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WILDLIFE DISEASES AND HUMANS

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WILDLIFE DISEASES AND HUMANS

INTRODUCTION

Diseases of wildlife can cause significant illness and death to individual animals and can significantly affect wildlife populations. Wildlife species can also serve as natural hosts for certain diseases that affect humans (zoonoses). The disease agents or parasites that cause these zoonotic diseases can be contracted from wildlife directly by bites or contamination, or indirectly through the bite of arthropod vectors such as mosquitoes, ticks, fleas, and mites that have previously fed on an infected animal. These zoonotic diseases are primarily diseases acquired within a specific locality, and secondarily, diseases of occupation and avocation. Biologists, field assistants, hunters, and other individuals who work directly with wildlife have an increased risk of acquiring these diseases directly from animal hosts or their ectoparasites. Plague, tularemia, and leptospirosis have been acquired in the handling and skinning of rodents, rabbits, and carnivores. Humans have usually acquired diseases like Colorado tick fever, Rocky Mountain spotted fever, and Lyme disease because they have spent time in optimal habitats of disease vectors and hosts. Therefore, some general precautions should be taken to reduce risks of exposure and prevent infection.

GENERAL PRECAUTIONS

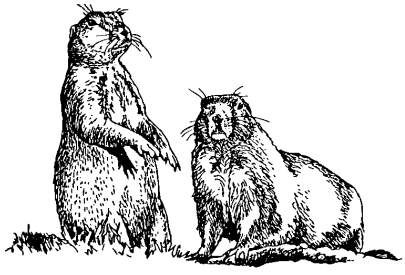
Use extreme caution when approaching or handling a wild animal that looks sick or abnormal to guard against those diseases contracted directly from wildlife. Procedures for basic personal hygiene and cleanliness of equipment are important for any activity but become a matter of major health concern when handling animals or their products that could be infected with disease agents. Some of the important precautions are:

1. Wear protective clothing, particularly disposable rubber or plastic gloves, when dissecting or skinning wild animals.
2. Scrub the work area, knives, other tools, and reusable gloves with soap or detergent followed by disinfection with diluted household bleach.
3. Avoid eating and drinking while handling or skinning animals and wash hands thoroughly when finished.
4. Safely dispose of carcasses and tissues as well as any contaminated disposable items like plastic gloves.
5. Cook meat from wild game thoroughly before eating.
6. Contact a physician if you become sick following exposure to a wild animal or its ectoparasites. Inform the physician of your possible exposure to a zoonotic disease.

Precautions against acquiring fungal diseases, especially histoplasmosis, should be taken when working in high-risk sites that contain contaminated soil or accumulations of animal feces; for example, under large bird roosts or in buildings or caves containing bat colonies. Wear protective masks to reduce or prevent the inhalation of fungal spores.

Protection from vector-borne diseases in high-risk areas involves personal measures such as using mosquito or tick repellents, wearing special clothing, or simply tucking pant cuffs into socks to increase the chance of finding crawling ticks before they attach. Additional preventive methods include checking your clothing and body and your pets for ticks and removing the ticks promptly after returning from infested sites. If possible, avoid tick-infested areas or locations with intense mosquito activity during the transmission season. Reduce outdoor exposure to mosquitoes especially in early evening hours to diminish the risk of infection with mosquito-borne diseases.

Equally important preventive measures are knowledge of the diseases present in the general area and the specific habitats and times of year that present the greatest risk of exposure. Knowledge of and recognition of the early symptoms of the diseases and the conditions of exposure are essential in preventing severe illness. Also



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

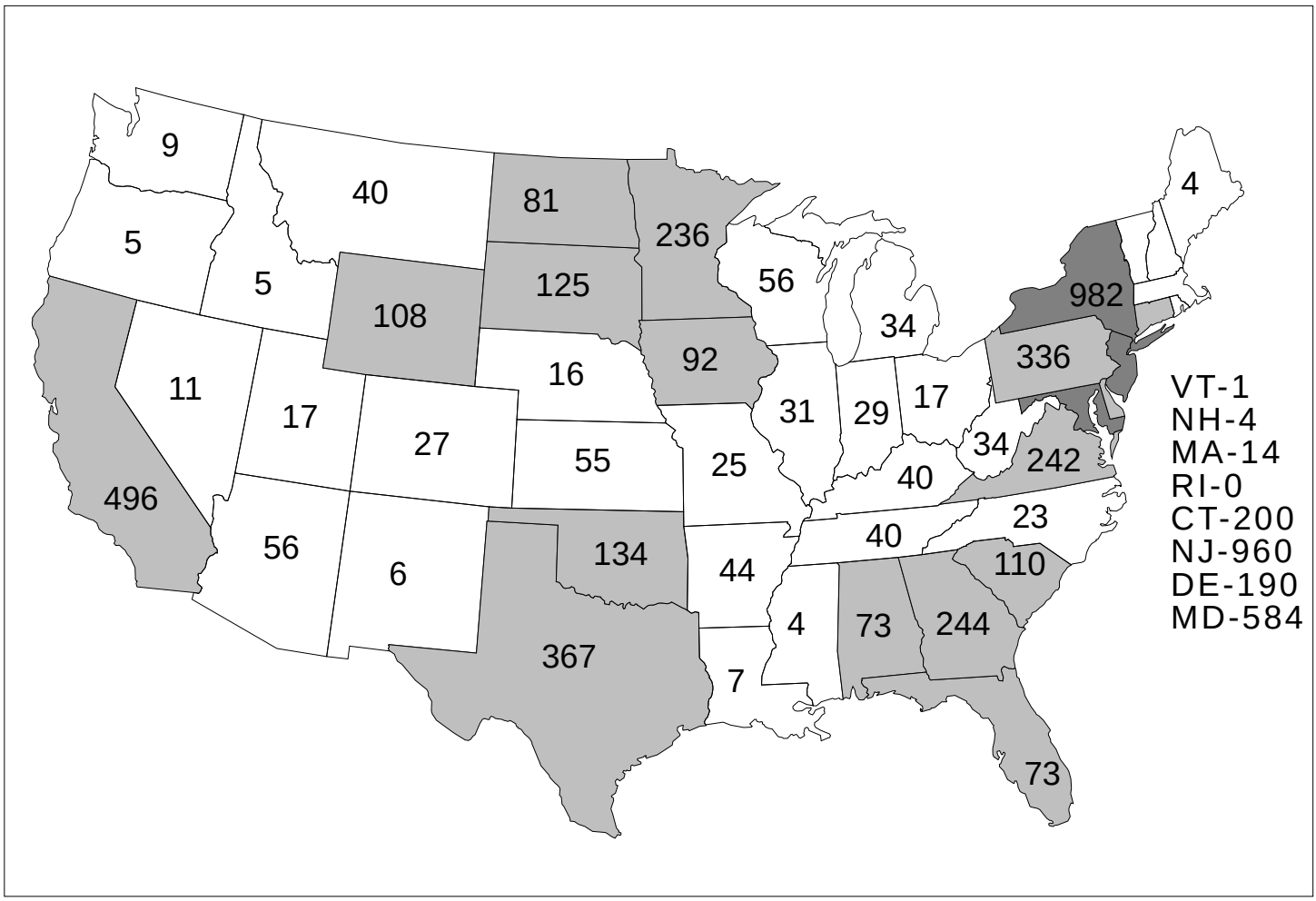


Fig. 1. Reported human cases of wildlife rabies in the United States, 1991.

important are medical evaluation and treatment with proper antibiotics. For example, if you become ill following some field activity in a known plague-endemic area and you recognize the early symptoms of the disease, seeking medical care and informing the attending physician of your possible exposure to plague will aid in the correct treatment of your illness and reduce the risk of complications or even death.

In addition to taking personal precautions, risk of acquiring vector-borne diseases can be reduced in specific locations through area-wide applications of insecticides to control mosquito or flea vectors or acaricides to control tick vectors. Reduction in host populations (for example, rodents) and their ectoparasites (fleas or ticks) may be needed to control transmission of such diseases as plague or Lyme disease. Vaccination of wildlife hosts as a means of reducing zoonotic diseases is currently being investigated and may soon be available for diseases like rabies.

WILDLIFE DISEASES OF PUBLIC HEALTH CONCERN

Directly Transmitted Diseases

Rabies

Rabies is an acute disease, caused by a virus (rhabdovirus), that can infect all warm-blooded animals, and is usually fatal. Certain carnivorous mammals and bats are the usual animal hosts (Fig. 1; Table 1). Rabies occurs throughout most of the world; only Australia and Antarctica are free of it. Most human cases have been contracted from rabies-infected dogs. In the United States, human cases have decreased to an average of one person per year (75% of cases are acquired outside the United States). Reduction in human rabies is likely linked with the intensive control of dog rabies during the 1950s and 1960s through massive vaccination campaigns, stray dog control programs, and improvement in human treatment following exposure. Nevertheless, thousands of people in the United States continue to receive treatment every year for possible exposure to rabies virus by animal bites. Most of the treatments are still due to dog and cat bites; however, these pet species have the lowest occurrence of reported rabies among all animal species tested.

Rabies in wildlife increased dramatically during the 1960s and now accounts for most of the reported animal rabies cases (91% in 1991). Some of the increase in reporting was due to real increases in the number of cases, and some was due to an increased awareness of wildlife rabies, particularly in striped skunks, raccoons, and bats. In 1991, 6,975 cases of animal rabies were reported in 49 states, the District of Columbia, and Puerto Rico. Raccoons (44.2%), striped skunks (29.7%), and various species of bats (9.9%) continued to be the major hosts. Red and gray foxes (4.6%), other wildlife species (2.8%), and domestic animals (8.9%) comprise the remainder of hosts. During the last 2 years, raccoons replaced striped skunks as the major wildlife host in the United States because of the continued expansion of raccoon rabies in the northeastern United States. Animal cases are reported throughout the year, although the number of cases reported reaches a seasonal peak for skunks in March and April, for raccoons in April, and for bats in August.

Clinical Signs. Rabies is considered almost 100% fatal once clinical signs develop. The disease progresses rapidly following the appearance of clinical signs, and the animal dies within a few days. Although abnormal behavior is not diagnostic for rabies (other diseases, like distemper, cause similar behavioral changes), atypical behavior and signs develop following brain infection, and rabies should be suspected whenever wild animals display unusual behavior.

Infected animals usually display either "furious" or "dumb" rabies, although some animals progress through both stages. Skunks, raccoons, foxes, and other canids usually have furious rabies and are unduly aggressive before convulsions and paralysis set in. Some animals, however, have dumb rabies and proceed to tremors and convulsions without agitation or aggression. Other behavioral changes include friendliness or loss of fear, appearance in the daytime for some typically nocturnal species (skunks, bats), unprovoked attacks on anything that moves (including inanimate objects), bewilderment, and aimless wandering. Unusual barking, crying, and frothing at the mouth are additional signs, which are the result of paralysis of the throat muscles. Occasionally, rabid bats are encountered prostrate or fluttering on the ground, unable to fly; they should be handled with care because they can still bite and transmit rabies. Some rabid bats, particularly solitary species like the hoary bat, are aggressive and have been known to attack people. In domestic animals, rabies should be suspected if there is any change in normal habits, such as sudden change in disposition, failure to eat or drink, running into objects, or paralysis.

Transmission. Rabies virus is transmitted primarily via the saliva during the bite of a rabid animal. However, other methods of transmission are possible. Accidental exposure of wounds or cuts to the saliva or tissues of infected animals can occur. The virus is also present in various body organs of infected animals, especially the brain and salivary glands, which poses a health hazard to persons who are field dressing or performing necropsies on these animals. In addition, aerosol exposure has occurred, although rarely, in caves containing very large populations of infected bats. Transmission between animals also occurs by ingestion of infected tissues and by transplacental passage to offspring.

When the virus enters the tissue of a susceptible animal or human, it multiplies at the bite or inoculation site and travels slowly up nerve fibers to the part of the brain that controls the bitten area. The virus multiplies there and spreads to other parts of the brain and eventually produces a variety of signs in the infected animal or person. The virus also spreads from the brain to other tissues, particularly to the salivary glands, where it multiplies and is released into the saliva. The virus is perpetuated in nature when an infected animal with virus in its saliva bites another animal.

The virus is rarely present in the salivary glands without first occurring in the brain and is present in the saliva for only a few days before clinical signs appear. Exceptions occur in a few species of bats and in a unique African virus strain found in dogs. The length of the incubation period (from the time the animal is bitten until clinical rabies appears) is usually 2 to 3 weeks, but varies from 10 days to several months.

Handling of Suspect Animals and Diagnosis. Use caution when approaching a suspected rabid animal since many are still aggressive and can bite even if paralyzed. If the animal is still alive, it should be killed humanely without damaging the head. To confirm whether an animal is infected with rabies, the animal must be submitted to the local health department or state diagnostic laboratory for testing.

Avoid exposure to any sick or dead animals that are suspected to have rabies. Handle any dead animal with gloves or with a plastic bag that can be turned inside-out to cover and contain the animal. Avoid direct skin contact with the animal. For large animals such as skunks and raccoons, remove the head cautiously and seal it in a plastic bag, avoiding contact or aerosol exposure. Seal the whole animal or head inside an additional plastic bag (double) and keep it cool at all times. Do not freeze the specimen unless a delay of several days is anticipated before it is examined for rabies. Disinfect gloves or knives that were in contact with the animal with a strong detergent or bleach or dispose of them.

For transport to the laboratory, place the double-wrapped specimen in a leak-proof container with a coolant (not wet ice). Send the container by bus or other prearranged transportation. Include information about the specimen (species, date, geographic data, behavior) and the names, addresses, and telephone numbers of the person submitting the specimen and of anyone exposed to the animal.

To test for rabies, a fluorescent antibody (FA) test is performed directly on brain tissue to distinguish rabies virus from other disease agents (like distemper virus) that could be present in the animal's brain. In some states, brain

material is inoculated into mice to demonstrate virus for those specimens that resulted in human exposure.

If a person or pet is exposed to an animal suspected of having rabies but that has not been captured, record a description of the suspect animal (species, behavior) and provide the description to public health officials or the attending physician to determine possible treatment.

Prevention and Treatment. The best treatment for rabies is prevention. Individuals at high risk of exposure to rabies, such as wildlife biologists, game wardens, animal control officers, animal handlers, and veterinarians should be vaccinated before potential exposure. Safe and highly effective vaccines are available through a physician or the local health department.

First aid should immediately be provided to a person who has been bitten by or had contact with a potentially rabid animal. Scrub the exposed site, including bite wounds, with soap and water or water alone and flush thoroughly. Then apply a strong first aid solution (iodine) or cream. First aid treatment is the most effective method of preventing infection by the rabies virus but should not preclude medical attention from a physician, hospital emergency room, or the local health department. Contact your physician or health department as soon as possible to determine dosage of rabies vaccine and whether antirabies serum is required. Inform the health care professionals about the rabid animal and the circumstances of the exposure (species of animal involved and its behavior, if the attack or bite from the animal was provoked, and what type of first aid was administered).

Hantavirus

Hantavirus includes a group of viruses that can cause a febrile illness in humans which can be accompanied by kidney, blood, or respiratory ailments and can sometimes be fatal. The febrile illness includes fever, headache, muscle aches, nausea, vomiting, and lower back pain. Field and commensal rodents are the natural reservoirs for viruses in this group and these viruses are found worldwide. Infected rodents shed virus in their urine, feces, and/or saliva and can remain chronically infected. The contaminated excreta from infected rodents are thought to be the source of virus for aerosol and direct (animal bite) transmission to other rodents and humans.

The recent discovery of a possible new hantavirus in the southwestern United States and its apparent increased virulence, has heightened the awareness of and concern for rodent-associated diseases. It produces produces respiratory distress and potential death in humans. Human cases and deaths from this viral infection were first reported in 1993 in the Four Corners area of Arizona, Colorado, New Mexico, and Utah and, more recently, throughout the United States. Preliminary information has incriminated the deer mouse (*Peromyscus maniculatus*) as the natural reservoir and source of human infection in that region. Individuals trapping and handling small rodents in this region should take increased precautions to reduce their exposure to this virus. They should at least wear surgical gloves and masks when processing rodents (contact CDC Hotline for more detailed and thorough safety information). Rodent control with careful handling and disposal of carcasses should be instituted at campsites or in cabins before they are occupied. The premises should be sprayed with detergents or diluted bleach before thorough cleaning. Wet-mopping is recommended. Dry sweeping and vacuuming may increase risk of producing airborne particles. Rodent harborage should be removed from premises and from the surrounding area. Exclude rodents where possible.

Trichinosis

Trichinosis may result in diahrrea, sudden edema of the upper eyelids, photophobia, muscle soreness and pain, skin lesions, thirst, sweating, chills, and weakness. Other respiratory and neurological symptoms may appear if treatment is delayed.

Trichinosis is contracted by eating infected meat which contains the encysted parasites. The parasites may remain infectious in meat which is raw or poorly cooked.

Trichinosis is caused by a nematode parasite which produces the disease in humans and domestic and wild animals. Evidence indicates that nearly all mammals are susceptible to infections with this parasite, which encysts in the muscle of the host and is then transmitted through consumption of infected flesh. As would be expected, the disease is most common in wild carnivores and scavengers.

As with other wildlife diseases, trichinosis is difficult to control in nature. However, certain steps can be taken to decrease the problem. Carcasses of carnivores and other meat-eating species should not be discarded in the fields or woods, but should be made unavailable by burying or other means. These carcasses also should not be fed to swine, dogs, or other domestic animals. Open garbage dumps should be replaced by the landfill type or other methods of disposal where wildlife will not have access to meat scraps. If open garbage dumps cannot be eliminated, rodent control programs should be initiated and the areas fenced to prevent scavenging by larger animals such as foxes. These steps would markedly reduce the problem of trichinosis in wildlife in the United States.

If carnivorous or omnivorous wildlife such as bears, bobcats, opossums, raccoons, or feral pigs are consumed by humans, the meat should be properly prepared by cooking, freezing, or curing to destroy any viable trichinae. Cooking to an internal temperature of 137^{o}F is deemed sufficient for pork, while freezing at 5^{o}F for 20 days, -10^{o}F for 10 days, or -20^{o}F for 6 days will kill trichinae. Curing should follow approved government regulations.

Mosquito-borne Encephalitis

Encephalitis is a disease caused by mosquito-borne viruses (arboviruses) that affect the central nervous system. Infections range from unapparent to mild, nonspecific illnesses (fever, headache, musculoskeletal pain, and malaise) to occasionally severe illness of the central nervous system resulting in permanent neurologic damage and possibly death. The four major types of encephalitis in the United States include St. Louis encephalitis (SLE), California encephalitis (CE primarily includes the LaCrosse virus [LAC]), eastern equine encephalitis (EEE), and western equine encephalitis (WEE). The distribution of these arboviruses varies (Fig. 2). SLE occurs throughout the United States (an epidemic occurred in central Florida in 1990 and Arkansas in 1991), WEE occurs west of the Mississippi River, EEE occurs east of the Mississippi River but mostly along the Atlantic and Gulf coasts and north-central states, and CE occurs in California and the eastern United States (LAC type). Human cases of arbovirus infection have a seasonal occurrence from mid- to late summer.

These distinct viruses naturally infect a variety of birds and mammals and are transmitted between animals by mosquito vectors. Occasionally, infected mosquitoes will feed on human or equine hosts that are "dead ends" for the viruses, with little or no chance of subsequent transmission to other mosquitoes. These viral infections may, however, result in severe illness or death in humans or horses (EEE and WEE). Only EEE and occasionally WEE viruses adversely affect wild vertebrates; for example, EEE causes death in ring-necked pheasants and other exotic game birds, house sparrows, red-winged blackbirds, whooping cranes, and other species. The wildlife hosts for LAC virus are the eastern chipmunk, tree squirrels, and foxes. The natural hosts for the other three viruses are mostly songbirds, although squirrels and jackrabbits may be involved in WEE transmission.

No treatment or commercial vaccine is available for humans, but vaccines for WEE and EEE are readily available for horses. The best preventive measures are personal protection against mosquito bites, especially avoiding exposure to mosquitoes during early evening hours, and the use of repellents. Mosquito populations can be reduced in an area by eliminating breeding sites for vector species. Killing adult mosquitoes with areawide applications of insecticides has been most effective in preventing epidemics.

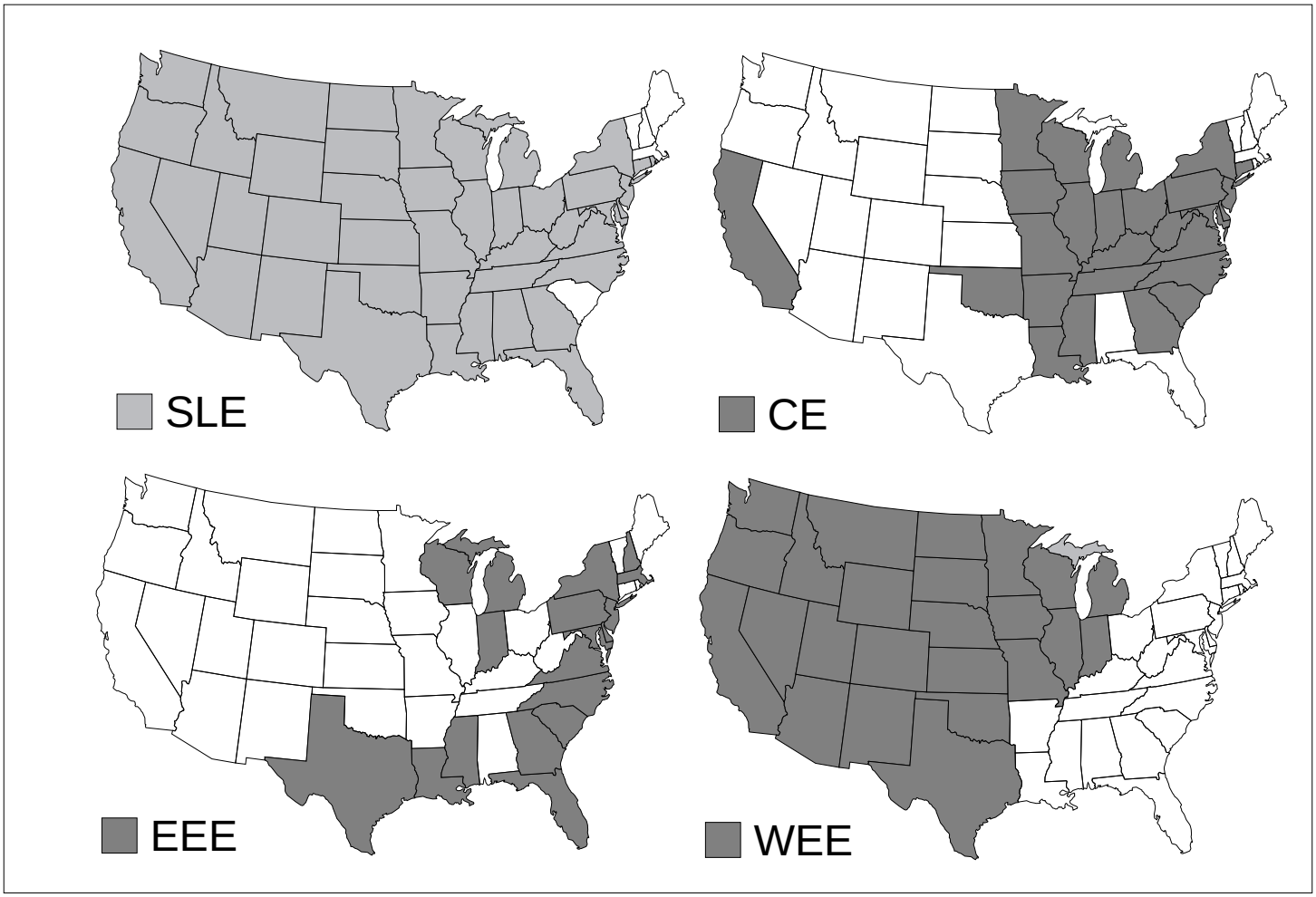


Fig. 2. Distribution of mosquito-borne encephalitis in the United States, 1964 to 1992; (a) St. Louis encephalitis (SLE); (b) California encephalitis (CE); (c) eastern equine encephalitis (EEE); and (d) western equine encephalitis (WEE).

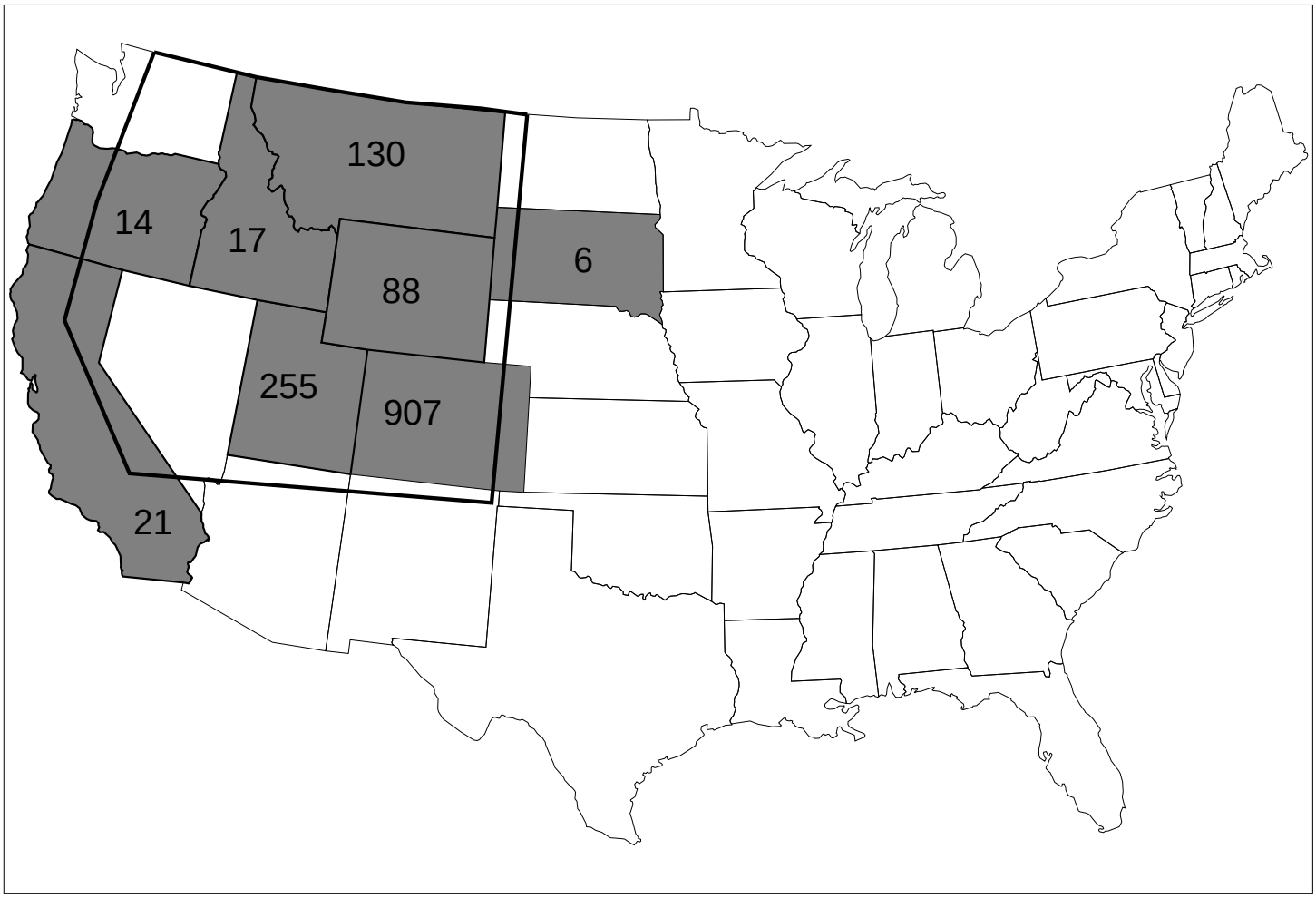


Fig. 3. Distribution of Colorado tick fever (human cases) in the United States, 1980 to 1988. (Solid line outlines distribution of *Dermacentor andersoni*.)

Tick-borne Diseases

Colorado Tick Fever

Colorado tick fever (CTF) is an acute and rather benign disease caused by a virus (coltivirus) that is transmitted to humans by ticks. Symptoms are usually limited to high fever, headache, muscle aches, and lethargy, but the symptoms are frequently biphasic and recurring. The disease is confined to the mountains or highland regions of eight western states and western Canada (Fig. 3). About 150 to 200 cases are reported each year; 1,438 cases were reported from 1980 to 1988 in eight western states, 63% of them in Colorado. CTF is transmitted to humans during the spring and early summer by the bite of the adult stage of the Rocky Mountain wood tick (*Dermacentor andersoni*) or by *D. occidentalis* in California. The virus is maintained in nature through transmission by immature stages of ticks to various species of small mammals, particularly chipmunks, ground squirrels, and deer mice during the spring and summer months. The virus survives the winter in infected tick nymphs and adults. The habitats that support the rodent hosts and tick vectors of the virus in the disease endemic region contain rocky surfaces with moderate shrub cover and scattered pines.

Avoid tick-infested habitats during spring and early summer and use personal protection against ticks. No vaccines or treatment are available.

Rocky Mountain Spotted Fever (Tick-borne Typhus)

Rocky Mountain spotted fever (RMSF) is a moderate to severe illness caused by a rickettsia (*Rickettsia rickettsii*). The disease is distinguished by a sudden onset of high fever, severe headache, muscle pain, and a red rash starting on the extremities about 3 to 6 days after onset of symptoms and extending to the palms of hands and soles of feet and then to the rest of the body. Delirium, coma, and death occur in about 1% to 2% of cases (15% to 20% in untreated cases). The disease is transmitted to humans in the United States by several hard tick (Ixodidae) species; *D. andersoni* in the Rocky Mountain region, *D. variabilis* in the east and southeast, and *Amblyomma americanum*

in the south-central states. In 1990, 649 cases of RMSF were reported from all regions of the United States, although more cases were reported in the south-Atlantic and south-central states (Fig. 4). The natural hosts for the rickettsia are a variety of wild rodents, although rabbits and wild and domestic carnivores are involved in some cases. The rickettsia survive the winter months in the tick vector and may be maintained by transovarial transmission from the female adult tick to its offspring.

Avoid tick-infested areas and use personal measures to protect against tick bites. No vaccine is presently licensed for public use, but antibiotic treatment is effective and should be initiated without waiting for laboratory confirmation of clinical diagnosis.

Lyme Disease

Lyme disease is caused by a spirochete bacterium (*Borrelia burgdorferi*) that is transmitted to humans by hard ticks. Early symptoms include a flu-like illness with headache, slight fever, muscle or joint pain, neck stiffness, swollen glands, jaw discomfort, and inflammation of the eye membranes. A diagnostic rash, erythema migrans (EM), occurs in 65% to 75% of the cases. The rapidly expanding red rash starts at the tick bite site and expands to a nearly circular lesion of about 1 to 8 inches (2 to 20 cm). It often has a bulls-eye appearance with central clearing and/or darkening around the edge. Additional smaller skin lesions may appear at other sites of the body and may last for days or weeks. Later symptoms, including heart, nervous system, and joint manifestations, may develop in untreated individuals. The joint pain and swelling usually occur one or more months after infection, may involve one or more joints, and may recur in different joints; the knee joint is most frequently affected. Domestic animals may be affected as well.

In 1992, 9,695 cases of Lyme disease were reported in 44 states (Fig. 5). Most cases were reported in the northeastern and upper midwestern states where the vector is the deer tick (*Ixodes scapularis*) and where transmission is predominately in residential communities. Other vectors are *I. pacificus* on the West Coast and possibly *A. americanum* in the Southeast and in

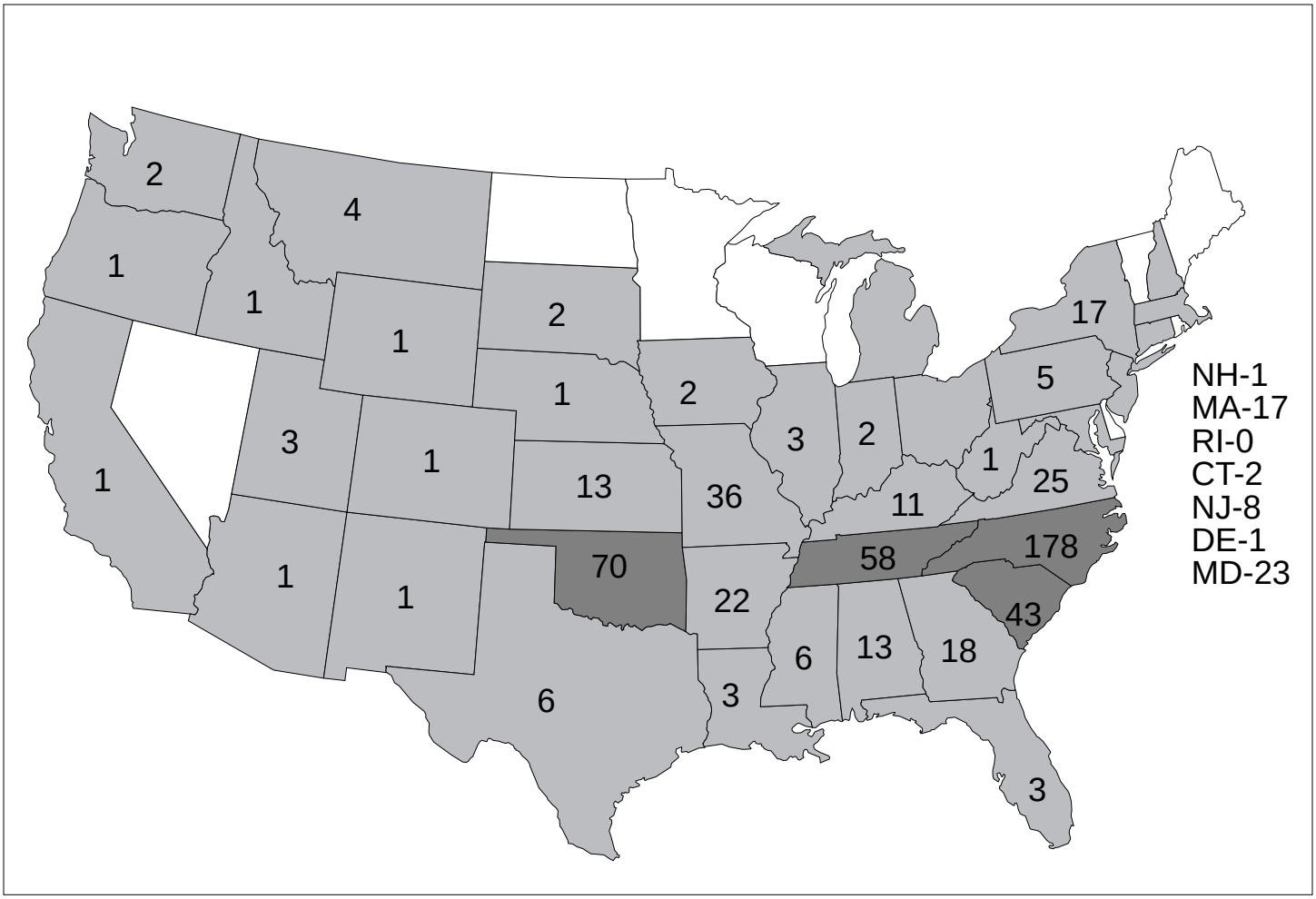


Fig. 4. Distribution of Rocky Mountain spotted fever (human cases) in the United States, 1990.

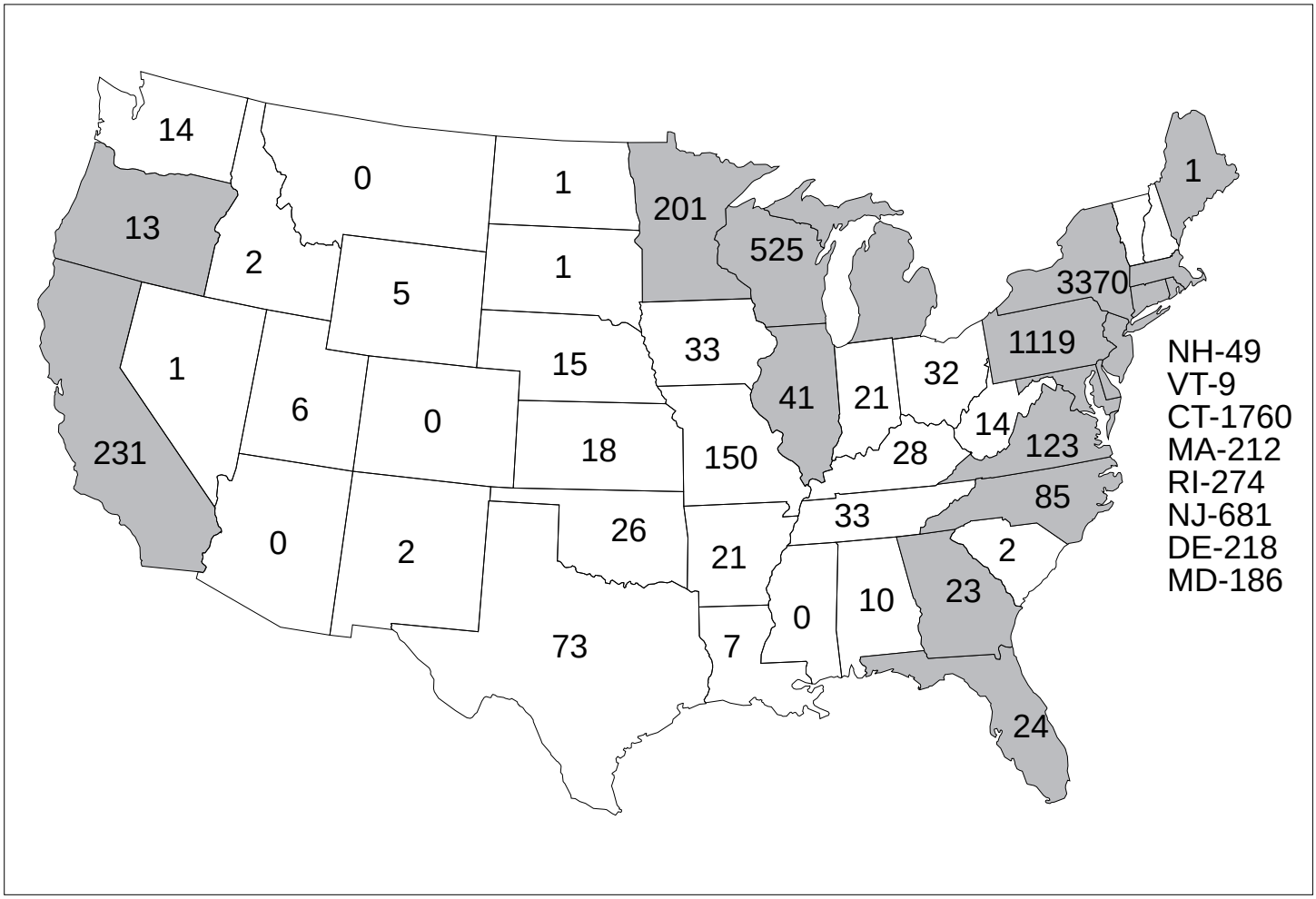


Fig. 5. Distribution of Lyme disease (human cases) in the United States, 1992.

south-central states. Transmission in these other regions of the United States may be more sporadic and occur during outdoor activities related to recreation and occupation. Acquisition of Lyme disease by humans peaks during the summer months when the tick nymphs are feeding on hosts. Because of its small size, the attached nymph frequently goes unnoticed and is not removed. The transmission cycle of Lyme disease begins when larvae acquire spirochetes while feeding on infected white-footed mice, chipmunks, other rodents, and birds. Engorged larvae drop to the ground, molt to the nymphal stage, and wait until the following summer to attach to and transmit spirochetes to susceptible rodents, birds, larger mammals, and humans. Uninfected larvae subsequently feed on these wild vertebrate hosts to complete the transmission cycle. The engorged nymphs drop to the ground and molt into adult ticks which are active during the fall and following spring and feed on large mammals, primarily deer. Deciduous forest is the predominant habitat for the tick vector and vertebrate hosts in the Northeast and Midwest. Other prime habitats include forested areas interspersed with residential development and grass and shrub areas, particularly along forest edges.

Patients treated with appropriate antibiotics during the early stages of the disease usually have rapid and complete recovery. Even patients treated during later stages generally respond well and recover. No vaccine is available except for domestic dogs. Avoid locations with ticks during seasonal activity periods, use personal measures to protect against ticks, become knowledgeable about the symptoms of Lyme disease, and seek medical care and treatment if infected.

Tularemia

Tularemia is caused by the bacteria *Francisella tularensis* and is characterized by sudden onset of high fever and chills, joint and muscle pain, and prostration. Slow-healing sores or lesions develop at the site of entry of the bacteria (or arthropod bite). Inflammation and swelling of nearby lymph nodes follow.

Tularemia is endemic throughout North America (Fig. 6). Most of the 100 to 300 cases reported each year are from the area between the Rocky Mountains and the Mississippi River (especially Arkansas and Missouri). Most cases are acquired during the summer months from vector transmis-

sion; however, a second peak of cases occurs during the winter and is probably associated with rabbit hunting and carnivore trapping.

The bacteria is maintained in rabbits, hares, rodents, and birds by tick transmission. The natural reservoir for the bacteria includes infected ticks and animal species that are less susceptible and thus survive acute infections. Hard ticks, primarily *D. andersoni*, *D. variabilis*, and *Haemaphysalis leporis-palustris*, and some flies, especially the deerfly (*Chrysops discalis*), can subsequently transmit the disease to humans. Tularemia can also be transmitted directly to humans. Transmission routes include drinking contaminated water; eating contaminated food or improperly cooked game meat; inhaling aerosols contaminated with rodent urine, feces, or dust; cuts from contaminated knives or other instruments; and scratches or bites from infected animals. Use personal protection measures against ticks and practice good sanitation procedures when handling wild animals, especially rabbits. Promptly seek medical care and treatment if symptoms develop.

Relapsing Fever

Relapsing fever can be caused by several *Borrelia* spirochete bacteria, which are related to the Lyme disease spirochete and are transmitted by soft ticks (Argasidae). Symptoms resemble Lyme disease except for the absence of the diagnostic rash and the presence of recurring fever. The most common type is caused by *B. hermsii*. Most human cases of this type of relapsing fever have been associated with log cabins or houses containing rodent nests (particularly of chipmunks and pine squirrels) and *Ornithodoros hermsi* ticks. This species of tick is active at night. Since it feeds rapidly and its bite is relatively painless, it may go unnoticed. The ticks feed on humans when the rodents disappear from the cabin nests because of rodent control measures or death from other diseases. Most human cases occur during the summer months when the cabins are in use. Sporadic cases are reported primarily in the mountainous regions of the western United States and British Columbia; 159 cases were reported during 1985 to 1991 in 10 western states (Fig. 7). Two outbreaks occurred among tourists and staff staying in cabins at the Grand Canyon in Arizona in 1973 and 1990. Inspect cabins for rodent use and nests, promptly remove nests, and treat cabins with insecticides or fumigate to kill any remaining ticks. Rodent-proof cabins to prevent rodent entry.

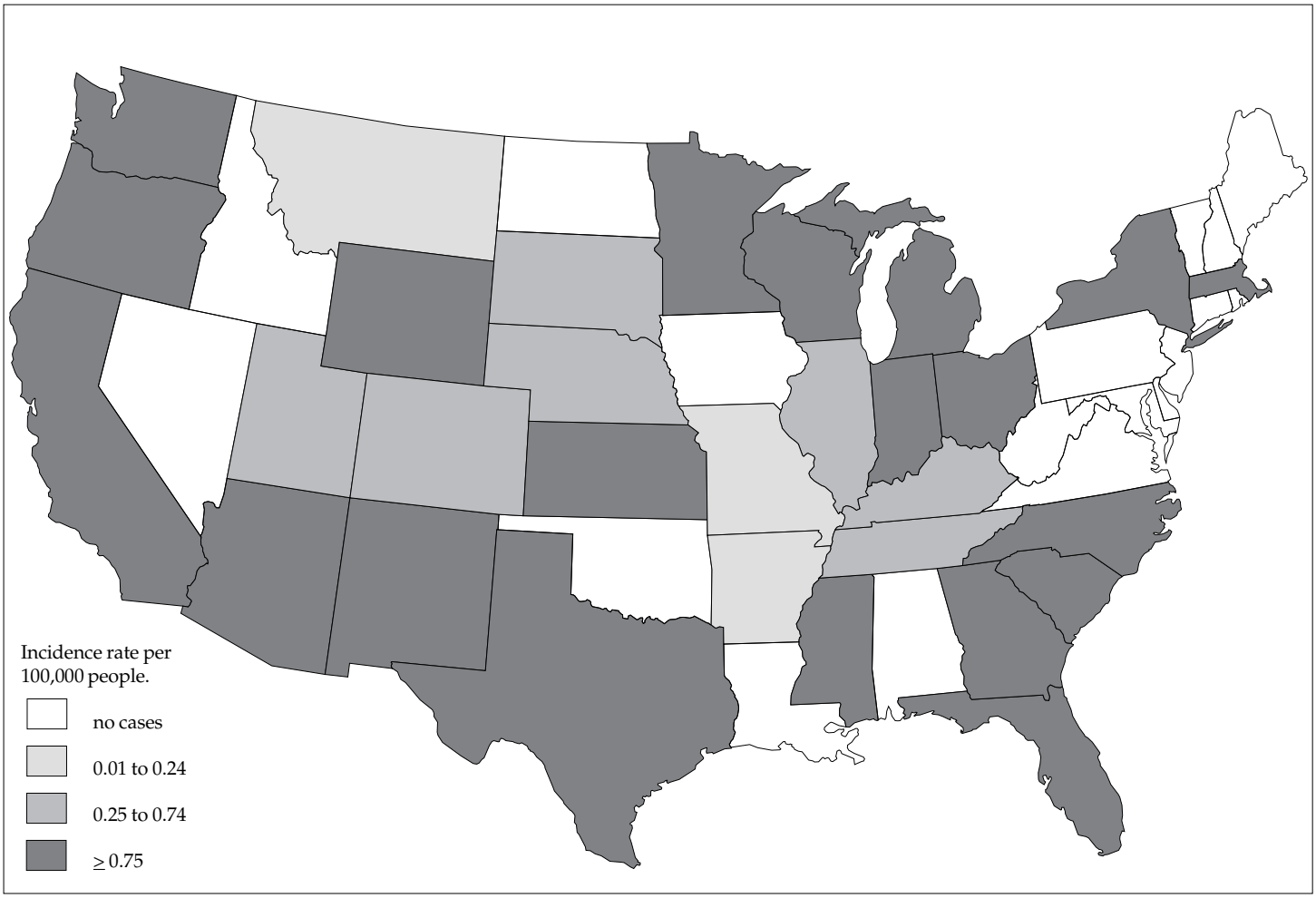


Fig. 6. Distribution of tularemia (human cases) in the United States, 1991 (191 cases reported).

Fig. 7. Distribution of relapsing fever (human cases) in the United States, 1985 to 1991.

Two other species of relapsing fever spirochetes are transmitted occasionally to humans in the western United States by *Ornithodoros* ticks. The spirochete *B. parkeri* is transmitted by *O. parkeri*, mostly in California, and *B. turicatae* by the tick *O. turicata*. Five humans were infected with *B. turicatae* in Texas in 1990 following exploration of a cave containing infected ticks. For prevention, use personal protection against tick exposure. If sick with relapsing fever, seek medical care and appropriate antibiotic treatment.

Other Tick-borne Diseases

Three other tick-borne diseases occur in the United States. Human ehrlichiosis is a recently recognized disease caused by a rickettsia, *Ehrlichia chaffeensis*. It is probably transmitted by ticks. Symptoms are similar to those of RMSF: an acute fever with headache, muscle ache, and nausea. A rash appears less frequently and for a much shorter duration. From 1986 to 1991, 262 cases and 4 fatalities were reported in 23 states, the majority occurring in Missouri and Oklahoma. Use personal protection against ticks and seek medical care and treatment if sick.

Powassan encephalitis is caused by a virus (flavivirus) which is transmitted by the ticks *I. cookei*, *D. andersoni*, and other *Ixodes* spp. Symptoms include the sudden onset of fever, sore throat, sleepiness, headache, and disorientation. Encephalitis, meningitis, and, occasionally, partial paralysis may develop. Natural hosts are marmots, sciurid rodents, rabbits, hares, carnivores, and possibly birds. Only 19 cases have been reported, all in New York, Pennsylvania, Ontario, and Quebec. Use personal protection to reduce exposure to ticks. No treatment is available.

Babesiosis is a protozoan disease with gradual onset of fever, sweating, loss of appetite, fatigue, general muscle ache, and possibly prolonged anemia. The disease can be severe and sometimes fatal. A protozoan, *Babesia microti*, is transmitted among wild rodents, particularly white-footed mice, by the tick *I. scapularis* along the coastal areas of New England and on adjacent offshore islands. This tick may be infected occasionally with both *B. microti* and the Lyme disease spirochete. Use personal protection measures to prevent tick exposure and seek medical care if sick.

Personal Protection

The following personal measures can protect against tick-transmitted diseases:

1. When possible, avoid tick-infested areas.

2. To better see crawling ticks, tuck pant legs into socks and tape the tops of socks over pant legs. Wear light-colored clothes.
3. Use tick repellent on exposed skin (DEET) or treat clothes with permethrin. Follow label instructions for use.
4. Check yourself frequently for ticks and remove them.
5. After outdoor activity, remove and wash field clothing promptly and dry clothes at a high temperature.
6. Inspect your body carefully and remove attached ticks with a pointed tweezers. Grasp ticks as close to the skin as possible and pull them loose with a slow, steady motion.
7. Inspect pets carefully for ticks and remove ticks soon after returning from the outdoors.

Flea-borne Diseases

Plague

Plague is an acute disease caused by the bacteria *Yersinia pestis*. Humans usually become infected by the bites of infected fleas but also directly from exposure to tissues or body fluids from diseased animals, especially when skinning animals. The disease is characterized by the sudden onset of fever and chills, followed by the development of swollen and painful lymph nodes (buboes) in the armpits, groin, and other areas 2 to 6 days following exposure. In addition to the bubonic form, septicemic infection may develop and involve other organs. Secondary infection of the lungs may lead to primary plague pneumonia, which then can be transmitted from person to person by aerosol. The disease may be only mild and short-lived but frequently progresses to a severe form, with 25% to 60% fatality in untreated cases. In the United States, plague is maintained in wild rodent populations in the western states by flea transmission between rodents. Sylvatic plague may persist in these animal populations with varying severity, depending on the species' resistance. Prairie dogs are susceptible to sudden die-offs. Outbreaks of plague have decimated prairie dog colonies in less than 1 to 2 years. Rabbits, hares, carnivores, and wild ungulates have also been infected occasionally. Human cases of plague are reported most frequently in New Mexico, Arizona, California, Colorado, and Oregon (Fig. 8). More than 50% of the 284 cases in the United States reported from 1970 to 1990 were in New Mexico. Use insect repellents on skin or treat field clothes with permethrin. Practice good sanitation procedures when handling animals. Seek medical care and treatment if sick.

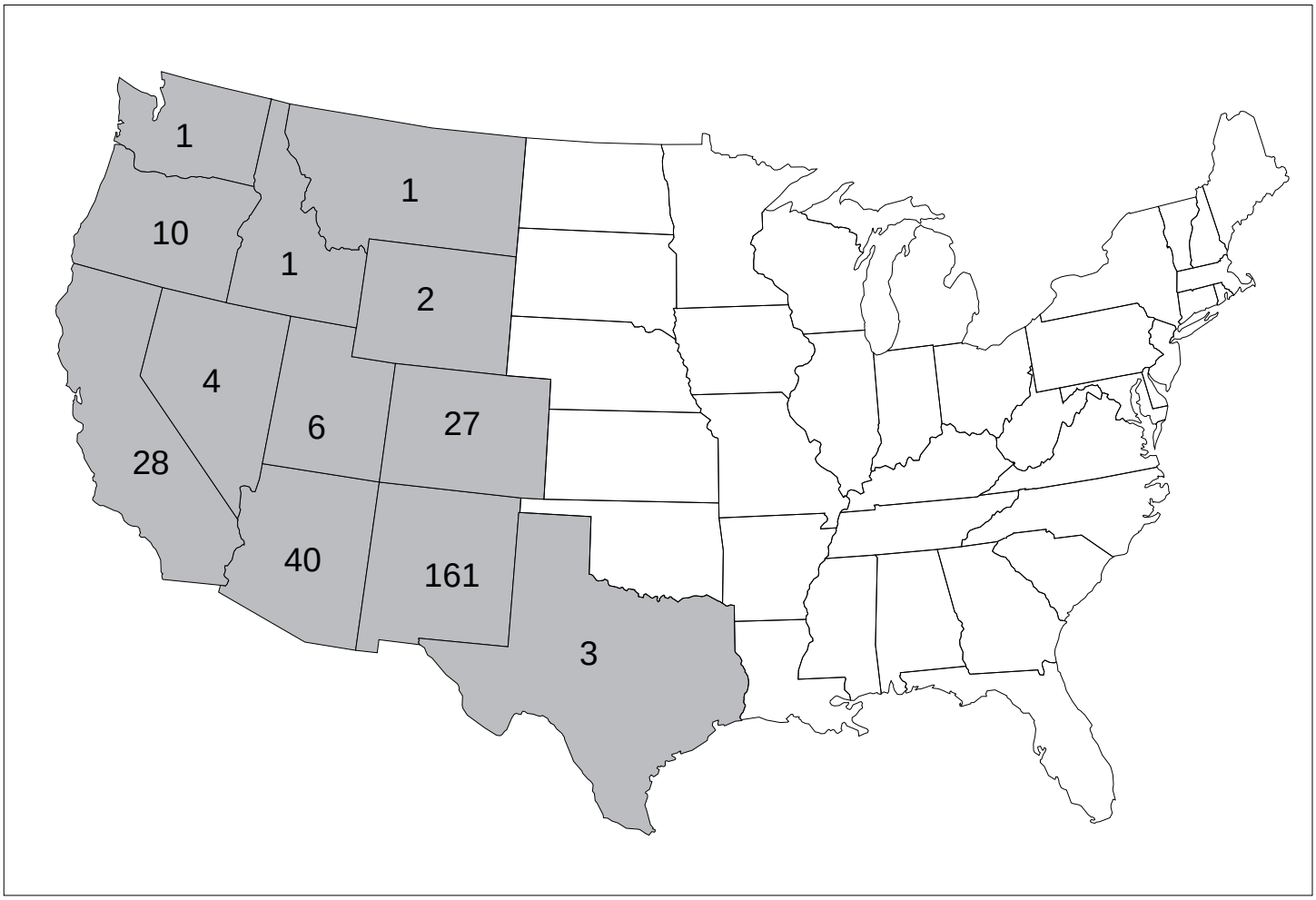


Fig. 8. Distribution of plague (human cases) in the United States, 1970 to 1990.

Murine Typhus Fever

Murine typhus fever is caused by *Rickettsia typhi*, a rickettsial organism that occurs throughout the southeastern and Gulf Coast states and southern California. Rats are the reservoir animals from which the disease reaches many humans by way of rat fleas. The oriental rat flea, *Xenopsylla cheopis*, is considered the most important vector of the disease. The causative organism enters the bloodstream when feces of infected fleas are scratched or rubbed into a flea-bite wound or other breaks in the skin. Murine typhus is similar to epidemic or louse-borne typhus, but illness is much milder and the fatality rate in untreated cases is much lower.

Commensal Rodent-borne Diseases

Rats and mice are responsible for the spread of over 35 diseases, either directly, through contamination of human food with their urine or feces, or indirectly, by way of rodent fleas and mites. Following are brief descriptions of the more common of these diseases.

Rat-bite Fever

Rat-bite fever is caused by the bacteria *Streptobacillus moniliformis*, which is found on the teeth and gums of rats. It is transferred from rats to humans by the bite of the rat. The most frequently occurring rat-bite fever in the United States is called Haverhill fever. It is similar to the rat-bite fever of the Orient called *sodoku* (caused by *Spirillus minus*).

Leptospirosis (Weil's Disease)

Leptospirosis is a mild to severe infection that is seldom fatal. Human cases of the disease result from direct or indirect contact with infected urine of rodents and other animals. The spirochetes (*Leptospira* spp., primarily *L. icterohemorrhagiae*) are found in contaminated water or on food, and may enter humans through mucous membranes or minute cuts or abrasions of the skin. Thus, Weil's disease is often found in sailors, miners, sewer workers, and fish or poultry dealers. In a recent study in Hawaii, Norway rats, roof rats, and house mice were found to have high *L. icterohemorrhagiae* carrier rates.

Symptoms of leptospirosis infection range from none to severe, with acute fatalities. Many infections are characterized by diarrhea, chills, vomiting, myalgia, and kidney damage. Prevention is the most important means of dealing with this disease. Proper sanitation, rodent-proofing, and food storage and handling are essential. Medical attention is typically required.

Salmonellosis

The *Salmonella* group of bacteria exists nearly everywhere in the environment and, unfortunately, several serotypes are pathogenic to humans and other animals. Salmonellosis can lead to severe cases of gastroenteritis (food poisoning), enteric fever septicemia (blood poisoning), and death. Food poisoning, the most common malady, is characterized by a sudden onset of abdominal pain, diahrrea, nausea, and vomiting. Due to the severity of this disease, medical attention is typically required.

Salmonella bacteria recognize few host barriers and are transmitted in many ways. One common form of transmission is through food contaminated by rat or mouse feces that contain *Salmonella* (especially *S. typhimurium*) organisms. It may also be spread by birds, which contaminate food with their feces or bacteria carried on their feet.

As with leptospirosis, the most important means of reducing the potential of this disease is through proper sanitation, rodent-proofing, and food storage and handling. Rodent control through trapping and appropriate use of toxicants may also be necessary.

Rickettsialpox

Rickettsialpox is a mild nonfatal disease resembling chicken pox. It is caused by a rickettsia (*Rickettsia akari*), which is transmitted from house mice to humans by the bite of an infected house mouse mite (*Liponyssoides sanguineus*). In this country rickettsialpox has been reported in Boston, West Hartford, New York, Cleveland, and Philadelphia.

Bird-borne Diseases

Large roosting concentrations of birds can be noisy, and the associated droppings can be a nuisance because of the objectionable odor and mess. In addition, birds may carry and transmit diseases to livestock and humans. Collections of droppings may provide a medium for bacterial and fungal growth that could pose a potential public health problem. Birds should be dispersed or controlled when they form large concentrations near human habitations and are judged to pose a threat to public health or livestock. Concentrations of birds that do not threaten human health or agriculture are usually better left undisturbed.

Histoplasmosis

Histoplasmosis is a respiratory disease in humans caused by inhaling spores from the fungus *Histoplasma capsulatum*. Birds do not spread the disease directly — spores are spread by the wind and the disease is contracted by inhalation. Bird droppings enrich the soil and promote growth of the fungus. Notable sources for histoplasmosis infection include: (1) traditional bird roosts, (2) poultry farms, (3) enclosed buildings where birds or bats have roosted, and (4) natural or organic fertilizers. In addition, the fungus can grow in various natural soils, with or without droppings. In some areas, such as the Ohio Valley, histoplasmosis is so widespread that 95% of the human population becomes infected, whether associated with birds or not.

Infection by only a few spores generally produces a mild case in humans and people are often unaware that they have contracted the disease (unless it is detected later through a skin reactivity test or lung X ray that reveals healed lesions). A more severe infection may result in an acute respiratory illness with flu-like symptoms

(in fact, histoplasmosis is often misdiagnosed as flu). The most serious infections, usually resulting from massive spore inhalation, may involve a dissemination of the fungus through the blood stream. Such cases may become chronic, recurring at later times, and affect organs other than the lungs. Treatment with an antifungal agent such as amphotericin B or imidazole ketoconazole may be prescribed in more severe cases.

Not all blackbird or starling roosts pose immediate public health problems related to histoplasmosis. The histoplasmosis fungus grows readily in the soil beneath bird roosts, but it cannot form spores under the acidic conditions of fresh droppings. An active, undisturbed roost may only give off a few spores. Old or abandoned roosts, however, can pose a significant threat to human health. After the droppings have dried out or been leached by the rain, the right conditions develop for spore release. If the soil is stirred up under dusty conditions, as may be the case in land clearing or bulldozing, massive amounts of spores may be released. Severe epidemics have occurred in association with bird roosts under such conditions.

Birds in large roosts can be dispersed by the use of various frightening devices or by roost thinning or clearing (see **Bird Dispersal Techniques**). Precautions should be taken when working around an old or abandoned roost site. It is wise to test for the presence of histoplasmosis before beginning any work. Wear a self-contained breathing apparatus or face mask with a dust filter (less than 2 microns) to prevent inhalation of the spores. Wear protective clothing, gloves, and boots that can be removed and disinfected with formalin and washed. If an area that was once a bird roost is going to be cleared or bulldozed, the area should be dampened with water or work should be done when the weather is wet or cold or both. Avoid working under dry, dusty conditions in late summer. A roost may be decontaminated by spraying it with a 3% to 5% solution of formaldehyde before clearing, but this option is very expensive.

Ornithosis (*Chlamydia psittaci, psittacosis*)

Ornithosis is an infectious respiratory disease caused by *Chlamydia psittaci,* a viruslike organism that affects humans, pets, and livestock. It usually leads to a mild pneumonia- or flu-like infection, but it can be a rapidly fatal disease (less than 1% of the cases reported in the United States). In humans many cases occur that are undetected or incorrectly diagnosed. Pigeons are most commonly associated with the transmission of ornithosis to humans. Birds have adapted to the disease and show no symptoms, but act as healthy carriers, shedding the organism in their feces, which later may become airborne as dust. The disease may also be contracted from parakeets, farm poultry, or waterfowl.

People working in dry, dusty areas where bird droppings are present, should wear face masks or respirators to avoid inhaling airborne avian fecal material. Spray work areas with water and/or disinfectants to minimize the potential for airborne infections particles. Medical attention, including antibiotic treatments are recommended for disease treatment.

Salmonellosis

The *Salmonella* group of bacteria can also be transmitted by birds. Refer to Commensal Rodent-borne Diseases (above) for additional information.

Other Bird-borne Diseases

Pigeons, starlings, sparrows, blackbirds, and other types of birds have been implicated in the transmission of various diseases of significance to humans or livestock. Starlings have been shown to be vectors of transmissible gastroenteritis (TGE) of swine. The virus can be carried in an infective state in the birds' intestines or on their feet for up to 30 hours. It is generally fatal to baby pigs and causes weight loss in adults. Starlings may also be involved in the transmission of hog cholera. Cryptococcosis is a fungal disease spread by pigeons and starlings that results in chronic, usually fatal, meningitis. Various species of birds may also play a part in the transmission of encephalitis, Newcastle disease, aspergillosis, toxoplasmosis, pseudotuberculosis, avian tuberculosis, and coccidiosis.

Conclusion

Wildlife workers tend to ignore the risks associated with handling wildlife species and working in natural environments. Diseases of wildlife or diseases present in their habitats can infect humans and some can cause serious illness or even death. Becoming aware of the potential diseases present and taking precautions to decrease exposure will greatly reduce chances of becoming infected with one of these diseases. This section provides a description of the major zoonotic diseases of wildlife in the United States that can also infect humans and gives information on disease prevention. Other diseases are briefly listed in Table 1 or can be found in one of the selected references.

You can prevent infection with zoonotic diseases and reduce the seriousness of an illness by observing the following recommendations:

1. Become aware of which zoonotic diseases are present in your area and their clinical symptoms.
2. Obtain any preexposure vaccinations that are available, particularly for rabies.
3. Take personal precautions to reduce exposure to disease agents and vectors such as ticks, mosquitoes, and fleas.
4. Practice good sanitation procedures when handling or processing animals or their products.
5. If you become ill, promptly seek proper medical treatment and inform the physician about possible exposures.

Acknowledgments

Portions of this chapter were derived from F. R. Henderson. 1983. Wildlife diseases and man. *in* R. M. Timm, *Prevention and Control of Wildlife Damage.* Univ. Nebraska Coop. Ext. Lincoln.

For Additional Information

For further information, consult the local or state health department or contact the CDC Voice Information System, Centers for Disease Control and Prevention, Atlanta, Georgia, at (404) 332-4555.

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Table 1. Some important wildlife diseases that affect humans.

Disease	*Parasite (Agent)*	*Method of Transmission*	*Wildlife Hosts*	*Type of Human Illness*
Direct				
Rabies	Virus (rhabdovirus)	Animal bite, aerosol	Striped skunk, raccoon, foxes, bats, and other mammals	Paralysis, convulsions, coma, death
Hantavirus	Virus (hantavirus)	Aerosol, animal bite	Deer mice, other wild and commensal rodents	Fever, headache, muscle aches, nausea, vomiting, back pain, respiratory syndrome
Leptospirosis	Bacteria (*Leptospira* spp.; *icterohemorrhagiae*)	Urine contamination, ingestion	Commensal and wild rodents, rabbits, fox, skunk, raccoon, opossum, deer	Fever; jaundice; neurologic; pain in abdomen, joints, or muscles; nausea; may be fatal
Brucellosis	Bacteria (*Brucella* spp.; *abortus*)	Contamination, ingestion (milk, etc.)	Hoofed animals (coyote)	Intermittent fever, chills, headache, body aches, weakness, weight loss
Rat-bite fever	Bacteria (*Streptobacillus moniliformis*)	Rodent bite	Commensal rodents	Abrupt onset with chills and fever, headache, muscle ache, followed by rash on legs and arms, arthritis
Salmonellosis	Bacteria (*Salmonella* spp.)	Ingestion of bacteria in food contaminated with feces	Rodents, swine, cattle, wild birds, poultry, pet turtles	Sudden onset of headache, fever, abdominal pain, nausea, diarrhea, vomiting
Ornithosis (Psittacosis)	Chlamydia (*Chlamydia psittaci*)	Inhalation of contaminated air	Parrot and sparrow-like birds, pigeons, waterfowl, domestic birds	Fever, chills, headache, muscle pain, loss of appetite, sweating, pneumonia
Histoplasmosis	Fungus (*Histoplasma capsulatum*)	Inhalation of spores	None, grows in soil enriched by feces under bird and bat roosts	Mild fever and influenza-like illness, pneumonia, hepatitis, endocarditis, death
Cryptococcosis	Fungus (*Cryptococcus neoformans*)	Inhalation is suspected	None, grows in droppings in pigeon nests	Meningitis; lung, liver, and bone infection; skin lesions or ulcers
Trichinosis	Nematode worm (*Trichinella spiralis*)	Ingestion of uncooked meat containing larval cysts	Swine, bear, wild and domestic carnivores, wild and domestic rodents	Nonspecific gastroenteritis, loss of appetite, nausea, diarrhea, swollen eyelids, fever, chills, muscle aches
Ascarid roundworm	Nematode (*Baylisascaris procyonis*)	Ingestion of nematode eggs (raccoon feces contamination)	Raccoon	Larval stage invades and damages body organs, including brain
Direct and Indirect				
Plague	Bacteria (*Yersinia pestis*)	Contamination from skinning animals, fleas	Wild rodents (prairie dogs, ground and tree squirrels, chipmunks), rabbits, carnivores	Fever, headache, severe discomfort, shaking chills, pain in groin or arm pits (swollen lymph nodes), death

Table 1. Some important wildlife diseases that affect humans (continued).

Disease	*Parasite (Agent)*	*Method of Transmission*	*Wildlife Hosts*	*Type of Human Illness*
Direct and Indirect				
Tularemia	Bacteria (*Francisella tularensis*)	Contamination from skinning animals, ticks, biting insects	Wild rodents, rabbits, hares, carnivores, birds, hoofed animals	Mild illness to severe meningitis, pneumonia, ulcer at inoculation site, swollen lymph nodes, death
Indirect				
Tick-borne				
Colorado tick fever	Virus (coltivirus)	Tick, *Dermacentor andersoni*, *D. occidentalis*	Wild rodents (sciurids, porcupine), hares, rabbits, marmots, carnivores	High fever, headache, muscle ache, lethargy, biphasic symptoms
Rocky Mountain spotted fever	Rickettsia (*Rickettsia rickettsii*)	Tick, *D. andersoni*, *D. variabilis*, *Amblyomma americanum*, *Haemaphysalis leporispalustris*	Wild rodents, rabbits, hares, carnivores, birds	Rapid onset, fever, headache, muscle aches, nausea, vomiting, abdominal pain, rash, loss of muscle control, possibly fatal
Ehrlichiosis	Rickettsia (*Ehrlichia chaffeensis*)	Tick, species unknown	Unknown, possibly dogs and other carnivores	Fever, headache, nausea, vomiting, muscle aches, fleeting rash
Lyme disease	Bacteria (*Borrelia burgdorferi*)	Tick, *Ixodes scapularis*, *I. pacificus*, *A. americanum*	Wild rodents (*Peromyscus*, chipmunks), raccoon, deer, rabbits, birds	Skin lesion (EM), fever, headache, fatigue, muscle ache, stiff neck, cardiac and neurologic manifestations, arthritis
Relapsing fever	Bacteria (*Borrelia hermsii*, *B. parkeri*, *B. turicatae*)	Tick, *Ornithodoros hermsi*, *O. parkeri*, *O. turicata*	Wild rodents (chipmunks, tree squirrels), particularly in cabins and caves	Rapid onset, severe headache, muscle weakness, rigor, joint pain, recurring fever
Babesiosis	Protozoa (*Babesia microti*)	Tick, *I. scapularis*	Wild rodents (white-footed mice, meadow vole)	Gradual onset, loss of appetite, fever, sweating, fatigue, general muscle aches, prolonged anemia, sometimes fatal
Tularemia (listed above)				
Mosquito-borne				
St. Louis encephalitis	Virus (flavivirus)	Mosquito, *Culex pipiens* complex, *Cx. tarsalis*, *Cx. nigripalpus*	Birds (mostly songbirds and waterbirds), some rodents	Fever, headache, musculoskeletal aches, malaise, low fatality
Eastern equine encephalitis	Virus (alphavirus)	Mosquito, *Culiseta melanura*, *Aedes* spp.	Birds (mostly songbirds and waterbirds), bats	Fever, intense headache, nausea, vomiting, muscle, aches, confusion, coma, high fatality

Table 1. Some important wildlife diseases that affect humans (continued).

Disease	*Parasite (Agent)*	*Method of Transmission*	*Wildlife Hosts*	*Type of Human Illness*
Indirect				
Western equine encephalitis	Virus (alphavirus)	Mosquito *Cx. tarsalis*	Birds (mostly songbirds and waterbirds), jackrabbits, rodents	Fever, headache, nausea, vomiting, malaise, loss of appetite, convulsions, low fatality
California encephalitis (LaCrosse)	Virus (bunyavirus)	Mosquito *Ae. triseriatus*	Eastern chipmunk, tree squirrel, red fox, deer mouse	Fever, irritability, headache, nausea, vomiting, loss of muscle control, confusion, coma, low fatality
Louse-borne				
Louse-borne typhus	Rickettsia (*Rickettsia prowazekii*)	Body louse *Pediculus humanus*, animal contact	Humans, flying squirrels	Onset variable, fever, headache, chills, general pains, prostration, skin rash after 5 to 6 days
Flea-borne				
Flea-borne typhus (Murine)	Rickettsia (*Rickettsia typhi*)	Rat flea *Xenopsylla cheopis*	Domestic rats, wild rodents, opossum	Fever, severe headache, chills, general pains, possibly skin rash
Plague (listed above)				