

The Role of Wildlife in Spreading Diseases

WILDLIFE DISEASES



Introduction: Wildlife are hosts to many different diseases, some of which may infect humans. In recent years there has been heightened public awareness of zoonotic wildlife diseases (those transmitted from animals to humans) e.g. West Nile virus, avian influenza H5N1, and hantavirus. In response to existing programs, USDA APHIS Wildlife Services has established a National Wildlife Disease Surveillance and Emergency Response System (SERS). The goal of SERS is to

develop and implement a nationally coordinated disease monitoring system aimed at safeguarding wildlife populations, agriculture, and human health and safety from disease threats. Deliberto and Beach (2006) discuss SERS in detail and further information is available at the [APHIS USDA](#) website. In California, the [Vector-Borne Disease Section \(VBDS\)](#) and the Veterinary Public Health Section of the California Department of Public Health (CDPH) is responsible for protecting Californians from diseases transmitted by vectors (insects and vertebrate pests), and other animal-borne diseases. Primary vector-borne diseases in California include diseases transmitted by mosquitoes (e.g. West Nile virus), fleas (e.g. plague), ticks (e.g. Lyme disease), and rodents (e.g. hantavirus) (Kjemtrup 2006). Important zoonotic diseases carried by wildlife in California includes rabies and raccoon roundworm. The following chapter provides an overview of some important diseases that represent a potential health threat to persons coming in contact with wildlife; particularly in the western United States. Persons who enter wildlife habitats or otherwise contact wildlife or their secretions should always take appropriate health precautions. The degree of risk depends on many factors, including geographical location and type of wildlife exposure. Local health departments and other public health officials should be consulted for recommendations for risk reduction specific to the activity involved.

Notifiable Diseases— are also known as reportable diseases, and include diseases that are highly communicable, cause high morbidity and or mortality or whose occurrence importantly impacts society. Reportable diseases are listed in Title 17 of the [California Code of Regulations](#). In California, vector-borne reportable diseases often associated with wildlife pests include West Nile virus, Dengue fever, plague, Lyme disease, relapsing fever, Rocky Mountain spotted fever, babesiosis, Q-fever, hantavirus, and tularemia. Rabies is reportable when it occurs in humans or animals.

Further information on all the diseases in this chapter is available at the [Centers for Disease Control and Protection](#).

Definitions

The following terms are used frequently in this chapter and the meanings are defined in this section:

Infection- The entry and development or multiplication of an infectious agent in the body.

Infectious Agent- An organism that causes infection (e.g., bacteria, viruses, parasites, fungi, etc.).

Zoonoses- Infections which are transmitted between animals and humans.

Host- The animal or human that harbors the infectious agent.

Reservoir- The animal in which the infectious agent completes its cycle of infection in nature and which serves as a source of infection for other species.

Accidental Host- A host that accidentally harbors an infectious agent and does not ordinarily serve as a source of infection in nature.

Vector- A carrier (usually an invertebrate) which transfers an infectious agent from one host to another.

Incubation Period- The interval between exposure to an infectious agent and the appearance of disease.

Sporadic- A disease that occurs occasionally.

Endemic- A disease that occurs regularly in a human population.

Enzootic- A disease that occurs regularly in an animal population.

Epidemic- A disease attacking greater than normal numbers of people in a region at the same time.

Epizootic- A disease attacking many animals in a region at the same time.

Serology- Blood tests that detect antibodies in order to obtain evidence of a previous infection.

COMMON DISEASES ASSOCIATED WITH SOME VERTEBRATE PESTS

Arboviral Encephalitis: Infectious agents that cause arboviral encephalitis belong to a group of viruses transmitted by mosquitoes. In the western United States, the most significant viruses of this group are Western equine encephalitis (WEE) and St. Louis encephalitis (SLE). The occurrence of arboviral encephalitis in people may be sporadic, or in some cases epidemic, if there are a large number of infected mosquitoes in an area. The disease is usually seen in the summer and early fall months when mosquitoes are most abundant. The infection is only spread by certain species of mosquitoes, primarily *Culex tarsalis*. The reservoirs of WEE and SLE are wild birds. Most infected bird species do not



become sick, but some types of birds may cause a large increase (amplification) of virus in nature. This can result in "spill over" of virus to accidental hosts, such as humans and horses. There is no person-to-person or horse-to-person transmission.

Anyone can potentially be infected with arboviral encephalitis, but children infected with WEE or elderly persons infected with SLE viruses are more apt to have severe illness. The incubation period is approximately 5-15 days. Most infected persons do not become sick or only develop a mild flu-like illness. Some persons become more severely ill with symptoms of meningitis or encephalitis (inflammation of the brain). Symptoms include a sudden onset of fever, headache, disorientation, convulsions, coma, and sometimes death. Approximately 7% of severe cases are fatal. Arboviral encephalitis is typically diagnosed by serology. There is no specific treatment or human vaccine to protect against WEE or SLE infections.

To prevent infection, people should avoid outdoor activity when mosquitoes are biting, particularly at dusk and dawn. Screens should be used to prevent mosquitoes from entering dwellings. While outdoors, protective clothing should be worn and insect repellent used in mosquito-infested areas. Some regions have surveillance and control programs to measure mosquito populations, detect arboviral encephalitis virus activity in nature, and initiate appropriate control measures. Further information is available at the [Centers for Disease Control and Protection](#).

Avian Influenza Virus H5N1 (Bird Flu): Avian influenza is an infection caused by avian (bird) influenza (flu) viruses. These influenza viruses occur naturally among birds. Wild birds worldwide carry the viruses in their intestines, but usually do not get sick from them. However, avian influenza is very contagious among birds and can make some domesticated birds, including chickens, ducks, and turkeys, very sick and kill them.

Of the few avian influenza viruses that have crossed the species barrier to infect humans, H5N1 has caused the largest number of detected cases of severe disease and death in humans. For the most current information about avian influenza and cumulative case numbers, see the [World Health Organization \(WHO\) avian influenza](#) website.



Of the human cases associated with the ongoing H5N1 outbreaks in poultry and wild birds in Asia and parts of Europe, the Near East and Africa, more than half of those people reported infected with the virus have died. In general, H5N1 remains a very rare disease in people. The H5N1 virus does not infect humans easily, and if a person is infected, it is very difficult for the virus to spread to another person.

Nevertheless, because all influenza viruses have the ability to change, scientists are concerned that H5N1 virus could, one day, be able to infect humans more readily and spread easily from one person to another. Presently, because these viruses do not commonly infect humans, there is little or no immune protection against them in the human population. If H5N1 virus were to gain the capacity to spread easily from person to person, an influenza pandemic (worldwide outbreak) could begin. For more information about influenza pandemics, see the U.S. government [Pandemic Flu website](#). Further information is also available at the [Centers for Disease Control and Protection](#).

Babesiosis: Human babesiosis is caused by *Babesia microti*, a small parasite that infects red blood cells. Other *Babesia* spp. may also cause human illness. In the United States, babesiosis is a rare disease in humans and most cases are reported from the East Coast in areas where the disease is endemic. The distribution of babesiosis may actually be more widespread and cases have also been reported from western states. The reservoirs of *B. microti* are wild rodents. In the Northeast, *B. microti* shares the same mouse reservoir (*Peromyscus leucopus*) and tick vector (*Ixodes scapularis*) as Lyme disease. There is limited information on the nature of the disease in the western United States. Similar to other tick-borne diseases, babesiosis is seen mostly in the spring, summer, and fall months when the tick vector is most active. The parasite is transmitted by the bite of an infected tick. There is no person-to-person transmission except by blood transfusion.



The incubation period ranges from one week to one year. Persons who have had their spleen removed are more susceptible to infection and may be infected with *Babesia* spp.

that are usually found in animals. The disease is characterized by a gradual onset of fever, fatigue, and anemia (blood loss). The illness may linger for several months. Babesiosis is diagnosed by identification of the parasite in blood cells or by serology. There is no specific vaccine or treatment, but some drugs used to treat malaria, another blood parasite, may be effective against babesiosis. To prevent infection, efforts should be made to avoid tick bites (see Lyme disease). Further information is available at the [Centers for Disease Control and Protection](#).

Raccoon Roundworm (Baylisascaris) Infection: Roundworms of the species *Baylisascaris procyonis* are parasites that live in the intestine of raccoons. Parasite eggs are shed in the feces of infected animals. The eggs can survive in the environment for long periods of time. The disease, called larva migrans, is transmitted to humans by ingestion of infective eggs, either directly from the feces or from a feces-contaminated environment. The disease occurs sporadically and is usually seen in children. Badgers, skunks, fishers, martens, bears, and other wildlife species also carry *Baylisascaris* spp. that may infect humans. Because humans are accidental hosts of these parasites, after ingestion, the egg hatches and the



parasite larvae migrate aberrantly in the organs and tissues, potentially causing severe damage. The infection is usually unapparent or mild, but sometimes symptoms persist for many years. Children are more commonly infected with larva migrans, probably because of poor hygiene and a tendency to eat contaminated soil. The incubation period is weeks to months; symptoms occur more rapidly if large numbers of eggs are ingested. The symptoms

depend on the location of the larvae and can be severe if the brain or eyes are infected. The disease may manifest as fever, fatigue, loss of coordination, stupor, coma, or loss of vision. Infection is sometimes fatal. Diagnosis of *Baylisascaris* larva migrans is difficult and depends on a history of exposure to raccoons, clinical signs, and a serological test. There is no vaccine or effective treatment, however, sometimes larvae can be located in the eye and removed.

To prevent infection, contact with raccoon feces or areas contaminated with animal feces should be avoided. Persons working with raccoons or other wildlife should follow good hygiene practices, including careful hand washing. Further information is available at <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/RaccoonRoundworms.aspx> or [Centers for Disease Control and Protection](#).

Brucellosis: Brucellosis is a bacterial disease caused by *Brucella* spp. and primarily associated with domestic animals, particularly cattle, goats, swine, and dogs. However, there is evidence that wildlife, especially feral swine, may also be infected. Brucellosis is transmitted to humans by direct contact with the tissues or body fluids, and most commonly, milk of infected animals. Airborne transmission is also possible, particularly in

laboratory settings.

The incubation period ranges from one week to two months. The disease is characterized by an illness that may reoccur for months or years after the first episode, thus it is sometimes called "undulant fever". The symptoms include fever, headache, weakness,



profuse sweating, chills, and joint pain. The illness may be complicated by infections of the bones, joints, and testes. Brucellosis is not usually fatal, but may cause disability. Diagnosis is made by isolation of the bacteria or by serological tests. Brucellosis can be treated with antibiotics, but relapses still occur about 5% of the time. There is no vaccine available for humans.

Brucellosis is prevented by consuming pasteurized milk and milk products or avoiding contact with tissues and body fluids from infected animals. Cuts and abrasions, as well as mucus membranes, are areas where the bacteria can enter your body (wear protective clothing, gloves, etc. to minimize exposure). Foods of animal origin should never be eaten raw or undercooked because they may be contaminated with disease causing organisms such as brucellosis. Further information is available at the <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/RaccoonRoundworms.aspx> or [Centers for Disease Control and Protection](#).

Coccidioidomycosis (San Joaquin Fever or Valley Fever): Coccidioidomycosis is caused by a soil-borne fungus, *Coccidioides immitis*. This fungus is found in arid and semiarid regions of the United States. In recent years, there have been an increasing number of cases reported from the Central Valley of California. In the eastern and central portions of the United States, there are other important fungal diseases (e.g., histoplasmosis, blastomycosis, etc.) that cause illness in humans. This fungus is neither vector nor animal-borne, however, workers may come in contact with the organism while working in endemic areas.



The reservoir of *C. immitis* is the soil, particularly around Indian middens and rodent burrows. Humans become infected by inhalation of airborne spores of the fungus in dust. The frequency of infection increases after dust storms. Transmission from person-to-person or directly from animals is not recognized.

Evidence of past infection in persons from endemic areas is common, but many persons living in these areas do not become ill from the infection. Visitors to areas are more likely to become ill. The illness (primary infection) is characterized by a one to four week incubation period followed by fever, chills, cough, and sometimes a rash on the legs. After infection, a person becomes immune from further coccidioidomycosis infection. Rarely, some persons will develop a progressive and highly fatal form of the disease called

disseminated coccidioidomycosis. The fungus spreads through the body and causes severe damage to organs including the lungs, bones, and nervous system. Coccidioidomycosis is diagnosed by isolation of the fungus from body fluids, serology, or by a skin test. Persons with primary infections do not usually require treatment. Disseminated infections are treated with antifungal medications. At this time, there is no vaccine to protect against coccidioidomycosis.

Coccidioidomycosis infections are prevented by minimizing exposure to dust. Dust control measures such as paving roads and planting vegetation have been used in some places to control the disease. Precautions should be taken when disturbing soil around rodent burrows. Further information is available at the <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/Coccidioidomycosis.aspx> or [Centers for Disease Control and Protection](#).

Colorado Tick Fever: Colorado tick fever is a rare tick-borne virus that occurs in mountainous regions of the western United States, including California. Wild rodents (e.g., ground squirrels, chipmunks, wood rats, mice, etc.) are the reservoirs of the virus.



Colorado tick fever is transmitted by the bite of an infected tick, primarily the wood tick (*Dermacentor andersoni*). There is no person-to-person transmission except by blood transfusion.

Persons entering tick-infested habitat in endemic areas are at an increased risk of exposure to Colorado tick fever. The incubation period is usually less than one week. Symptoms are fever, chills, headache, muscle pain, and sometimes a rash. The symptoms may resolve and reappear several times, but the disease is rarely fatal. Diagnosis of Colorado tick fever is made by isolation of the virus from the blood or by serological tests. There is no specific treatment or vaccine. Colorado tick fever is prevented by avoiding tick bites (see Lyme disease). Further information is available at the [Centers for Disease Control and Protection](#).

Tick-Borne Relapsing Fever: Endemic (tick-borne) relapsing fever is caused by spiral-shaped bacteria in the *Borrelia* genus. Natural foci of this disease exist in high elevation areas of the western United States, including California.

Human cases are sporadic, but outbreaks are occasionally reported. The disease has a seasonal occurrence with most cases seen in the summer and early fall. Wild rodents and ticks are the reservoirs. The disease is transmitted by the bite of the soft tick (*Ornithodoros* spp.) or by contamination of a wound with the body fluids of an infected tick, for example if it is crushed or squeezed. Endemic (tick-borne) relapsing fever is distinct from louse-borne relapsing fever, a disease with similar signs but which has not been reported in the United States for many



years.

Human cases of endemic relapsing fever have been associated with the occupation of rodent-infested vacation homes in endemic areas. The incubation period is approximately one week. The illness is characterized by fever for three to four days and a brief recovery. This is followed by multiple episodes of fever, chills, profuse sweating, headache, and muscle pains, thus the name "relapsing fever." The disease is fatal 2-5% of the cases. Endemic relapsing fever is diagnosed by detection of the bacteria on a blood smear. There is no vaccine, but antibiotics can be used to treat the infection. Endemic relapsing fever can be prevented by avoiding tick bites (see Lyme disease) and preventing rodent-infestation of human dwellings and otherwise limiting rodent/human contact. Further information is available at <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/TickBorneRelapsingFever.aspx> or [://www.cdph.ca.gov/HealthInfo/discond/Documents/TBRF2007.pdf](http://www.cdph.ca.gov/HealthInfo/discond/Documents/TBRF2007.pdf) or the [Centers for Disease Control and Protection](#).

Giardiasis (Backpacker's Disease): Giardiasis is an infection caused by a small protozoan parasite (*Giardia lamblia*). It is one of the most common causes of diarrhea in the United States. Humans are the reservoir, but wild and domestic animals may also be infected and shed the parasite in their feces. Person-to-person transmission by the fecal-oral route is the usual mode of spread. Drinking untreated water is another common source of infection. Stream and lake waters may be contaminated with human or animal feces and serve as a source for human infections.



The incubation period ranges from one to four weeks. The infection may be unapparent, mild, or severe. Symptoms are diarrhea, abdominal cramps, bloating, weight loss, and fatigue; the diarrhea may last for several months. Diagnosis is made by visualizing the parasite in the feces under a microscope, but it is not always shed in the feces every day. Therefore, to diagnosis giardiasis, fecal specimens may need to be collected and examined several times. Antibiotics are used to treat the infection. Similar to most parasitic infections, there is no vaccine available to protect against giardiasis. To prevent giardiasis, follow good hygiene practices, including thorough hand washing, and never drink untreated water, such as from streams and lakes. Further information is available at the <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/Giardiasis.aspx> and [Centers for Disease Control and Protection](#).

Hantavirus Cardiopulmonary Syndrome: Hantavirus Cardiopulmonary Syndrome (HCPS) is a severe and frequently fatal respiratory disease. An outbreak of HCPS was first recognized in the Four Corners area (Arizona, New Mexico, Colorado, and Utah) in 1993, and has since been identified in many areas of the U.S., including California. The primary reservoir of the virus in California is the deer mouse



(*Peromyscus maniculatus*). Studies of hantavirus are ongoing and detailed update information and statistics are available at the Center for Disease Control, <http://www.cdc.gov>. Hantavirus is shed in the urine, feces, and saliva of infected rodents but it apparently does not cause illness in these hosts. The disease is transmitted to humans by inhalation of aerosolized rodent urine, feces, or saliva containing the virus. There is no evidence of person-to-person transmission of hantaviruses found in the U.S.

Persons engaged in activities that bring them into contact with rodents, especially in a rural setting, are at increased risk of exposure to the disease. To date, the average age of the HPS cases is 38 years (range from 12 to 69 years). There are slightly more cases in males compared with females. The incubation period is one to two weeks, but may be as long as six weeks. Initially, the symptoms are flu-like with fever, chills, muscle aches, cough, headache, and sometimes abdominal pain being the most frequently reported symptoms. The illness may quickly progress to signs of lung disease similar to adult respiratory distress syndrome (ARDS). ARDS is a life-threatening condition of the lungs that can lead to respiratory failure and death. At this time, 35% of the patients diagnosed with HCPS have died. HCPS is diagnosed by serology and other special tests. There is no specific treatment or vaccine.

To prevent HCPS, avoid contact with rodents and rodent urine or droppings. Vector-control personnel, researchers, mammologists, and any others who work with rodents should consult local or state health officials for specific recommendations for risk reduction before handling live wild rodents (e.g., live-trapping, processing, etc.). General precautions include eliminating and preventing rodent infestation of human dwellings. Special precautions apply for cleaning buildings with heavy rodent infestations. Further information is available <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/HantavirusPulmonarySyndrome.aspx> or the [Centers for Disease Control and Protection](http://www.cdc.gov).

Leptospirosis (Weil's disease): Leptospirosis, is caused by the bacteria (*Leptospira interrogans*). The disease occurs worldwide. Human cases of leptospirosis occur sporadically in the western United States. Wild and domestic animals are the reservoirs including cattle, horses, pigs, dogs, raccoons, rats, mice, badgers, squirrels, deer, foxes, skunks, opossums, and marine mammals. Wild rodents are well-adapted to the bacteria and do not show signs of illness. Many rodent species maintain the disease within their populations with no apparent illness, even at low densities (Faine 1999). *L. interrogans* is shed in urine and may contaminate water and moist environments. Transmission to humans occurs by direct contact of the skin (especially if abraded or cut) or mucous membranes with the urine, placental fluids, or milk of infected animals (Witmer, Martins & Flor 2004). Less commonly, the route of transmission is by ingestion or inhalation of contaminated water or aerosols, respectively. Person-to-person transmission is very rare.

Persons in certain occupations (e.g. farmers, sewer workers, miners, veterinarians, etc.) are at a higher risk of exposure to the disease. The illness ranges from no symptoms to severe



illness. The incubation period is approximately one to two weeks. The symptoms are fever, chills, headache, vomiting, jaundice (yellowness of the skin and mucous membranes), anemia, and sometimes a rash. Leptospirosis can cause damage to the kidneys, liver, brain, lungs, or heart, but the disease is not usually fatal. Leptospirosis is diagnosed by serological tests, and antibiotics are used to treat the infection. There is no vaccine available for humans in the United States.

To prevent leptospirosis, workers should have good personal hygiene and wear protective clothing when working in potentially contaminated areas, particularly around water and moist soil or vegetation. Direct contact with wild rodents, or their secretions should be avoided. Further information is available at the <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/Leptospirosis.aspx> or [Centers for Disease Control and Protection](#).

Lyme Disease: Lyme disease is a tick-borne disease caused by spiral-shaped bacteria called *Borrelia burgdorferi*. Lyme disease is currently the most commonly reported vector-borne disease in the United States. Since 2002, over 20,000 human cases are reported each year to the Centers for Disease Control and Prevention; in California about 100 cases are reported each year.. Most of the human cases are reported from the East Coast, parts of the Midwest, and Northern California. On the East Coast, Lyme disease is maintained in nature by a tick-rodent cycle of transmission involving the white-footed mouse (*Peromyscus leucopus*) and the deer tick (*Ixodes scapularis*). In the western United States, rodents such as the dusky-footed woodrat (*Neotoma fuscipes*), deer mice (*Peromyscus maniculatus*), western gray squirrel (*Sciurus griseus*) are reservoirs of the spirochete and the western black-legged tick (*Ixodes pacificus*) transmits the organism to people. Transmission to humans is by the bite of an infected tick. Lyme disease is not transmitted person-to-person.

The incubation period is three to thirty days after the tick bite. The illness may start as a characteristic rash (large red circle that sometimes clears in the center like a "bull's-eye"). Flu-like symptoms such as fever, headache, fatigue, stiff neck, and muscle and joint pain may accompany the rash or may occur without a rash. If Lyme disease is not recognized and treated in its early stage, it may progress to a more severe and chronic illness involving the nervous system, heart, or joints. Lyme disease is diagnosed by clinical signs combined with serological tests. Early in disease (< 30 days after infection), a person may test negative. Properly performed serological tests, combined with clinical symptoms and appropriate exposure history help a physician make the diagnosis. Antibiotics are used to treat Lyme disease and treatment is most expedient if initiated early in the course of the illness. There is no vaccine available for humans.



To prevent Lyme disease and other tick-borne diseases efforts should be made to prevent exposure to tick bites. Ticks carry multiple diseases e.g. Human Granulocytic Anaplasmosis. (Foley 2006). Further information is available at

<http://www.cdph.ca.gov/HealthInfo/discond/Pages/TickBorneDiseases.aspx> or the

[Centers for Disease Control and Protection.](#)

How To Avoid Tick Bites:

1. Tuck pants into boots or socks, and shirt into pants.
2. Wear light-colored clothing so ticks can easily be seen.
3. Apply insect repellent containing DEET on exposed skin. Use an insect repellent containing permethrin on pants, socks, and shoes. Use insect repellent registered for use against ticks.
4. Avoid trail margins, brush, and grassy areas when in tick country.
5. Check yourself for ticks frequently. Check bedding for several days after exposure to tick-infested habitats to see if engorged ticks have dropped off.

How To Remove Attached Ticks:

1. Remove the tick as rapidly as possible.
2. Use tweezers or forceps rather than your fingers, if they are readily available.
3. If you must touch the tick, use a tissue to protect your hand, if tissue is available.
4. Grasp the tick's mouthparts as close to the skin as possible.
5. Gently pull the tick straight out, steadily and firmly. Do not twist or jerk the tick as these methods are ineffective.
6. Wash hands and bite site with soap and water. Apply antiseptic to bite site.
7. If mouthparts of the tick break off and remain in your skin, consult your physician.
8. Dispose of tick in alcohol (if you would like it identified later, submit it to your local vector control agency) or by flushing it down the toilet.

Further information is available at <http://ww2.cdph.ca.gov/HealthInfo/discond/Pages/LymeDisease.aspx> or the [Centers for Disease Control and Protection.](#)

Lymphocytic Choriomeningitis: Lymphocytic choriomeningitis (LCM) is a viral disease carried by animals, especially mice. The disease in humans is rare, but there have been outbreaks associated with pet and laboratory rodents. The reservoir of LCM is the house mouse (*Mus musculus*). The virus is excreted in the urine, feces, and saliva of infected



rodents. Transmission to humans occurs by inhalation of contaminated aerosols or by ingestion of contaminated food. Person-to-person spread is not known to occur.

After an incubation period of approximately ten days, the illness begins with flu-like symptoms. The signs may disappear or progress to involve the nervous system. Recovery is usually rapid and deaths from the disease are rare. Diagnosis is made by isolation of the virus from body fluids or by serological tests. There is no specific treatment or vaccine. To prevent LCM, avoid contact with rodents and their excretions and secretions and follow good personal hygiene practices. Further information is available at the [Centers for Disease Control and Protection](#).

Murine Typhus Fever: Murine typhus fever is a flea-borne disease caused by the bacteria (*Rickettsia typhi*). The disease is endemic in certain regions of the western United States. Human cases are usually sporadic and occur in late summer and fall. Rodents are the



common reservoirs of *R. typhi*. But, opossums and domestic cats can also serve as reservoirs. *R. typhi* is shed in the feces of certain flea species that infest the reservoir animals. Murine typhus fever is transmitted to humans by feces from an infected flea that contaminates the flea-bite site or other wounds. Less commonly, the disease is transmitted by inhalation of aerosols contaminated with feces from infected fleas. Person-to-person transmission is not

recognized.

The incubation period is one to two weeks. The symptoms are fever, chills, and headache which may be followed in five to six days by a rash. Endemic typhus is not usually fatal. The diagnosis is made by serology and antibiotics are used to treat the infection. There is no vaccine available to protect against endemic typhus fever. For prevention, insecticides are used to control wild and domestic animal fleas. Where Murine typhus fever is suspected in the area, flea control should always precede rodent control measures. Further information is available at the [Centers for Disease Control and Protection](#).

Plague: Plague is a disease caused by the bacteria *Yersinia pestis*. Plague was first recognized in the United States in San Francisco in the early 1900's and has since become established in wild rodent populations of many western states where it is maintained in nature by wild rodent reservoirs. Certain rodent species are very susceptible to the disease, while others are infected but show no symptoms. The infection may cause epizootics



characterized by massive "die-offs" in susceptible rodent populations, such as ground squirrels. Plague is usually transmitted between rodents by flea bites. The most frequent route of transmission to humans is by the bite of an infected flea. In addition, humans may be infected by direct contact

with the tissues of rodents, rabbits, and other wildlife or domestic animals, especially cats, infected with plague. Person-to-person transmission does occur, particularly if the person has pneumonic plague where the bacteria can spread by aerosol. Sputum from an infected person is also very contagious. Outbreaks or epidemics of human plague can be devastating and were responsible for the Black Death epidemic in the middle ages. Although human outbreaks of plagues are rare today, the potential for person-to-person transmission makes recognition and control of this disease a high priority for public health officials.

The incubation period for plague is short, only two to six days. There are three clinical forms of plague in humans. Bubonic plague is the most common form and is characterized by fever, chills, headache, muscle aches, and swollen and painful lymph nodes, called "buboes." Septicemic plague is caused by the bacteria spreading in the bloodstream. Pneumonic plague is potentially the most deadly form of the disease and causes a serious lung infection. Untreated plague is often fatal. Prompt diagnosis by identification and isolation of the bacteria or by serological tests is very important to facilitate early treatment with antibiotics. A vaccine is available, but it is only given to persons in high risk groups.

To prevent plague, avoid contact with rodents and their fleas and never touch sick or dead rodents. Signs of a rodent "die-off" should be reported to public health officials immediately. Flea control should always precede any rodent control efforts in areas of suspected plague infestations. For personal protection, use insect repellent and wear long pants tucked into socks to reduce flea exposure.

Ground squirrels are the most common plague vector via the fleas which infest the squirrel (Harrison 1996); and are the most common rodent associated with plague in California. Squirrels are highly susceptible to plague which can cause high mortality in local squirrel populations. Squirrels are also good hosts for fleas. These fleas feed on the infected squirrel taking up bacteria with the blood meal. If the flea bites another animal or human, it will inject some bacteria as part of the feeding process. Ground squirrels are often found in close proximity to offices, family housing, or recreation areas and flea transmission or biting may readily occur. Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/Plague.aspx> or the [Centers for Disease Control and Protection](#).

Psittacosis: Psittacosis is a bacterial disease of wild and domestic birds caused by *Chlamydia psittaci*. The disease is distributed worldwide, but human cases are usually sporadic. Outbreaks have been linked to pet shops, aviaries, and pigeon lofts. The reservoirs are psittacine birds (e.g., parrots, macaws, cockatoos, parakeets, etc.), pigeons, domestic fowl, and other birds. Infected birds shed *C. psittaci* in their droppings. Transmission to humans is usually by inhalation of aerosols contaminated with droppings from infected birds. Pet birds are the most common source of infection. Transmission from person-



to-person is rare.

The incubation period is approximately ten days. Symptoms are fever, chills, headache, muscle aches, chills, and respiratory signs, such as coughing. Occasionally the disease is more severe and relapses may occur. Diagnosis is made by serological tests. There is no vaccine, but the disease is treatable with antibiotics.

Precautions should be taken to avoid inhaling contaminated aerosols where birds are kept, particularly in enclosed spaces. To control psittacosis, some states regulate the importation and sale of pet birds. Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/Psittacosis.aspx> the [Centers for Disease Control and Protection](#).

Q Fever: Q fever is a disease caused by bacteria (*Coxiella burnetti*). The disease is endemic in many areas, including parts of the western United States. A number of wild and domestic animals can be infected with Q fever, but livestock are the usual source of human infections. There are two possible transmission cycles: the most common one involves domestic animals (e.g., cattle, sheep, goats, etc.) and the other less common cycle is between wildlife (e.g., rodents, marsupials, lagomorphs, etc.) and ticks in nature. Many species of soft and hard-shelled ticks may be infected with Q fever. *C. burnetti* is found in the afterbirth and other body fluids, including milk, of infected animals. *C. burnetti* can live in the environment for a



long time and continue to serve as a source of infection to livestock and humans. Inhalation of contaminated aerosols is the usual mode of transmission to humans. Transmission by the bite of an infected tick is less common and person-to-person transmission is very rare.

Persons at a higher risk of exposure to Q fever include veterinarians, farmers, slaughterhouse workers, researchers, and others who handle livestock, especially sheep. Persons entering wildlife habitat in endemic areas may also be at an increased risk of infection. The incubation period is two to three weeks. Symptoms are fever, chills, headache, weakness, profuse sweating, and sometimes pneumonia. Complications may include damage to the heart, lungs, liver, or other organs. If treated, the disease is not usually fatal. Q fever is diagnosed by serological tests and antibiotics are used to treat the infection. A vaccine is available for persons at a high risk of exposure to the disease. Q fever is prevented by practicing good hygiene while working with livestock, pasteurizing milk, and preventing tick bites (see Lyme disease). Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/QFever.aspx> or the [Centers for Disease Control and Protection](#).

Rabies: Rabies is caused by a virus that attacks the nervous system. The disease is widely distributed in animals throughout much of the United States, but human rabies is rare in this country. Wild animals account for over 90% of all rabid animals identified. The principal rabies reservoirs today are wild carnivores and bats (Childs, Krebs & Rupprecht 1998). The wild animals most frequently reported rabid are skunks, raccoons, bats, coyotes, and foxes. In California, skunks and bats are the most common wildlife reservoir. However, any mammalian species may theoretically contract rabies. Some animals, such as rodents, are very resistant to infection. In the past, rabies in dogs was reported more frequently than in wild animals. Statutes mandating rabies vaccination and licensing of dogs resulted in a substantial drop in the number of dog rabies cases since that time.



The rabies virus is shed in the saliva of infected animals and is usually transmitted by bites. Scratches or contamination of wounds, abrasions, or mucous membranes with saliva or nervous system tissue from an infected animal are other documented routes of transmission. Airborne transmission of rabies has occurred in humans entering caves with roosting bats.

In contrast to many of the diseases described in this chapter, rabies causes clinical signs in infected animals. Rabies often causes abnormal behavior in wildlife and it should be suspected in any wild animal showing a lack of fear around humans, activity during the day (if normally nocturnal), or aggression and unprovoked attacks. Other signs of rabies in animals include weakness, paralysis, and increased excitability.

The incubation period in humans may be as short as ten days or as long as one year. Symptoms include a sense of apprehension, headache, fever, and unexplained sensations, usually at the site of the bite. The disease may progress to severe weakness or paralysis, delirium, convulsions, and death. Spasms in the throat make swallowing very difficult; this



sign has been described as a fear of water or hydrophobia. The course of illness is usually less than one week and rabies is almost always fatal. Diagnosis is made by special tests of the brain tissue. There is no specific treatment once clinical signs begin.

A preexposure rabies vaccine is available and strongly recommended for persons at significant risk for rabies exposure (e.g., veterinarians and their staff, wildlife rehabilitators, animal control officers, etc.). More information regarding the preexposure vaccine and its availability can be found at http://www.cdc.gov/rabies/news/2008-05-20_PreEVax.html To prevent exposure to rabies, direct contact with wildlife should be avoided. If an animal is behaving strangely or appears to be sick, the local health department or animal control agency should be notified. Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/rabies.aspx> or the [Centers for](#)

Disease Control and Protection.

What To Do If Bitten By An Animal: All animal bites should be treated seriously because of the potential for exposure to rabies and other diseases (e.g., pasteurellosis, tularemia, rat-bite fever, tetanus, etc.).

1. Always clean bite wounds thoroughly with soap and water as soon as possible after the bite. This is one of the most important steps to prevent infection.
2. A physician should be consulted immediately after any animal bite. There is a specific treatment available for rabies prevention after an exposure incident.
3. If the biting animal is available, the local animal control agency should be contacted. Wild animals are sacrificed and the brain submitted to a public health laboratory for rabies testing.

Check the [Centers for Disease Control and Protection](#) for further information specific to the disease you are researching.

Rat Bite Fever: Rat bite fever is a bacterial disease caused by *Streptobacillus moniliformis*. The disease has a widespread distribution, but human cases are rare. The bacteria that cause rat bite fever are part of the normal flora of the mouth of many rodents, especially rats. Animals that eat rodents may also become infected and transmit the disease to humans. Rat bite fever is usually transmitted by animal bites or by direct contact with the secretions of infected animals. Persons have also become infected by eating infected rodents or food contaminated by infected rodents.



The incubation period is ten days or less and symptoms include an abrupt onset of high fever, headache, vomiting, muscle pains, swollen joints, and a rash on the arms and legs. Some people develop complications including damage to the joints, heart, liver, lungs, or brain. Without treatment, the disease is fatal 10-12% of the time. Diagnosis of rat bite fever is made by isolation of the bacteria or by serological tests. There is no vaccine, but the infection can be treated with antibiotics. To prevent this disease, precautions should be taken to avoid animal bites and human dwellings should be rodent-proofed. Further information is available at the [Centers for Disease Control and Protection](http://www.cdc.gov).

Rocky Mountain Spotted Fever: Rocky Mountain spotted fever (RMSF) is a tick-borne disease caused by the bacteria *Rickettsia rickettsii*. RMSF is one of the most frequently reported vector-borne diseases in the United States. The main tick vectors are the wood tick (*Dermacentor andersoni*) and the American dog tick (*D. variabilis*). The incidence of human disease is greatest between April and August, which can coincide with the increased activity of adult ticks. The reservoirs of RMSF are wild rodents, rabbits, and the ticks themselves. RMSF is transmitted by the bite of an infected tick or by contamination of the skin (especially if wounded or abraded) with the body fluids or feces of infected ticks.



Persons who enter tick-infested areas where RMSF is endemic are at an increased risk of exposure to the disease. Symptoms begin within two weeks after the tick bite and include fever, chills, headache, fatigue, muscle pain, and a characteristic rash. The rash usually starts on the legs or arms and may spread to the feet, hands, and rest of the body. Some people do not develop the rash. The disease can be very severe and is fatal 15-20% of the time if untreated and 4-6% of the time if treated. RMSF is diagnosed by clinical presentation and history. Serological tests are used to confirm the diagnosis but treatment with antibiotics should begin as soon as possible, often before serology results can be obtained. There is no vaccine available in the United States. Tick bites should be avoided to prevent RMSF (see Lyme disease). Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/TickBorneDiseases.aspx> or the

[Centers for Disease Control and Protection.](#)

Salmonella: Salmonellosis is caused by bacteria in the *Salmonella* genus. The disease is a common cause of "food poisoning" worldwide. *Salmonella* spp. are found in many animals, including wildlife. Cold-blooded animals (e.g., reptiles, turtles, tortoises, etc.) often carry the bacteria without any signs of illness and salmonellosis is the most frequent zoonotic disease transmitted by reptiles. *Salmonella* spp. are shed in the feces of infected animals and humans. Humans acquire the infection by ingestion of the bacteria directly from the infected animal, feces-contaminated environment, or contaminated food. Persons with salmonellosis can transmit the disease to other persons by the fecal-oral route of transmission.



Anyone can be infected with *Salmonella* spp., but the very young, very old, and immunosuppressed are at the greatest risk of serious illness. The incubation period is approximately 12-36 hours. Symptoms are fever, abdominal cramps, diarrhea, nausea, loss of appetite, and sometimes vomiting. The illness may be mild to very severe, even fatal. Salmonellosis is diagnosed by isolation of the bacteria from feces. Treatment depends on the severity of the illness, but preventing dehydration from fluid loss is very important. There is no vaccine for humans.

To prevent salmonellosis, persons in contact with animals should practice good personal hygiene, including thorough hand washing after handling animals or working in their environment. Salmonellosis is also prevented by properly storing, handling, and cooking food. Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/Salmonellosis.aspx> or the [Centers for Disease Control and Protection.](#)

Tick Paralysis: Tick paralysis is a clinical syndrome described in humans and animals caused by a toxin (poison) secreted in the saliva of certain female ticks. The ticks of the species *Dermacentor* spp. have been associated with tick paralysis in North America; children appear to be more commonly affected than adults. Most cases occur in the Pacific Northwest and Rocky Mountain States in the spring and summer months. The symptoms usually begin after the tick has been attached for four to seven days. Symptoms are weakness and in coordination in the legs which may progress to paralysis (ascending paralysis). Removal of the tick usually results in recovery; often these ticks attach on the head just at the hairline. Tick paralysis is prevented by avoiding tick bites and promptly removing attached ticks (see Lyme disease). Further information is available at the [Centers for Disease Control and Protection.](#)

Tularemia: Tularemia is a bacterial disease caused by



Francisella tularensis. The disease occurs sporadically in the western United States. More cases are seen in the summer during tick season and the winter during rabbit hunting season. The reservoirs of tularemia are ticks, primarily of the genus *Dermacentor*, and wildlife, especially rabbits, hares, and rats. There are many possible routes of transmission to humans including: 1) direct contact with the tissues or body fluids of infected animals, ticks, or deer flies, 2) the bite of an infected tick, 3) the consumption of undercooked meat from an infected animal, 4) swimming in or drinking water contaminated by infected animals, and 5) inhaling dust contaminated by infected animals.

Rabbit hunters and persons visiting tick-infested areas are at a higher risk of exposure to tularemia. There is a short incubation period, usually three days. The most common symptoms are swollen glands and an ulcer, often on the hand. Tularemia can cause other clinical signs including pneumonia, diarrhea, vomiting, or eye infections, but the disease is not usually fatal. Tularemia is diagnosed by isolation of the bacteria or by serological tests, and antibiotics are used to treat the infection. A vaccine is available to certain individuals in high-risk groups.

Precautions should be taken to avoid contact with the tissues and body fluids of animals, flies, and ticks. Tick and fly bites should be prevented (see Lyme disease). Other precautions include avoiding swimming in or drinking untreated water and thoroughly cooking meat. Further information is available at <http://www.cdph.ca.gov/HealthInfo/discond/Pages/Tularemia.aspx> or the [Centers for Disease Control and Protection](#).

West Nile Virus: West Nile virus (WNV) is a mosquito transmitted virus infection of birds that historically was distributed throughout Africa, Middle East, Europe and western Asia (McLean 2006). The virus was responsible for human epidemics within its historical range, but the virus strains there did not cause noticeable mortality in native birds. WNV



was introduced into the United States in 1999 via the Middle East (likely Israel where an identical WN virus strain was circulating at the same time). The exact source of introduction is unknown. WNV is maintained in nature in a mosquito-bird cycle. People and other mammals become infected when they are bitten by an infected mosquito (Kjemtrup 2006). The American Crow has emerged as being highly susceptible to the strain of WNV in the U.S., and as such has become a valuable indicator of the diseases spread throughout the U.S. (McLean 2004). WNV is now a widely disseminated enzootic disease throughout North America. The strain is highly virulent. Targeted mosquito control is at present the only method available to suppress local transmission and reduce human risk. Equine vaccinations reduce the risk in equine cases. National surveillance indicators are posted on the [USGS Disease map](#) website. In California, local information is available at the [California West Nile Virus](#) website. Further information is available at the [Centers for Disease Control and Protection](#).

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