



# Information to Prevent Human Exposure to Disease Agents Associated with Wildlife—U.S. Geological Survey Circulars on Zoonotic Disease

By Carol U. Meteyer and Gail Moede Rogall

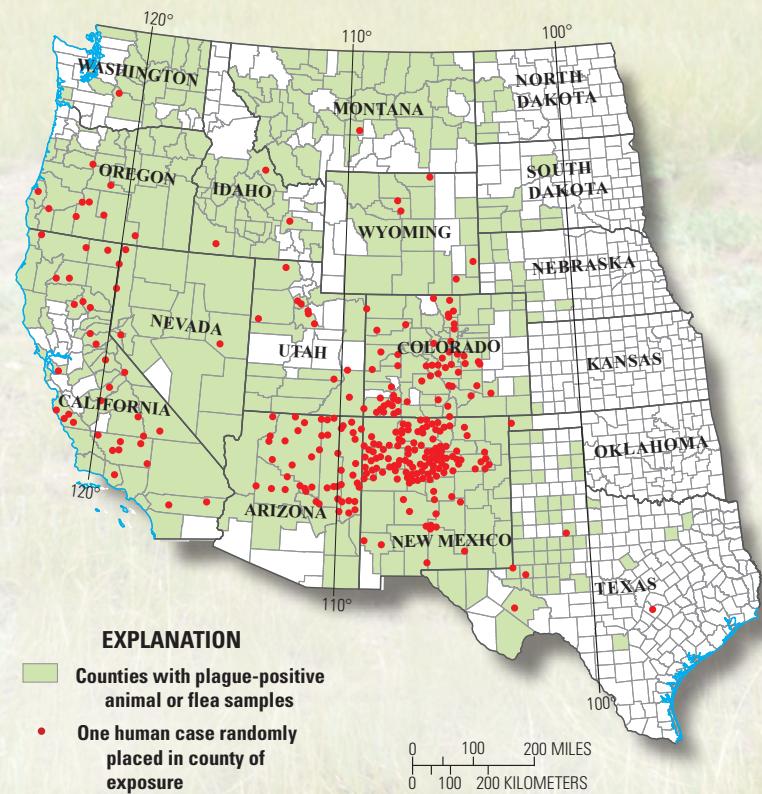
Zoonotic diseases, or zoonoses, are diseases that can be passed from animals to humans, such as rabies and plague. Because humans can protect themselves from direct contact with wildlife or with wildlife feces and urine, controlling these diseases is often a matter of education, avoidance, and prevention. The U.S. Geological Survey (USGS) investigates wildlife diseases, including zoonoses, at places where wildlife, domestic animals, humans, and the environment interact. In collaboration with both government and nongovernment disease specialists and the U.S. Fish and Wildlife Service, the USGS National Wildlife Health Center (NWHC) has published information circulars about seven zoonotic diseases. These circulars include information about steps you can take to protect yourself and others from infection. The circulars about plague, bat rabies, and raccoon roundworm larva infection are highlighted in this fact sheet. This fact sheet and the circulars are not intended to provide medical advice; if you are concerned about disease exposure, contact your health care provider.

## Plague

Plague is caused by the bacterium *Yersinia pestis*. Rodents and fleas are the natural hosts of *Y. pestis* in the wild, but people and their pets can also be infected if they come in contact with infected rodents or are bitten by an infected flea. In the United States, plague in prairie dogs is most commonly found in grassland ecosystems (fig. 1) and in the arid southwest (fig. 2). Plague is also frequently seen in ground squirrel populations. This disease is primarily spread by fleas during the summer, and it has the potential to kill all of the prairie dogs in affected colonies (Abbott and Rocke, 2012). Plague is found in most of the Western States (fig. 2) and has even occurred in squirrels within Denver's city limits.



**Figure 1.** A *Cynomys ludovicianus* (black-tailed prairie dog) runs back to its burrow in Wind Cave National Park, South Dakota, after being released from a trap. The prairie dog is part of a field test to determine the effectiveness of an oral vaccine against plague that was developed by USGS scientists. (Photo by Marisa Lubeck, U.S. Geological Survey.)



**Figure 2.** In the United States, most counties where samples from animals or fleas have tested positive for plague from 1970 to 2009 were west of the 100° west meridian, where the infection in wildlife is common. Cases of plague in humans from 1970 to 2007 occurred most commonly in the Southwest and Pacific States. (Map based on K. Gage, Centers for Disease Control and Prevention, written commun.)

## Plague (continued)

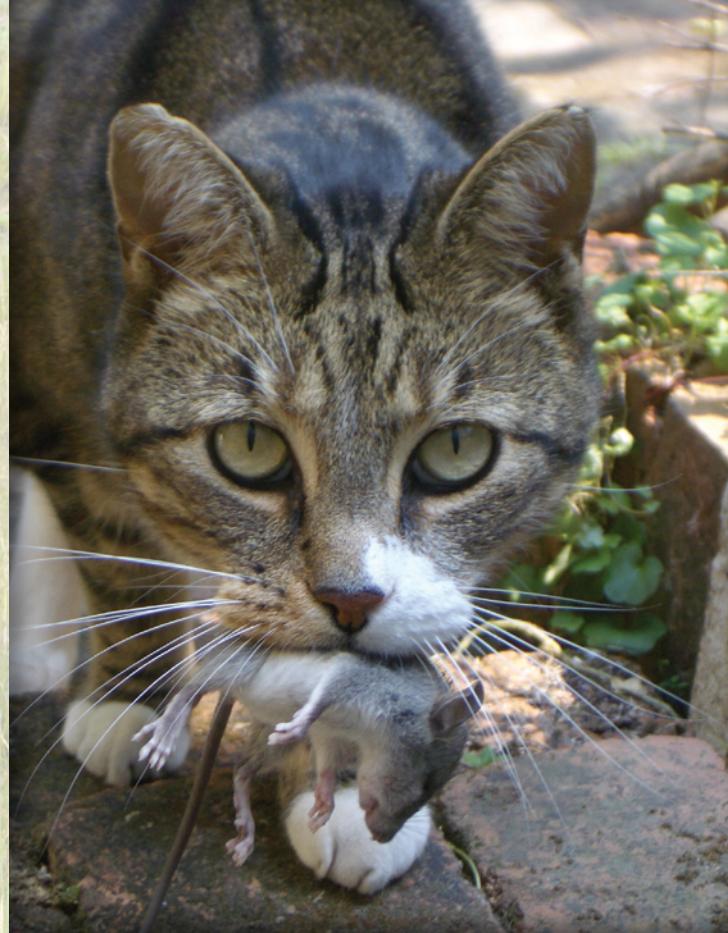
As few as 10 bacteria can cause infection. A single milliliter of blood can contain 100 million bacteria (Abbott and Rocke, 2012). Fleas that have fed on an infected rodent can transmit the plague bacteria to humans. Humans can also become infected through direct contact with dead or sick rodents or pets.

The best way to prevent plague is to know where plague is found, stay clear of rodents and their burrows that might contain fleas, and avoid handling sick or dead rodents. The public can also stay alert for news about plague warnings provided by public health departments. House pets, particularly cats that have contact with wild rodents or their fleas, can transport infected fleas into homes or directly transmit plague to their owners and caregivers (fig. 3) (Abbott and Rocke, 2012).

Scientists at the USGS NWHC and the University of Wisconsin-Madison have developed an oral plague vaccine for wildlife. The vaccine is undergoing field trials to test its effectiveness as a tool for managing plague in wild prairie dogs (Rocke and others, 2017).

For more information on plague and human health, please visit <https://www.cdc.gov/plague/>.

**Figure 3.** Domestic cats catching rabid prey is one way that people come into contact with rabid animals. Cats can also become infected with plague and infested with plague-carrying fleas and spread plague to their owners. (Photo by Lxowle ©○○.)

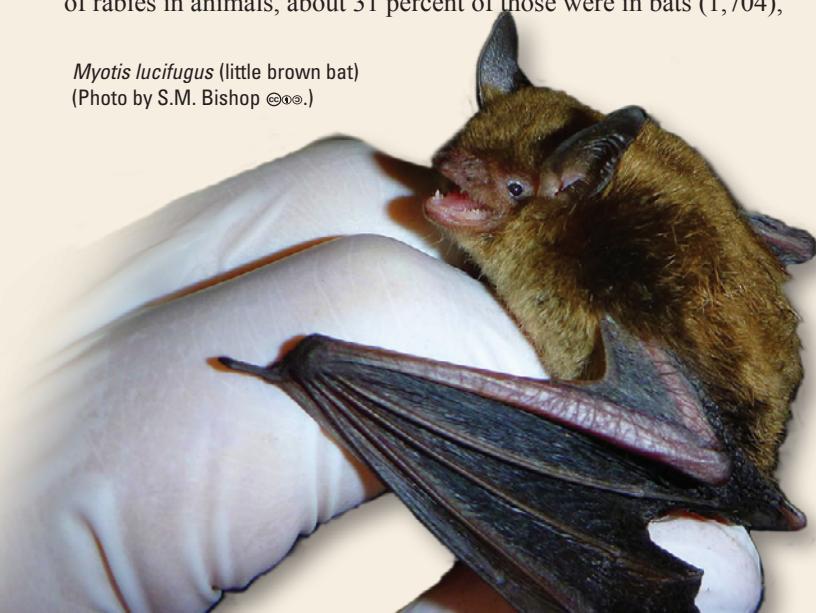


## Bat Rabies

Rabies is a viral disease that infects the nervous systems of mammals. The natural hosts of rabies include bats and many carnivorous mammals such as dogs, cats, foxes, raccoons, and skunks. Although there are only one to two cases of human rabies in the United States each year, the estimated cost to prevent rabies is \$245 to \$510 million annually. These costs include vaccination of domesticated animals, national rabies testing of wildlife and domesticated animals, and postexposure treatment of approximately 40,000–50,000 humans bitten by a potentially rabid animal each year (<http://www.cdc.gov/rabies/location/usa/cost.html>) (fig. 3).

Surveys conducted on insect-eating bats in the United States showed that approximately 0.1 percent of apparently healthy bats and up to 10 percent of bats found sick or dead were infected with rabies (Constantine, 2009). Of the 5,508 rabid animals submitted to the CDC in 2015, 92.4 percent of these cases (5,089) were in wildlife. Of all reported cases of rabies in animals, about 31 percent of those were in bats (1,704),

*Myotis lucifugus* (little brown bat)  
(Photo by S.M. Bishop ©○○.)



29 percent in raccoons (1,619), 25 percent in skunks (1,365), and about 6 percent in foxes (325). The remaining cases of rabies were in domestic animals (244 cats, 85 cattle, 67 dogs) ([https://www.cdc.gov/rabies/location/usa/surveillance/wild\\_animals.html](https://www.cdc.gov/rabies/location/usa/surveillance/wild_animals.html)). Public health specialists tracking the different strains of rabies virus among these animals have made it possible to determine that bats are the most common cause of rabies exposure in humans (Constantine, 2009).

The public is generally unaware of the potential risk for bats to carry and spread rabies to pets and humans. People are most commonly exposed to bat rabies by a bite or by handling dead or sick bats, but exposure to bat saliva can also transmit the virus. People may be more likely to seek postexposure treatment to prevent rabies when they are bitten by a fox, stray cat, or raccoon than when they are bitten by a bat. Rabies in humans can be greatly reduced by promoting awareness that bats are a source of human infection and by limiting their interactions, and their pets' interactions, with bats and wild carnivores. Uninformed young naturalists have brought sick or dead bats to school, exposing dozens of people to rabies, who then all required postexposure treatment. Bite wounds from bats are small and not easily recognized. If a bat is found in a bedroom where someone has been sleeping, their health care provider can discuss options regarding potential exposure to rabies.

Bats serve critical ecological functions by consuming insect pests of crops and forests. Without bats it is estimated that, in North America alone, agricultural losses would exceed \$3 billion each year (Boyles and others, 2011). However, bats can expose humans to disease when they roost in homes. To prevent a bat biting a human, professionals can safely remove bats without harming them.

## Raccoon Roundworm Larva Infection in Humans

*Baylisascaris procyonis* (raccoon roundworm) is a roundworm parasite commonly found in raccoon intestines. Eggs from this worm are excreted in raccoon feces. When the eggs are ingested by an animal other than a raccoon, the immature stage of this roundworm can invade and migrate through tissues of the infected animal and cause a condition known as larva migrans. The larva migrans disease most commonly recognized is a potentially fatal encephalitis which occurs when the larvae invade the brain or spinal cord of humans or other animals. The prevalence of this parasite in raccoons in urban settings creates a risk for human infection. A 2017 publication provides evidence that exposure to raccoon roundworm can occur without leading to disease in humans (Weinstein and others, 2017). Fewer than 25 cases of baylisascaris disease have been documented in the United States, but these cases are generally severe (<https://www.cdc.gov/parasites/baylisascaris/epi.html>).

One potential route of human exposure is through soil contaminated by raccoon feces. Although raccoon feces can be found in a variety of locations, raccoons tend to establish latrines where they defecate repeatedly, creating piles of feces that may concentrate *B. procyonis* eggs (Kazacos, 2016) (fig. 4). These latrines present a potential danger to animals and humans that come in contact with them. Children are at highest risk of ingesting the eggs of *B. procyonis*, because they may be more likely to put contaminated fingers or dirt into their mouths. *Baylisascaris procyonis* larvae also creates health problems for a wide variety of free-ranging and captive wildlife, zoo animals, and domestic animals. The Centers for Disease Control and Prevention (<https://www.cdc.gov/parasites/baylisascaris/prevent.html>) provides information about identifying and removing raccoon latrines and discouraging raccoons from living around your home (see sidebar, below).

### Discourage raccoons from living around your home:

- Do not keep, feed, or adopt wild animals
- Prevent access to food
- Keep trash containers tightly closed
- Close off access to attics and basements
- Keep sandboxes covered when not in use, because raccoons may use sandboxes as latrines
- Remove fish ponds—raccoons eat the fish and drink the water
- Eliminate water sources
- Remove bird feeders
- Clear brush so raccoons are not likely to make a den on your property

**Figure 4.** Based on test results, researchers estimate that over 50 percent of the *Procyon lotor* (raccoons) in the United States are infected with *Baylisascaris procyonis* (raccoon roundworm; Kazacos, 2016), which can be passed to humans through contact with raccoon feces. (Photo by David Menke, U.S. Fish and Wildlife Service <https://digitalmedia.fws.gov/cdm/singleitem/collection/natdiglib/id/10918/rec/4>.)



## Acknowledgments

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Constantine, D.G., 2009, Bat rabies and other lyssavirus infections: U.S. Geological Survey Circular 1329, 68 p., accessed August 9, 2017, at <https://pubs.usgs.gov/circ/circ1329/>.

Kazacos, K.R., 2016, *Baylisascaris* Larva Migrans: U.S. Geological Survey Circular 1412, 122 p., accessed August 9, 2017, at <https://doi.org/10.3133/cir1412>.

Rocke, T.E., Tripp, D.W., Russell, R.E., Abbott, R.C., Richgels, K.L.D., Matchett, M.R., Biggens, D.E., Griebel, Randall, Shroeder, Greg, Grassel, S.M., Pipkin, D.R., Cordova, Jennifer, Kavalunas, Adam, Maxfield, Brian, Boulerice, Jesse, and Miller, M.W., 2017, Sylvatic plague vaccine partially protects prairie dogs (*Cynomys* spp.) in field trials: *EcoHealth*, p. 1–13, accessed August 9, 2017, at <https://doi.org/10.1007/s10393-017-1253-x>.

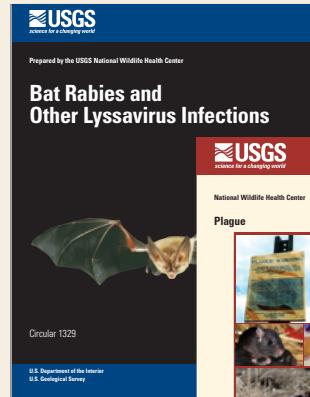
Weinstein, S.B., Lake, C.M., Chastain, H.M., Fisk, David, Handali, Sukwan, Kahn, P.L., Montgomery, S.P., Wilkins, P.P., Kuris, A.M., and Lafferty, K.D., 2017, Seroprevalence of *Baylisascaris procyonis* infection among humans, Santa Barbara County, California, USA, 2014–2016: *Emerging Infectious Diseases*, v. 23, no. 8, p. 1397–1399, accessed August 9, 2017, at <https://doi.org/10.3201/eid2308.170222>.

## For additional information on USGS zoonoses circulars contact:

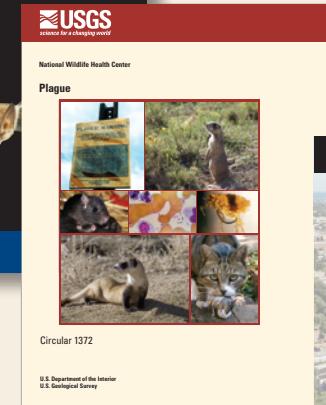
National Wildlife Health Center  
U.S. Geological Survey  
6006 Schroeder Road  
Madison, WI 53711  
(608) 270-2400  
<http://www.nwhc.usgs.gov>

## Zoonoses circulars published by the U.S. Geological Survey, National Wildlife Health Center (as of January 2018)

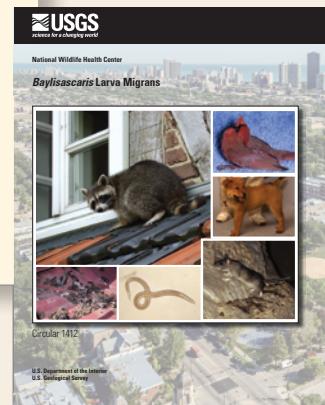
USGS circulars about zoonoses can be viewed on the web:



**Circular 1329 Bat Rabies and Other Lyssavirus Infections**  
<https://pubs.er.usgs.gov/publication/cir1329>



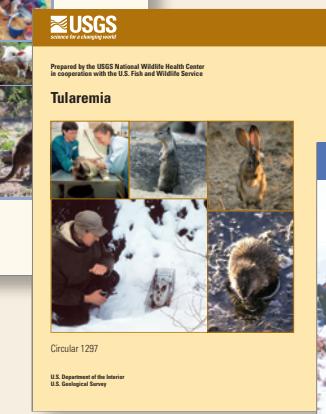
**Circular 1372 Plague**  
<https://pubs.usgs.gov/circ/1372/>



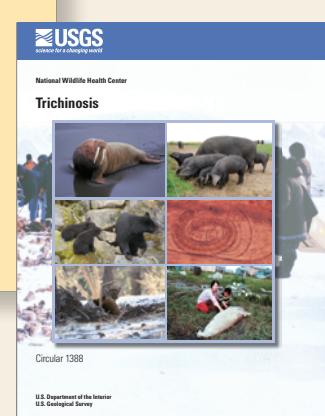
**Circular 1412 Baylisascaris Larva Migrans**  
<https://pubs.er.usgs.gov/publication/cir1412>



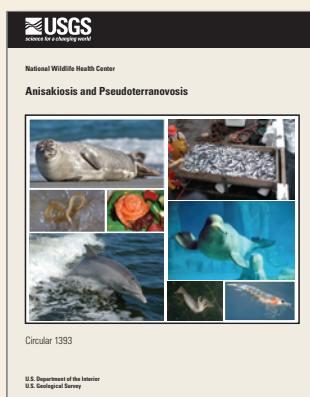
**Circular 1389 Toxoplasmosis**  
<https://pubs.er.usgs.gov/publication/cir1389>



**Circular 1297 Tularemia**  
<https://pubs.usgs.gov/circ/1297>



**Circular 1388 Trichinosis**  
<https://pubs.usgs.gov/circ/1388/>



**Circular 1393 Anisakiosis and Pseudoterranovaosis**  
<https://pubs.usgs.gov/circ/1393>