particularly sensitive. Certain songbirds have been implicated as the primary amplifying hosts, but the important species vary by region.
  - Pets
    - Disease has been reported in pet psittacines (parrots), although they are usually resistant. A low number of neurologic infections have been reported in cats, alpacas, and other species[53].
- Environmental Impacts
  - The original WNV outbreak led to a marked decrease in the crow population in the United States, which as of 2007, was still recovering. There continues to be concern regarding the impact of WNV on the persistence and recovery of grouse and wild turkey populations. Other bird species, such as black-billed magpie and black-capped chickadee, appear to have been less severely affected or to have returned to normal more rapidly[56]. Without the use of an experimental DNA vaccine among the endangered California Condor population, it is likely that this species would have become extinct due to WNV infections.

Current Work

- CDC
  - ArboNET: Partnership between CDC and state health departments to collect surveillance data on arboviral infections[57]
  - Investigation of ecological risk factors influencing enzootic and epidemic transmission
  - Investigation of genetic bases of avian virulence and vector competence
  - Promotion of insecticide resistance monitoring in vectors (mosquitoes) and Integrated Pest Management methods for vector control
  - Funding for enhanced laboratory capacity for WNV diagnostics and surveillance among state health departments
  - Funding for five academic Centers of Excellence to enhance capacity for medical entomology nationwide
- USDA
  - Participates in ArboNET[54, 55].
- DOI
  - Supported development of ArboNET
  - Surveillance for WNV in non-native birds in Hawaii[47, 58]
  - Research to understand the relationship between environmental stressors, such as environmental contaminants (e.g. exposure of wild birds to pesticides), and WNV[47]
  - Research on WNV in kestrels, grouse, pelicans, and other avian species[47]
  - Measuring seroprevalence in wild and migratory bird populations[56]

4. *Plague*

Causative Agent

- *Yersinia pestis* (bacteria)

Disease Burden and Impacts

- Human Disease Burden
  - From 1965 to 2012, a median of 8 cases of plague were reported in the United States annually. During this time period, the human case fatality rate was approximately 13%[59]. Although the endemic burden is small, pneumonic plague has epidemic potential. *Yersinia pestis* is a potential bioterrorist agent and is classified as a tier 1 biological agent on the HHS Select Agents and Toxins list[59].
- Animal Disease Burden
  - Livestock and Poultry
    - At least 1 case has been reported in a llama and a goat [60].
  - Wildlife
    - The reservoir is wild rodents. Ground squirrels, prairie dogs, and black-footed ferrets are highly susceptible to fatal infection[61]. Recently, Piute ground squirrels were found to contract fatal disease in Idaho[61].

- Pets
  - Cats are very susceptible to infection, can develop fatal disease, and have caused numerous human infections. From 1926 to 2012, 43% of all primary pneumonic cases of human plague had contact with a domestic cat[62]. Dogs are less susceptible, but can also become infected[63].

- Environmental Impacts
  - Plague can cause up to 90% mortality in prairie dog colonies, leading to local extinction. Black-footed ferrets are also susceptible to the disease, and direct mortality as well as loss of the prairie dog food supply are major obstacles to population recovery[61]. Many other sensitive species, such as badger, swift fox, mountain plover, burrowing owl, and others, are associated with the habitat or prey base that prairie dogs provide, and thus are also affected by plague on the landscape[47, 61].

Current Work

- CDC
  - Surveillance and outbreak response (including environmental investigation) for human cases of plague
  - Plague training module for veterinarians[63]
- USDA
  - Long-term surveillance for plague exposure in wildlife across the Western United States[64]
  - Development of multi-species laboratory assays to detect plague exposure in wildlife and domestic animals
  - Plague risk maps based on analyses of climate and wildlife hosts
- DOI
  - The National Wildlife Health Center (NWHC) diagnoses and monitors rodent populations for plague and other infectious diseases. Researchers there developed an oral plague vaccine in collaboration with academic and state partners[47, 61]. NWHC also supports immunization program to protect prairie dogs and black-footed ferrets from plague[47, 61].
  - Fort Collins Science Center is attempting to reduce the incidence of plague by reducing the populations of fleas. Disease ecologists are assessing the efficacy, longevity, and cost of flea control using pulicides (e.g., deltamethrin) delivered as dust within burrows. FORT researchers are also measuring the population responses of prairie dogs and associated mammals to flea control treatments.

Photo 11. A pair of wild prairie dogs.

5. Emerging Coronaviruses

Causative Agent

- Coronaviridae
  - Examples include severe acute respiratory syndrome-associated coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV).

Disease Burden and Impacts

- Human Disease Burden
  - There have been two travel-acquired cases of MERS-CoV in the U.S. in 2014, neither of which was fatal[65]. During the 2002-2003 SARS outbreak, there were 27 probable cases in the United States, none of which were fatal[66].
- Animal Disease Burden
  - Livestock and Poultry
    - MERS-CoV causes minor disease in dromedary camels. Extensive investigations in other animal species have not demonstrated other reservoirs of infection to date. No cases have been recorded in camels in the U.S.[67].
  - Wildlife
    - There is no evidence of wildlife infection with MERS-CoV or SARS-CoV in the U.S. Bats are suspected to be the evolutionary source for MERS-CoV [68], but that is not proven. Horseshoe bats are believed to be the source of SARS-CoV [68]. A SARS-like virus has been isolated from civets and the importation of civets infected with SARS could present a public health threat [69, 70].
  - Pets
    - Cats and ferrets can be experimentally infected with SARS-CoV [69]. No cases have been recorded in pets in the U.S.
- Environmental Impacts
  - There is no evidence that either MERS-CoV or SARS-CoV has the potential to cause a significant environmental impact. Contact with wildlife may have been associated with the 2003 SARS outbreak in China [71].

Current Work

- CDC
  - CDC provides a real-time reverse transcription–PCR assay to test for MERS-CoV in clinical specimens to qualified laboratories in the U.S. Any presumptive positive or equivocal test results must immediately be reported to CDC, where the test results are confirmed.
  - CDC is also available 24/7 to provide MERS testing guidance, and to provide laboratory and epidemiologic support for any imported case.
- USDA
  - No current work on zoonotic coronaviruses
- DOI
  - The NWHC has done limited surveillance for novel viruses, including coronaviruses, in North American bat populations.

6. *Rabies Virus*

Causative Agent

- Rhabdoviridae, *Lyssavirus*

Disease Burden and Impacts

- Human Disease Burden
  - It is estimated that U.S. citizens experience a potential rabies exposure at a rate of 140 exposures per 100,000 persons each year (40,000 – 50,000 exposures annum)[72]. Post-exposure prophylaxis costs an average of $4,500 U.S. dollars (USD) per person, for an estimated national PEP expenditure of at least $225 million. Compulsory rabies vaccination of domestic pets is a critical component for preventing human deaths and is estimated to cost pet owners more than $30 million per year.
    Overall, rabies control costs in the United States exceed $510 million annually.

Photo12. Bats in flight.

  - Despite relatively frequent human rabies exposures in the United States, human deaths are relatively uncommon due to accessible post-exposure treatment[72]. There have been 8 cases per year on average since 2004[73].
  - Globally, rabies causes approximately 60,000 deaths annually, more than any other zoonotic pathogen[74].
- Animal Disease Burden
  - Livestock and poultry
    - A total of 85 rabid cattle were reported in 2015. Fourteen rabid horses and mules were reported in 2015[73]. Rabies prevention activities targeted at limiting the westward spread of raccoon rabies are estimated to prevent roughly $45 million in economic losses, with a large degree of cost attributed to livestock losses.
  - Wildlife
    - In 2015, 5,088 cases of rabid wildlife were reported: 1,704 bats, 1,619 raccoons, 1,365 skunks, and 325 foxes[73]. The major reservoir species vary by geographic region[75].
  - Pets
    - Sixty-seven rabid dogs were reported in 2015. Two hundred fourty-four rabid cats were reported in 2015[73]. Domestic animal vaccination costs are estimated to exceed $30 million per year.

Photo 13. A racoon in a barn.

- Environmental Impacts
  - The USDA APHIS Wildlife Services conducts a wildlife rabies control program targeting raccoonsin the Eastern United States and foxes along the U.S.-Mexico border. This program distributes more than 10 million oral rabies vaccine (ORV) baits to prevent expansion of the endemic zone[76].

- An economic evaluation of rabies prevention data indicates that for every dollar spent on a coyote ORV program in Texas, between $4 and $13 USD are saved[76].
- The domestic dog-coyote variant of rabies was successfully eliminated from the United States in 2008 as a result of an ORV baiting program in Texas, proving that ORV of wildlife can successfully eliminate terrestrial rabies.
- Rabies is considered a threat to endangered populations of carnivores in Africa.

Current Work

- CDC
  - National Notifiable Disease Surveillance System [77]
  - Respond to >600 public inquiries related to rabies exposures per year [77]
  - World Rabies Day: Annual event to raise awareness of rabies[78]
  - CDC serves as an OIE Reference Laboratory for Rabies.
  - CDC serves as a WHO Collaborating Center for Rabies.
  - National reference laboratory for rabies in the United States
  - Detection and response to cases of imported rabid animals to prevent introduction of foreign rabies viruses
- USDA
  - Rabies in the Americas: Annual international meeting to discuss rabies in the new world[79]
  - National Rabies Management Program: prevent further spread of wildlife rabies and eliminate terrestrial rabies by activities including oral rabies vaccination[75]
  - Develop and refine tools to improve wildlife rabies control at the National Wildlife Research Center[80]
- DOI
  - National Wildlife Health Center scientists are developing an oral rabies vaccine to mitigate human health risks from vampire bat rabies[81].

7. Brucellosis

Causative Agent

- *Brucella* species (bacteria)

Disease Burden and Impacts

- Human Disease Burden
  - Incidence in the United States is 0.4 cases per million. There are approximately 100 cases per year reported in the United States, with the highest numbers reported by California, Texas, Arizona, and Florida[82]. Brucellosis is rarely fatal if treated; in untreated cases, case fatality rate ranges from <2 to 5%. Death is usually caused by endocarditis or meningitis. Most cases recover in 2-4 weeks, although a minority of patients become chronically ill, and relapse can occur even in successfully treated cases [83]. Most human cases are acquired overseas or due to consumption of infected milk products[83].

Photo 14. A woman holding a goat kid.

Animal Disease Burden

Livestock and Poultry

- *Brucella abortus*, the most important *Brucella* species in the United States, mainly infects ruminants. National herd prevalence is less than 0.0001%, but the number of affected herds has been increasing since 2005[84]. The state of Wyoming estimated in 2004 that brucellosis prevention and testing costs were $1.50 - $11.50 per animal head, with a total costs of $495,000 to $3.795 million for protecting 330,000 cattle. Meanwhile, the costs incurred in the first year of infection can be up to $200 per infected animal[85]. It is estimated that prevention efforts save $7 for every $1 spent[85]. Equine cases are occasionally found among imported horses or horses that had exposure to infected cattle herds[86].

Wildlife

- *B. abortus* has two primary reservoirs in the United States: bison and elk in the Greater Yellowstone Area (GYA).Transmission of *B. abortus* to domestic cattle herds in the GYA is mainly due to elk. There is 50% seroprevalence in bison in Yellowstone National Park. Disease burden in elk has been increasing since 2005 and is expanding at a rate of about 12 kilometers per year. Brucellosis is associated with artificial winter feeding of elk herds. Seroprevalence in areas of artificial feeding ranges from 12-80%, while population seroprevalence of hunter-killed elk is 2-3%[89]. *Brucella suis* is endemic in feral swine, and serology has documented exposure in 16 states with seropositive prevalence varying both in time and region from 0.3% to 52.6%[90]. There is significant opportunity for spillover of infections into domestic swine, cattle, and humans from feral swine as the population of feral swine continues to grow and expand in range[90].
- Note: There are spillover events of *B. suis* into cattle but the full extent is unknown. This spillover runs about 2-3 cases per year (Unpublished). *B. ceti* affects marine mammals[91, 92].

Photo 15. Bison herd grazing in Grand Teton National Park.

Pets

- Dogs may become sporadically infected with *Brucella* when exposed to infected livestock or wildlife[87]. Dogs have their own *Brucella* species, *B. canis*, which causes reproductive failure, and rarely causes disease in humans. However, disease burden data for *B. canis* in the United States is not known[88].

Environmental Impacts

- Brucellosis affects populations of bison and elk. Yellowstone bison birth rates are significantly lower for seropositive Yellowstone bison[93]. The population impacts on elk are less well studied, but brucellosis is known to cause abortion[93].

Current Work

CDC

- The National Notifiable Diseases Surveillance System (NNDSS) tracks brucellosis cases in the United States[94]. CDC also collects extended case data on probable and confirmed cases of brucellosis diagnosed in the United States, which supplements the information collected through NNDSS.
- CDC supports state health departments during case investigations, laboratory exposure follow-up, and laboratory testing, and provides subject matter expertise on diagnostics, treatment, and related follow-up for clinicians. CDC also collaborates with state agriculture departments, FDA, and USDA on case and exposure investigations related to domestic human brucellosis cases.
- CDC provides support to other countries building public health and laboratory capacity and collaborates with international organizations to achieve these goals.

Photo 16. Farmers tending their cattle.

USDA

- National Bovine Brucellosis Surveillance and Eradication Plan: national plan to detect and eradicate brucellosis by testing and vaccinating cattle herds[95]
- Tuberculosis and Brucellosis Regulatory Working Group: discusses overarching regulatory concepts for bovine tuberculosis and brucellosis[95-97]
- Nationwide surveillance of *Brucella* species exposure in feral swine[979]

DOI

- Northern Rocky Mountain Science Center brucellosis research: models disease dynamics in wildlife, identifies areas of cattle risk, and assesses effectiveness of management interventions[98]
- Management and research of brucellosis in bison and elk herds[99]

Photo 17. The blacklegged tick, which can carry the pathogen responsible for causing Lyme disease.

8. Lyme disease

Causative Agent

- *Borrelia burgdorferi* (bacteria)

Disease Burden and Impacts

- Human Disease Burden
  - *Borrelia burgdorferi*, an obligatory zoonosis, is the most common vector-borne pathogen in the United States. During 2004-2016, more than 400,000 cases were reported to CDC, but these might represent as little as 10% of true incidence[100]. The range of the principal vector, the tick *Ixodes scapularis*, has been expanding and the number of cases rising, representing a substantial burden on state and local health department resources in high incidence states[100]. Lyme disease is rarely fatal, but the economic cost of testing, treatment, and lost productivity is a major national burden[101]. Even with treatment, a small percentage of cases experience post-treatment Lyme disease syndrome and experience symptoms such as fatigue and muscle aches that can last for more than 6 months[101, 102].
- Animal Disease Burden
  - Livestock and Poultry
    - Lyme disease has been reported in cattle and horses. However, cattle appear largely resistant to infection[103, 104]. Clinical manifestations of equine Lyme disease are a significant problem in the United States. The overall nationwide prevalence is unknown, although it is estimated to be higher than the prevalence in humans but with similar geographic distribution[100].

- Wildlife
  - Disease in wildlife is unknown. The white-footed mouse is the main reservoir for *B. burgdorferi*, although other wild rodents can also act as reservoirs. Birds and lizards may also act as reservoirs, although their role is unclear[106, 107]. Although deer are not reservoirs of Lyme disease, they serve as hosts for the vector tick, and growing populations of white-tail deer have been implicated in expanding the risk to humans[108].
- Pets
  - While most seropositive dogs and cats show no signs of illness, when illness does occur in dogs, Lyme disease is most commonly associated with arthritis, although nephritis and a rare cardiac form have also been described. Research is ongoing to better describe morbidity and mortality in pets[103, 105].

Environmental Impacts

- It is not well understood what the impacts of Lyme disease and efforts to manage ticks are on ecology and wildlife health[109]. Deer population control measures have been instituted in many locations in the northeastern United States due to rampant Lyme disease, but more research is needed to understand the relationship between deer populations and human Lyme disease cases.
- The desirability of housing near natural areas and the increasing attraction of outdoor recreation might be increasing human exposure to infected tick bite[106].
- Environmental changes may lead to increased range of the tick vector[110-112]. Forest fragmentation is associated with increased infection prevalence in ticks[113].

Current Work

CDC

- Advanced Molecular Detection Project: Development and use of whole genome sequencing and metagenomics to identify and track tick-borne pathogens[114]
- Development and large-scale field evaluation of improved acaracides in prevention[115]
- Extensive public outreach and education on tick bite prevention and response[115]
- Evaluation of the economic burden of Lyme disease[115]
- TickNET: Collaborative network with state public health partners and researchers to coordinate research, education, and surveillance[115]
- Funding for Centers of Excellence, state health departments, and the Tick Project[115]
- National Notifiable Disease Surveillance System (NNDSS)

USDA

- USDA Northeast Area-wide Tick Control Project: Multi-site field trial of tick control technology[116]
- Research on tick-host interaction, tick behavior, and tick management[117]
- Tick and tick-borne disease monitoring in wildlife

DOI

- Lyme disease studies at Patuxent Wildlife Research Center: research on tick and tick-borne disease ecology[118] and on approaches to management of vector-borne pathogens that minimize adverse effects on nontarget species[119]

Photo 18. A man standing in California's Sequoia National Forest.

Photo 19. A veterinarian vaccinating pigs.

BACKGROUND

One Health and Zoonotic Diseases

In the 19th century, Dr. Rudolf Virchow first recognized that diseases could be transmitted between humans and animals. Virchow used the term "zoonosis" when studying *Trichinella spiralis*, a parasite found in swine that can be transmitted to humans. In 1947, Dr. James H. Steele recognized the relationship between animal health and human health, and established a veterinary public health platform in the United States by founding the Veterinary Public Health Division at the CDC. In 1966, Dr. Calvin Schwabe, appreciating the need for collaboration between veterinary and human health professionals, coined the term "One Medicine," and established an Epidemiology and Preventative Medicine program at the University of California, Davis, School of Veterinary Medicine[120]. The term "One World – One Health" was introduced in 2004 at the Wildlife Conservation Society conference, and eventually the term "One Health" was established among the human and veterinary medical communities[121].

One Health is defined as a collaborative, multisectoral, and transdisciplinary approach – working at the local, regional, national, and global levels – with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment[120].

One Health

A collaborative, multisectoral, and transdisciplinary approach – working at the local, regional, national, and global levels – with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment

The One Health approach is critical as changing interactions between people, animals, and our shared environment have led to an increase in the emergence and reemergence of infectious diseases of public health importance. By working across the human-animal-environment interface through a One Health approach, public health and animal health partners can coordinate, implement, and promote science-based policies and practices that can support the prevention, detection, and response to infectious disease threats in people and animals, both domestic and wild. Zoonotic diseases, emerging and reemerging infectious diseases, antimicrobial resistance, food safety and security concerns, and other shared health threats demonstrate how human, animal, and environmental health are interconnected, and reinforce the need to address the complexity of these threats through a multisectoral, One Health approach.

Today, there are over 100 organizations worldwide that recognize the importance of One Health through initiatives, programs, or platforms. This includes governmental and non-governmental organizations, international governing bodies, universities, and others[122]. Below is the history of One Health within CDC, USDA, and DOI and their specific activities related to One Health.

Photo 20. A girl holding a rabbit.

One Health at the Centers for Disease Control and Prevention

CDC has been fighting public health threats at the human-animal-environment interface since 1947 and formally established its One Health Office in 2009. CDC works to protect the United States from health, safety, and security threats, both foreign and domestic, including zoonotic diseases, vector-borne diseases, food safety issues, and antimicrobial resistance. Whether diseases start at home or abroad, are chronic or acute, curable or preventable, naturally occurring or deliberate attack, CDC fights disease and supports communities and citizens to do the same, helping to increase the health security of the nation. To accomplish its mission, CDC conducts critical science and provides health information that protects the United States against dangerous and expensive health threats, and responds when these arise.

CDC uses a One Health approach to prevent, detect, and respond to zoonotic diseases and other shared health threats at the human-animal-environment interface. CDC's One Health Office leads domestic and global One Health efforts and partnerships with the goal of achieving optimal health outcomes for both people and animals, as well as a safer environment. CDC is home to thousands of technical and subject matter experts stationed around the globe with world-renowned expertise in endemic and emerging zoonotic diseases of public health importance. CDC scientists study how diseases in animals become threats to human health in the United States and around the world. The CDC One Health Office also hosts the Zoonoses and One Health Updates, or ZOHU Call, to provide timely education on zoonotic and infectious diseases, One Health, and related health threats at the human-animal-environment interface[123]. The CDC One Health Office provides education and resources on preventing zoonotic diseases linked to pets, livestock, and wildlife through the Healthy Pets, Healthy People website[124]. CDC collaborates with numerous domestic (local, state, and federal) and global One Health partners, providing technical assistance and implementing projects to strengthen capacities to prevent, detect, and respond to emerging infectious and zoonotic diseases and other shared health threats of public health importance. This includes helping over 20 countries and one region prioritize their top zoonotic diseases as of 2018.

One Health at the U.S. Department of Agriculture

One Health activities have been integral to the work of USDA since its inception. In 1884, USDA established the Bureau of Animal Industry to protect the public from infected or diseased meat products, eradicate animal diseases, and improve livestock quality and health. That and other One Health-related work continues today as integral functions of eight of the 29 agencies within USDA: the Animal and Plant Health Inspection Service; Agricultural Marketing Service; Agricultural Research Service; Economic Research Service; Food Safety and Inspection Service; Foreign Agricultural Service; National Agricultural Statistics Service; and National Institutes of Food and Agriculture. These agencies all actively serve the American public by ensuring production of wholesome and nutritious foods; preserving the safety of meat, poultry and egg products, animals, and plants entering our country; and safeguarding animal health and welfare. As part of these efforts, USDA's work includes specific projects and activities to better understand and address zoonotic diseases and other complex issues that occur at the human-animal-environment interface.

Photo 21. A young male farmer feeding cows.

In 2009, USDA recognized the need to formalize strategies to guide One Health collaboration efforts within the Department, leading to the creation of the USDA One Health Joint Working Group. The One Health Joint Working Group oversees and guides One Health activities across USDA, as well as with our federal, state, territorial, Tribal, and local partners, to create a comprehensive and holistic One Health approach for domestic and global challenges such as antimicrobial resistance, zoonotic influenzas, pandemic preparedness, and global health security.

USDA-APHIS' One Health Coordination Center (OHCC) was established in 2012 to further One Health operations specific to the animal health component of One Health, including the prevention, mitigation, and control of zoonotic disease threats. OHCC also supports the efforts of the One Health Joint Working Group to strengthen collaboration at all levels within USDA. OHCC's activities include strengthening disease investigation and control activities to protect animal and public health; providing tools and methods for zoonotic disease prevention, preparedness and response; leveraging Veterinary Services (VS) expertise in animal disease surveillance, investigation, and response activities to address zoonotic diseases and other One Health issues; and enhancing communication, coordination, and outreach with stakeholders to promote multisectoral, One Health approaches to addressing zoonotic diseases and other One Health issues. OHCC works directly with CDC and DOI on initiatives to strengthen interagency coordination to address One Health issues to help achieve optimal health outcomes for the nation's livestock, poultry, people, wildlife, and the environment in which they live.

One Health at the U.S. Department of the Interior

DOI conserves and manages the nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper. The DOI One Health Group formed in November 2010 out of recognition that DOI's mission contains the nexus of environmental stewardship, ecosystem, and species protection, the hundreds of millions of visitors to DOI-managed lands, and the nation's responsibilities to Tribal Nations and America's island communities. The DOI One Health Group uses a Department-wide transdisciplinary, coordinated approach to promote the health of all species and the environment in the stewardship of public lands and to promote sound science with interagency collaboration to inform policy and management decisions for issues at the human-animal-environment interface.

DOI uses a One Health approach to support Department-wide surveillance and response capabilities, and activities consistent with the Department's science priorities to enhance the identification and response to emerging health issues. A One Health approach is used to promote and facilitate collaboration across the Department, as well as with other federal agencies and partners. This provides a forum for expert and consensus management advice. It also promotes DOI's wildlife health, public health, and environmental health expertise, resources, and assets.

DOI conducts numerous One Health activities within its bureaus. The U.S. Fish and Wildlife Service (FWS) collaborates with local public health departments on zoonotic disease issues involving wildlife; hosts disease awareness and biosafety training for field staff; attends ongoing public health and zoonotic disease update forums; and provides emergency assistance during zoonotic disease outbreak

Photo 22. A red fox.

response and disaster response such as oil spills and hurricanes. As the FWS encourages greater public use of Refuge lands, knowledge of disease risks to wildlife, livestock, and humans is critical. FWS strives to respond quickly to disease outbreaks, to communicate risks evenly, and to ensure that disease surveillance and diagnostic testing is conducted routinely.

Since 2000, the National Park Service (NPS) has had a working collaboration between Natural Resources Stewardship and Science Directorate and the Office of Public Health, which was formalized with the creation of the Zoonotic and Environmentally-Transmitted Disease Working Group in 2008, the Disease Outbreak Investigation Team (DOIT) in 2009, and the One Health Coordinator Position in 2012. The One Health Coordinator currently serves as one of two epidemiologists responsible for infectious disease response in humans and one of five veterinarians addressing wildlife health issues in parks, and the One Health Program leads the service-wide Integrated Pest Management Activities. In 2009, the NPS Office of Public Health and Wildlife Health Branch created a response team mechanism to ensure response activities and recommendations provided to parks would include a One Health approach, with participation from experts representing human, animals, and environmental health. This team was named the Disease Outbreak Investigation Team (DOIT) and has been relied upon by parks as an urgent response mechanism for a range of human and wildlife health issues. As a federal land management agency, the NPS DOIT team led response to most of these efforts with close and extensive collaboration with local and state health agencies, state wildlife agencies, and other federal partners.

One Health activities at the U.S. Geological Survey (USGS) include collaborative surveillance, risk assessment, and research activities on zoonotic diseases; collaborative vector-borne disease surveillance and research activities including monitoring of the abundance and spatiotemporal distribution of vectors (mosquitoes, ticks, and fleas), passive surveillance and research on West Nile virus, research on Lyme disease, and development of an oral sylvatic plague vaccine for prairie dogs; collaborative surveillance and research on zoonotic pathogens in the environment including anthrax and avian influenza; and support of disaster response and recovery regarding zoonotic diseases and wildlife disease events.

In addition, USGS also has specialized expertise in environmental health science that provides significant contributions to One Health. USGS activities include monitoring environmental quality and the health of wildlife at local, regional, and national scales; identifying the environmental properties and health effects of natural and anthropogenic contaminants that can affect immune response to zoonotic pathogens; characterizing the potential for exposure to pathogens and contaminants via drinking and recreational water, air, dust, soil, and sediment; developing advanced field, laboratory, and modeling methods to measure, map and predict the distribution of environmental pathogens and contaminants; and providing capabilities for geographic analysis and interpretation of environmental data.

Zoonotic Diseases in the United States

Zoonotic diseases are a global burden, including in the United States. Approximately 60% of infectious diseases in humans are zoonotic[125] and about 70% of emerging infections in humans are zoonotic[125,126]. At the federal level, CDC, USDA, and DOI have well-established collaborations for specific zoonotic diseases such as rabies and *Salmonella* infections, as well as vector-borne diseases such as West Nile virus. Below are a few recent and notable zoonotic disease outbreaks that helped incite One Health collaboration between the sectors.

Zoonotic diseases are shared between animals and people. These diseases impact society in three main ways:

- Threaten the health of people and may have the ability to cause a large number of illnesses and deaths, which is associated with significant social and economic loss
- Threaten the health of animals, resulting in illness, loss of productivity, and death
- Threaten the livelihood of a large segment of the population dependent on livestock or other animals as a major source of income

Photo 23. A cow and calf.

Photo 24. A girl holding a parrot.

In 1999, **West Nile virus** was first detected in the United States when birds and humans began to get sick and die in New York City. After a veterinary pathologist at the Bronx Zoo proposed that the human and bird cases were connected, USDA's National Veterinary Services Laboratories isolated viruses from the birds' tissues and forwarded them to CDC for identification and characterization, which confirmed that West Nile virus was the cause of the disease seen in humans, and was spreading from birds to humans via mosquitoes[127, 128]. These were the first documented cases of West Nile virus in the country, causing 61 human infections that year[129]. In addition, thousands of birds, representing 19 species, died from West Nile virus in the New York City area in the 1999 outbreak[130]. In 2003, total human case numbers had climbed to 9,862, and the epidemic had also spread to horses[53, 131]. Online mapping of West Nile virus activity began in 2000 as part of the President's Security and Prosperity Partnership initiative[132]. The maps highlighted West Nile virus detections in sentinel animals, horses, mosquitoes, and humans. This CDC and USGS partnership expanded to include all arboviral diseases in 2006 and further collaboration with USDA to verify and validate equine cases included in ArboNET, the national surveillance system for arboviral diseases maintained by CDC. West Nile virus has established a strong presence in the United States, and in 2017 alone caused 2,097 human cases[133-135]. West Nile virus remains a threat to the United States, including Alaska and Hawaii[136].

Influenza is a zoonotic disease that has driven a number of collaborations, particularly after the H5N1 virus infections in humans from 1997, and the H7N9 virus infections in humans from 2013. In the United States, the largest zoonotic disease outbreak of recent years was the 2009 H1N1 pandemic, which led to an estimated 60.8 million human cases and over 12,000 human deaths[10]. This outbreak emphasized the need for a multisectoral approach to disease surveillance and response. The H1N1 pandemic virus is a novel reassortant with gene segments from two swine influenza virus lineages (North American classical H1N1 and avian-like Eurasian H1N1), as well as North American avian (unknown subtype) and human seasonal H3N2 gene segments. A study by Mena et al. published in 2016 showed that the novel reassortant virus evolved from swine in central Mexico and then crossed to humans in Mexico[137]. From there, independent introductions occurred throughout the United States, including in Texas, the Midwest (Wisconsin), the West (California), and the Northeast (New York)[137]. The virus then spread globally to Europe, Asia, and South America. This was a devastating outbreak that brought attention to the connection between human and animal health. The H1N1 pandemic resulted in a supplemental appropriation from Congress to fund influenza surveillance in swine. USDA developed a network of partners – including CDC and the commercial swine industry – to establish a strong surveillance system to monitor genetic evolution of endemic influenza A viruses occurring in swine. The system also provides isolates for research and for further development of diagnostic reagents, assays, and vaccine seed stock. Additionally USDA, USFWS, and USGS partner to monitor avian influenza viruses in domestic and wild birds for early detection of this disease that can affect poultry health and potentially human health[138, 139]. This collaborative effort laid the groundwork for future coordinated efforts and was critical[140] for the first detection of highly pathogenic avian influenza virus in wild birds and backyard domestic poultry in the United States in 2014, a precursor to the 2015 U.S. poultry outbreak that led to approximately $3.3 billion estimated economy-wide losses[140].

Photo 25. A woman feeding chickens by hand.

In 2017, CDC recorded the largest number of ***Salmonella* infections** linked to contact with backyard poultry that resulted in 1,120 human cases in 48 states, with 249 hospitalizations and 1 death[32]. This outbreak was associated with the increased popularity of owning backyard poultry among people without prior experience working with farm animals. The USDA, CDC, and many other public health partners are actively working to spread awareness among backyard poultry owners on safe handling and simple, effective biosecurity practices[141]. This includes handwashing, keeping poultry outside the home, not eating or drinking in the area where the birds live or roam, and other safe handling practices[141-143]. Together, USDA and CDC have also been working with mail-order hatcheries and feed stores that sell or display live poultry to raise awareness on best practices to reduce *Salmonella* contamination and spread of disease.

As noted above, the importance of using a One Health approach to combat zoonotic diseases has gained traction over the last two decades within the United States. As the threat that zoonotic diseases pose to animals, humans, and the environment continues to increase, there has been an increased urgency to these efforts, particularly as fears of intentional introduction (bioterrorism) have increased. Approximately 80% of agents with potential bioterrorist use are zoonotic pathogens[144]. A notable example of a zoonotic agent being used as a weapon was in 2001, when anthrax spores were mailed to government and media personnel in envelopes. *Bacillus anthracis* is a spore-forming bacterium found in soil that typically spreads to people who come in contact with infected livestock or associated products (meat, hides, and hair). The Environmental Protection Agency (EPA) and USGS partnered to identify links between soil geochemistry and the occurrence of anthrax in the environment in order to provide a risk assessment for natural outbreaks of this pathogen[145]. In the intentional outbreak of 2001, 22 people were infected and five people died[146].

The threat of zoonotic diseases is perpetuated by factors such as expanding human populations; increased industrialization and deforestation; and an increase in international travel and trade. Cumulatively, these factors contribute to increased opportunities for contact between humans, animals, and the environment and provide additional opportunity for disease transmission[147]. Recent estimates suggest pathogens can travel from a remote town around the world to a major city in only 36 hours[148]. The United States has 13,513 airports, more than any other country in the world, making it a key player in globalization and highlighting the critical need for systems in place to prevent transboundary diseases from entering[149]. In 2014, health officials confirmed four human cases of Ebola in the United States linked to the concurrent epidemic in West Africa. Two of the patients had traveled to West Africa and became ill upon their return to the United States. Two were healthcare workers who had treated the first travel patient[150]. These were the first human cases of Ebola ever to be diagnosed in the United States, which emphasized the risk that transboundary diseases pose to the United States and the need to work together to respond appropriately across sectors. In response to concerns about one Ebola patient being in contact with a pet dog while symptomatic, the federal agencies worked with federal, state, and non-governmental partners to develop guidance documents including Interim Guidance for Public Health Officials on Pets of Ebola Virus Disease Contacts and Interim Guidance for Dog or Cat Quarantine after Exposure to a Human with Confirmed Ebola Virus Disease. This outbreak highlighted the importance of considering the human-animal bond and providing for animal care in emergency response[151].

In addition to these transboundary threats, there are growing numbers of endemic zoonotic diseases in the United States resulting from changes at the animal-human-environmental interface, such as *Salmonella, Escherichia coli,* Rocky Mountain spotted fever, hantavirus, avian influenza, and cryptosporidiosis[152]. Increasing occurrence of zoonotic diseases can also be linked to a growing interest in having what are considered non-traditional pets in the household, such as reptiles, amphibians, and small mammals. Sixty-eight percent of U.S. households own one or more pets[153]. Pets have been linked to outbreaks of zoonotic diseases including *Salmonella* transmitted by pet guinea pigs, turtles, and water frogs, monkey pox transmitted by prairie dogs, lymphocytic choriomeningitis virus transmitted by pet rodents, and Seoul Virus transmitted by pet rats, among others[38, 154-157].

Photo 26. A young woman holding a pet chinchilla.

Photo 27. Migrating geese.

Strengthening the One Health Approach to Address Zoonotic Diseases in the United States

Zoonotic disease outbreaks in the United States pose a uniquely challenging situation. As the previous examples illustrate, many One Health collaborations have evolved and are currently in place. For example, USDA and DOI work together to monitor influenza in domestic and wild bird populations, while the CDC conducts influenza surveillance in humans[158, 159]. USDA, CDC, and the Food and Drug Administration (FDA) collaborate to monitor antibiotic resistance of *Salmonella* and other foodborne pathogens via the National Antimicrobial Resistance Monitoring System (NARMS)[160]. U.S. government agencies also conduct programs to prevent and monitor other zoonotic diseases such as Lyme disease, brucellosis, and rabies.

Although progress has been made, there are still opportunities to implement use of a One Health approach to address zoonotic diseases. In 2016, the United States underwent an assessment of its International Health Regulation (2005) capacities using the **Joint External Evaluation (JEE)** tool. The JEE is a voluntary, collaborative, multisectoral process to assess a country's capacity to prevent, detect, and rapidly respond to public health risks occurring naturally or due to deliberate or accidental events[161, 162]. It allows countries to identify the most urgent needs within their health security system, to prioritize opportunities for enhanced preparedness, response and action, and to engage with current and prospective partners to target resources effectively. Among other elements, JEE indicators measure progress based on zoonotic diseases of greatest national public health concern. Recommendations for the United States from the JEE around zoonotic diseases include:

- Establish a National One Health approach which can formally delineate common goals, roles, and responsibilities for the various health and multidisciplinary sectors taking into account the steady state and emergency response[162, 163]
- Formalize interagency networks to address One Health issues through joint investigation, data sharing, communications, and funding of high priority projects and diseases using existing or new multidisciplinary tool[162, 163]
- Increase dedicated public health veterinarians to work on zoonotic diseases at the national, state and local levels[162, 163]

The U.S. One Health Zoonotic Disease Prioritization Workshop was a step to address these recommendations by identifying a prioritized list of zoonotic diseases as well as key areas and priority action items to strengthen common goals, collaboration, and communication around these diseases by the relevant federal agencies.

WORKSHOP METHODS

This workshop used a combination of two One Health tools. First, participants used the One Health Zoonotic Disease Prioritization tool to prioritize endemic and emerging zoonotic diseases of greatest national concern using equal input from key transdisciplinary, multisectoral One Health stakeholders including human, animal (domestic and wildlife), and environmental health agencies and organizations[1, 2].

Once the priority zoonotic diseases were identified, facilitators used elements of the One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART™) co-developed by USDA and the University of Minnesota, to develop specific implementation plans and processes to strengthen cross-sector operations[3, 4].

One Health Zoonotic Disease Prioritization (OHZDP)

The prioritization process involved a semi-quantitative tool developed by CDC. The methods have been previously described in detail (Appendix A)[1]. As of 2018, the OHZDP tool has been used in 20 countries on four continents and one region of 15 countries in the Economic Community of West African States (ECOWAS), including the United States, to prioritize endemic and emerging zoonotic infectious diseases at the federal or ministerial level.

Selection of Voting Members, Advisors, and Facilitators

Three voting members each from CDC, USDA, and DOI were selected to participate (Appendix B). They were chosen based on their technical knowledge, as well as familiarity with operational activities and leadership roles. Their role during the workshop was to provide key input to develop and rank the criteria, develop the questions for prioritizing zoonotic diseases, and confirm the final prioritized zoonotic disease list.

Advisors represented relevant federal and state agencies (Appendix B). There were 6-8 advisors each from CDC, USDA, and DOI, as well as representatives from other relevant federal agencies including HHS (FDA and ASPR), EPA, and the National Oceanic Atmosphere Association (NOAA). Representatives from state agencies were also invited to share their perspective, including a state public health veterinarian from the Virginia Department of Public Health, an assistant state veterinarian from the Delaware Department of Agriculture, and a state wildlife veterinarian from the Maryland Department of Natural Resources. Advisors were selected based on their subject matter expertise and provided key input and expertise during the discussion.

Three experienced facilitators were selected, each representing a different health sector including human health (CDC), animal and plant health (USDA), and environment and wildlife health (DOI). The facilitators were trained to use the OHZDP tool at CDC headquarters in Atlanta before the workshop.

Zoonotic List Development

The first step of the OHZDP process, which starts before the workshop, is to identify a country-specific list of potential zoonotic diseases of concern. CDC and USDA reportable disease lists for humans and animals were cross-checked and all zoonotic diseases were compiled to develop the initial zoonotic disease list. The list was shared with subject matter experts from participating agencies for input. Diseases included on the list were those with known transmission routes between humans and animals, as well as one disease considered 'potentially zoonotic'. Endemic diseases, as well as those occurring regionally or globally, were included, resulting in an initial list of 52 diseases. On the first day of the workshop, participants reviewed the initial list and added four zoonotic diseases. The voting members confirmed a resulting list of 56 zoonotic diseases (Appendix C).

Photo 26. Bald eagle flying over water with Northern Pike in talons.

Criteria and Question Development

The workshop participants then identified a list of criteria for semi-quantitative ranking of the 56 zoonotic diseases. Criteria are characteristics that define why the disease is important to address. The nine voting members each voted to select the top five criteria most important to their agency. Voting members then individually ranked the relative importance of each criterion. The OHZDP tool uses a semi-quantitative Analytical Hierarchy Process to combine the individual ranked criteria lists from each voting member and generate a final weight for each of the five criteria (Appendix D). The criteria weight gives a relative importance to each criterion compared to the others and is applied when the zoonotic disease list is ranked.

Five groups of workshop participants – each with representatives from the three sectors – developed one categorical question for each criterion. The questions are developed in order to assess and assign a score to each disease for each criterion. Each group presented the question they developed and then the five questions were discussed and refined among participants in plenary. The nine voting members convened to finalize the question and scoring rubric for each criterion to ensure it would capture the specific aspects of interest for each disease. All questions were constructed to have ordinal, multinomial (1-5%, 5-10%, 10-20%, etc.) answers, which is necessary for the OHZDP tool.

Ranking the Zoonotic Diseases

Workshop facilitators used data collected through an extensive peer-reviewed literature search that occurred before the workshop, as well as information from WHO, OIE, FAO, ProMED, other relevant websites, and subject matter experts to answer and give a score to each disease for each question. The literature review was designed to collect data on incidence, prevalence, mortality, morbidity, disability-adjusted life years (DALYs), and over 60 other variables specific to human, domestic animal, and wildlife health. Over 650 resources (publications, websites, and reports) were included in the review; global data were used if U.S.-specific data were not available for a particular zoonotic disease.

The OHZDP tool was used for the final disease ranking. The tool uses a decision tree, designed in Microsoft Excel®, to rank the diseases by applying the weighted criterion to the resulting scores for each question for each disease. The scores for all five questions were summed for each disease and then normalized such that the highest final score a disease could receive was 1.0. See Appendix C for a complete listing of normalized scores for all zoonotic diseases that were considered in the workshop.

Workshop facilitators reviewed the ranked list of zoonotic diseases and their normalized scores with the participants. The scoring process for each question for each disease was reviewed and validated. Then the nine voting members from three agencies (CDC, DOI, and USDA), with input from the advisors, confirmed a final list of eight priority zoonotic diseases (Table 1).

Criteria and Question Development

The criteria for ranking zoonotic diseases selected by the voting members in the United States are listed in order of importance below (and also Appendix D).

1 Pandemic/Epidemic Potential

If the disease had previously caused a pandemic either in the United States or globally, it was given a score of 2.

If the disease had previously caused an epidemic in the United States or globally, it was given a score of 1.

If neither was true about the disease, it was given a score of 0.

2 Severity of Disease in Humans, Domestic Animals and Wildlife

This criterion had two parts:

Part 1 assessed the disease mortality or population impact in humans [>5% Case Fatality Rate (CFR)], domestic animals (>10% CFR), or wildlife (mortality or population declines) separately.

The disease was given a score of 3 if it met the criteria for all three sectors, a score of 2 if it met the criteria for humans and either domestic animals or wildlife, a score of 1 if only animals (domestic or wildlife) or only humans were affected, and a score of 0 if it did not meet the criteria for any sector.

When scoring the question, assumptions were made, including: The human CFR assumed that human patients had routine access to health care in the United States. If the pathogen was not present in the United States, global CFRs were used in a comparable developed country, if available. For wildlife it was assumed that if the pathogen causes die offs internationally, it would also cause die offs in the United States. If the literature showed mortality in wildlife, the disease was considered to have met the threshold for that sector.

Part 2 assessed the incidence of the disease in humans or animals in the United States. The thresholds High (≥ 100,000 cases per year), Medium (>5000 - <100,000 cases per year), and Low (≤ 5000 cases per year) were used to score each disease. If a disease was considered to have a High incidence in the United States it was given a score of 2, if it was considered to have a Medium incidence in the United States it was given a score of 1, and if it was considered to have a Low incidence in the United States it was given a score of 0.

To determine the final score for each disease, the scores for Part 1 and Part 2 were summed. If the sum of Part 1 and Part 2 equaled a score of 5, the disease was given a total score of 3. If Parts 1 and 2 combined score equaled 3 or 4 it was given a total score of 2. If Parts 1 and 2 combined equaled a score of 1 or 2, it was given a total score of 1. If Parts 1 and 2 combined equaled a score of 0, it was given a total score of 0.

Photo 27. A couple vacationing at a seaside town.

3 Economic Impact to the United States

Variables for this criterion included trade restrictions in the face of an outbreak (the proxy for this was whether the disease was present on the OIE reportable disease list or not), decreased animal production, impact to outdoor recreation or tourism, intervention costs, or other secondary impacts (specifically ecological impacts). Diseases were categorized as High, Medium, Low, or No economic impact.

A disease was considered High if three or more of the above sectors faces an economic impact and given a score of 3. If two sectors face an economic impact, the disease was considered to be Medium and given a score of 2. If only one sector faces an economic impact, the disease was considered to be Low and given a score of 1. If no sector faces an economic impact, the disease was given a score of 0.

4 Potential for Introduction or Increased Transmission in the United States

This criterion included both potential for introduction to the United States as well as the potential for increased transmission of a disease that is already present in the United States. The three variables considered included: (a) does the disease have a feasible transmission pathway to the United States; (b) has it been detected in North America, and; (c) has there been detection and spread in five or more new countries, regions, or states?

If a disease met the criteria for all three variables, it was given a score of 3. If it met the criteria for two of the 3 variables, it was given a score of 2. If it met the criteria for one of the 3 variables, it was given a score of 1. If it did not meet the criteria for any variable, it was given a score of 0.

5 National Security

This criterion evaluated the potential of the disease to be used for bioterrorism. If the disease was included in the United States Department of Health and Human Services or the USDA Select Agents and Toxins List, and considered a Category A or Tier 1 Agent, it was given a score of 2. If the disease was on either list, but not a Category A or Tier 1 Agent, it was given a score of 1. If the disease was not on either list, it was given a score of 0.

One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART™)

Facilitators used components of the One Health Systems Mapping and Analysis Resource Toolkit (OH-SMART™), developed by USDA and the University of Minnesota, to review the procedures and processes for transdisciplinary coordination for a subset of the top five prioritized zoonotic diseases in the United States. As of 2018, OH-SMART™ has been used in 19 countries for One Health action planning. This was the second time that the OH-SMART™ tool was used with the OHZDP tool in the same workshop to decide upon action items and next steps following the determination of a prioritized list of zoonotic diseases. Participants selected diseases from the prioritized list with varying ecological components, transmission pathways, and control strategies and conducted systems mapping to illustrate interagency interactions during outbreak investigation and response.

Participants were organized into four groups, each focused on a different disease. A mix of advisors and voting members from the human, animal, and environmental sectors and a trained facilitator worked at each table. Each group developed and analyzed a map of the system of communication and coordination between sectors during surveillance and response activities for that disease. Groups identified areas of mission responsibility, current best practices, and gaps. These multi-stakeholder system process maps use a modified swim-lane mapping approach to outline the flow of information, data sharing, decisions, or actions taken among agencies for an outbreak scenario. During the mapping, when questions arose or when people noted a discrepancy in understanding, participants flagged them for further analysis. Facilitators then encouraged participants to review the process maps and also identify areas where:

2. Agencies disagreed on what steps were being taken at any given point;
3. Agencies felt there was a gap or lack of information as to what the appropriate step should be for agency coordination or collaboration; or
4. Points where agencies were coordinating well that were not institutionalized in official regulations or policies.

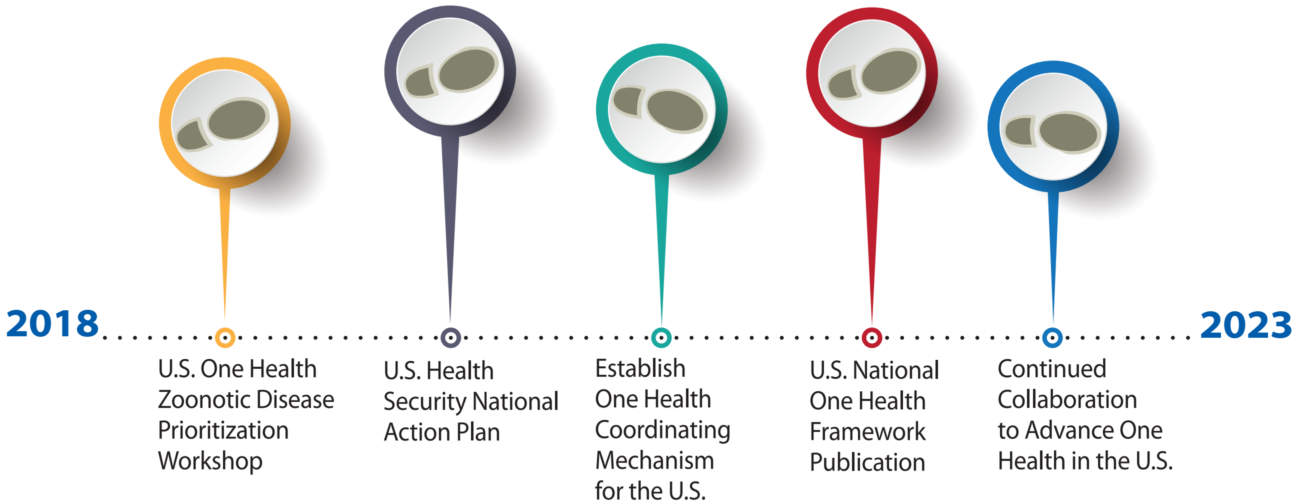
During the analysis, participants identified missing stakeholders, discussed communication and coordination mechanisms, and identified areas of discrepancy between how interagency coordination should occur versus how it actually occurs. Participants were encouraged to think through existing areas of multisectoral, One Health collaboration in terms of surveillance, laboratory capacity, prevention and control strategies, outbreak response, and research. Each table group identified best practices and action steps to address the gaps and then reported their results to all participants.

The systems mapping and analysis process led to a robust group discussion around key themes to improve these systems and potential next steps for the agencies to take together to strengthen One Health coordination around the prioritized zoonoses.

Photo 28. Woman selling produce at a farmer's market.

RECOMMENDATIONS FOR NEXT STEPS

Projected Timeline for Next Steps to Strengthen One Health in the United States



After determination of the prioritized list of zoonotic diseases, participants had a discussion about next steps for multisectoral, One Health collaboration around the priority zoonotic diseases. Through the systems mapping and analysis process and plenary discussions, workshop participants identified themes for improvement in eight key areas (Appendix E. Key Themes and Next Steps). The summary that follows highlights the priority recommendations for next steps and milestones that evolved from the key themes discussion. Activities for these next steps began after the workshop and will continue on an ongoing basis by CDC, USDA, and DOI in collaboration with relevant human, animal, and environmental health partners.

Increase and Leverage Leadership Engagement

Leadership engagement from all relevant sectors is critical to the successful, sustainable implementation of a One Health approach to prevention, detection, and response for the prioritized zoonoses. A key component to engaging leadership is to demonstrate that One Health efforts help maximize resources and increase impact.

Following the workshop, representatives from CDC, USDA, and DOI will present the preliminary results of the workshop to leadership within their own organizations and across the federal government and partner organizations. CDC, USDA, and DOI will develop a communication plan to keep leadership and partners informed of upcoming activities and opportunities to engage with the process. This includes endorsement of the finalized workshop report.

The CDC, USDA, and DOI core planning team will continue to inform senior leadership of One Health successes and activities on an ongoing basis using existing mechanisms and forums such as regularly occurring leadership meetings, written updates, and briefings. The CDC, USDA, and DOI core planning team will also continue to inform partners of One Health successes and activities on an ongoing basis using existing mechanisms and forums such as webinars, attendance at conferences and meetings, and, written updates. Keeping leadership and partners informed of One Health activities on a regular basis will also be a key directive of the federal One Health Coordination Mechanism once established.

Photo 29. A man holding his pet dog.

Create a Formalized One Health Coordination Mechanism at the Federal Level

The creation of a formalized One Health coordination mechanism at the federal level is necessary to strengthen One Health collaboration related to prevention, detection, control, and response for the prioritized zoonotic diseases and related One Health work across the federal government.

To support this, the CDC, USDA, and DOI core planning team will identify appropriate points of contact at relevant agencies with authority to create a coordination mechanism. Once the points of contact are identified, a follow-up meeting will be held to determine what mechanism is most appropriate and draft a charter or other documentation needed for the mechanism to be formally established.

Once a One Health coordination mechanism is established and functioning, it will be responsible for holding regular meetings to assess progress on follow-up activities to improve multisectoral, One Health collaboration. This will include additional follow-up action planning to improve coordination around the prioritized zoonotic diseases as well as other established One Health priorities, including those outlined in other key areas listed in this report.

Development of a National One Health Framework

A national One Health framework is an important step to guide U.S. Government One Health collaborations. A core group from CDC, USDA, and DOI are drafting a national One Health framework that describes a common vision and goals, and defines the roles and responsibilities of federal partners in the multisectoral, One Health space to prevent, detect, and respond to shared health threats at the human-animal-environment interface during both the steady state and emergency response.

This framework will reference established priorities and activities as well as address any identified gaps in collaboration. The draft framework will be shared with key federal partners actively working in the human, animal, and environmental health sectors for feedback. If established by this time, the One Health coordination mechanism would serve as a platform for the coordination of the draft document, leadership engagement, and publication.

Improve Knowledge and Data Sharing for Laboratory, Surveillance, and Response Activities

Improved knowledge and data sharing is needed to address gaps in disease surveillance, prevention, and control as well as to identify gaps in laboratory data sharing. This will help to formalize communication and collaboration related to the prioritized zoonotic diseases as well as other One Health priorities between relevant federal and state departments and agencies.

Existing gaps in knowledge and data sharing as identified through the 2016 JEE or by the One Health Coordination mechanism once established will be addressed by drafting standard operating procedures or memoranda of understanding for sharing data, protocols, lab samples, and others as needed. Activities will align with JEE National Action Plan action items when appropriate that include the development and promotion of indicator-based surveillance tools and strategies for the rapid detection and characterization of emerging and re-emerging pathogens at the human-animal-environment interface. Further work will explore collaborations between academic, state, local, and federal partners for improved knowledge and data sharing among relevant sectors. Joint training opportunities will also be expanded to increase capacity and trust building, and improve skills.

Photo 30. Mother with daughter holding a baby pig.

Improved Coordination during an Outbreak Response

The 2016 JEE report recommended strengthening and standardizing multiagency outbreak response plans. Once formalized, the One Health coordination mechanism will develop a standard approach to initiate interagency coordination in the event of a multiagency response. The One Health coordination mechanism will also consider the development of an interagency plan to coordinate response efforts.

To incorporate a One Health approach to outbreak response, it is important to have appropriate workforce development and training opportunities that integrate One Health among relevant departments and agencies. This could include incorporating multiple disciplines (e.g., veterinarians, physicians, health scientists, laboratorians, epidemiologists, social scientists, behavioral scientists, economists, ecologists, environmental health scientists, toxicologists, geochemists, microbiologists, hydrologists, and others) into existing training programs, jointly conducting a tabletop exercise for a zoonotic disease outbreak response using a One Health approach, a field epidemiology course for federal veterinary epidemiologists, or conducting additional One Health courses for a multisectoral audience in emergency response.

Strengthen Joint Investment for One Health and Prioritized Zoonoses

Joint investment for the prioritized zoonotic diseases will help maximize resources and increase impact of activities related to prevention, detection, control, and response to these shared health threats. It will demonstrate the commitment by the relevant agencies to address these diseases collaboratively. Additionally, strengthened joint investment would help meet JEE recommendations to address One Health issues through funding of high priority projects and diseases using existing or new multidisciplinary tools.

In planning specific activities based on recommendations from the U.S. OHZDP workshop, the One Health coordination mechanism is also to consider appropriate performance metrics and the development of a monitoring and evaluation plan for these activities. The outcomes of these measures will demonstrate to leadership that One Health efforts help maximize resources and increase impact.

Photo 31. Woman with her pet cockatiel.

Education and Awareness

A mainstay of One Health activities is the dissemination of accurate and timely messages to the public to help prevent disease. There are many examples of the relevant federal agencies collaborating to develop and share these messages, but coordinated messaging efforts could be increased and streamlined to allow for joint development of educational material.

Additionally, education and awareness efforts could benefit from expanded partnerships with academia, industry, and non-profit organizations. These organizations can provide additional subject matter expertise and reach a broader audience. Expansion of One Health training opportunities focused around the prioritized zoonotic diseases, both within the federal government and with external stakeholders, is an opportunity for workforce development that would also help to increase awareness of One Health. Continued education and awareness efforts will help improve the long-term sustainability of a One Health approach to prevention, detection, control, and response to zoonotic diseases and related health threats.

One Health Discussion on Research Gaps and Needs

A broader discussion on One Health research gaps and needs is crucial to identify areas where research priorities align between the relevant federal agencies and departments. The One Health coordination mechanism will be tasked with convening a working group to identify the best approach to have a One Health discussion on current research questions, lines of coordination, identify data gaps, science gaps, and research needs. The outcomes of this working group will be to identify and cross align research priorities or data gaps.

Appendices:

- Appendix A: Overview of the One Health Zoonotic Disease Prioritization Process
- Appendix B: One Health Zoonotic Disease Prioritization Workshop, Participants
- Appendix C: Final Results of the One Health Zoonotic Disease Prioritization Workshop
- Appendix D: The Numerical Weights for the Criteria Selected for Ranking Zoonotic Diseases
- Appendix E: Key Themes and Next Steps

APPENDIX A: Overview of the One Health Zoonotic Disease Prioritization Process

One Health Zoonotic Disease Prioritization Workshop in the United States

Washington, DC, December 2017

One Health is the collaborative effort of multiple disciplines and sectors- working locally, nationally, regionally and globally- with the goal of achieving optimal health outcomes, recognizing the interconnection between people, animals, plants, and their shared environment.

What are the goals of the U.S. One Health Zoonotic Disease Prioritization Workshop?

This workshop is a critical step towards a unique, U.S. approach to One Health, ensuring that all stakeholders have a shared vision and roadmap for implementing One Health for disease prevention, surveillance, response, preparedness, and prevention and control activities in their current and future areas of focus.

The specific goals of this workshop include the following:

5. Use a multisectoral, One Health approach to determine the zoonotic diseases of greatest national concern that should be jointly addressed by human, animal, and environmental health sectors responsible for federal zoonotic disease programs in HHS, USDA, and DOI.
6. Develop plans for implementing and strengthening multisectoral approaches to address these diseases in the United States.

Who are the invited workshop participants?

Strengthening a One Health approach encompassing interdisciplinary and multisectoral partnerships requires contributions from all sectors and identification of common priorities for collaboration.

- The U.S. Centers for Disease Control and Prevention (CDC), the U.S. Department of Interior (DOI), and the U.S. Department of Agriculture (USDA) are collaborating to host the U.S. One Health Zoonotic Disease Prioritization Workshop.
- Three trained, neutral facilitators - one from each of CDC, DOI, and USDA – will lead the efforts for workshop preparation and facilitation.
- Core voting members representing each of the key federal agencies responsible for zoonotic disease programs will create the prioritized list of diseases and will validate the plans for strengthening One Health in the U.S.
    - Voting members will consist of 3 representatives each from CDC, DOI, and USDA.
- Advisors provide relevant subject matter expertise to inform the zoonotic disease prioritization process and work with voting members to develop plans to strengthen multisectoral zoonotic disease prevention, detection and response in the U.S. (20-25 advisors).
    - Advisors represent relevant federal agencies, state human and animal health organizations, global health organizations, key academic partners, and non-governmental institutions working in the area of zoonotic diseases.

How will the U.S. One Health Zoonotic Disease Prioritization Workshop be conducted?

- This workshop will use a combination of two methods.
    - The first phase uses the One Health Zoonotic Disease Prioritization tool to prioritize endemic and emerging zoonoses of greatest national concern using equal input from key One Health sectors (developed by CDC).

- The second phase uses the One Health Systems Mapping and Analysis Resource Toolkit (OH SMART™), to develop specific implementation plans and processes to strengthen cross-sector operations (co-developed by USDA and the University of Minnesota).

- In advance of the workshop, CDC, DOI, and USDA are collaborating to collect information, reports, and data on zoonotic diseases of concern in order to create a shortened list of emerging and endemic zoonoses for prioritization during the workshop.
- During the first half of the workshop, voting members will develop and decide upon criteria (such as pandemic potential, disease severity, presence in country) to score and rank each disease. Advisors participate in open discussion during the workshop and provide key information to voting members to support workshop activities.
- The second half of the workshop is dedicated to analyzing the existing cross-sector coordination, identifying opportunities and building an action plan to jointly strengthen the prevention, detection and responses activities to the U.S. list of prioritized zoonoses. All workshop participants will participate in these discussions.
- Workshop participants leave with timely results including a ranked zoonotic disease list that both human and animal sectors can support for multisectoral collaboration and an agreed upon set of next steps and action items for future One Health implementation plans.
- See graphic for an overview of the 7 steps in this One Health workshop process

What are the expected outcomes of the U.S. One Health Zoonotic Disease Prioritization Workshop?

A clearly defined and well-coordinated One Health strategy for the United States will improve the ability to prevent, detect, and respond to health threats at the human-animal-ecosystem interface, and ensure that we are fully prepared for outbreaks of emerging and reemerging infectious and zoonotic diseases from national and international sources. Specific workshop outcomes include.

- A prioritized list of at least five zoonotic diseases of greatest national concern agreed upon by human, animal, and environmental health sectors responsible for federal zoonotic disease programs in CDC, USDA, and DOI.
- Plans that identify specific next steps for multisectoral engagement to develop control and prevention strategies to address the newly prioritized zoonoses.
- A foundation for plans to improve multisectoral collaboration and communication across federal organizations.
- A jointly developed list of necessary action items and next steps for strengthening and integrating One Health approaches to integrate surveillance systems, laboratory systems, joint outbreak response capacity, preparedness planning, and cross-sector prevention and control strategies.
- Final report co-authored by CDC, DOI, and USDA will be published and distributed outlining the details of the process, the list of the prioritized zoonoses, and discussions and recommendations by the participants on how to jointly address the priority zoonotic diseases and plans for strengthening One Health in the U.S.
- The outcomes of this workshop will also support post-Joint External Evaluation (JEE) activities and assist in development of a National One Health Framework for the United States.

7 Steps for the One Health Zoonotic Disease Prioritization Workshop in the United States

BEFORE THE WORKSHOP

STEP 1

Prepare for the Workshop

- Clearly define the purpose and goal of the workshop with all participating sectors
- Identify an equal number of voting members and advisors from each sector to participate in the workshop
- Gather reportable zoonotic disease lists from all participating sectors
- Generate a list of all endemic and emerging zoonoses to be considered for ranking with input from all represented sectors

DURING THE WORKSHOP

STEP 2

Develop Criteria

- Voting members and advisors discuss potential criteria of concern for the country
- Identify 5 criteria that will be used to define the relative national importance of the list of zoonoses; criteria should be locally appropriate and agreed upon by voting members

STEP 3

Develop Questions

- Voting members and advisors discuss categorical question for each of the selected criteria
- Develop one categorical question for each of the selected criteria

STEP 4

Rank Criteria

- Each voting member individually ranks the selected criteria
- Individual scores are combined to produce an overall ranked list of criteria

STEP 5

Rank the Zoonoses to Identify Priority Zoonotic Diseases

- Score each zoonotic disease based on the answers to the categorical questions
- The score is used to create a rank list of the zoonotic diseases
- Voting members come to consensus on the top five priority zoonoses

STEP 6

Analyze Existing Processes

Voting members and advisors will:

- Map existing processes for control and prevention of the prioritized zoonoses across federal organizations, including roles and responsibilities
- Identify best practices and gaps for a One Health approach
- Define collaborative solutions to address each identified gap

STEP 7

Build an Action Plan

Voting members and advisors will:

- Identify specific next steps for multi-sectoral engagement to develop control and prevention strategies to address prioritized zoonoses
- Develop a series of recommendations on next steps to improve multi-sectoral collaboration and communication across federal organizations
- Identify next steps for strengthening One Health approaches to integrate surveillance systems, laboratory systems, joint outbreak response capacity, preparedness planning, and multi-sectoral prevention and control strategies.

WORKSHOP OUTCOMES

- A prioritized list of at least five zoonotic diseases of greatest national concern agreed upon by human, animal, and environmental health sectors responsible for federal zoonotic disease programs in CDC, USDA, and DOI.
- Plans that identify specific next steps for multisectoral engagement to develop control and prevention strategies to address the newly prioritized zoonoses.
- A foundation for plans to improve multisectoral collaboration and communication across federal organizations.
- A jointly developed list of necessary action items and next steps for strengthening One Health approaches to integrate surveillance systems, laboratory systems, joint outbreak response capacity, preparedness planning, and cross-sector prevention and control strategies.
- Final report co-authored by CDC, DOI, and USDA will be published and distributed outlining the details of the process, the list of prioritized zoonoses, and discussions and recommendations by the participants on how to jointly address the priority zoonotic diseases and plans for strengthening One Health in the U.S.

APPENDIX B: One Health Zoonotic Disease Prioritization Workshop Participants for the United States

VOTING MEMBERS

Name	Organization	Department	Position
Dr. Neena Anandaraman	USDA	Office of the Chief Scientist	Veterinary Science Policy Advisor
Dr. Casey Barton Behravesh (Captain, US Public Health Service)	CDC	National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), One Health Office	Director
Dr. Pat Basu	USDA	Food Safety Inspection Service (FSIS), Office of Public Health Science	Chief Public Health Veterinarian
Dr. Chris Braden	CDC	NCEZID, Office of the Director	Deputy Director
Dr. Allen Craig	CDC	National Center for Immunization and Respiratory Diseases (NCIRD), Office of the Director	Deputy Director
Anne Kingsinger	DOI	United States Geological Service (USGS), Ecosystems	Associate Director
Dr. Brian McCluskey	USDA	Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS), Surveillance, Preparedness and Response Services (SPRS)	Associate Deputy Administrator
Dr. Geoff Plumlee	DOI	USGS Environmental Health	Associate Director
Dr. Noah Matson	DOI	Fish and Wildlife Service (FWS), Branch of Conservation Policy and Planning	Policy Advisor, Migratory Birds/Acting Chief

ADVISORS

Name	Organization	Department	Position
Dr. Karen Becker	USDA	FSIS, Office of Public Health Science	Director of Applied Epidemiology
Dr. Sarah Bevins	USDA	APHIS, Wildlife Services	Research Scientist
Elaine Bond (Commander, US Public Health Service)	DOI	Office of Emergency Management	Public Health Emergency Planner & DOI One Health Group Lead
Dr. Patricia (Patti) Bright	DOI	USGS, Environmental Health Mission Area	Senior Advisor
Dr. Michael Carter	USDA	APHIS, VS, SPRS, Cattle Health Commodity	Assistant Director
Dr. Gary Disbrow	ASPR	Biomedical Advanced Research and Development Authority	Acting Deputy Director
Dr. Cindy Driscoll	Maryland Department of Natural Resources	Fish & Wildlife Health Program	State Fish & Wildlife Veterinarian
Dr. Deborah Fauquier	NOAA/NMFS	Office of Protected Resources	Veterinary Medical Officer
Dr. Cyril Gay	USDA	Research, Education, Economics, Agricultural Research Service, Office of National Programs	National Program Leader
Dr. John Gibbins (Captain, US Public Health Service)	CDC	National Institute of Occupational Safety and Health (NIOSH), Division of Surveillance, Hazard Evaluations and Field Studies	Veterinary Epidemiologist

ADVISORS (CONTINUED)

Name	Organization	Department	Position
Jack Herrmann	ASPR	Office of Policy and Planning	Deputy Director
Dr. M. Camille Hopkins	DOI	USGS, Ecosystems Mission Area	Fish & Wildlife Disease Coordinator
Dr. Adam Langer	CDC	National Center for HIV/AIDS, Viral Hepatitis, STD, and TB (NCHHSTP), Division of TB Elimination, Surveillance, Epidemiology and Outbreak Investigations Branch	Surveillance Team Lead
Dr. Karen Lopez	Delaware Department of Agriculture	Delaware Department of Agriculture	Assistant State Veterinarian
Dr. Diane Mann-Klager	DOI	Bureau of Indian Affairs (BIA), Great Plains Regional Office, Division of Natural Resources	Natural Resources Officer
Dr. Jennifer McQuiston (Captain, US Public Health Service)	CDC	NCEZID, Division of High Consequence Pathogens and Pathology	Deputy Director
Dr. Julia Murphy	Virginia Department of Public Health	Department of Public Health	State Public Health Veterinarian
Dr. Megin Nichols	CDC	NCEZID, Division of Foodborne, Waterborne and Environmental Diseases (DFWED), Outbreak Response and Prevention Branch, Enteric Zoonoses Activity	Activity Lead
Dr. Tonya Nichols	EPA	National Homeland Security Research Center, Office of Research and Development	Associate Director for Strategic Operations
Dr. Sonja Olsen	CDC	NCIRD, Influenza Division, Epidemiology and Prevention Branch	Epidemiologist
Dr. Donald Prater	FDA	Office of Foods and Veterinary Medicine	Assistant Commissioner for Food Safety Integration
Dr. Jill Rolland	DOI	USGS, Western Fisheries Research Center	Director
Dr. Jane Rooney	USDA	APHIS, VS, SPRS, One Health Coordination Center	Assistant Director
Dr. Ronald Rosenberg	CDC	NCEZID, Division of Vector-Borne Diseases, Office of the Director	Associate Director For Science
Dr. Jonathan Sleeman	DOI	USGS, National Wildlife Health Center	Director
Dr. Kendra Stauffer	CDC	NCEZID, Division of Global Migration and Quarantine, Quarantine and Border Health Services Branch	Veterinary Medical Officer
Dr. Anne Straily	CDC	Center for Global Health, Division of Parasitic Diseases and Malaria, Parasitic Diseases Branch	Veterinary Medical Officer
Dr. Darrel Styles	USDA	APHIS, VS, Science, Technology, and Analysis Services, Risk Identification/Risk Assessment Unit	Senior Staff Veterinarian
Dr. Elaine Wencil	ASPR	Medical Countermeasures Requirements	Senior Health Scientist/ Acting Branch Chief
Dr. Margaret Wild	DOI	National Park Service (NPS), Biological Resources Division, Wildlife Health Branch	Chief Wildlife Veterinarian

OBSERVERS

Name	Organization	Department	Position
Colleen Brouillette	CDC	NCEZID, Office of the Director	Public Health Program Specialist
Grace Goryoka	CDC	NCEZID, One Health Office	Health Scientist
Dr. Emily Lankau	CDC/DOI	National Wildlife Health Center	CDC Preventive Medicine Fellow Assigned to US Geological Survey, National Wildlife Health Center
Nadia Oussayef	CDC	NCEZID, One Health Office	Public Health Analyst
Dr. Christopher Perdue (Commander, US Public Health Service)	ASPR	ASPR, Office of Policy & Planning	Commander (CDR), US Public Health Service Branch Chief, International Health Regulations
Dr. Kate Varela	CDC	NCEZID, One Health Office	Veterinary Medical Officer

FACILITATORS

Name	Organization	Department	Position
Dr. Tracey Dutcher	USDA	APHIS, VS, SPRS, One Health Coordination Center	Agricultural Health Systems Specialist
Dr. Samantha Gibbs	DOI	FWS, National Wildlife Refuge System, Natural Resource Program Center, Wildlife Health Office	Wildlife Veterinarian
Dr. Vikram Krishnasamy	CDC	NCEZID, DFWED, Outbreak Response and Prevention Branch	Medical Officer

WORKSHOP ORGANIZERS

Name	Organization	Department	Position
Dr. Casey Barton Behravesh (Captain, US Public Health Service)	CDC	NCEZID, One Health Office	Director
Elaine Bond (Commander, US Public Health Service)	DOI	Office of Emergency Management	Public Health Emergency Planner & DOI One Health Group Lead
Dr. Tracey Dutcher	USDA	APHIS, VS, SPRS, One Health Coordination Center	Agricultural Health Systems Specialist
Dr. Samantha Gibbs	DOI	FWS, National Wildlife Refuge System, Natural Resource Program Center, Wildlife Health Office	Wildlife Veterinarian
Grace Goryoka	CDC	NCEZID, One Health Office	Health Scientist
Dr. M. Camille Hopkins	DOI	USGS, Ecosystems Mission Area	Fish & Wildlife Disease Coordinator

WORKSHOP ORGANIZERS (CONTINUED)

Name	Organization	Department	Position
Dr. Vikram Krishnasamy	CDC	NCEZID, DFWED, Outbreak Response and Prevention Branch	Medical Officer
Nadia Oussayef	CDC	NCEZID, One Health Office	Public Health Analyst
Dr. Jane Rooney	USDA	APHIS, VS, SPRS, One Health Coordination Center	Assistant Director
Dr. Kate Varela	CDC	NCEZID, One Health Office	Veterinary Medical Officer

Photo 32. The Washington Monument and tidal basin in Washington, D.C.

APPENDIX C: Final Results of the One Health Zoonotic Disease Prioritization Workshop in the United States

Zoonotic diseases considered for prioritization in the United States: Final results of prioritization and normalized weights for 56 zoonotic diseases. The top prioritized zoonotic diseases selected by the voting members representing all agencies active in zoonotic disease work are shown in bold.

#	Zoonotic Disease	Rank
1	**Zoonotic Influenzas**	1
2	Anthrax	0.795
3	**Salmonellosis**	0.750
4	**West Nile Virus**	0.750
5	**Plague**	0.735
6	**Severe Acute Respiratory Syndrome (Coronavirus)**	0.715
7	**Rabies**	0.705
8	Rift Valley Fever Virus	0.693
9	**Brucellosis**	0.686
10	Chronic Wasting Disease*	0.654
11	**Lyme Disease**	0.654
12	Psittacosis	0.641
13	Q Fever	0.641
14	Venezuelan Equine Encephalitis	0.641
15	Crimean-Congo Hemorrhagic Fever	0.629
16	Ebola Virus	0.626
17	Bovine Spongiform Encephalopathy	0.596
18	Yellow Fever Virus	0.596
19	Zoonotic Tuberculosis	0.596
20	Nipah Virus	0.584
21	Cryptosporidiosis	0.581
22	Western Equine Encephalitis	0.581
23	New World Screwworm	0.539
24	Campylobacteriosis	0.536
25	Hantaviruses	0.536
26	Listeriosis	0.536
27	**Middle Eastern Respiratory Syndrome (Coronavirus)**	0.536
28	Spotted Fever Rickettsiosis	0.533
29	Monkeypox	0.523
30	Eastern Equine Encephalitis	0.521
31	Shiga Toxin-Producing Escherichia coli	0.521
32	Meliodosis	0.508
33	Tularemia	0.494
34	Giardiasis	0.476
35	Leptospirosis	0.476
36	Toxoplasmosis	0.476
37	Hendra virus	0.463
38	Marburg Hemorrhagic Fever	0.451
39	Lassa Fever	0.406
40	Coccidioidomycosis	0.404
41	Cryptococcosis	0.392
42	Glanders	0.376
43	Japanese Encephalitis	0.370
44	Vibriosis	0.328
45	Lymphocytic Choriomeningitis Virus	0.306
46	Histoplasmosis	0.284
47	Trichinellosis	0.235
48	Blastomycosis	0.223
49	Rat Bite Fever	0.223
50	Cysticercosis-Bovine	0.175
51	Cysticercosis-Porcine	0.175
52	Murine Typhus	0.175
53	Anaplasmosis	0.114
54	Babesiosis	0.114
55	Ehrilichiosis	0.114
56	Trypanosomiasis (Chagas)	0.114

*CWD was suggested to be kept on the initial list for consideration because even though no human cases have been detected, CWD falls within a class of pathogens that includes some that have been show to infect humans (namely, BSE). There is also evolving laboratory animal data showing transmission of CWD to macaques through feeding of meat from infected animal, which heightens our concerns for potential zoonotic transmission.

Due to the unique circumstances of prion diseases—including a long and unpredictable incubation period that could be years or even decades—long-term surveillance is needed to know whether or not human infections could be occurring. For this reason, the "question" of CWD as a zoonotic disease has been approached with a strong One Health purpose.

APPENDIX D: Numerical weights for the criteria selected for ranking zoonotic diseases in the United States

Criteria 1: Pandemic and Epidemic Potential (criterion weight = 0.3328852)

Question: Does the disease have pandemic or epidemic potential?

Answer:

- ☐ Pandemic = 2
- ☐ Epidemic = 1
- ☐ None = 0

Criteria 2: Severity of Disease (criterion weight = 0.2832083)

Question: Part 1. Does the disease cause mortality or population impact in humans (>5% CFR), domestic animals (>10% CFR), or wildlife (mortality or population declines) in the United States?

[1. The assumption was with routine health care in the United States. If pathogen is not present in the United States, we used global CFR and tried to use a comparable developed country, if available. 2. Wildlife assumption was that if it causes die offs internationally, this would also cause die offs in the United States. If literature showed there is mortality in wildlife, we said yes.]

Answer:

- ☐ All = 3
- ☐ Humans and either domestic animals or wildlife = 2
- ☐ Only animals (domestic or wildlife) or only humans = 1
- ☐ None = 0

Question: Part 2. Was the incidence of the disease in humans or animals in the United States High (≥ 100,000 cases per year), Medium (>5000 - <100,000 cases per year) or Low (≤ 5000 cases per year)?

Answer:

- ☐ High = 2
- ☐ Medium = 1
- ☐ Low = 0

Answer: Total Score of Part 1 and Part 2

- ☐ If parts 1 and 2 combined equals a score of 5 [High CFR/population decline AND high incidence] = 3
- ☐ If parts 1 and 2 combined equals a score of 3 or 4 =2
- ☐ If parts 1 and 2 combined equals a score of 1 or 2 = 1
- ☐ f parts 1 and 2 combined equals a score of 0 [No or low CFR/population decline AND low incidence] = 0

Criteria 3: Economic Impact (criterion weight = 0.156703)

Question: Does the disease cause economic impacts in the United States? (Variables included trade restrictions, decreased animal production, impact to outdoor recreation or tourism, intervention costs, or other secondary impacts [ecological impacts])?

Answer:

- ☐ High (three or more sectors face economic impacts) = 3
- ☐ Medium (two sectors face economic impacts) = 2
- ☐ Low (one sector impacted) = 1
- ☐ No sector faces economic impact = 0

Criteria 4: Potential for introduction or increased transmission in the United States (criterion weight = 0.1493002)

Question: Does the disease have a feasible transmission pathway, has it been detected in North America, or has there been detection and spread in five or more new countries, regions, or states?

Answer:

- ☐ All subparts = 3
- ☐ 2 out of 3 subparts = 2
- ☐ 1 out of 3 subparts = 1
- ☐ None of the above = 0

Criteria 5: National security (criterion weight = 0.0779034)

Question: Is the disease on the USDA/HHS Select Agents or CDC bioterrorism list?

Answer:

- ☐ Category A or Tier 1 Agent = 2
- ☐ Agent on either list, but not Category A or Tier 1 Agent = 1
- ☐ Agent not on either list = 0

APPENDIX E: Key Themes and Next Steps from the One Health Zoonotic Disease Prioritization Process

The table below is a summary of key opportunities identified during steps 6 & 7 of the workshop, analyzing existing processes and building action plans. The opportunities and potential next steps outlined here represent an informal roadmap to addressing gaps identified in multisectoral, One Health coordination for the prioritized zoonotic diseases. This was the first step in brainstorming action items as identified by the stakeholders present. Follow-up planning will include bringing together subject matter experts and other stakeholders to determine and move forward with specific action items.

Identified Opportunity	Rationale	Considerations	Potential Next Steps
Increase and Leverage Leadership Engagement	• Essential for sustainability and implementation of action items • Necessary in order to incorporate a One Health approach into decision-making • Fundamental for policy, decision-making and resource allocation	• Determine the levels of leadership that need to be engaged • Identify the best methods for engagement • Ensure senior leadership has the information needed to take informed action	• Engage leadership in post-workshop outreach and awareness activities, including endorsement of the workshop report • Develop a roadmap to keep leadership informed of activities and to know at what steps their input will be needed • Keep leadership informed of One Health successes and activities on an ongoing basis • Demonstrate to leadership that One Health efforts help to maximize resources and increase impact
Create a Formalized One Health Coordination Mechanism at the Federal Level (Leadership, Technical)	• Necessary to strengthen One Health collaboration related to prevention, detection, control and response of the prioritized zoonotic diseases and related One Health work across federal government • Needed to support the institutionalization of One Health coordination mechanisms • Important to address 2016 Joint External Evaluation (JEE) of the U.S. report findings recommending closer collaboration on interagency One Health activities Important to build trust across federal agencies	• Determine how best to operationalize coordination mechanisms at both the senior and technical working group level • Identify how different levels of government (including state partners) can best be engaged • Ensure leadership buy-in • Determine most appropriate organizational framework including frequency of meetings and necessity of charter/ terms of reference or other documentation	• Convene a follow-up meeting to review and select a potential coordination mechanism: » Establish a core group of subject matter experts » Embedded liaison model (such as FDA, USDA liaisons to CDC) » Interagency detail opportunity » Identify a point of contact for each agency for multiagency response » Formalize the Federal Interagency One Health Working Group • Make a recommendation on selected potential mechanism to leadership • Once a coordination mechanism is determined, follow up with action planning • Include state level advisors once coordination mechanism is established and functional

Identified Opportunity	Rationale	Considerations	Potential Next Steps
Development of a national One Health framework	• Important to guide U.S. Government One Health Collaborations • Needed to improve capacity to prevent, detect and respond to public health threats using a One Health approach • Important to address JEE recommendations	• Define common vision and goals » Objectives must be achievable and measurable • Formalize roles and responsibilities of federal partners during steady state and during One Health emergency response events	• Core group from CDC, USDA, and DOI to draft document and maintain responsibility for soliciting feedback from partners working in the human, animal and environmental health sectors
Improve Knowledge and Data Sharing for Laboratory, Surveillance, and Response Activities	• Needed to formalize communication and collaboration related to prioritized zoonotic diseases • Important to address gaps in disease surveillance, prevention and control • Needed to identify gaps in laboratory data sharing • Address JEE finding that interoperability among information systems used in animal and human health sectors for zoonotic diseases is limited	• Identify existing knowledge gaps • Determine best approach to improve surveillance and data collection systems architecture across federal agencies to improve information sharing • Discussed need to understand ecological knowledge gaps in risk factors for disease emergence • Address operational and academic research needs	• Identify gaps in data sharing between agencies and potential mechanisms for improvement • Write additional protocols or SOPS as needed • Write additional MOUs or establish other means for sharing data, protocols and lab samples and other relevant data as needed • Expand joint training opportunities to increase capacity, trust building and improve skills • Explore collaborations between academic, state, local and federal partners
Strengthen Joint Investment for Prioritized Zoonotic Diseases	• One Health efforts help to maximize resources and increase impact by focusing scarce resources to more efficiently work on joint activities including building laboratory capacity, surveillance, outbreak response, preparedness, and other collaborative activities • Needed to meet JEE recommendation to address One Health issues through funding of high priority projects and diseases using existing or new multidisciplinary tools	• Opportunities for joint investment must be identified • One Health requires a shared commitment by multiple sectors	• Demonstrate to leadership that One Health efforts help to maximize resources and increase impact • Once formalized, the One Health coordination mechanism to consider: » Appropriate performance metrics » Development of a monitoring and evaluation plan » Best method to allocate shared resources when appropriate and potential for reallocation of existing funds

Identified Opportunity	Rationale	Considerations	Potential Next Steps
Education and Awareness	• Needed to formulate a coordinated, effective educational messaging plan between federal agencies	• Identify and reach target populations through partnerships • Determine target populations	• Establish an MOU for co-branding educational materials • Expand partnerships: » Academia » Industry » Non-profit organizations • Offer One Health joint training opportunities
One Health Discussion on Research Gaps and Needs	• Crucial to identify research needs and areas where research priorities may be aligned	• Determine a platform or mechanism to share research findings • Explore opportunities to leverage existing programs and partnerships such as Centers of Excellence to better coordinate research on identified knowledge gaps	• Convene a working group to identify and cross align research priorities or data gaps • Create repository of shared research • Collaborate on research and development tools • Organize workshops or working groups to share information about current research questions, lines of coordination, identify data gaps, science gaps, and research needs
Improved Coordination During an Outbreak Response	• Important to address 2016 JEE report recommendation to strengthen and standardize multiagency outbreak response plans	• Determine core agencies involved in a multiagency response • Determine previous or current coordinated response plans that are already in place	• Once formalized, the One Health coordination mechanism to consider: » Development of a multiagency plan to coordinate response efforts » Potential development of multi-disciplinary teams • Assign a point of contact by agency for multiagency response • Offer One Health joint training opportunities for preparedness and response

Photo 33. Artic fox standing in snow.

ACKNOWLEDGEMENTS

We thank the numerous individuals who provided support for the literature review, workshop preparation, and report development.

CDC Epidemiology Elective Students:

7. Anna Biesbrock
8. Kimberly Calloway
9. Nathan Crilly
10. Kimberly Conway
11. Stephanie Folkerts
12. Angela Giaquitno
13. Frances Goglio
14. Judy Jean
15. Nina Paletta
16. Sydney Stein
17. Marissa Tan
18. Alice Tin
19. Michelle Waltenberg

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20. Nicolletta Cuthbert
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26. Abby Gates
27. Jennifer Groetsch
28. Emily Hamilton
29. Pauline Harrington
30. Erika Lessien
31. Josh Mongillo
32. Armaghan Nasim
33. Elizabeth Rabold
34. Kanya Rajagopalan
35. Ramya Ramaraju
36. Elizabeth Ritter
37. Salah Shaikh
38. Merete Tschokert
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48. Mary Choi
49. Julie Cleaton
50. Shannon Cooney
51. Diego Caceres Contreras
52. Samuel Crowe
53. Elizabeth Ervin
54. Marc Fischer
55. Katie Fullerton
56. Susan Gerber
57. Ria Ghai
58. Elizabeth Gray
59. Christopher Gregory
60. Susan Hill
61. Alison Hinckley
62. Christine Hughes
63. Brendan Jackson
64. Namita Joshi
65. Gilbert Kersch
66. James Kile
67. Marie Killerby
68. Barbara Knust
69. Miwako Kobayashi
70. Aaron Kofman
71. Nick Komar
72. Ryan Maddox
73. Andrea McCollum
74. Orion McCotter
75. Susan P. Montgomery
76. Jennifer Murphy
77. Maria Negron
78. Megin Nichols
79. Brett Peterson
80. Mary Reynolds
81. Dawn Roelig
82. Pierre Rollin
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Photo 33. A pair of skunks peeking out of a hollowed tree

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CS298887A