

Carnivores

(Class Mammalia, Order Carnivora)

Chapter 5



General Characteristics

- **Taxonomy**

- Eleven families and approximately 271 species of carnivores are currently identified. In California, there are approximately 23 species, including feral dogs and cats.



- **Anatomy**

- Carnivores are quite diverse in size and appearance. Terrestrial carnivores range from the least weasel, at 35 g (1.3 oz), to the grizzly and polar bears weighing as much as 800 kg (1760 lb).
- Common to all North American carnivores are three pairs of small incisor teeth and one pair of large strong canine teeth on the upper and lower jaw. These canine teeth are the most characteristic feature of the Order Carnivora.



General Characteristics

Reproduction

Most species produce one litter per year. Young are born blind and dependent on parental care for an extended period of time. Carnivores do not truly hibernate but will "winter sleep" or remain in their dens during periods of exceptionally cold weather.

Food

"Carnivore" means "flesh-eating", but this label is overly restrictive in that the diets of many carnivores also contain large amounts of fruits, berries, roots, and vegetation. Bears, for example, subsist almost exclusively on plant material. Some carnivores require freshly killed prey; others will scavenge and eat carrion.

Habitat/Distribution

Carnivores inhabit all continents and have adapted to a variety of terrestrial and aquatic habitats. The distributions of individual carnivore species naturally follow the distribution and density of their prey.



California Carnivores of Public Health Importance

**FAMILY CANIDAE: DOGS, COYOTES, FOXES,
AND WOLVES**

Coyote *Canis latrans*

Description: Coyotes are grizzled gray or reddish gray with a buff color on their underside. They have rust or yellowish legs with a dark vertical line on lower forelegs; their tails are bushy with a black tip. They weigh 20-40 lb with a total length of 41-52 in. Tail length is 12 -16 in.

Distribution/habitat: Coyotes are found in eastern Alaska, northwestern Canada, all of the western United States east to Louisiana, Tennessee, Ohio, and northern New York. Coyotes are very adaptive predators that are tolerant of human activities. They can rapidly adjust to changes in the environment. In the West, they inhabit mostly open plains.

Food: Coyotes are opportunists that will eat insects, birds, reptiles, amphibians, fruit, and eggs, but their primary diet is mice, rats, ground squirrels, and carrion.

Reproduction: Pairs tend to remain together for life. They have one litter per year, with an average of 5-6 offspring per litter.

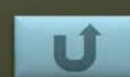
Significance: Occasionally prey on domestic pets and livestock. Can serve as reservoir for disease agents infectious to humans and domestic dogs. Important sentinel species in plague surveillance programs. Protected Status: Non-game species.



Red Fox (*Vulpes vulpes*)



- Description: Red foxes are small, dog-like canines that are rust-red in color with white underneath the chin and throat. Coat can be reddish-brown, with a dark cross on the shoulders, or black with silver-tipped hair. They have black feet. These foxes weigh 8-15 lb. Their height at the shoulders is about 16 in. Their total length is 35-40 in with the tail 14-17 in.
- Distribution/habitat: Red foxes are found in most of Canada and the United States except for southwest California, northern Nevada, and Arizona. *Vulpes vulpes necator* are found in the Cascades, Siskiyou Co., and from Lassen Co. to Tulare Co. Preferred habitat includes mixed cultivated and wooded areas.
- Food: They are opportunists that feed on insects, earthworms, fruit, carrion, birds, and rodents.
- Significance: Occasionally preys on domestic pets and livestock, particularly fowl. Can serve as reservoir for disease agents infectious to humans and domestic dogs.
- Protected Status: California Subspecies (*V. v. necator*): California Threatened. Introduced Populations: Fur-bearing species.



Kit Fox

(Vulpes macrotis)

- Description: Kit foxes are smaller than red foxes. Their color is buff-yellowish above and white underneath. The tail is black or it is the color of the body with a black tip. Feet are light in color. Kit foxes weigh approximately 3-6 lb. Their total length is 24-32 in. The tail length is 9-12 in. The height at the shoulders is about 12 in.
- Distribution/habitat: Kit foxes inhabit the arid regions of the southern half of California. Kit foxes inhabit open level areas where there is little human disturbance. Preferred habitat is a loose-textured soil with scattered shrubby vegetation.
- Food: The principal foods of kit foxes are black-tailed hares and desert cottontails, rodents, insects, reptiles, small birds, and eggs.
- Reproduction: Kit foxes have one litter per year with an average of 4 offspring per litter.
- Significance: Rarely presents a nuisance or disease threat.
- Protected Status: San Joaquin Kit Fox (*V.m. macrotis*): Federal Endangered and California Threatened.



Gray Fox

(Urocyon cinereoargenteus)



Description: Gray foxes are grizzled gray above and red-brown underneath and on the back of the head. The throat is white. The tail is black on the top and black at the tip. The feet are rust-colored. The total length is 32-44 in. Tail length is 9-17 in. Height at the shoulders is 14-15 in. Gray foxes weigh 7-13 lb.

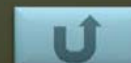
Distribution/habitat: Gray foxes inhabit the eastern United States to eastern North and South Dakota, Nebraska, Kansas, Oklahoma, most of Texas, New Mexico, Arizona, California, northern Colorado, southern Utah, southern Nevada, and western Oregon. They inhabit shrub lands, brushy and open-canopied forests that are interspersed with creeks, streams, rivers, ponds, or lakes.

Food: Gray foxes are opportunists that feed on fruits, cottontail rabbits, mice, voles, and insects.

Reproduction: Gray foxes have one litter a year with an average of 4 offspring per litter.

Significance: Occasionally preys on domestic pets and livestock. Can serve as reservoir for disease agents infectious to humans and domestic dogs.

Protected Status: Fur-bearing species.



Feral domestic dog

(*Canis lupus*)



- Description: Feral dogs are domestic dogs that no longer have a commensal relationship with humans for more than one generation. They are more independent of and more aggressive toward humans than stray or abandoned dogs.
- Distribution: May be found anywhere that domestic dogs are abandoned and uncontrolled.
- Food: Unlike stray dogs which usually scavenge on garbage, feral dogs typically prey on small to medium- sized wild or domestic animals.
- Reproduction: Feral dogs often form well-organized packs that communally rear litters of pups. Because of uncontrolled inter-breeding, feral dogs tend to resemble a hybridized mongrel breed of domestic dog.
- Significance: Aggressive disposition and habituation to humans pose an increased risk of injury and disease transmission to humans and domestic animals compared to wild canids. Feral dogs may serve as a reservoir for disease agents infectious to domestic dogs in areas of human habitation.
- Protected Status: None





Family Ursidae: Bears

Black Bear

(*Ursus americanus*)

- Description: In the west, the black bear's color ranges from black to cinnamon with a white patch on the chest. Total length ranges from 5-6 ft. Tail is 3-7 in. Height at the shoulders is about 3 ft. Black bears weigh from 200-600 lb.
- Distribution/habitat: Black bears inhabit most of Canada, Alaska, Washington, and Oregon; parts of California, Rocky Mountain states to Mexico; northern Minnesota, Wisconsin, and Michigan; in New England, New York, Pennsylvania south through the Appalachians; in the South, most of Florida, parts of Arkansas, and southern Louisiana. In the West, black bears inhabit forests and wooded mountains below 2100 m (7000 ft) elevation. In the East, these bears inhabit forest and swamps.
- Food: Black bears are opportunists that feed on roots, fruits, nuts, insects, fish, rodents, and carrion.
- Reproduction: Black bears have one of the lowest re-productive rates of the large land mammals in North America. Females give birth to young about every two years. Usually twins or triplets are born.
- Significance: May become a nuisance or destroy property when they enter human habitations in quest of food. Infrequently present risk of physical injury. Important sentinel species in plague surveillance programs, particularly in montane forest habitat.
- Protected Status: Game species



Ringtail

(*Bassariscus astutus*)

- Description: Ringtails have a catlike body with a fox-like face. They are yellowish-gray in color above and whitish-buff underneath. Their tail is bushy, very long, and black and white banded. Ringtails weigh about 2 lb. Their total length is 24-32 in. Tail length is 12-17 in.
- Distribution/habitat: Ringtails are found in southwestern Oregon, California, and southern Nevada. Ring-tails inhabit forests and shrub lands in close association to rocky areas or areas adjacent to bodies of water. They are primarily active at night (nocturnal).
- Food: Ringtails primarily feed on rodents, rabbits; birds, eggs, insects, fruit, nuts, and some carrion.
- Reproduction: Ringtails have one litter per year with an average 3 offspring per litter.
- Significance: Minimal public health importance.
- Protected Status: California: Fully Protected: May not be taken under any circumstances





Raccoon

(*Procyon lotor*)



- Description: Raccoons are reddish-brown and black above and gray underneath. They have a bushy tail with alternating bands of black and brown or brownish gray. Their most distinguishing characteristic is the black mask or band across the eyes. Their body length is 24-37 in. The tail is 8-16 in. Raccoons weigh 12-48 lb.
- Distribution/habitat: Raccoons are found throughout the United States except portions of the Rocky Mountain states, central Nevada, and Utah; they are also found in the southern portions of the Canadian provinces bordering the United States. Raccoons inhabit wetlands and the areas along bodies of water in forestlands and shrublands. They are most common along wooded streams. They are nocturnal.
- Food: Raccoons are opportunists that feed on crayfish, fish, insects, amphibians, small mammals, birds, and eggs in the spring. During the summer and fall, they feed primarily on fruits, nuts, acorns, and grains.
- Reproduction: Offspring are born between March and May with an average of 3-4 young per litter.
- Significance: Large peridomestic populations may present a nuisance and destroy property. Occasionally may cause injury (bite, scratch) to humans and domestic pets. Present risk of infectious disease transmission, including rabies and *Baylisascaris*.
- Protected Status: Fur-bearing species.



FAMILY MEPHITIDAE: SKUNKS

Skunks

Striped Skunk (*Mephitis mephitis*)



- Description: Striped skunks are black with two broad, white stripes on their back that meet on top of the head. There is a thin white stripe down the middle center of the face. They have a bushy black tail that is either tipped with or fringed with white. Their total length is 21-32 in, and their total tail length is 7-16 in. Striped skunks weigh 6-14 lb.
- Distribution/habitat: Striped skunks are distributed throughout the United States and southern Canada. They are found throughout most of California except parts of the Mojave and the Colorado deserts. These skunks inhabit deserts, woodlands, grassy plains, and suburbs. Striped skunks are nocturnal.
- Food: The striped skunk's diet is primarily insects, small mammals, birds, eggs, amphibians, reptiles, fruits, and some carrion.
- Reproduction: They have one litter per year with an average of 4 offspring per litter. Young are usually born from April through June.
- Significance: An important reservoir for rabies in California. Occasionally damage property and prey on laying fowl and their eggs. Defensive spraying can be irritating to humans and domestic pets. Predation on rodents may locally decrease the risk to humans of some infectious diseases carried by rodents.
- Protected Status: Non-game species.



Western Spotted Skunk

(Spilogale gracilis)



Description: Spotted skunks are smaller than other skunks. They are black with horizontal white stripes on the neck and shoulders, and irregular vertical white stripes and elongated spots on their sides. The tail has white spots on the top and a white tip. Spotted skunk's total length is 13-22 in in length. The tail is 3-9 in in length. Spotted skunks weigh about 2 lb.

Distribution/habitat: Western spotted skunks are found in the western United States except in the high mountains and very dry areas such as the Mojave and Colorado Deserts. These skunks inhabit moderately open shrub and forest habitats that have streams or bodies of water associated with them. They are also found in areas with rocky lava rims and outcrops. Spotted skunks are nocturnal.

Food: Spotted skunks' diet is primarily insects and small mammals; they will also eat fruits, grains, reptiles, birds, eggs, and carrion.

Reproduction: They have one litter per year with an average of 4 offspring per litter. The young are usually born in April or May.

Significance: An important reservoir for rabies in California. Important sentinel species for plague surveillance in lava rim and rocky outcrop habitats. Occasionally damage property and prey on poultry and their eggs. Defensive spraying can be irritating to humans and domestic pets.

Protected Status: Non-game species. Subspecies *S. g. amphiala*: California Species of Special Concern



Family Mustelidae: Weasels, Minks, Martens, Wolverines, Badgers, Otters



Badger

(*Taxidea taxus*)

Description: Badgers have a flattened body that is wider than long. Their legs are short and bowed, with dark feet. They have a shaggy grizzled grey to brown coat. There is a white stripe that runs from the shoulder down the forehead to the tip of the nose. Males are larger than females. The total length is 21-34 in. The tail is 4-6 in long. Badgers weigh from 8-25 lb.

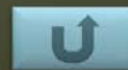
Distribution/habitat: Badgers are found in the western United States east to eastern Texas, Oklahoma, northern Illinois, northern Indiana, and northern Ohio. In Canada, they inhabit southeastern British Columbia, Alberta, Manitoba, and southern Saskatchewan. Badgers inhabit plains, farmlands, and occasionally the edge of woods where the soil is usually dry and friable.

Food: Badgers primarily feed on rodents. Occasionally, they feed on reptiles, insects, earthworms, birds, eggs, and carrion.

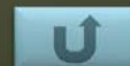
Reproduction: Offspring are usually born in March or April. On average, there are 2-3 offspring per litter.

Significance: May respond aggressively to threats, causing physical injury. May infrequently prey on domestic fowl. Extensive burrows may destroy property and pose risk of hazardous injury. An important sentinel species in plague surveillance in areas where they live in close association with large ground squirrel populations.

Protected Status: Fur-bearing species.



FAMILY FELIDAE: CATS, MOUNTAIN LIONS, AND BOBCATS





Mountain Lion

(*Puma concolor*)

- Description: Mountain lions are yellowish to tawny. The underneath side of the body is white overlaid with buff. The tail is long with a black tip and the same color as the body. Their total length is 59-108 in. The tail is 21-36 in in length. The adult mountain lion weighs from 75-275 lb.
- Distribution/habitat: Mountain lions are found in western North America from British Columbia and southern Alberta south through western Wyoming to California and west Texas. They are also found in southern Texas, southern Louisiana, parts of Tennessee, southern Alabama, and the southern tip of Florida. Mountain lions inhabit mountainous regions, hilly northern forests, semiarid regions, tropical and subtropical forests and swamps.
- Food: They feed primarily on deer, but will also feed on coyotes, porcupines, beaver, marmots, rabbits, raccoons, mice, and insects.
- Reproduction: Litters are produced every 2 years with 1-6 offspring per litter. Offspring are usually born mid-summer.
- Significance: May occasionally prey on domestic pets and livestock. Infrequently reported as a cause of human injury and death. Valuable sentinel species in plague surveillance programs.
- Protected Status: Specially protected species. May not be taken except by the California Department of Fish & Game or their specifically authorized agent. Property owner may take a mountain lion only if it poses an immediate threat of injury or death to livestock or domestic animals. (Fish & Game Code: Section 4800-9) *F. c. browni*, California Species of Special Concern.



Bobcat

(Lynx rufus)

- Description: Bobcats are tawny with indistinct black spotting. The upper legs have black or dark horizontal bars. The tail is short with a black tip and 2-3 black bars. The total body length is 28-49 in. The tail length is 4-7 in. Bobcats weigh 14-40 lb.
- Distribution/habitat: Bobcats are found from southern Canada into Mexico, though their distribution is spotty. They are absent to scarce in the Midwest. Bobcats are most plentiful in the Far West. Bobcats inhabit scrubby country, broken forests, swamps, farmlands, and rocky or brushy arid lands.
- Food: Bobcats eat rodents, young deer, birds, reptiles, amphibians, and invertebrates. They will also eat fruits and vegetation.
- Reproduction: Bobcats have one litter per year with 2-3 offspring per litter. Young are born in April to early May.
- Significance: Valuable sentinel species in plague surveillance. May occasionally prey on domestic pets, small livestock, and poultry.
- Protected Status: Non-game species



Feral Domestic Cat

(Felis silvestris)



- Description: Feral cats are domestic cats that have been abandoned and adapted to the wild. Physically, they share the variety of colors and coat lengths present in their domestic kin. Due to their feral existence, most are slightly thinner than domestic cats, averaging 3-8 lb.
- Distribution: May be found in any urban or suburban area where domestic cats are abandoned. They prefer vacant or infrequently used buildings or other structures for shelter.
- Food: Opportunistic feeders that will prey on any small animal, especially rodents and birds. They will also consume garbage and uneaten pet food.
- Reproduction: Feral cats can be quite fertile, capable of 3-4 litters a year of 3-6 off-spring each. However, due to harsh environmental pressures, only a small percentage of offspring likely survive to sexual maturity.
- Significance: Source of injury and infectious disease to humans and domestic cats. Depredation on native bird species may be significant if large, unregulated colonies are present.
- Protected Status: Domestic cats are personal property of their legal owner. If ownership cannot be established, they are the property of the landowner on whose property they reside. Local ordinances vary in their legal consideration of feral domestic cats.



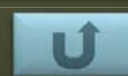
Public Health Significance

- Bites & physical trauma
 - All carnivores will attack if cornered or threatened in an attempt to defend themselves. In many cases these attacks result in bites and trauma.
- Disease
 - Any mammal can pose a theoretical risk of rabies transmission. However, because of their well-developed dentition and efficient anatomy designed for hunting, carnivores are of particular concern as carriers of rabies. Also, because of their relatively large size, carnivores are more likely to survive an encounter with a rabies-infected animal and thus more likely to develop disease and shed virus weeks to months later. The primary reservoirs for rabies in California are skunks and various species of bats.
 - In California, carnivores are an important component of surveillance programs for plague in enzootic areas. Most large carnivores do not develop illness when exposed to the plague organism. However, they usually develop antibodies to the plague bacillus which can be detected on blood test.
 - Raccoons are probably the most notorious of the carnivores for being a pest and a health threat to humans and domestic animals. Besides killing domestic live-stock and destroying crops, they carry rabies, tularemia, leptospirosis, Chagas' disease, trichinosis, and canine distemper. Raccoons commonly are infected with intestinal roundworms (*Baylisascaris procyonis*) the larvae of which can be spread to humans through ingesting or inhaling roundworm eggs from the feces of infected raccoons. While rare, the disease caused by these migrating larvae can be devastating, leading to brain or vision disorders, coma, and death.



Management & Control

- The control and relocation of carnivores should be left to professionals. Harassment, injury, or removal of many of these animals is restricted by federal and state legislation. Failure to abide by these restrictions can result in fines and imprisonment. All wildlife in California are classified as game (e.g., bear), non-game (e.g., skunk), fur-bearing (e.g., raccoon), or specially protected (e.g., mountain lion) (California Fish and Wildlife Code, Sections 2000-2085, 3950-4190).
- It is critical before implementing any carnivore control program that one consult the CDFG, local animal control agencies, the County Agriculture Commissioner, law enforcement authorities, U.S. Fish and Wildlife, the United States Department of Agriculture Wildlife Services, or State/National Park Service personnel to ensure that the proposed program complies with all current laws and regulations.



- **Badgers**

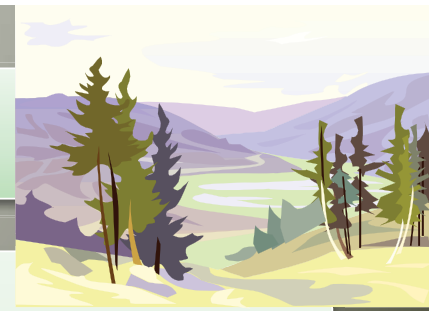
- Professional control is recommended. Mesh fencing buried to a depth of 30-46 cm (12-18 in) can be an effective exclusion technique. Eliminating the badger's principal prey (gophers, squirrels) can reduce problems associated with badger diggings. Bright lights can frighten badgers from certain areas.

- **Bears**

- Installation of electrified fencing is an effective means of excluding bears from sensitive areas, but is expensive and requires constant maintenance. Deployment of bright lights and placement of human effigies can be used to frighten bears away from areas of human activity. However, these scare methods may lose their effectiveness over time as bears become accustomed to them. It is important to vary the type, location, duration and hour of deployment of scare methods to prolong their effectiveness.
- Sources of food that can attract bears should be eliminated or placed in containers that reduce attractive odors and prevent access. Garbage should be buried or regularly removed. Capsaicin repellent and use of strong fences and bear-proof buildings and garbage containers can reduce food odors and further dissuade bear activity around human dwellings.
- Removal of problem bears should only be attempted by professionals.



Felids



- Bobcats.

- Fencing at least 2 m tall around sensitive areas (e.g., poultry coops) can dissuade bobcats from preying on domestic animals. Bobcats shy from open areas that lack cover; keeping trees and shrubs cleared for several meters around homes and building can reduce the attractiveness of these areas to bobcats. Loud noises and bright, flashing lights can temporarily frighten bobcats.

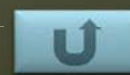
- Mountain lions.

- Because mountain lions are a protected species in California, any and all management and control programs must be conducted by, or in full collaboration with, California Department of Fish and Wildlife officials. Exclusion and frightening techniques as described above for bobcats may be effective for mountain lions as well.



- Feral domestic cats

- Feral cats must be differentiated from stray cats. Feral cats should be maintained in well managed colonies by an informed and responsible caretaker. Colonies should be restricted to a defined geographic area that minimizes risk to human health and sensitive wildlife species. Individual colony members should be identifiable by tag or subcutaneous micro-chips.
- Caretakers should adhere to a written protocol describing how the colony is to be fed, watered, and provided health care. The contribution and cooperation of local veterinarians toward the monitoring the health of the colony should be documented. Health care programs should include routine examinations, vaccinations, deworming, serologic screening for infectious diseases, sterilization surgery, and euthanasia of cats for which ill health or other factors prevent their reintroduction to the colony.
- Abandoned and stray cats that are not part of a managed colony should be removed from the environment and dealt with in accordance with local animal control regulations.



Canids



- Coyotes and Foxes



- Prevention of damage and predation by coyotes relies on appropriate exclusion and avoidance methods; efforts to remove all coyotes is neither practical nor effective.
- Solid fencing can often reduce, though usually not permanently eliminate, predation of livestock by coyotes. Fencing should rise 2 m above the ground and extend 0.8 m below the ground. Installation of electrically charged wire, particularly at the top of the fence, can provide additional deterrence. Steady, intermittent, or strobe lights which automatically turn on at dusk may be placed around livestock enclosures or other sensitive areas. Lights should be relocated at irregular intervals to minimize accustomation by coyotes. Auditory, olfactory, and gustatory repellants have been less successful in frightening coyotes.



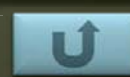
- Feral domestic dogs. Control methods are similar to those used for wild canids. Abandoned and stray dogs should be dealt with in accordance with local animal control regulations.
- Successful long-term management and elimination of feral dogs is dependent upon responsible ownership of domestic dogs, including confinement, health care, sterilization, and appropriate disposition of unwanted dogs.





• Raccoons

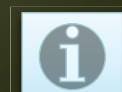
- Exclusion is the most effective means of counteracting raccoon damage. Doors, windows, and other potential entry points to buildings should be tightly closed. Fences should be placed around sensitive areas and an electrically charged "hot wire" positioned at the top of the fence.
- Raccoons can be deterred from activity in and around areas of human habitation by removing attractive sources of food. Garbage cans and grain storage bins should be securely sealed. Unconsumed pet food should be regularly removed from around human residences.

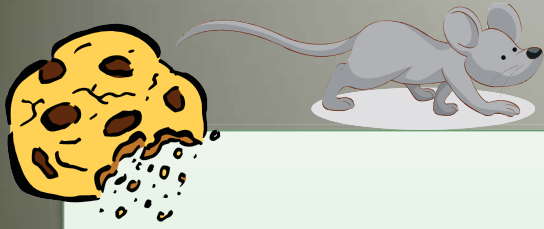




- **Skunks**

- Skunks can be excluded from sensitive areas through installation of fencing that is buried 40-60 cm (1.5-2 ft) below the surface. Garbage containers should be securely sealed and garbage regularly disposed of to remove the attraction of food for skunks. Wood and debris piles provide shelter for skunks and should be removed from around human residences.

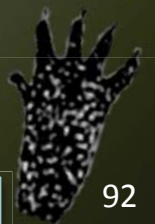




Rodents

(Class Mammalia, Order Rodentia)

Chapter 6



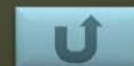


Rodents are the most common group of mammals in the world. It is estimated that over 40% of all mammals living today are rodents, with over 2000 species and 28 families.

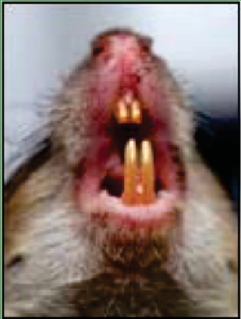
Among the vertebrates, they represent one of the most successfully adapted groups, but also one of the most notorious. The history of western civilization, if not mankind itself, is inextricably linked with that of the rodent. Arguably the most important public health event of the last millennium was the Black Death of the 14th century which reduced the world's human population by a third. And yet, this pandemic of plague, fomented by the rat and its baggage the fleas, set the stage for the social transformation that followed, including the end of feudalism, the Renaissance, and the Reformation.

Today, rodents continue to be both boon and bane to human health and economy. Fur bearing rodents like the beaver and chinchilla provide a natural source of income for some societies. On the other hand, rodents wreak billions of dollars of damage to agriculture every year. Pet hamsters, gerbils, and other small rodents provide companionship to many households, while their brethren simultaneously cause considerable consternation as intrusive pests.

Finally, rodents are useful models and subjects in scientific research which advances the quality of human life, but are also reservoirs and vectors for numerous infectious disease agents. In the animal kingdom, only insects surpass the importance of rodents to contemporary human civilization.



General Characteristics



Rodents are a diverse group, ranging from miniscule mice of just a few inches, to the South American capybara which can get up to 4 feet in length and weigh 120 lbs.

- Feet, legs, and other body parts can also be highly specialized for digging, climbing, swimming, or even gliding. As a group, rodents are readily distinguished from other mammals by their large incisor teeth two upper and two lower. The incisors have a hard enamel on the front surface with a softer dentine in the back. The incisors grow continually making it necessary for the rodents to constantly gnaw to keep their teeth sharp and a manageable length.
- California rodents may be classified into two groups which are distinct in their phylogeny, behavior, and habitat. The commensal, or domestic, rodents are Old World rodents which were imported to North America. The native, or wild, rodents include various species of squirrels, chipmunks, field mice, meadow mice, and woodrats. Because the ecology, behavior, and public health significance of these rodent groups are distinct, each group will be discussed separately.



Taxonomy

- Class Mammalia
- Order Rodentia, Family Muridae
- Subfamily Murinae (Old World rats and mice)
- Subfamily Sigmodontinae (wild mice, wood rats, and others)
- Family Sciuridae, (ground squirrels, tree squirrels, and marmots)



COMMENSAL (DOMESTIC) RODENTS (FAMILY MURIDAE, SUBFAMILY MURINAE)

- The three species of domestic rodents are also correctly referred to as commensal rodents because they live in close association with humans. These commensal rodents are not indigenous to North America, but accompanied humans as stowaways on their ships of emigration and trade.
- The roof rat, *Rattus rattus*, originated from the southeast Asian mainland, spread along the ancient caravan routes from India across the Middle East, to East Africa and the eastern Mediterranean. By the Middle Ages, this species was distributed throughout most of Europe. Roof rats were probably introduced to the New World during the 15th or 16th Century, first reaching South America in the mid 1500s. The first record of roof rats in the United States was in the early 1600s.
- The Norway rat, *Rattus norvegicus*, was introduced later, migrating westward from Central Asia, first appearing in the beginning of the 18th Century. The first record of its introduction into the United States (possibly from Europe) was in the late 1700s.
- The house mouse, *Mus musculus*, also spread westward from central Asia, through the Middle East, to the Mediterranean shores and Europe. These mice were probably introduced into Latin America aboard ships from Spain and Portugal and subsequently spread into the southern United States and California.



General Characteristics

Sensory abilities

Vision. Commensal rodents are nocturnal (active at night). Though their eyes are specialized for vision in low light, acuity is generally poor. Most rodents are color blind, perceiving light in shades of gray.

Taste. The sense of taste is well developed in commensal rodents. They prefer fresh food to old or spoiled food. Some species seem especially sensitive to extremely minute quantities of bitter or other unpleasant substances included in toxic baits. Hence, repeated sub lethal applications can lead to bait-refusal or bait-shyness among survivors.

Smell Commensal rodents have an acute sense of smell. They leave odor trails as they move about. These odors aid them in recognition of kin and in locating sexually active mates. Commensal rodents are accustomed to human activity and thus lingering human odors do not usually dissuade them from traps and baits.

Touch. The vibrissae ("whiskers") and the long guard hairs on their bodies are extremely sensitive to tactile stimuli. The vibrissae and guard hairs serve as guides ("thigmotaxis") along vertical walls and nearby objects, providing compensation for rodents' poor vision.

Hearing. Commensal rodents have a keen sense of hearing and can detect vibrations in the ultrasonic range. They are extremely sensitive to sudden or loud noise.



Physical capabilities

- Gnawing

- The incisors of rodents grow throughout their lifetime requiring constant gnawing to keep the length down. Rodents can gnaw through any material that is softer than their enamel, including wood, aluminum, sheetrock, poor quality concrete, asphalt, hard rubber hoses, electrical wiring, and plastic tubing. Since they cannot gnaw through galvanized sheet metal and galvanized hardware cloth, these materials can be used as rodent exclusion materials in structures.

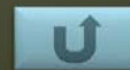
- Climbing

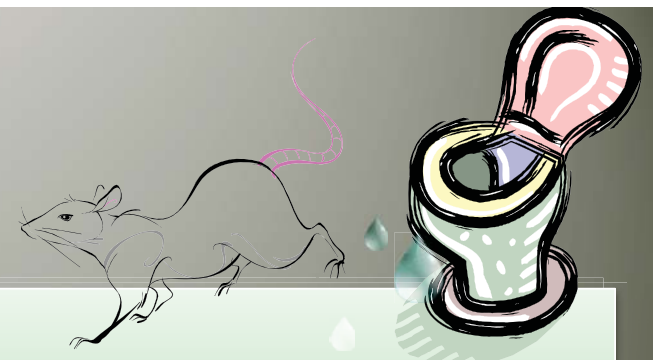
- Rats and mice have prominent footpads and well developed claws. They have four toes on their front feet and five on their hind feet. They use their tails, which are usually scaly and lacking of hair to balance their bodies while climbing. Commensal rodents are excellent climbers and have little or no difficulty climbing rough surfaces of vertical wooden beams or walls, and can traverse utility and telephone wires with relative ease. Norway rats can ascend vertical pipes up to 7cm in diameter.



Front foot

Hind foot





- Jumping.

Rats are known to jump vertically over 75 cm (2 ft). Adult house mice can jump vertically up to 35 cm (1 ft).

- Swimming.

All three species of commensal rodents are good swimmers. Rats can swim continuously from one to almost three days if necessary, and can remain submerged for almost 30 seconds. Rats have been known to enter homes by swimming through the water seal in toilets

- Burrowing.

Norway rat nests are located up to about 50 cm (18 in) underground. They may dig much deeper in loose soil. Their burrows consist of several connecting tunnels and have more than one exit. They may burrow into poultry and other animal manure or into the ground when infestations are encountered on ranches and in animal quarters. When living outdoors, house mice will construct shallow burrows in the open or cultivated fields, or live under piles of rubbish.



Behavior/ Reproduction

Periods of activity / Home ranges

- Commensal rodents are primarily nocturnal and usually have two peaks of night-time feeding activity. Weaker and less-dominant individuals may be forced to be active during daytime. Significant daytime activity observed among primarily nocturnal species may indicate increased population density.
- Home ranges may overlap with individuals of one or more other rodent species, depending on the type and carrying capacity of the environment. Commensal rodents are relatively tolerant of changes to the environment given their association with human habitation. House mice are by nature curious and less neophobic than rats, tending to investigate objects that are recently introduced in their environment.

Seasonal movements/migration

- Weather can significantly affect rodent movement. In cooler weather, during late fall or early winter, commensal rodents tend to move indoors to warmer areas. In late spring or early summer they return to the outdoors, or might remain indoors if food and suitable harborage are available.

Reproduction.

- Rodents are, in general, prolific breeders. Most species reach sexual maturity in 3-5 months. Gestation is generally no more than 3-4 weeks, so sexually active females can have several litters during a single breeding season. Number of young per litter ranges from one to a dozen or more. Rodents in the wild rarely live more than a single year; however, in captivity some species may live up to 3-4 years.



California Commensal Rodents of Public Health Importance





Roof Rat

(black rat, fruit rat, ship rat)

(Rattus rattus)

- Description

The roof rat is a moderate-sized rodent, slightly smaller than the Norway rat. The body is slender, adults averaging 8-10 oz. The total length (tip of nose to tail-end) is approximately 14-18 in. Tail is longer than the head and body, measuring 7-10 in, sparsely haired, and uniformly colored. The body is covered with softer fur and long, prominent guard hair. Roof rats in California vary in color from black with a gray belly to brownish- black with a whitish belly.

- Food

While omnivorous, they prefer vegetables, fruit, nuts, and cereal grains.

- Reproduction

Sexual maturity in 3-5 months. Gestation period averages 22 days. 6-8 young per litter with 2-6 litters per year.

- Habitat

Roof rats are semi-arboreal species, preferring to live in fruit and nut orchards, in the crowns of palm trees, in shrubs and vines, and dense growths of Algerian ivy. They prefer to nest above ground, often in attics, within walls, and in enclosed spaces of cabinets and shelving. Older residential neighborhoods with overgrown vegetation and newer residential suburban developments amidst former orchards are likely habitats.

- Significance

Roof rats can cause considerable damage to building and vegetation. They are associated with infectious diseases including *Salmonella*, *Streptobacillus*, and *Leptospira*, and are natural hosts for *Ornithonyssus bacoti*.



Norway Rat

(brown rat, sewer rat, wharf rat, house rat, barn rat)

(Rattus norvegicus)



- Description

The Norway rat is the largest of the commensal rodents. The body is heavy and stocky, averaging 7-20 oz in adults. The total length is approximately 13-18 ½ in. The tail is bicolored (dark above and lighter below), 6-8 ½ in in length, and sparsely covered with stiff hairs.

- Food

Norway rats are omnivorous, but prefer meat, poultry, fish and other sea food, garbage, and cereal grains.

- Reproduction

Sexual maturity in 3-5 months. Gestation period averages 22 days. 8-12 young per litter. 2-7 litters per year. Life expectancy of 9-12 months.

- Habitat

Norway rats are primarily a burrowing species. They burrow in the ground, under foundations of buildings, in soil banks, rock piles, along the banks of ditches, streams, rivers, and marshes. They also occupy poorly managed rubbish and garbage dumps. They can also be encountered in sewers, in wharf areas, and in the riprap of shores. In older urban communities they frequent cellars, stores, warehouses, slaughterhouses, and rendering plants.

- Significance

The Norway rat is the natural host of the oriental rat flea, *Xenopsylla cheopis*, the classic vector of plague. Plague-positive Norway rats were found in four San Francisco Bay area counties and two southern California counties between the early 1900s and the 1940s.



House Mouse

(*Mus musculus*)



- **Description**

The house mouse is small and resembles a young roof rat. The body of the house mouse is slender, averaging 0.5-0.75 oz. The total body length is 5½ -7½ in. The tail is uniformly gray in color and equal to, or slightly longer than the head and body, measuring 3-4 in. Fur is gray to brown with the underside slightly lighter, varying from white to gray.

- **Food**

They prefer cereal grains, but feed on many edible materials.

- **Reproduction**

Sexual maturity in 1 ½ -2 months.
Gestation is about 19 days, with 5-6 young per litter and as many as 8 litters per year.

- **Habitat**

House mice will occupy any convenient space between walls, inside cabinets, in or under furniture, warehouses, and storage areas. Their home range is very limited usually 10-30 ft. as they like to have nesting sites close to food sources.

- **Significance**

Cause damage through consumption and contamination of food stores. Damage walls, cup- boards, electrical boxes which they use for nest sites. Principal reservoir for lymphocytic choriomeningitis virus. They are also often infected with *Salmonella* and carry mites capable of transmitting rickettsial pox.



Public Health Significance

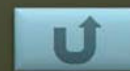
- Because of their close association with human habitat, commensal rodents pose a substantial risk for transmission of infectious disease agents. In addition to fecal contamination of foodstuffs, commensal rodents serve as a reservoir or vector for numerous microbiologic pathogens that are potentially infectious to humans.
- Rodent-borne diseases are transmitted directly by contamination of human food with their feces or urine, contact with infected body fluids and/or rodent blood, or indirectly by way of rodent ectoparasites such as fleas or mites.
- Rats are also a potential source of traumatic injury through bites defensive bites.



Management and Control

Recognizing evidence of infestation

Commensal rodents are habitually nocturnal and usually secretive. They are rarely seen during daytime unless their populations are large. Usually it is the evidence from their activity is what sheds light on their presence. Looking at the evidence of infestation will tell you what type of rodent is present, the population density and whether the infestation is old or new.



Evidence of Rodent Activity

Fresh droppings are usually shiny, soft, and moist. Color of droppings may vary with the food eaten. Older droppings are usually dull, grayish, hard, dry, and will crumble easily.

Rodents will generally use the same, familiar pathways from their harborage to obtain food and water, navigating by continual body contact with a vertical wall, fence, or other surface.

Norway rat rub marks are usually near ground or floor level, rub marks caused by roof rats are more common overhead among beams in attics. "Swing marks" can be seen at the juncture point of cross beams as the roof rats travel along rafters, or where the rafters connect to the walls

Sounds of running, gnawing, and scratching between walls and floors, and in attics and crawlspaces, may provide evidence of rodents, especially roof rats.

Because they are nocturnal and secretive, live rodents are rarely observed. However, when infestations are heavy, rodents may be seen during daytime. Carcasses may indicate either a current or past infestation.

Depending upon the species encountered, burrows may or may not be seen. Burrow systems are usually located near a source of food and water. The presence of fresh food fragments and freshly dug earth will indicate current activity.

Rodents gnaw to gain entrance, to obtain food, and to keep constantly growing incisors in check. The gnaw marks made by these incisors are very characteristic of rodents. Freshly gnawed marks will show distinct tooth marks, but as they get older, the gnawed areas become darker with grease and smoother with repeated body contact.

Laying smooth tracking patches of flour or talc along runways may bring to light rodent activity. The five-toed hind feet may leave more distinct tracks than the four-toed front feet.

Urine stains may or may not be readily observed in normal light. A portable ultraviolet light usually helps fluoresce suspected urine stains. Rats and mice shed great amounts of hair. These may be found lodged around entry points, in their feces, and contaminated food products. Characteristic musty odors may be present when heavy infestations occur, especially in damp, poorly ventilated areas.



Planning an Integrated Rodent Control Program

- Identify the rodent species and estimate the size and extent of infestation.
- Document extent of damage to property, contamination of food.
- Identify sources of food, water, harborage, and entry (reinfestation) points.
- Assess the motivation, knowledge, attitude, and acceptance of affected persons towards the control program.
- Cooperate with local and regional governmental agencies and community organizations.
- Consult with building code enforcement agencies.
- Consider potential legal implications.
- Estimate costs and relative benefits of control program.
- Implement rodent suppression measures (e.g., trapping).
- Evaluate the need for related ectoparasite control.
- Conduct environmental sanitation/modification, structural modification (exclusion), and preventive maintenance.
- Educate the public and encourage active participation by the community.
- Evaluate program efficacy.
- Establish ongoing monitoring and surveillance.



Integrated rodent control

- Trapping
 - Trapping is often the preferred initial step for controlling small numbers of rodents within homes, schools, food processing/handling plants, hospitals and other environments in which sanitation and limited exposure to toxic agents is desired.
- Glue boards
 - Glue boards are commercially available, but they are not recommended because the user may be exposed to diseases such as hantavirus pulmonary syndrome.
- Tracking powders
 - Tracking powders containing toxic chemicals (e.g., diphacinone, chlorphacinone, zinc phosphide) are not consumed like bait, but collected on the fur of the animal and then it is ingested during grooming.
- Anticoagulants
 - These are used for commensal rodent control throughout the world. Anticoagulants are toxicants that disrupt the blood-clotting mechanism causing fatal internal hemorrhages.
- Rodenticides
 - Acute rodenticides are classified as extremely, moderately, or minimally hazardous; their use should explicitly follow label directions.
- Ectoparasites control
 - Ectoparasites of rodents, including fleas and mites, can be a health concern to humans. Deprived of their natural rodent hosts following a successful population control program, these ectoparasites will seek out a new host upon to feed on including humans. An insecticide needs to be used either before or during the rodent removal program.



Environmental Modification

Environmental sanitation: The abundance of food, water, and harborage in a given environment determines the population size each environmental niche can support ("carrying capacity"). If the capacity of the environment is changed, a corresponding change in the rodent population may follow.



Environmental modification: The physical alteration of the environment to deny rodents a favorable habitat. Since suppressive measures such as poisoning or trapping provide only short-term solutions, integrated management concepts should incorporate good sanitation practices, environmental modification, and rodent exclusion measures to achieve long-term control.

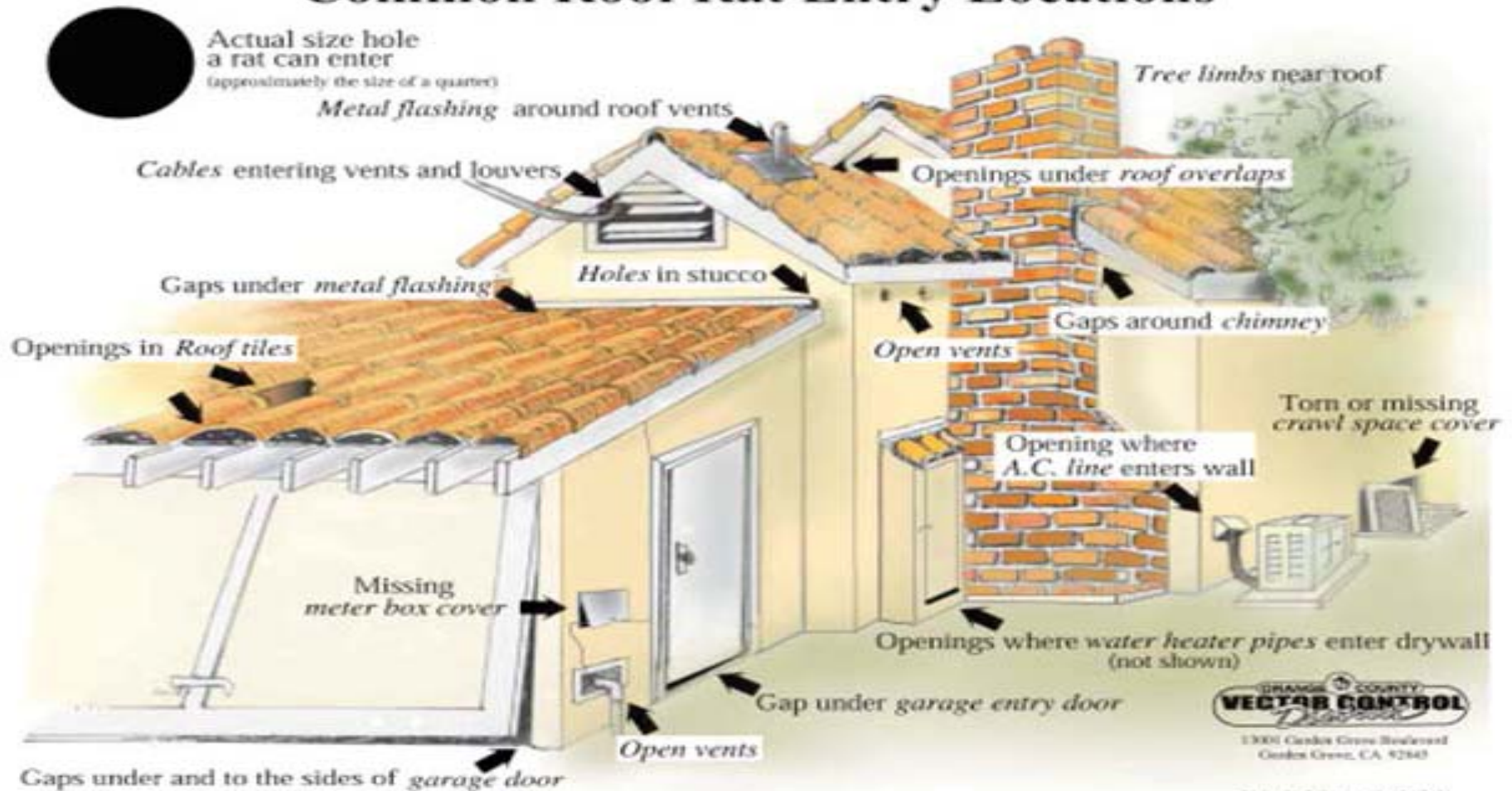


Exclusion: Rodents, such as mice, can enter openings as narrow as 2 cm (0.75 inch) in diameter; therefore effective exclusion requires that all such potential points of entry, above ground and at ground level, be identified and corrective measures be implemented.



Places to Keep in Mind Where Rodents May Enter a Location

Common Roof Rat Entry Locations



WILD RODENTS

(FAMILIES SCIURIDAE, HETEROMYIDAE, AND MURIDAE [SUBFAMILIES SIGMODONTINAE AND ARCVOLINAE])



California Wild Rodents of Public Health Importance

California has an abundance of wild native rodent species: 28 species in the family Sciuridae and 27 species in the subfamily Sigmodontinae. Several wild rodent species are important to public health as they are involved in maintenance or transmission of some serious and occasionally fatal infectious diseases to humans. Wild rodents of California that have public health or economic significance will be discussed.



California Ground Squirrel (*Otospermophilus beecheyi*)

Description: California ground squirrels are large rodents with generally gray-brown fur, often with lighter-colored flecks. Total adult length is 15-20 in, weight is 11-22 oz.

Reproduction: The breeding season varies throughout California. Mating may occur as early as January and extend into June or July. Females produce one litter a year, with an average of 6-8 young per litter. Gestation period is 25-30 days. Young are weaned in 6 weeks and scatter to new territories in April or June. They are full-grown in 7-8 months and live five years or more in the wild.

Distribution: The squirrels are found throughout California with the exception of the Mojave and Colorado desert regions. The California ground squirrel is diurnal.



Food: Feed upon seeds, nuts, fruits, green herbage, insects, bird eggs, and carrion.

Habitat: They make elaborate burrow system with many entrances. Rocky areas, bases of trees, tree stumps, fallen logs and other ground cover are preferred sites for burrows. They prefer open areas, natural range- lands, meadows, pastures, grain fields, rocky ridges, embankments along roadsides, and terraced hillsides and other disturbed areas of newer housing developments. They avoid thick chaparral. Home range is usually limited to a 140 m (450 ft) radius. Population density averages 2-4 squirrels per acre.

Significance: In large numbers can become a nuisance, especially in parks and campgrounds. Can cause considerable loss of agricultural crops. The California ground squirrel is the most important wild rodent involved in plague epizootics in California. Sudden decreases in squirrel populations can indicate a plague epizootic and the need to implement control measures to reduce risk of disease transmission.





Belding's ground squirrel (*Urocitellus beldingi*)

Description: Belding's ground squirrels are stout with gray brown fur, darker on the dorsum. Legs and underside are often pinkish. The tail is very short, reddish, and scantily furred. Total length is 26-10- 12 in and weight is 5-10 oz.

Reproduction: Mating occurs soon after emergence from hibernation. Following a gestation period of about 28 days, the young are born in May to July.

Distribution: The Belding's ground squirrel ranges from Fresno, Tulare, and Inyo Counties along the high Sierra Nevada to the Oregon border. They are also prevalent north of the Sierra Nevada in the Cascade and Warner Mountains and the inter-mountain valleys of northeastern California.

Food: They feed on a variety of grasses, leaves, stems, bulbs, fruits, and seeds, and also insects and carrion.

Habitat: Prefer meadows, perennial grassy areas, alpine dwarf-shrub, bitterbrush, sagebrush, and chaparral with grassy understories. Their burrows are often found in open areas, commonly near water sources within patches of bunchgrass and shrubs. Belding's ground squirrels tend to occur in large, semi-colonial populations. They are diurnal, emerging from their burrows at sunrise and at dusk to avoid the midday heat. They tend to remain near their burrows.

Significance: Similar to California ground squirrel.



Golden-mantled ground squirrel (*Callospermophilus lateralis*)



- Description: Golden-mantled ground squirrels are medium-sized (total length, 9-12 in) with distinct white stripes, bordered by black stripes, on their sides. They appear superficially like a large chipmunk, but lack stripes on the sides of their face.
- Reproduction: They mate from March-May. The gestation period is about 4 weeks and young are born in May-June. Females produce 1-2 litters per year, with an average of 5 young per litter. They reach sexual maturity in one year.
- Distribution: Golden-mantled ground squirrels are abundant in forested areas of Jeffery, ponderosa, and lodge pole pines. They are abundant in mountain forests and meadow edges of the Klamath, Siskiyou, Cascade, Sierra Nevada, and North Coast ranges, as well as the San Bernardino Mountains. They are found at elevations from 4800-11,000 ft. They will hibernate at the higher elevations from fall through winter, emerging in spring.
- Food: Preferred foods include underground fungi, pine nuts, seeds, bulbs, flowers, insects, bird eggs, and carrion.
- Habitat: They prefer to burrow under rocks, logs, tree stumps and They have a home range of 1-2 acres, with a territory of about 100 ft around the burrow entrance. Like other species of ground squirrels, they are diurnal.
- Significance: Similar to California ground squirrel. They can be significantly involved in plague epizootics in areas where they occur.





Yellow-bellied Marmot (*Marmota flaviventris*)



- Description: The marmot is a large squirrel: total length is 18-28 in and weight 3-8 lb. Fur is rust-colored with lighter yellowish beneath. Tail is comparatively short.
- Reproduction: They mate in early spring soon after emergence. Young are born in late spring following a gestation period of about four weeks. They have one litter per year with an average of 4-6 young per litter.
- Distribution: Yellow-bellied marmots range from the Sierra Nevada and Cascades in southern Tulare County, north to the Oregon border. They are widespread in or near rocky areas within grasslands, meadows, sub-alpine conifers, alpine dwarf-shrubs and lodgepole pine forests. They are also common in the montane riparian, red fir, eastside pine, Jeffery pine, montane chaparral, sagebrush, bitterbrush and pinon-juniper habitats. At higher elevations, they hibernate from early autumn to spring; populations at lower elevations may aestivate in June and July.
- Food: They forage during mid-morning and again in the late afternoon on grasses, shrubs, seeds, flowers, leaves, and insects.
- Habitat: Their burrow systems are usually under rocks, at the bases of trees. They have a home range from ½-5 acres. Marmots may congregate in colonies or pairs, or be solitary. Yellow-bellied marmots are diurnal.
- Significance: Minimal public health significance





Tree Squirrels

Western gray squirrel (*Sciurus griseus*)

Eastern gray squirrel (*S. carolinensis*)

Eastern fox squirrel (*S. niger*)

Douglas's squirrel (*Tamiasciurus douglasii*)

Description: Tree squirrels are easily distinguished from the ground squirrels and chipmunks by their long and bushier tails, uniformly grayish to dark grayish in color, and lack of dorsal spots or stripes.

Reproduction: They have 1-2 litters per year, with an average of 1-5 young per litter. Tree squirrels are long-lived and live up to six years in the wild.

Distribution: The Western gray squirrel is common and more widespread in California than the other species of tree squirrels. The Eastern gray squirrel was introduced from the eastern U.S. into Golden Gate Park in San Francisco, and established in niches in Calaveras, San Joaquin, and possibly Sacramento and Stanislaus Counties. The Eastern fox squirrel, also an introduced species, has been reported in many counties throughout California. The Douglas's squirrel is commonly encountered in the conifer-hardwood and riparian habitats of the Sierra Nevada, Cascade, Klamath, North coastal and Warner Ranges, from sea level to 11,000 ft elevation.

Food: Tree squirrels feed on the seeds and nuts of coniferous and deciduous trees. Leaves, buds, and fruits also occasionally comprise their diet.

Habitat: Tree squirrels are diurnal, most active in early morning or late afternoon. They are arboreal and usually nest high above ground in tree holes, enlarged woodpecker holes, and cavities of trees.

Significance: Tree squirrels can damage forest trees by removing bark or consuming cones and green stems. Around residences, they can damage power lines, destroy fruit and nut trees. In urban areas, they can damage buildings and other structures by gnawing into walls. Western gray squirrels frequently show evidence of infection with the Western equine encephalomyelitis virus (WEE) and thus may play a role as reservoir for WEE. They are important reservoirs for the agents of relapsing fever and plague in mountainous areas of northern California



Chipmunks

Alpine chipmunk (*Tamias alpinus*)

Yellow-pine chipmunk (*T. amoenus*) Merriam's chipmunk (*T. merriami*)

Least chipmunk (*T. minimus*) California chipmunk (*T. obscurus*)

Redwood chipmunk (*T. ochrogenys*) Panamint chipmunk (*T. panamintinus*)

Long-eared chipmunk (*T. quadrimaculatus*) Shadow chipmunk (*T. senex*)

Siskiyou chipmunk (*T. siskiyou*) Sonoma chipmunk (*T. sonomae*)

Lodgepole chipmunk (*T. speciosus*) Uinta chipmunk (*T. umbrinus*)



Description: California chipmunks are smaller than other species of squirrel. Most species are brightly colored with four lightly colored stripes on their backs, separated by darker stripes, and dark stripes on the sides of their face.

Reproduction: Mating occurs from April to June. Females produce 1-2 litters per year, with 2-7 young per litter. Gestation is about 4 weeks and young are born in May-June.

Distribution: Chipmunks are found in most mountain ranges in California.

Food: Chipmunks have the same food preferences as ground squirrels.

Habitat: Like most other ground squirrels, chipmunks are common in campgrounds and outdoor recreational areas

Significance: They are an important indicator species for plague, though susceptibility varies with species. In northern California, *T. senex* and *T. quadrimaculatus* are relatively resistant to infection and may serve as reservoir species. In central and southern California, *T. amoenus* and *T. merriami* may function in a similar capacity.



FAMILY HETEROMYIDAE

Approximately 10 species of pocket mice and 14 species of kangaroo rats occur in California.

Description: They are small to medium-sized rodents. Most have reduced forelimbs and enlarged hind limbs. Kangaroo rats are aptly named for both their appearance and their means of hopping on their enlarged hind limbs with a long tail. Cheeks have fur-lined pouches.

Reproduction: Breeding is highly dependent on food availability. In years with abundant food, females may have 2-3 litters of 5-7 young each.

Distribution: Typically abundant in sparsely vegetated, seasonally arid or desert areas. All are nocturnal. May hibernate in the winter and aestivate in the hot, dry summer.

Food: Seeds and vegetation comprise their diet. Water is obtained through metabolism of oils in seeds.

Habitat: Occur in sparsely vegetated and loose, sandy soils. Generally reside in underground burrows during the day, often plugging the entrance.



Kangaroo rats
(*Dipodomys* spp)



Pocket mice
(*Chaetodipus* spp.,
Perognathus spp.)

Significance: Kangaroo rats can serve as a reservoir for *Borrelia burgdorferi*, the bacterial cause of Lyme disease. Six species and subspecies of kangaroo rat are listed as endangered or threatened by the U.S. Fish and Wildlife Service. Persons conducting rodent surveillance and collection should be skilled in identification of these species and familiar with the regulations regarding their capture and handling.



Family Muridae, Subfamily Sigmodontinae



White-footed mice
(*Peromyscus* spp.)

Six species of *Peromyscus* mice occur in California:

Brush mouse (*Peromyscus boylii*)

California mouse (*P. californicus*) Canyon mouse (*P. crinitus*)

Cactus mouse (*P. eremicus*) Deer mouse (*P. maniculatus*) Pinon mouse (*P. truei*)

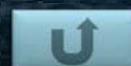
- Description: All *Peromyscus* species are small (total length, 6-10 in), mouse-like rodents. Eyes are dark and beady; ears are membranous and often large. Fur is variably brown, rust, or gray on dorsum, white on ventrum and feet. Deer mice are relatively small (15-20 cm) with a bicolored tail that is <50% of body length. The pinon mouse is moderately large (18-20 cm) with very large ears. The California mouse is the largest of the *Peromyscus* spp. at 22-25 cm.
- Reproduction: They have an incredible reproductive ability, breeding year-round. Having 1-4 litters a year with 1-8 young per litter, and a gestation period of 22-25 days.
- Distribution: The deer mouse is the most abundant *Peromyscus* species and is found throughout California and most of North America, except the southeastern states. The California mouse is found along the coast from the San Francisco Bay to the Mexican border.
- Food: *Peromyscus* spp. are omnivorous, feeding on a wide variety of items including seeds, nuts, acorns, fruits, leaves, fungi, and insects.
- Habitat: *Peromyscus* can be found in a variety of habitats, especially woodlands, grasslands, brush, and chaparral.





- Significance: *Peromyscus* mice serve as reservoirs for several infectious diseases of public health importance. Deer mice are the principal reservoir for Sin Nombre virus, the cause of hantavirus pulmonary syndrome in the western United States, which they shed in urine and feces. Other *Peromyscus* mice may also become infected with Sin Nombre virus, but their capacity to maintain infection and shed virus in urine and feces is unknown.

Peromyscus mice are also a reservoir for the bacteria that cause plague and can serve as a source of infection for epizootics among susceptible rodents (e.g., chipmunks). *Peromyscus* mice are involved in the enzootic maintenance cycle of *Borrelia burgdorferi*, the Lyme disease spirochete, in California, though probably to a lesser extent than woodrats. *Peromyscus* mice may also be involved in the maintenance of agents of other tick-transmitted diseases, such as *Anaplasma*, in California



Woodrats

(*Neotoma spp.*)



Four species of woodrats occur in California: Dusky-footed woodrat (*Neotoma fuscipes*), Desert woodrat (*N. lepida*), Bushy-tailed woodrat (*N. cinerea*), and Big-eared woodrat (*N. macrotis*).

Description: Woodrats resemble a large (total length 10-17 in) deer mouse with prominent eyes and ears. Fur is gray to grayish-brown on dorsum and pale or white beneath. The tail is faintly bicolored and sparsely haired in *N. fuscipes*, distinctly bicolored in *N. lepida*, and bushy in *N. cinerea*.

Reproduction: Breeding season is usually from mid- spring to early autumn. Usually one litter per year, though *N. fuscipes* may have up to five if conditions permit. Average of 3-4 young per litter.

Distribution: The dusky-footed woodrat is a common inhabitant of the coastal range of California, from the Oregon border to the Mexican border, the northern interior, and the entire western slope of the Sierra Nevada. They are absent from agricultural and open grass-lands of the Central Valley.

Food: They forage on the ground as well as on bushes and trees, feeding on a wide variety of vegetation.



- Habitat: *N. fuscipes* prefer the moderate canopies of forest and chaparral; in the north, they are prevalent in juniper woodlands and oak chaparral. *N. lepida* prefer desert habitats, including Joshua tree, pinon-juniper, chaparral, and sagebrush. *N. cinerea* are found in rocky outcrops, rimrock and rockslide areas of high mountains, riparian, hardwood, conifer, and other montane habitats. *N. cinerea* are also common in lava rim and lava cave habitat in northern California. *N. macrotis* are found from central and eastern California (United States) south into northwestern Baja California.
- Woodrats build elaborate conical-shaped huts consisting of sticks and leaves, located at the base of trees or shrubs for *N. fuscipes*, cactus or creosote bushes for *N. lepida*, and at the entrance to rocky crevices for *N. cinerea*. Some woodrat huts reach a height of 2.5 m (8 ft). Woodrats are active year-round, mostly nocturnal, but may be active during the day.
- Significance: Principal California reservoir for *Borrelia burgdorferi*, the agent of Lyme disease. May also serve as reservoir for *Ehrlichia* spp and the arenavirus Whitewater Arroyo. Dusky-footed woodrats are an important host for the kissing bug, *Triatoma* spp., the bite of which can cause a severe allergic reaction or possibly transmit the agent of Chagas' disease. Woodrats are in general susceptible to plague and may serve as an early warning indicator for epizootics. Bushy-tailed woodrats are involved in plague epizootics in the lava rim habitat of northern California.



Western Harvest Mouse

(*Reithrodontomys megalotis*)



- Description: Buff or brown on top; white underneath with occasionally a buff spot on chest. Tail is bicolored, with large ears and a length of 4.5-6in.
- Reproduction: Breeds in spring and maybe in autumn with a litter of 3-5.
- Distribution: Throughout California.
- Food: Grasses and seeds.
- Habitat: Grasslands and other uncultivated areas where grasses and weeds are present.
- Significance: Reservoir of El Moro Canyon virus, a hantavirus not yet associated with human disease.



California Vole

(*Microtus californicus*)

Family Muridae, Subfamily Arvicolinae



- Description: Small (total length, 6-8 in), darkly colored rodent with small eyes and partially furred ears. Tail less than one-third of body length.
- Reproduction: May breed throughout the year. Gestation period is 20 days, 2-5 litters per year, with an average of 4 young per litter. Females reach sexual maturity in 1 month.
- Distribution: Common from Shasta County to San Diego County, from the Sierra Nevada and the Cascades west to the Pacific coast. They are active year-round.
- Food: Herbivorous, preferring leaves, grasses, and fresh seeds. They are capable of causing considerable damage to field crops and orchards.
- Habitat: Preferred habitats are wet meadows, montane riparian, and dense annual grasslands. They seek cover in the dense grass, brush piles and logs. Burrows are shallow and generally built in soft soil with obvious pathways.
- Significance: Reservoir of Isla Vista virus, a hantavirus not yet associated with any human disease. Also a reservoir species for plague and tularemia in some regions of California.



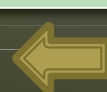
Protected status

- A collecting permit must be obtained from California Department of Fish and Wildlife before surveillance or control actions are initiated for any rodent species, though certain disease surveillance activities may be exempted from such requirements. Most of the ground squirrels, chipmunks, *Peromyscus* mice, voles, and woodrats are classified as non-game mammals by the California Fish and Wildlife Code. Because they are considered economic and public health pests, they may be taken at any time or in any manner by the owner or tenant of the premises. They may also be taken by officers or employees of the California Department of Food and Agriculture or by federal, state, or county officials or employees when acting in their official capacities pursuant to the provisions of the Food and Agriculture Code pertaining to pests.
- Many species of kangaroo rat are listed as state or federal Endangered Species and are thus restricted in their collection or harassment. Some subspecies of pocket mouse, woodrat, and vole are considered California State Species of Special Concern. Although there are currently no restrictions on their collection, protection designations change frequently and one should discuss the status of particular species with California Fish and Wildlife officials when obtaining the collection permit and before initiating any rodent collection or control.



Public Health Significance

- Plague: Wild rodents are the primary reservoir for *Yersinia pestis*, the plague bacillus, in California. Numerous rodent species have been associated with plague in California, including chipmunks, ground squirrels, woodrats, *Peromyscus* spp., voles, and, formerly, *Rattus* spp. In general, the California ground squirrels are an amplifying host for the plague bacillus (mortality usually occurs when they are infected), but in a few selected areas of California they may serve as a reservoir.
- Tick-transmitted disease: Wild rodents are the known or suspected maintenance host for several pathogens that are transmitted to humans by tick bites. The dusky footed woodrat is the principal reservoir for *Borrelia burgdorferi*, the spirochete that causes Lyme disease in humans. Woodrats may also serve as a reservoir for the rickettsiae (*Anaplasma* spp.) that cause anaplasmosis in humans. Chipmunks which enter and build nests in mountain cabins are a common source of soft ticks that transmit relapsing fever spirochetes to humans who later occupy the infested building after the rodents have abandoned it. Small rodents (e.g., *Peromyscus* spp.) are a common feeding host for larval and nymphal ticks and thus areas where these rodents are abundant may support a larger population of ticks.
- Hantaviruses: The deer mouse is the sole reservoir for Sin Nombre, the virus that causes hantavirus pulmonary syndrome in the western United States. Other species of *Peromyscus* may become infected with Sin Nombre virus, but their capacity to serve as competent vectors is unknown. The virus is shed in urine, feces, and possibly saliva. Humans are most susceptible to infection when they disturb enclosed, poorly ventilated areas contaminated with rodent excreta. Because of their ubiquity in western North America and propensity to enter human dwellings in search of food and nesting materials, deer mice and the hantavirus they carry are a considerable public health concern in California.



Management and Control

- Control of wild rodents on a large scale is time consuming, expensive, and usually unsuccessful, and therefore is not generally recommended. However, when localized populations of certain species, such as California ground squirrels, golden-mantled ground squirrels, Belding's ground squirrels, or chipmunks become a nuisance or potential threat for disease transmission to humans, efforts to reduce population size may be attempted. Many of the techniques previously discussed for control of commensal rodents may also be implemented for localized populations of wild rodents.





Safety



Rodent species are found everywhere in California and the potential for contact between rodents and humans is significant. While only a few California rodent species have been associated with human disease, it is a good general policy to consider any rodent as a potential source of disease. Activities that pose a potential risk for rodent-borne disease include:

- Occupying or disturbing rodent-infested areas during outdoor recreational activities
- Occupying buildings or dwelling that were previously vacant
- Visiting or residing in areas where there is a substantial sudden change in rodent population density
- Inhabiting or cleaning rodent infested dwellings, barns, outbuildings, intermittently occupied summer homes/cabins
- Working in rodent-infested structures

- For the general public, the opportunity for rodent contact, and transmission of rodent-borne pathogens, is greatest in and around the home or during outdoor recreational activities. Some of the areas in which recommendations can be made to the public on prevention of rodent-borne diseases include:
 - Recommendations on rodent and ectoparasite suppression techniques
 - Good hygiene and household sanitation practices
 - Use of gloves and respirators or dust-masks
 - Environmental modification and rodent exclusion recommendations
 - Guidance on proper clean-up of rodent-contaminated areas and household items
 - Proper disposal of possibly contaminated items, such as rodent carcasses, nesting materials and excreta
 - Avoiding contact with rodents
 - Use of currently recommended disinfectants such as 10% household bleach, hospital-grade Lysol, and other general-purpose household disinfectants

