California Department of Fish & Game
Trapping License Examination
Reference Guide

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CALIFORNIA DEPARTMENT OF FISH AND GAME TRAPPING LICENSE EXAMINATION REFERENCE GUIDE

INTRODUCTION

This manual describes basic methods, laws, and regulations for trapping furbearers and nongame mammals and handling animals after they are trapped. This information is directed towards individuals who trap for purposes of recreation or commerce in fur or nuisance wildlife control. This manual is a comprehensive publication to assist individuals to prepare for and pass the California Department of Fish and Game (DFG) Trapping License Examination in order to obtain a DFG Trapping License.

All of the questions on the trapping license examination have been taken from this manual. The examination is designed to test one's knowledge of furbearing and nongame mammal natural history and associated health concerns and diseases, and sections in Title 14, California Code of Regulations (CCR), and the Fish and Game Code that address trapping and the take of furbearing and nongame mammals.

Until December 31, 2002, a DFG Trapping License was required only for trapping for purposes of recreation or commerce in fur. In 2002, the California legislature passed Senate Bill 1645 which became law on January 1, 2003. This new law additionally required anyone providing trapping services to trap furbearing or nongame mammals for hire or profit to obtain a California Department of Fish and Game Trapping License.

Those taking the examination for a trapping license must be aware that there are major differences in trap use regulations, depending on whether trapping is occurring to prevent property damage, or to obtain furs. Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations). There are zones throughout California where the use of Conibear-type (kill) traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

The illustrations and discussions of methods and techniques for the use of body-gripping traps in this guide generally apply only when trapping for damage control; not for recreational/commercial fur trapping.

For a partial summary of trapper's requirements listed in the regulations and the Fish and Game Code, please turn to pages 3 and 4. Please keep in mind that the Trapping License Examination will test your knowledge of laws and regulations that apply to both trapping for furs and trapping to control nuisance animals.

ACKNOWLEDGMENTS

The DFG would like to acknowledge the fact that this Trapping License Examination Reference Guide reflects the hard work of many individuals and organizations outside the walls of the Department of Fish and Game. Without the approval to use their text, research, and information, the materials in this guide could not have been assembled.

Important contributors were: Professor Scott Hygnstrom of the University of Nebraska's Cooperative Extension Program; Mr. Gary A. Larson (retired), Eastern Region Director, U. S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), Wildlife Services; and Mr. Robert M. Timm, Superintendent and Extension Wildlife Specialist, University of California, Hopland Research and Extension Center. They jointly co-edited the book, "Prevention and Control of Wildlife Damage" through which all of the specific trapping control measures were employed for key wildlife species in California. Authorized and legal trapping devices, methods, and types are detailed in the individual species accounts. A small portion of the existing text has been omitted, modified, and supplemented with additional text necessary to render the affected chapter more applicable to California.

The Department of Fish and Game would also like to recognize Bat Conservation International (BCI) and Associate Professor and Certified Wildlife Biologist Robert H. Schmidt from Utah State University for their contributions to the Trapping License Examination Reference Guide.

SUMMARY OF TRAPPING LAWS AND REGULATIONS

Laws and regulations that apply when trapping for profit to alleviate animal damage and nuisance wildlife problems:

- Trapping license is required if working for an animal damage/nuisance wildlife control company (Fish and Game Code Section 4005)
- You must have your trapping license in your immediate possession while trapping for either commercial fur or nuisance wildlife control purposes (FGC Sect. 1054.2)
- Cage and box traps, nets, suitcase-type live beaver traps, and common rat and mouse traps are not considered body-gripping traps (Title 14 California Code of Regulations Section 465.5)
- Leg-hold traps may be used only to protect human health or safety, and only by government agencies (T 14 CCR Sect. 465.5)
- Body-gripping traps may be used to prevent property damage (T 14 CCR Sect. 465.5)
- Poison is not an authorized method of take (T 14 CCR Sect. 465.5 & 475)
- Steel-jawed leg-hold traps are prohibited (T 14 CCR Sect. 465.5)
- Traps must be inspected and trapped animals removed at least once daily (T 14 CCR Sect. 465.5)
- A trapper must either euthanize a trapped animal or release it immediately on site (T 14 CCR Sect. 465.5)
- It is illegal to set or maintain traps which do not bear a number or other identifying mark registered to the department (T 14 CCR Sect. 465.5)
- A trapper may not set a trap within 150 yards of any structure used as a permanent or temporary residence, unless such traps are set by a person controlling such property or by a person who has and is carrying with him written consent of the landowner to so place the trap or traps (T 14 CCR Sect. 465.5)
- Depredating fur-bearing or nongame mammals, taken by trapping, may not be bought or sold (T 14 CCR Sect. 465.5)
- The pelts of animals taken with body-gripping traps may not be sold (T 14 CCR Sect. 465.5)
- A trapping license may be revoked for a violation of the trapping laws and regulations (FGC Sect. 4043)
- Fur-bearing and/or nongame mammals that are injuring property may be taken at any time and/or in any manner (FGC Sect. 4152 & 4180)

Laws and regulations that apply when trapping for fur:

- Trapping license is required (FGC Sect. 4005)
- You must have your trapping license in your immediate possession while trapping for either commercial fur or nuisance wildlife control purposes (FGC Sect. 1054.2)

- Cage and box traps, nets, suitcase-type live beaver traps, and common rat and mouse traps are not considered body-gripping traps (T 14 CCR Sect. 465.5)
- Leg-hold traps may be used only to protect human health or safety, and only by government agencies (T 14 CCR Sect. 465.5)
- Body-gripping traps may not be used when trapping for fur (T 14 CCR Sect. 465.5)
- Poison is not an authorized method of take (T 14 CCR Sect. 465.5 & 475)
- Steel-jawed leg-hold traps are prohibited (T 14 CCR Sect. 465.5)
- Traps must be inspected and trapped animals removed at least once daily (T 14 CCR Sect. 465.5)
- A trapper may not set a trap within 150 yards of any structure used as a permanent or temporary residence, unless such traps are set by a person controlling such property or by a person who has and is carrying with him written consent of the landowner to so place the trap or traps (T 14 CCR Sect. 465.5)
- A trapper must either euthanize a trapped animal or release it immediately on site (T 14 CCR Sect. 465.5)
- It is illegal to set or maintain traps which do not bear a number or other identifying mark registered to the department (T 14 CCR Sect. 465.5)
- An annual trapping report is required by July 1 (T 14 CCR Sect. 467)
- A trapping license may be revoked for a violation of the trapping laws and regulations (FGC Sect. 4043)
- Commercial fur takers who use dogs or predator calls must abide by both hunting and trapping laws and regulations (T 14 CCR Sect. 478)

§263. Prohibition Against Night Hunting.
Not withstanding any other provisions of these regulations, hunting wildlife from one-half hour after sunset to one-half hour before sunrise is prohibited in Monterey and San Benito counties east of Highway 101.

§264. Use of Lights While Hunting--Specific Areas.

(a) Lights of any size or voltage may be used to take furbearing or nongame mammals only in the areas described in subsections (b) and (c) below, and only under the following conditions:
   (1) The use of lights for night hunting is prohibited in any area where the general deer season is open.
   (2) Furbearing mammals and nongame mammals may be taken with the aid of a spotlight or other artificial light operated from a vehicle provided such vehicle is stopped and standing with the motor off. No spotlight may be used from a vehicle which is on a public road or highway.

(b) Zone 1. (Portions of Butte, Colusa, Glenn, Placer, Sacramento, Sutter, Tehama, Yolo and Yuba counties.) Area: Within the boundary beginning at the junction of Interstate 880 and Interstate 5 near Sacramento; east on Interstate 880 to its junction with Interstate 80; north and east on Interstate 80 to its junction with Highway 65 near Roseville, along Highway 65 to its junction with Highway 20 at Marysville; west on Highway 20 to its junction with Highway 45; north on Highway 45 to its junction with Highway 162; east on Highway 162 to its junction with Highway 99; north on Highway 99 to South Avenue near the town of Corning; west on South Avenue to Interstate 5 in Corning; north on Interstate 5 to Corning Road; west on Corning Road to Paskenta Road; west on the Paskenta Road to the town of Paskenta; southwest on the Round Valley Road to the Garland Road; south on the Garland Road to the town of Newville; south on the Newville-Elk Creek Road to the town of Elk Creek; south on the Elk Creek-Stonyford Road to the town of Stonyford; south on the Stonyford-Leesville Road to the town of Ladoga; south on the Stonyford-Leesville Road to the town of Leesville; south from Leesville on the Bear Valley Road to its intersection with Highway 20; east on Highway 20 to its intersection with Highway 16; south and east on Highway 16 to its intersection with Interstate 5; east on Interstate 5 to Interstate 880 and the point of beginning.

(c) Zone 2. (Portions of Inyo, Kern, Los Angeles, Mono and San Bernardino counties and all of Imperial, Orange, Riverside and San Diego counties.
   Area: Inyo, Mono and Kern counties south and east of a line beginning at the junction of Highway 182 and the California-Nevada state line; south on Highway 182 to its junction with Highway 395; south on Highway 395 to its intersection with Highway 168 at Bishop; west on Highway 168 to its intersection with the Inyo National Forest boundary; south on the Inyo National Forest boundary to its junction with County Highway J41; south and east on County Highway J41 to its junction with Highway 395; south on Highway 395 to its junction with Highway 14 near Inyokern; south on Highway 14 to its junction with Highway 178 at Freeman; west on Highway 178 to its junction with the Bodfish-Caliente Road at Isabella; south on the Bodfish-Caliente

Road to its junction with Highway 58; east on Highway 58 to its junction with the Los Angeles Aqueduct; south and west on the Los Angeles Aqueduct Road to its junction with 265th Street West near Neenach; south on 265th Street West to its junction with the Elizabeth Lake-Pine Canyon Road at Three Points; east along the Elizabeth Lake-Pine Canyon Road to its junction with Highway 14 at Palmdale; south on Highway 14 to its intersection with the Angeles Forest Highway; south on the Angeles Forest Highway to the Mill Creek Summit Road; east and south on the Mill Creek Summit Road to its intersection with the Angeles Crest Highway (Highway 2) at Upper Chilao Campground; east on the Angeles Crest Highway to its intersection with the Los Angeles-San Bernardino county line; north on the Los Angeles-Kern-San Bernardino county line to its intersection with Highway 58; east on Highway 58 to its intersection with the range line between R3W and R4W; south along the range line between R3W and R4W to the southeast corner of T8N, R4W; east along T8N to its intersection with the west boundary of the U.S. Marine Corps Training Center; south and east on that boundary to its intersection with Giant Rock Road; east along Giant Rock Road to a point where it turns southeast and corresponding with a projected north extension of Sunfair Road; south on Sunfair Road and its projected extension to the San Bernardino-Riverside county line; and all of Imperial, Orange, Riverside and San Diego counties.

§264.5. Use of Lights While Hunting--Remainder of State.

Lights may be used, in those portions of the state not listed in Section 264, to take furbearers and nongame mammals under the following conditions only:

(a) Only 9 volt lights or smaller, hand-held or worn on the head are permitted.

(b) Persons using such lights must be on foot.

(c) Lights may not be used in or from a vehicle and may not be attached or powered from any source other than self-contained batteries.

(d) A landowner or tenant suffering damage to livestock or other property by furbearing mammals or nongame mammals may designate, in writing, persons allowed by such landowner or tenant to use artificial lights in excess of 9 volts to assist in taking the depredating mammals. The landowner or tenants shall notify the closest fish and game office whenever furbearing or nongame mammals are taken under this authority.

No furbearing or nongame mammals including any threatened, endangered or fully protected species may be taken contrary to any other prohibition set forth in these regulations.

§265. Use of Dogs for Pursuit/Take of Mammals or for Dog Training.

(a) Prohibitions on the Use of dogs. The use of dogs for the pursuit/take of mammals or for dog training is prohibited as follows.

  (1) The use of dogs is prohibited during the archery seasons for deer or bear.

  (2) The use of dogs is prohibited for the take of elk, bighorn sheep and antelope.

  (3) Mountain lions may not be pursued with dogs except under the provisions of a depredation permit issued pursuant to Section 4803 of the Fish and Game Code. Dog training on mountain lions is prohibited.

(4) The use of dogs for the pursuit/take of mammals or for dog training is prohibited from the first Saturday in April through the day preceding the opening of the general deer season in the following dog control zones:

(A) Central California Dog Control Zone: Napa County north of Highway 128 and east of Highway 29; Lake County east of a line beginning at the Lake-Napa county line and Highway 29; northwest on Highway 29 to Highway 20; northwest on Highway 20 to the Lake-Mendocino county line; Mendocino County east of Highway 101, and north of Highway 20; Sierra and Alpine counties, and those portions of Nevada, Placer, Amador and Calaveras counties east of Highway 49; and El Dorado County east of the following line: Beginning at the junction of Highway 49 and the Placer-El Dorado county line; south on Highway 49 to Highway 193 at Cool; east and south along Highway 193 to Highway 49 in Placerville; south on Highway 49 to the Amador-El Dorado county line.

(B) Northern California Dog Control Zone: Plumas and Trinity counties; Butte County east of the following line: Beginning at the junction of Highway 99 and the Butte-Tehama county line; south and east along Highway 99 to Highway 149; south and east along Highway 149 to Highway 70; south along Highway 70 to the Butte-Yuba county line; Del Norte County east of Highway 101; Glenn County west of a line beginning at the intersection of the Stonyford-Ladoga Road and the Glenn-Tehama county line; south along this road to the Colusa-Glenn county line; Humboldt County north and east of Highway 36 and 101; Siskiyou County south and west of the following line; from the Oregon-California state line south on Interstate 5 to Highway 97 at the town of Weed; north on Highway 97 to the town of Macdoel; south from Macdoel on the Mt. Hebron Road to the Redrock Road; east on the Redrock Road to the Davis Road; north on David Road to the Gold Digger Pass Road; east on the Gold Digger Pass Road to the western boundary of the Lava Beds National Monument; north and east on said boundary to the Siskiyou-Modoc county line; Shasta County south and west of Highways 89 and 44 and north of the following line; where the Trinity National Forest boundary intersects the Shasta-Tehama county line; north on said boundary to Highway 36 near the town of Platina; east on Highway 36 to County Road A16; north on Road A16 to the city of Redding; north on Interstate 5 to the south shore of Shasta Lake; east and north along the shore of Shasta Lake to Fender's Ferry Road; southeast on Fender's Ferry Road to Highway 299; southwest on Highway 299 to Oakrun; southwest on the Oakrun Road to Fern Road; east and south on Fern Road to the town of Whitmore; south on Ponderosa Way to Highway 44 near Innwood; east on Highway 44 and the Wilson Hill Road to the Shasta-Tehama county line; those portions of Tehama County within the Mendocino and Trinity National Forests and east of the Ponderosa Truck Trail; those portions of Lassen County north and west of the following line: north from the Lassen-Sierra county line on Highway 395 to Highway 36 east of Susanville; northwest on Highway 36 to Highway 139; north on Highway 139 to the Lassen-Modoc county line.

(C) Southern Sierra Dog Control Zone: Those portions of Tuolumne, Mariposa, Madera, Fresno and Tulare counties east of the following line: Beginning at the intersection of Highway 49 and the Calaveras-Tuolumne county line; south on Highway 49 to Highway 120; east on Highway 120 to the Smith Station Road

(J20); south on the Smith Station Road (J20) to the Greeley Hill Road; east on the Greeley Hill Road to the North Fork of the Merced River at Bower Cave; south on the North Fork of the Merced River to Road 3S15 (Black Mountain Road); east on Road 3S15 to Forest Service Road 3S02; southwest on Forest Service Road 3S02 crossing the U.S. Forest Service-Bureau of Land Management property boundary in Section 28 located in Township 3S, Range 18E to Forest Service Road 2S05 (Bull Creek Road); south on Forest Service Road 2S05 (Bull Creek Road) to the Main Fork of the Merced River; west on the Main Fork of the Merced River to Highway 49; south on Highway 49 to Highway 140 at Mariposa; north on Highway 140 to the South Fork of the Merced River; east along the South Fork of the Merced River to Hite Cove and south on the U.S. Forest Service Road and its continuation from Hite Cove, through Jerseydale Station and Darrah to the Triangle Road; south along the Triangle Road to Highway 49; south along Highway 49 to Highway 41 at Oakhurst; north along Highway 41 to its intersection with the Bass Lake Road at Yosemite Forks; south along Bass Lake Road and Road 274 past Bass Lake on the east side of the lake to the junction with the Mammoth Pool Road at North Fork; south along the North Fork-Auberry Road to the San Joaquin River; east along the San Joaquin River to Italian Bar Road at the Italian Bar Bridge; south on Italian Bar Road to Jose Basin Road (County Road M2441; east on Jose Basin Road (County Road M2441) to its intersection with Forestry Service Roads 8S08 (Railroad Grade Road) and 9S07 (Jose Basin Road); south on 9S07 (Jose Basin Road) to Auberry Road near Pine Ridge; east on Auberry Road to Highway 168; east on Highway 168 to Toll House Road; south on Toll House Road to Peterson Mill Road; east on Peterson Mill Road to Rush Creek Road at Soaproot Saddle; south on Rush Creek Road to Big Creek Road; east on Big Creek Road to Dinkey-Trimmer Road at Haslett Basin; east on Dinkey-Trimmer Road to Sycamore Springs Road; east on Sycamore Springs Road to Black Rock Road at Balch Camp; east on the Black Rock Road to the Rodgers Ridge Road at Black Rock Station; east along Rodgers Ridge Road to Garlic Spur; south on Garlic Spur to the Kings River; west along the Kings River to Verplank Ridge; south on Verplank Ridge-Hoise Ridge to Highway 180 near Cherry Gap; south along Highway 180 to the north boundary of Kings Canyon National Park; south along that park boundary and along the west boundary of Sequoia National Park to the boundary of Sequoia National Forest between Grouse Peak and Dennison Mountain; south along the common line between R29E and R30E, M.D.B.M. to the boundary of the Sequoia National Forest; east and south along that boundary to Balch Park Road; southeast along that road to the west boundary of Mountain Home State Forest; south and east along that boundary to Forest Trail 30E15; southeast along 30E15 to the Doyle Springs Road; southwest along Doyle Springs Road to Camp Wishon; southeast along the Alder Creek Grove-Hossack Meadow Road to Camp Nelson; south along Highway 190 and the Coy Flat Road to the boundary of the Tule River Indian Reservation; south along the east boundary of that reservation to Parker Peak; southeast through Upper Parker Meadow to Parker Pass; south through Starvation Creek Grove to the southwest corner of Section 15, T23S, R31E, M.D.B.M.; east to the northeast corner of Section 22, T23S, R31E,

M.D.B.M.; south approximately 6 miles to Sugarload Campground; southeast along the Forest Road 24S06 through Portuguese Pass to the Tulare-Kern county line; that portion of Kern County within a line beginning where the Tulare-Kern county line intersects the west boundary of the Sequoia National Forest; south along the said boundary to the Poso Flat-Davis Station Road; northeast along said road through Davis Flat and Shirley Meadow to Forest Highway 90 at Greenhorn Summit; northeast along Forest Highway 90, Cow Creek and Bull Run Creek to the Tulare-Kern county line; west along said county line to the point of beginning; and those portions of Inyo and Mono counties west of Highway 395.

(D) Southern California Dog Control Zone: Those portions of Los Angeles, Ventura and Santa Barbara counties within the Los Padres and Angeles National Forests; and those portions of San Bernardino County within the San Bernardino and Angeles National Forests.

(b) Authorized Use of Dogs. The use of dogs for the pursuit/take of mammals or for dog training is authorized as follows:

(1) Dog Control Zones. The use of dogs for the pursuit/take of mammals or for dog training is permitted in the dog control zones described in subsections 265(a)(4)(A), (B), (C) and (D) from the opening day of the general deer season through the first Friday in April.

(2) Areas of the State Outside the Dog Control Zones. The use of dogs for the pursuit/take of mammals or for dog training in areas outside of the dog control zones is permitted year-round, except for closures and restrictions described in this Section 265 and section 364, and the provisions of sections 3960 and 4800 of the Fish and Game Code which prohibit allowing any dog to pursue any big game mammal during the closed season on such mammal or mountain lions, elk or any fully-protected, threatened or endangered mammal at any time.

(3) Take of Depredating Mammals. The use of dogs is permitted for pursuing/taking depredating mammals by federal and county animal damage control officers or by permittees authorized under a depredation permit issued by the department.

(4) Take of Furbearers and Nongame Mammals. Furbearers and nongame mammals as specified in Section 472(a) may be taken with the aid of dogs during the appropriate open season, except for closures and restrictions described in subsections 265(a) and (b).

(5) Prohibition on Starting Pursuit Within 400 Yards of Baited Area. Pursuits may not be started within 400 yards of a baited area as described in Section 257.5 of these regulations.

(6) Dog Training. Except for the prohibitions of subsection 265(a), dog training is permitted pursuant to the following provisions:

(A) Dog Training Defined. For purposes of these regulations, dog training is defined as the education of dogs through “breaking” or “practicing” under strict provisions that preclude the injuring or take of animals. Training is distinguished from “pursuit”, as used in Section 86 of the Fish and Game Code, in that the animal being chased shall not be killed, captured, or injured.

(B) Prohibition on Killing, Capturing or Injuring Mammals. No person shall kill, capture or injure any mammal, nor shall any person's dog be allowed to kill, capture or injure any mammal during dog training.

(C) Prohibition on Possession of Equipment. No firearm, archery gear, crossbow or other instrument capable of killing, injuring or capturing any animal may be possessed by any person training dogs during the seasons described in subsection 265(b)(6)(F) below. Possession of a firearm, archery gear, crossbow or other instrument capable of killing or capturing any animal is prohibited while training dogs, but such equipment may be transported to or from a campsite, transported to or from a residence or lawfully possessed by a person at a campsite provided all dogs are secured and under the control of the owner, agent or person training or transporting said dogs.

(D) Prohibition on Starting Dog Training Within 400 Yards of Baited Area. Dog Training may not be started within 400 yards of a baited area as described in Section 257.5 of these regulations.

(E) Prohibition on Training Dogs on Bear and Other Big Game Mammals or on Protected, Threatened or Endangered Mammals. It shall be unlawful to train any dog on any big game mammal or to train any dog on any fully-protected, threatened or endangered mammal at any time. A person in possession of a valid bear tag may utilize the general bear season for purposes of educating dogs for bear. A person in possession of a valid deer tag may utilize the general deer season for purposes of educating a dog for deer. Only one dog may be used for training in areas where the general deer season (as described in subsection 360(a) and (b)) is open.

(F) Seasons.

(1) Gray Fox. Dogs may be trained on gray fox from March 1 through the day preceding the opening of the general gray fox season, except for closures and restrictions described in subsections 265(a) and (b).

(2) Raccoon. Dogs may be trained on raccoon from April 1 through the day preceding the opening of the general raccoon season, except for closures and restrictions described in subsections 265(a) and (b).

(3) Bobcat. Dogs may be trained on bobcat from the day following the close of the bobcat seasons through the day preceding the opening of the general bobcat seasons, except for closures and restrictions described in subsections 265(a) and (b).

(4) Other Mammals. Except for closures and prohibitions described in this Section 265 and sections 3960 and 4800 of the Fish and Game Code, dogs may be trained on mammals other than gray fox, raccoon and bobcat at any time.

(c) Restrictions on the Number of Dogs per Hunter.

(1) One Dog per Hunter Limitation During Deer Season. No more than one dog per hunter may be used in the area where the general deer season is open.

(2) Three Dogs per Hunter Limitation for the Take of Wild Pigs. Up to three dogs per hunter may be used for the purpose of taking wild pigs, pursuant to the following provisions:

(A) No more than one dog per hunter may be used in an area where the general deer season is open.

(B) No dogs may be used within the closures described in subsection 265(a).

(C) After the general deer season (as described in subsections 360(a) and (b)) closes, there is no limit on the number of dogs that may be used during the general bear season.

(D) Prohibition on Treeing Switches and Use of Global Positioning System Equipment.

(1) Treeing Switches. Effective July 1, 1995, electronic dog retrieval collars containing functioning treeing switches (devices consisting of a mercury switch mechanism that results in a change in the transmitted signals when the dog raises its head to a treed animal) are prohibited on dogs used for the pursuit/take of mammals.

(2) Global Positioning System Equipment. Electronic dog retrieval collars employing the use of global positioning system equipment (devices that utilize satellite transmissions) are prohibited on dogs used for the pursuit/take of mammals.

§ 401. Issuance of Permit to Take Animals Causing Damage.

(a) Application. A person who is a property owner or tenant may apply to the department for a permit to take elk, bear, beaver, wild pigs, deer, wild turkeys, or gray squirrels that are damaging or destroying, or immediately threatening to damage or destroy, land or property.

(b) Permit Period. Permits issued pursuant to this section shall be valid for a period not to exceed one year, except that permits for elk, bear, wild turkey, or deer shall not be valid for more than 60 days. Permits may be renewed if damage or threatened damage to land or property continues to exist.

(c) Form and Conditions of Permit. Applications shall be made on form entitled "PERMIT TO KILL DEER, BEAR, ELK, WILD PIG, GRAY SQUIRREL, BEAVER, WILD TURKEY, OR MOUNTAIN LION CAUSING CROP OR PROPERTY DAMAGE" (FG WPB 543 (new 5/05)). The department may add terms and conditions to the permit necessary to protect wildlife and ensure public safety. To be valid, the permit shall contain a statement signed by the applicant that he/she has read, understands, and agrees to be bound by all the terms of the permit.

(d) Methods of Take.

(1) Animals taken pursuant to a permit may be taken in any legal manner except as herein provided and in accordance with the provisions of Section 465.5 of these regulations. Permits to take deer shall include conditions that comply with Fish and Game Code section 4181.5. No iron-jawed or any type of metal-jawed traps may be used to take squirrels or bears. No poison may be used. The department may specify the caliber and type of firearm and ammunition, archery equipment or crossbow to be used based upon safety considerations. The department may require that a permittee take animals alive by the use of live traps.

(2) The permittee and/or agent shall ensure that all animals are killed in a humane manner instantly and prevent any injured animal from escaping.

(e) Government Employees and Designated Agents.

An employee of a federal, State, or local government agency or local district with responsibilities including but not limited to animal control, animal damage control, irrigation, flood, or natural resource reclamation, while acting in his/her official

capacity may take depredating animals on the property designated in a permit issued pursuant to this section.

The permittee may designate up to three other persons as his/her agents to take animals under the terms of the permit. A designated agent shall be any person who is acting under the direction and control of the permittee and who is 21 years of age or older. The designated agent(s) shall be named on the permit. The permittee may substitute designated agents with prior written approval of the department.

(f) Persons Prohibited from Taking Animals. No person may take animals pursuant to the permit if he/she has been convicted of a violation related to the take or possession of game or furbearing mammals in the past 12 months or if he/she is on probation and may not hunt or possess a firearm as part of the terms of probation. A landowner who is on probation and may not hunt or possess a firearm as part of the terms of probation must designate a qualified agent to take animals under a permit.

(g) Written Report Required for Wild Pigs. The permittee shall provide a report listing the date and sex of each wild pig taken. A report shall be submitted whether or not any animals were taken. The reporting period shall be by calendar month. The permittee or designated agent shall complete and mail the report to the department on or before the 15th day of the following month. Reports shall be mailed to the address provided by the department.

(h) Tagging Animals. All animals taken pursuant to a permit, except wild pigs, shall be immediately tagged with tags provided by the department. Wild pigs shall be tagged prior to being transported from the property designated in the permit. Tags for animals except wild pigs shall be completed at the time the animal is taken. Tags for wild pigs shall be completed before the wild pigs are removed from the property. Tags shall clearly show the permittee's name, address, date and location the animal was taken and shall include the signature of the person taking the animal. The report portion of each tag shall be mailed to the department without delay. No tags are required for squirrels and beavers.

(i) Utilization of Carcass. Animals taken pursuant to this permit must be disposed of as required in the permit. No animals, except wild pigs, may be utilized by the permittee or designated agent. The permittee or designated agent may leave the carcass of any wild pig where it was taken for reasons of high air temperatures, disease, parasites, or conditions which preclude use of the carcass. A person who makes every reasonable attempt to utilize the carcass of any wild pig as required in this subsection shall be deemed to be in compliance with Section 4304 of the Fish and Game Code.

(j) Suspension and Revocation of Permits.

(1) Permits may be suspended temporarily by the director for a breach or violation of the permit by the holders thereof, their agents, servants, employees or any person acting under their direction and control. The commission shall be notified of any such suspension and subsequently may revoke or reinstate the permit, or fix the period of its suspension, after written notice to the permittee and the permittee has been afforded an opportunity to be heard.

(2) Any person who has had his/her permit revoked or suspended by the commission shall be required, upon application for a new or subsequent permit, to appear before the commission and demonstrate to its satisfaction that the use of such a

permit will be consistent with depredation control, with these regulations, and with the laws under which they are promulgated.

(k) It is unlawful for a permittee or agent to violate any of the terms or conditions of a permit issued pursuant to this section.

(l) The permit does not invalidate any city, county, or state firearm regulation.

§ 460. Fisher, Marten, River Otter, Desert Kit Fox and Red Fox.

Fisher, marten, river otter, desert kit fox and red fox may not be taken at any time.

§ 461. Badger and Gray Fox.

(a) Badger may be taken as follows:

(1) Season and Area: November 16 through the last day of February, statewide.

(2) Bag and Possession Limit: No limit.

(b) Gray fox may be taken as follows:

(1) Season and Area: November 24 through the last day of February, statewide.

(2) Bag and Possession Limit: No limit.

(3) Dogs may be permitted to pursue gray fox in the course of breaking, training, or practicing dogs in accordance with the provisions of Section 265 of these regulations.

§ 462. Muskrat and Mink.

Except as noted in Section 4180, Fish and Game Code, muskrat and mink may be taken only as follows:

Season and Area: November 16 through March 31, statewide. (This regulation supersedes Section 4001 of the Fish and Game Code.)

Bag and Possession Limit: No limit.

§ 463. Beaver.

Beaver may be taken only as follows:

(a) Season and Area: November 1 through March 31 in the counties of Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Madera, Mariposa, Merced, Modoc, Mono, Monterey, Nevada (except Sagehen Creek), Placer, Plumas, Sacramento, San Joaquin, San Luis Obispo, Shasta, Sierra, Siskiyou, Solano, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Yolo and Yuba; and those portions of Riverside and San Bernardino counties within 10 miles of the Arizona-California border. (This regulation supersedes Section 4001 of the Fish and Game Code.)

Bag and Possession Limit: There is no bag or possession limit in these areas for the taking of beaver.

(b) Beaver or any part thereof may not be taken in the balance of the state including the counties of Los Angeles, Marin, Mendocino, Napa, Orange, San Benito, San Diego, San Francisco, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Sonoma, and Ventura; and those portions of Riverside and San Bernardino counties further than 10 miles from the California-Arizona border. (This regulation supersedes Section 4001 of the Fish and Game Code.)

§464. Raccoon.

(a) Seasons and Areas:
  (1) Raccoon may be taken from July 1 through March 31 in the following area: All of Imperial County and those portions of Riverside and San Bernardino counties lying south and east of the following line: Beginning at the intersection of Highway 86 with the north boundary of Imperial County; north along Highway 86 to the intersection with Interstate 10; east along Interstate 10 to its intersection with the Cottonwood Springs Road in Section 9, T6S, R11E, S.B.B.M.; north along the Cottonwood Springs Road and the Mecca Dale Road to Amboy; east along Highway 66 to the intersection with Highway 95; north along Highway 95 to the California-Nevada state line.
  (2) November 16 through March 31 in the balance of the state.

(b) Bag and Possession Limit: No limit.

(c) Method of Take: When taking raccoon after dark, pistols and rifles not larger than .22 caliber rimfire and shotguns using shot no larger than No. BB are the only firearms which may be used during this night period. (This regulation supersedes Sections 4001 and 4002 of the Fish and Game Code.) (See Sections 264 and 264.5 for light regulations.)

(d) Dogs may be permitted to pursue raccoons in the course of breaking, training or practicing dogs in accordance with the provisions of Section 265 of these regulations

§465. Methods for Taking Furbearers.

Furbearing mammals may be taken only with a firearm, bow and arrow, or with the use of dogs, or traps in accordance with the provisions of Section 465.5 of these regulations and Section 3003.1 of the Fish and Game Code.

§465.1. Use of Dogs in Taking Furbearers.

§465.5. Use of Traps.

  (a) Traps Defined. Traps are defined to include padded-jaw leg-hold, steel-jawed leg-hold, and conibear traps, snares, dead-falls, cage traps and other devices designed to confine, hold, grasp, grip, clamp or crush animals' bodies or body parts.
  (b) Affected Mammals Defined. For purposes of this section, furbearing mammals, game mammals, nongame mammals, and protected mammals are those mammals so defined by statute on January 1, 1997, in sections 3950, 4000, 4150 and 4700 of the Fish and Game Code.

(c) Prohibition on Trapping for the Purposes of Recreation or Commerce in Fur. It is unlawful for any person to trap for the purposes of recreation or commerce in fur any furbearing mammal or nongame mammal with any body-gripping trap. A body-gripping trap is one that grips the mammal's body or body part, including, but not limited to, steel-jawed leg-hold traps, padded-jaw leg-hold traps, conibear traps, and snares. Cage and box traps, nets, suitcase-type live beaver traps, and common rat and mouse traps shall not be considered body-gripping traps and may be used to trap for the purposes of recreation or commerce in fur any furbearing or nongame mammal.

(d) Prohibition on Exchange of Raw Fur. It is unlawful for any person to buy, sell, barter, or otherwise exchange for profit, or to offer to buy, sell, barter, or otherwise exchange for profit, the raw fur, as defined by Section 4005 of the Fish and Game Code, of any furbearing mammal or nongame mammal that was trapped in this state, with a body-gripping trap as described in subsection (c) above.

(e) Prohibition on Use of Steel-jawed Leg-hold Traps by Individuals. It is unlawful for any person to use or authorize the use of any steel-jawed leg-hold trap, padded or otherwise, to capture any game mammal, furbearing mammal, nongame mammal, protected mammal, or any dog or cat

(1) Exception for Extraordinary Case to Protect Human Health or Safety. The prohibition in subsection (e) does not apply to federal, state, county, or municipal government employees or their duly authorized agents in the extraordinary case where the otherwise prohibited padded-jaw leg-hold trap is the only method available to protect human health or safety.

(A) Leg-hold Trap Requirements. Leg-hold traps used to implement subsection (e)(1) must be padded, commercially manufactured, and equipped as provided in subsections (A)1. through (A)5. below:

1. Anchor Chains. Anchor chains must be attached to the center of the padded trap, rather than the side.
2. Chain Swivels. Anchor chains must have a double swivel mechanism attached as follows: One swivel is required where the chain attaches to the center of the trap. The second swivel may be located at any point along the chain, but it must be functional at all times.
3. Shock Absorbing Device. A shock absorbing device such as a spring must be in the anchor chain.
4. Tension Device. Padded leg-hold traps must be equipped with a commercially manufactured pan tension adjusting device.
5. Trap Pads. Trap pads must be replaced with new pads when worn and maintained in good condition.

(f) Use of Non-Body-Gripping Traps for Purposes of Recreation or Commerce in Fur. Any person who utilizes non-body-gripping traps for the take of furbearing mammals and nongame mammals for purposes of recreation or commerce in fur must comply with the provisions of subsections (g)(1) through (3) below.

(1) Trap Number Requirement. Any person who traps furbearing mammals or nongame mammals shall obtain a trap number issued by and registered with

the department. All traps, before being put into use, shall bear only the current registered trap number or numbers of the person using, or in possession of those traps. This number shall be stamped clearly on the trap or on a metal tag attached to the chain of the trap or to any part of the trap.

(g) Use of Conibear Traps, Snares, Cage and Box Traps, Nets, Suitcase-type Live Beaver Traps and Common Rat and Mouse Traps for Purposes Unrelated to Recreation or Commerce in Fur. Conibear traps, snares, cage and box traps, nets, suitcase-type live beaver traps and common rat and mouse traps may be used by individuals to take authorized mammals for purposes unrelated to recreation or commerce in fur, including, but not limited to, the protection of property, in accordance with subsections (1) through (5) below. Except for common rat and mouse traps, all traps used pursuant to this subsection must be numbered as required by subsection (f)(1) above. The prohibitions of subsections (c) and (d) above shall apply to any furbearing or nongame mammal taken by a conibear trap or snare pursuant to this subsection (g).

(1) Immediate Dispatch or Release. All furbearing and nongame mammals that are legal to trap must be immediately killed or released. Unless released, trapped animals shall be killed by shooting where local ordinances, landowners, and safety permit. This regulation does not prohibit employees of federal, state, or local government from using chemical euthanasia to dispatch trapped animals.

(2) Trap Visitation Requirement. All traps shall be visited at least once daily by the owner of the traps or his/her designee. Such designee shall carry on his/her person written authorization, as owner's representative, to check traps. In the event that an unforeseen medical emergency prevents the owner of the traps from visiting traps another person may, with written authorization from the owner, check traps as required. The designee and the person who issues the authorization to check traps shall comply with all provisions of Section 465.5. Each time traps are checked all trapped animals shall be removed.

(3) Trap Placement Requirement. Traps may not be set within 150 yards of any structure used as a permanent or temporary residence, unless such traps are set by a person controlling such property or by a person who has and is carrying with him written consent of the landowner to so place the trap or traps.

(4) Placement of Conibear Traps. Traps of the conibear-type with a jaw opening larger than 8” x 8” may be used only in sets where the trap is wholly or partially submerged in water or is:

(A) Within 100 feet of permanent water.

(B) Within 100 feet of seasonally flooded marshes, pastures, agricultural lands or floodways when standing or running water is present.

(C) Within the riparian vegetation zone, characterized by, but not limited to, willow, cottonwood, sycamore, salt cedar, cattail, bulrush and rushes, when found within the area defined in section 463(a) where the take of beaver is permitted.

(5) Zones Prohibited to the Use of Conibear-type Traps and Snares. Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited in the following zones.

(A) Zone 1: Beginning at Interstate 5 and Highway 89, east on Highway 89 to Harris Springs Road near Bartle, north on Harris Springs Road (primary U.S. Forest Service Road 15) to Powder Hill Road (primary U.S. Forest Service Road 49), northeast on Powder Hill Road to Road 42N56, east on Road 42N56 to the Siskiyou/Modoc county line, north on the Siskiyou/Modoc county line to the boundary of the Lava Beds National Monument, north along the eastern boundary of the Lava Beds National Monument, then west then south along the western boundary of the Lava Beds National Monument to Road 46N21, west along Road 46N21 over Gold Digger Pass to the western boundary of the Modoc National Forest, south along the western boundary of the Modoc National Forest to the boundary of the Shasta National Forest, west along the northern boundary of the Shasta National Forest to Highway 97, southwest on Highway 97 to Interstate 5, northwest on Interstate 5 to Old Highway 99, northwest on Old Highway 99 to Stewart Springs Road, southwest on Stewart Springs Road to the Yreka Ditch, west along the Yreka Ditch to the Gazelle/Callahan Road, southwest on the Gazelle/Callahan Road to Highway 3, south on Highway 3 to Ramshorn Road, northeast on Ramshorn Road to Castle Creek Road, east on Castle Creek Road to Interstate 5, north on Interstate 5 to the point of beginning.

(B) Zone 2: Beginning in Tehama County at the intersection of Highway 36 and the western boundary of the Lassen National Forest, south along the western boundary of the Lassen National Forest to the boundary of the Plumas National Forest, south along the western boundary of the Plumas National Forest to the boundary of the Tahoe National Forest, south along the western boundary of the Tahoe National Forest to the boundary of the El Dorado National Forest, south along the western boundary of the El Dorado National Forest to the boundary of the Stanislaus National Forest, south along the western boundary of the Stanislaus National Forest to the boundary of the Sierra National Forest, south along the western boundary of the Sierra National Forest to the boundary of the Sequoia National Forest, south along the western boundary of the Sequoia National Forest to Highway 245, southwest on Highway 245 to Road 168, southwest on Road 168 to County Road J40, west on County Road J40 to Henderson Road, northwest on Henderson Road to Lincoln Avenue, west on Lincoln Avenue to Highway 145, north on Highway 145 to Avenue 7, west on Avenue 7 to Road 21, north on Road 21 to Avenue 12, west on Avenue 12 to Road 16, north on Road 16 to Avenue 18 1/2, west on Avenue 18 1/2 to Road 9, north on Road 9 to Highway 152, west on Highway 152 to Highway 59, north on Highway 59 to Highway 99, northwest on Highway 99 to Highway 140, west on Highway 140 to Highway 33, north on Highway 33 to Interstate 5, north on Interstate 5 to County Road J4, west on County Road J4 to County Road J2, north on County Road J2 to Highway 4, west on Highway 4 to Lone Tree Way, west on Lone Tree Way to James Donlon Boulevard, west on James Donlon Boulevard to Somersville Road, south on Somersville Road to Nortonville Road, north

on Nortonville Road to Kirker Pass Road, southwest on Kirker Pass Road to Clayton Road, southeast on Clayton Road to Mitchell Canyon Road, south on Mitchell Canyon Road to the boundary of Mount Diablo State Park, south along the western boundary of Mount Diablo State Park to Mt. Diablo Scenic Boulevard, south on Mt. Diablo Scenic Boulevard to Blackhawk Road, southeast on Blackhawk Road to Camino Tassajara, west on Camino Tassajara to Dougherty Road, south on Dougherty Road to Interstate 580, west on Interstate 580 to Interstate 680, south on Interstate 680 to Highway 84, northeast on Highway 84 to Holmes Street, south on Holmes Street to Wetmore Road, east on Wetmore Road to Arroyo Road, south on Arroyo Road to Del Valle Regional Park, southeast along the western boundary of Del Valle Regional Park to Arroyo Del Valle Creek, southeast on Arroyo Del Valle Creek to the Alameda/Santa Clara county line, east on the Alameda/Santa Clara county line to San Antonio Valley Road, south on San Antonio Valley Road to Del Puerto Canyon Road, east on Del Puerto Canyon Road to Santa Clara/Stanislaus county line, south along the Santa Clara/Stanislaus county line to the Santa Clara/Merced county line, south along the Santa Clara/Merced county line to the San Benito/Merced county line, south along the San Benito/Merced county line to Little Panoche Road, south on Little Panoche Road to Panoche Road, east on Panoche Road to New Idria Road, south along New Idria Road to Clear Creek Road, southwest on Clear Creek Road to Coalinga Road, southeast on Coalinga Road to Coalinga-Mineral Springs Road, south on Coalinga-Minerial Springs Road to Highway 198, east on Highway 198 to Parkfield Grade, south on Parkfield Grade to Vineyard Canyon Road, west on Vineyard Canyon Road to Highway 101, north on Highway 101 to Bradley Road, north on Bradley Road to Sargents Road, north on Sargents Road to Pancho Rico Road, west on Pancho Rico Road to Cattleman's Road, north on Cattleman's Road to Highway 198, west on Highway 198 to Highway 101, north on Highway 101 to County Road G13, northeast on County Road G13 to Highway 25, north on Highway 25 to Browns Valley Road, north on Browns Valley Road to Santa Anita Road, northwest on Santa Anita Road to Santa Ana Valley Road, north on Santa Ana Valley Road to Fairview Road, north on Fairview Road to Highway 156, north on Highway 156 to Highway 152, southwest on Highway 152 to County Road G7, southwest on County Road G7 to Highway 25, west on Highway 25 to Highway 101, south on Highway 101 to the San Benito/Monterey county line, south on the San Benito/Monterey county line to Highway 146, west on Highway 146 to Highway 101, south on Highway 101 to Paraiso Springs Road, south on Paraiso Springs Road to County Road G17, south on County Road G17 to County Road 16, northeast on County Road 16 to Central Avenue, southeast on Central Avenue to Highway 101, south on Highway 101 to County Road G14, south on County Road G14 to Milpitas Road, west on Milpitas Road to the boundary of Fort Hunter Liggett, south along the western boundary of

Fort Hunter Liggett to the Nacimiento River, southeast along the Nacimiento River to Nacimiento Reservoir, southeast along the western boundary of Nacimiento Reservoir to Chimney Rock Road, south on Chimney Rock Road to Klau Mine Road, south on Klau Mine Road to Adelaida Road, east on Adelaida Road to Vineyard Drive, southeast on Vineyard Drive to Highway 101, south on Highway 101 to Highway 41, east on Highway 41 to Highway 229, south on Highway 229 to Creston O'Donovan Road, southeast on Creston O'Donovan Road to Highway 58, east on Highway 58 to the boundary of the Los Padres National Forest, south and east along the eastern boundary of the Los Padres National Forest to Highway 33, south on Highway 33 to Quatal Canyon Road, east on Quatal Canyon Road to Cerro Noroeste Road, east on Cerro Noroeste Road to Cuddy Valley Road, east on Cuddy Valley Road to Interstate 5, north on Interstate 5 to Wheeler Ridge Road, east on Wheeler Ridge Road to Laval Road, east on Laval Road to Rancho Road, north on Rancho Road to Sycamore Road, east on Sycamore Road to Tejon Highway, north on Tejon Highway to Highway 223, northeast on Highway 223 to Highway 58, east on Highway 58 to Caliente Bodfish Road, north on Caliente Bodfish Road to Highway 155, northeast then west on Highway 155 to the eastern boundary of the Sequoia National Forest, north and east along the southern boundary of the Sequoia National Forest to the Dome Land Wilderness, north along the eastern boundary of the Dome Land Wilderness to the boundary of the Inyo National Forest, north along the eastern boundary of the Inyo National Forest west of Highway 395 to the intersection of Inyo National Forest and Highway 395 near Sherwin Summit in Mono County, north on Highway 395 to the California/Nevada state line, north on the California/Nevada state line to Highway 395 in Sierra County, north on Highway 395 to Long Valley Road, south on Long Valley Road to the boundary of the Toiyabe National Forest, west along the Toiyabe National Forest boundary to the Tahoe National Forest boundary, west then south then west then north along the Tahoe National Forest boundary to the Plumas National Forest boundary, north then east then north along the eastern boundary of the Plumas National Forest to the Lassen National Forest boundary, north along the eastern boundary of the Lassen National Forest to the northern boundary of the Lassen National Forest, west along the northern boundary of the Lassen National Forest to the western boundary of the Lassen National Forest, south along the western boundary of the Lassen National Forest to the point of beginning.

(h) Statutory Penalty for Violation of Provisions. Violation of Section 3003.1 or 3003.2 of the Fish and Game Code, or any rule or regulation, including this Section 465.5, adopted pursuant thereto, is punishable by a fine of not less than three hundred dollars ($300) or more than two thousand dollars ($2,000), or by imprisonment in the county jail for not more than one year, or by both that fine and imprisonment.

§466. Hours for Taking Furbearers
Furbearers may be hunted at any hour of the day or night except that they may not be taken between one-half hour after sunset and one-half hour before sunrise in the area described in Section 474(a) of these regulations.

§467. Trapping Reports
All holders of trapping licenses must submit to the department a sworn statement or report by July 1 of his/her annual take of fur for the preceding trapping season. Statement or report shall show the number of each kind of furbearing mammals and nongame mammals taken, number sold, county in which furs were taken and the names and addresses of the persons to whom furs were shipped or sold. If the annual report is not received by July 1 following the most recent trapping year, or if it is not completely filled out, the trapper's license will be suspended. The commission shall be notified of any suspension and, subsequently, may revoke or reinstate applicant's license renewal application after written notice is given to the applicant and after he has been afforded an opportunity to be heard.

§472. General Provisions.
Except as otherwise provided in Sections 478 and 485 and subsections (a) through (d) below, nongame birds and mammals may not be taken.

(a) The following nongame birds and mammals may be taken at any time of the year and in any number except as prohibited in Chapter 6: English sparrow, starling, coyote, weasels, skunks, opossum, moles and rodents (excluding tree and flying squirrels, and those listed as furbearers, endangered or threatened species).
(b) Fallow, sambar, sika, and axis deer may be taken only concurrently with the general deer season.
(c) Aoudad, mouflon, tahr, and feral goats may be taken all year.
(d) American crows (Corvus brachyrhynchos) may be taken only under the provisions of Section 485 and by landowners or tenants, or by persons authorized in writing by such landowners or tenants, when American crows are committing or about to commit depredations upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance. Persons authorized by landowners or tenants to take American crows shall keep such written authorization in their possession when taking, transporting or possessing American crows. American crows may be taken only on the lands where depredations are occurring or where they constitute a health hazard or nuisance. If required by Federal regulations, landowners or tenants shall obtain a Federal migratory bird depredation permit before taking any American crows or authorizing any other person to take them.

American crows may be taken under the provisions of this subsection only by firearm, bow and arrow, falconry or by toxicants by the Department of Food and Agriculture for the specific purpose of taking depredating crows. Toxicants can be used for taking crows only under the supervision of employees or officers of the Department of Food and Agriculture or federal or county pest control officers or employees acting in their official capacities and possessing a qualified applicator certificate issued pursuant to sections 14151-14155 of the Food and Agriculture Code. Such toxicants must be applied

according to their label requirements developed pursuant to sections 6151-6301, Title 3, California Code of Regulations.

§473. Possession of Nongame Animals.
Any nongame bird or mammal that has been legally taken pursuant to this chapter may be possessed.

§474. Hours for Taking.
Nongame mammals may be taken at any time except as provided in this section**.**

(a) Area Closed to Night Hunting. Nongame mammals may be taken only between one-half hour before sunrise and one-half hour after sunset in the following described area: Beginning at a point where Little Panoche Road crosses Interstate 5 near Mendota; south on Interstate 5 to Highway 198; east on Highway 198 to Highway 99; south on Highway 99 to Interstate 5; south on Interstate 5 to the Los Padres National Forest boundary in Section 8, T 9 N, R 19 W, S.B.B.M near Fort Tejon Historical Monument; west along the National Forest boundary to Cerro Noroeste Road; northwest on Cerro Noroeste Road to Highway 33-166; north on Highway 33-166 to the Soda Lake Road; northwest on the Soda Lake Road and on the Simmler Soda Lake San Diego Creek Road to Highway 58 at Simmler; west on Highway 58 to the Cammotti Shandon Road; north on the Cammotti Shandon Road to the Shandon San Juan Road; north on the Shandon San Juan Road to Highway 41; northeast on Highway 41 to the Cholame Valley Road; northwest on Cholame Valley Road and Cholame Road to the Parkfield Coalinga Road in Parkfield; north on Parkfield Coalinga Road and Parkfield Grade to Highway 198; northwest on Highway 198 to the Fresno-Monterey county line; north along the Fresno-Monterey county and Fresno-San Benito county lines to the Little Panoche Road; north and east on the Little Panoche Road to the point of beginning at Interstate 5.
This section does not pertain to the legal take of nongame mammals with traps as provided for by Sections 461-480 of these regulations, and by Sections 4000-4012, 4152 and 4180 of the Fish and Game Code. (This regulation supersedes Section 3000 Of the Fish and Game Code.)

(b) On privately-owned property, not included in (a) above, nongame mammals may be taken from one-half hour after sunset to one-half hour before sunrise only by the landowner or his agents, or by persons who have in their immediate possession written permission issued by the landowner or tenant that states the permittee can trespass from one-half hour after sunset to one-half hour before sunrise on property under the ownership or control of such landowners or tenants.

(c) Fallow deer, axis deer, sambar deer, sika deer, aoudad, mouflon, tahr and feral goats may be taken only from one-half hour before sunrise to one-half hour after sunset.

§475. Methods of Take for Nongame Birds and Nongame Mammals.
Nongame birds and nongame mammals may be taken in any manner except as follows.

(a) Poison may not be used.

(b) Recorded or electrically amplified bird or mammal calls or sounds or recorded or electrically amplified imitations of bird or mammal calls or sounds may not be used

to take any nongame bird or nongame mammal except coyotes, bobcats, American crows and starlings.

(c) Fallow deer, sambar deer, axis deer, sika deer, aoudad, mouflon, tahr and feral goats may be taken only with the equipment and ammunition specified in Section 353 of these regulations.

(d) Traps may be used to take nongame birds and nongame mammal only in accordance with the provisions of Section 465.5 of these regulations and sections 3003.1 and 4004 of the Fish and Game Code.

(e) No feed, bait or other material capable of attracting a nongame mammal may be placed or used in conjunction with dogs for the purpose of taking any nongame mammals. Nothing in this section shall prohibit an individual operating in accordance with the provisions of Section 465.5 from using a dog to follow a trap drag and taking the nongame mammal caught in that trap.

§478. Bobcat.

Except as provided in subsections (c) and (d) below no person shall pursue, take or possess any bobcat without first procuring a trapping license or a hunting license and bobcat hunting tags. The pursuit, take and/or possession of a bobcat under the authority of a hunting license and a bobcat hunting tag shall be in accordance with the provisions of this section and Sections 265 and 472-479 of these regulations.

Bobcats taken under the authority of a trapping license shall be taken with traps or other means in accordance with this section and Sections 265, 465, 465.5 and 475. Bobcats taken under a trapping license must be tagged in accordance with the provisions of Section 479.

(a) Trapping Season and Area: Bobcat may only be taken under the authority of a trapping license as follows:
   (1) Area: Statewide.
   (2) Season: November 24 through January 31.

(b) Hunting Season and Area: Bobcats may only be taken under the authority of a hunting license and bobcat hunting tags as follows.
   (1) Area: Statewide.
   (2) Season: October 15 through February 28.

(c) Bag and Possession Limit:
   (1) Bobcats taken under a hunting license and bobcat hunting tags: Five bobcats per season.
   (2) Bobcats taken under a trapping license: No limit.

(d) Dogs may be permitted to pursue bobcats in the course of breaking, training or practicing dogs in accordance with the provisions of Section 265 of these regulations.

(e) This section shall not apply to bobcats trapped under the provisions of Sections 4152 and 4180 of the Fish and Game Code (also see Section 480 of these regulations).

§478.1. Bobcat Hunting Tags.

(a) Any person who possesses a valid hunting license may, upon payment of *$11.50, procure only five revocable, nontransferable bobcat hunting tags. Such tags shall be acquired at designated department offices. These tags do not act as shipping tags as required in Section 479 for pelts taken under a trapping license.

(b) Bobcat hunting tags are valid only during that portion of the current hunting license year in which bobcats may be legally harvested as provided in Section 478.
(c) The holder of a bobcat hunting tag shall fill in his/her name, address, and hunting license number prior to hunting, and carry the tag while hunting bobcats. Upon the harvesting of any bobcat, the hunter shall immediately fill out both parts of the tag and cut out and completely remove appropriate notches that clearly indicate the date of harvest. One part of the tag shall be immediately attached to the pelt and kept attached until it is tanned, dried or mounted. The other part of the tag shall be sent immediately to the department.
(d) Possession of any untagged bobcat taken under the authority of the hunting license shall be a violation of this section except that the provisions of this section shall not apply to the owner or tenant of land devoted to the agricultural industry nor to authorized county, state or federal predatory animal control agents operating under a written trapping agreement with the appropriate landowner while on such land and in connection with such agricultural industry. It is unlawful for any person to sell, offer for sale, barter, trade, purchase, transport from this state, or offer for out-of-state shipment by any common carrier any bobcat pelts, or parts thereof taken pursuant to this provision.
(e) Any person who is convicted of violating any provision of this chapter shall forfeit his bobcat hunting tags, and shall not apply for additional tags during the then current hunting license year.

* - Fees are subject to change annually.

§479. Bobcat Pelts.

Bobcat pelts may be taken only pursuant to the provisions of sections 465.5 and 478 of these regulations.

(a) Any person who takes a bobcat shall, at any time during the trapping season or within 14 days after the end of the bobcat season, have the following appropriate department mark or tag affixed to the pelt.
    (1) Pelts from bobcats taken under a hunting license shall be tagged as provided in Section 478.1. Pelts taken by a licensed trapper for only his personal use shall, at no cost, be marked by the department. Such pelts shall not be sold.
    (2) Pelts from bobcats taken for commercial purposes under a trapping license shall be tagged with a department shipping tag.
(b) It is unlawful for any person to sell, offer for sale, barter, trade, purchase, transport from this state, or offer for out-of-state shipment by any common carrier any bobcat pelts, or parts thereof unless the department has affixed a shipping tag to the pelt or parts thereof.
(c) Shipping tags and marking are available from the department. All persons taking bobcat pelts under provisions established by the commission must personally present the pelt to a representative of the department for placement of the nontransferable tag or mark and shall furnish the following:
    (1) Date of take;
    (2) County of take and nearest major geographical landmark;
    (3) Sex; and
    (4) Method of take (trap, call or hounds).

The department shall mark bobcat pelts and issue bobcat shipping tags for export of pelts at designated department offices during the trapping season and for a 14-day period immediately following the trapping season.
An administrative fee of $3.00 shall be charged for the issuance of each shipping tag. There is no fee for marking bobcat pelts not for sale.

(d) It is unlawful for any person to import, receive from out-of-state, or receive for sale, any bobcat pelt, or parts thereof that is not:
   (1) Marked with the current export or shipping tag from the state of origin.
   (2) Accompanied by an import declaration in accordance with Section 2353 of the Fish and Game Code, and specifying the number and kind of raw pelts in the shipment, the state in which the bobcats were taken, the license number under which they were taken and attesting that they were legally taken. Demonstration of the declaration of entry, pelt ownership and proof of legal take and marking is required of anyone receiving bobcat pelts from out-of-state upon the request of the department. The provisions of subsections (a), (b) and (c) shall not apply to raw bobcat pelts, or parts thereof, which were not taken in California.

§480. Bobcat Depredation.

Any person taking a depredating bobcat pursuant to the provisions of Fish and Game Code Section 3003.1 and Section 465.5 of these regulations, shall notify the department within thirty days from the date any bobcat is taken.

§1054.2. Possession of License When Taking Game; Requirements.
Every person while engaged in taking any bird, mammal, fish, amphibian, or reptile shall have on his or her person or in his or her immediate possession, or where otherwise specifically required by law to be kept, any license, tag, stamp, or permit that is required in order to take the bird, mammal, fish, amphibian, or reptile. In the case of a person diving from a boat, the license or permit may be kept on the boat, or in the case of a person diving from shore, the license or permit may be kept within 500 yards of the shore.

§2080. Import, Export, Take, Possess, Purchase or Sell Endangered Species; Exceptions.
No person shall import into this state, export out of this state, or take, possess, purchase, or sell within this state, any species, or any part or product thereof, that the commission determines to be an endangered species or a threatened species, or attempt any of those acts, except as otherwise provided in this chapter, the Native Plant Protection Act (Chapter 10 commencing with Section 1900) of this code), or the California Desert Native Plants Act (Division 23 (commencing with Section 80001) of the Food and Agricultural Code).

§2080.1. Taking Endangered Species with Federal Incidental Take Statement.
(a) Notwithstanding any other provision of this chapter, or Chapter 10 (commencing with Section 1900) or Chapter 11 (commencing with Section 1925) of Division 2, but subject to subdivision (c), if any person obtains from the Secretary of the Interior or the Secretary of Commerce an incidental take statement pursuant to Section 1536 of Title 16 of the United States Code or an incidental take permit pursuant to Section 1539 of Title 16 of the United States Code that authorizes the taking of an endangered species or a threatened species that is listed pursuant to Section 1533 of Title 16 of the United States Code and that is an endangered species, threatened species, or a candidate species pursuant to this chapter, no further authorization or approval is necessary under this chapter for that person to take that endangered species, threatened species, or candidate species identified in, and in accordance with, the incidental take statement or incidental take permit, if that person does both of the following: (1) Notifies the director in writing that the person has received an incidental take statement or an incidental take permit issued pursuant to the federal Endangered Species Act of 1973 (16 U.S.C.A. Sec. 1531 et seq.). (2) Includes in the notice to the director a copy of the incidental take statement or incidental take permit.
(b) Upon receipt of the notice specified in paragraph (1) of subdivision (a), the director shall immediately have published in the General Public Interest section of the California Regulatory Notice Register the receipt of that notice.
(c) Within 30 days after the director has received the notice described in subdivision (a) that an incidental take statement or an incidental take permit has been issued pursuant to the federal Endangered Species Act of 1973, the director shall determine whether the incidental take statement or incidental take permit is consistent with this chapter. If the director determines within that 30-day period, based upon substantial evidence, that the

incidental take statement or incidental take permit is not consistent with this chapter, then the taking of that species may only be authorized pursuant to this chapter.
(d) The director shall immediately publish the determination pursuant to subdivision (c) in the General Public Interest section of the California Regulatory Notice Register. (e) Unless deleted or extended by a later enacted statute that is chaptered before the date this section is repealed, this section shall remain in effect only until, and is repealed on, the effective date of an amendment to Section 1536 or Section 1539 of Title 16 of the United States Code that alters the requirements for issuing an incidental take statement or an incidental take permit, as applicable.

§2250. Muskrats; Import, Transport or Possess.
It is unlawful to import or transport into or possess any live muskrat (genus Ondatra) in California except under permit issued by the department pursuant to Section 2118, or as otherwise provided by law. A county agricultural commissioner, fish and game deputy, or state plant quarantine officer may enter upon lands or waters west of the crest of the Cascade-Sierra Nevada mountain system, and west and south of the Tehachapi, Liebre, San Gabriel, San Bernadino, San Jacinto, Cuyamaca, and connected mountains south to the international boundary, or in any watershed tributary to, or draining into, the Pacific Ocean to remove or destroy the muskrats.

§3003.1. Use of Body-Gripping Traps Prohibited; Buy, Sell, Barter, etc. Fur from Animal Trapped with Prohibited Trap.
Notwithstanding Sections 1001, 1002, 4002, 4004, 4007, 4008, 4009.5, 4030, 4034, 4042, 4152, 4180, or 4181: (a) It is unlawful for any person to trap for the purposes of recreation or commerce in fur any fur-bearing mammal or nongame mammal with any body-gripping trap. A body-gripping trap is one that grips the mammal's body or body part, including, but not limited to, steel-jawed leghold traps, padded-jaw leghold traps, conibear traps, and snares. Cage and box traps, nets, suitcase-type live beaver traps, and common rat and mouse traps shall not be considered body-gripping traps. (b) It is unlawful for any person to buy, sell, barter, or otherwise exchange for profit, or to offer to buy, sell, barter, or otherwise exchange for profit, the raw fur, as defined by Section 4005, of any fur-bearing mammal or nongame mammal that was trapped in this state, with a body-gripping trap as described in subdivision (a). (c) It is unlawful for any person, including an employee of the federal, state, county, or municipal government, to use or authorize the use of any steel-jawed leghold trap, padded or otherwise, to capture any game mammal, fur-bearing mammal, nongame mammal, protected mammal, or any dog or cat. The prohibition in this subdivision does not apply to federal, state, county, or municipal government employees or their duly authorized agents in the extraordinary case where the otherwise prohibited padded-jaw leghold trap is the only method available to protect human health or safety. (d) For purposes of this section, fur-bearing mammals, game mammals, nongame mammals, and protected mammals are those mammals so defined by statute on January 1, 1997.

§3003.2. Use of Sodium Fluoroacetate to Poison Any Animal Prohibited.
Notwithstanding Sections 4003, 4152, 4180, or 4180.1 of this code or Section 14063 of the Food and Agricultural Code, no person, including an employee of the federal, state,

county, or municipal government, may poison or attempt to poison any animal by using sodium fluoroacetate, also known as Compound 1080, or sodium cyanide.

§3003.5. Pursue, Drive, or Herd Any Bird or Mammal with Motorized Vehicle; Exceptions.
It is unlawful to pursue, drive, or herd any bird or mammal with any motorized water, land, or air vehicle, including, but not limited to, a motor vehicle, airplane, powerboat, or snowmobile, except in any of the following circumstances:
(a) On private property by the landowner or tenant thereof to haze birds or mammals for the purpose of preventing damage by that wildlife to private property.
(b) Pursuant to a permit from the department issued under regulations as the commission may prescribe.
(c) In the pursuit of agriculture.

§3039. Sale or Purchase of Wild Animals; Exceptions.
(a) Except as otherwise provided in this section and Sections 3087 and 4303, or any other provision of this code, or regulations adopted pursuant thereto, it is unlawful to sell or purchase any species of bird or mammal or part thereof found in the wild in California.
(b) Products or handicraft items made from furbearing mammals and nongame mammals, their carcass or parts thereof, lawfully taken under the authority of a trapping license, may be purchased or sold at any time.
(c) Shed antlers, or antlers taken from domestically reared animals that have been manufactured into products or handicraft items, or that have been cut into blocks or units which are to be handcrafted or manufactured into those articles may be purchased or sold at any time. However, complete antlers, whole heads with antlers, antlers that are mounted for display, or antlers in velvet may not be sold or purchased at any time, except as authorized by Section 3087.
(d) Notwithstanding Section 3504, inedible parts of domestically raised game birds may be sold or purchased at any time.
(e) Any person who illegally takes any bird or mammal for profit or for personal gain by engaging in any activity authorized by this section is subject to civil liability pursuant to Section 2582.

§4000. Definition of Fur-Bearing Mammals.
The following are fur-bearing mammals: pine marten, fisher, mink, river otter, gray fox, red fox, kit fox, raccoon, beaver, badger, and muskrat.

§ 4002. Methods of taking for Fur-Bearing Mammals.
Fur-bearing mammals may be taken only with a trap, a firearm, bow and arrow, poison under a proper permit, or with the use of dogs. § 4003. Use of Poison to Take – Permit Required. It is unlawful to use poison to take fur-bearing mammals without a permit from the department. The department may issue such a permit upon a written application indicating the kind of poison desired to be used and the time and place of use. § 4004. Unlawful Methods of Taking. It is unlawful to do any of the following:
(a) Use a trap with saw-toothed or spiked jaws.

(b) Use or sell leghold steel-jawed traps with a spread of 51/2 inches or larger without offset jaws.
(c) Use steel-jawed traps larger than size 11/2 or with a spread larger than 47/8 inches for taking muskrat.
(d) Set or maintain traps which do not bear a number or other identifying mark registered to the department or, in the case of a federal, state, county, or city agency, bear the name of that agency, except that traps set pursuant to Section 4152 or 4180 shall bear an identifying mark in a manner specified by the department. No registration fee shall be charged pursuant to this subdivision.
(e) Fail to visit and remove all animals from traps at least once daily. If the trapping is done pursuant to Section 4152 or 4180, the inspection and removal shall be done by the person who sets the trap or the owner of the land where the trap is set or an agent of either.
(f) Use a steel leghold trap with a spread exceeding 71/2 inches or killer-type trap of the conibear type that is larger than 10 inches by 10 inches.
(g) Set or maintain steel leghold traps within 30 feet of bait placed in a manner or position so that it may be seen by any soaring bird. As used in this subdivision, "bait" includes any bait composed of mammal, bird, or fish flesh, fur, hide, entrails, or feathers.
(h) Set or maintain steel leghold traps with a spread of 51/2 inches or larger without a tension device.

§ 4005. Take with Trap or Sell Raw Furs; License Required.
(a) Except as otherwise provided in this section, every person, other than a fur dealer, who traps fur-bearing mammals or nongame mammals, designated by the commission or who sells raw furs of those mammals, shall procure a trapping license. "Raw fur" means any fur, pelt, or skin that has not been tanned or cured, except that salt-cured or sun-cured pelts are raw furs.
(b) The department shall develop standards that are necessary to ensure the competence and proficiency of applicants for a trapping license. No person shall be issued a license until he or she has passed a test of his or her knowledge and skill in this field.
(c) Persons trapping mammals in accordance with Section 4152 or 4180 are not required to procure a trapping license except when providing trapping services for profit.
(d) No raw furs taken by persons providing trapping services for profit may be sold.
(e) The license requirement imposed by this section does not apply to any of the following: (1) Officers or employees of federal, county, or city agencies or the department, when acting in their official capacities, or officers or employees of the Department of Food and Agriculture when acting pursuant to the Food and Agricultural Code pertaining to pests or pursuant to Article 6 (commencing with Section 6021) of Chapter 9 of Part 1 of Division 4 of the Food and Agricultural Code. (2) Structural pest control operators licensed pursuant to Chapter 14 (commencing with Section 8500) of Division 3 of the Business and Professions Code, when trapping rats, mice, voles, moles, or gophers. (3) Persons and businesses licensed or certified by the Department of Pesticide Regulation pursuant to Chapter 4 (commencing with Section 11701) and Chapter 8 (commencing with Section 12201) of Division 6 of, and Chapter 3.6, (commencing with Section 14151) of Division 7 of, the Food and Agricultural Code, when trapping rats, mice, voles, moles, or gophers.

(f) Except for species that are listed pursuant to Chapter 1.5 (commencing with Section 2050) of Division 3 or Chapter 8 (commencing with Section 4700), nothing in this code or regulations adopted pursuant thereto shall prevent or prohibit a person from trapping any of the following animals:(1) Gophers. (2) House mice. (3) Moles. (4) Rats. (5) Voles.

§ 4006. License Fees.
A trapping license shall be issued as follows: (a) To any resident of this state over the age of 16 years upon payment of a base fee of forty-five dollars ($45), as adjusted under Section 713. (b) To any resident of this state under the age of 16 years upon payment of a base fee of fifteen dollars ($15), as adjusted under Section 713. (c) To any person not a resident of this state upon payment of a base fee of two hundred twenty-five dollars ($225), as adjusted under Section 713. A license shall not be issued to a nonresident if the state in which he or she resides does not provide for issuance of a nonresident trapping license to California residents. Also, a nonresident issued a license under this subdivision may take only those species, and may take or possess only that quantity of a species which a resident of California may take or possess under a nonresident trapping license or permit in the state of residence of that nonresident.

§ 4007. License Term and Authorizations.
A trapping license authorizes the person to whom it is issued to take, during the open season, fur-bearing mammals and nongame mammals for a term of one year from July 1st, or if issued after the beginning of such term, for the remainder thereof and to sell the raw fur of any such animal.

§ 4008. License Applicant's Statement of Previous Trapping, etc.
No trapping license shall be issued to any applicant within one year following the expiration of any trapping license previously issued to such applicant unless he has submitted to the department a sworn statement showing the number of each kind of fur-bearing mammals and nongame mammals taken under the previous license and the names and addresses of the persons to whom they were shipped or sold.

§ 4009. Traps; Remove or Disturb.
It is unlawful to remove or disturb the trap of any licensee while the trap is being used by the licensee on public land or on land where the licensee has permission to trap. This section does not apply to any employee of the department while engaged in the performance of official duties.

§ 4009.5. Trapping License – Adoption of Regulations by Commission.
The commission may adopt such regulations as it determines to be necessary to regulate the taking and sale of fur-bearing mammals or nongame mammals taken under a trapping license.

§ 4010. Confined Fur-bearing Mammals.
The provisions of this chapter do not apply to, or prohibit the propagation of, fur-bearing mammals which are confined in accordance with the regulations of the commission.

§ 4011. Taking of Mammals Involved in Dangerous Disease Outbreaks.
Fur-bearing mammals, game mammals, and nongame mammals, when involved in dangerous disease outbreaks, may be taken by duly constituted federal officers of the United States Departments of Agriculture, Interior, and Public Health and state officers of the California Departments of Food and Agriculture, Health Services, and Fish and Game.

§4012. Taking of Fox for Profit.
It is unlawful to take any red fox for profit making purposes.

§4030. License Requirements for Fur Dealer.
Every person engaging in, carrying on, or conducting wholly or in part the business of buying, selling, trading or dealing in raw furs of fur-bearing mammals or nongame mammals is a fur dealer and shall procure a fur dealer license. No fur dealer license shall be required of a licensed trapper selling raw furs which he has lawfully taken, or a domesticated game breeder selling raw furs of animals which he has raised.

§ 4031. License Fee.
A revocable fur dealer license shall be issued to any person upon payment of a base fee of seventy dollars ($70), as adjusted under Section 713.

§ 4032. License Requirements for Fur Agent.
Any person who is employed by a licensed fur dealer to engage in the business of buying, selling, trading, or dealing in raw furs only on behalf of the fur dealer and not on his own behalf is a fur agent and shall procure a fur agent license.

§ 4033. Fur Agent Revocable License.
A revocable fur agent license shall be issued to any person who is employed by a licensed fur dealer upon payment of a base fee of thirty-five dollars ($35), as adjusted under section 713.

§ 4034. Authority and Term of Fur Dealer License.
A fur dealer license authorizes the person to whom it is issued to buy, sell, barter, exchange, or possess raw furs or parts thereof of fur-bearing mammals and nongame mammals for a term of one year from July 1st, or if issued after the beginning of such term, for the remainder thereof.

§ 4035. Display of License.
A fur dealer or fur agent license shall be shown upon request to any person authorized to enforce the provisions of this code.

§ 4036. Raw Fur Purchase Restrictions.
It shall be unlawful for any fur dealer to purchase the raw fur of any fur-bearing mammal or nongame mammal from any person who does not hold a valid trapping license, fur dealer license, or fur agent license.

§ 4037. Raw Fur Transfer Record Requirements.
Every fur dealer licensed pursuant to this article shall maintain a true and legible record of any transfer of raw furs to show: (a) The license number, name, and address of the seller. (b) The signature, name, and license number, if applicable, of the buyer. (c) The number and species of raw furs transferred, by county of take. (d) The price paid or terms of exchange. (e) The date of transfer. (f) Such other information as the department may require.

§ 4038. Records – Available for Inspection at All Times.
The record of sale, exchange, barter, or gift shall be available for inspection at any time by the department.

§ 4040. Annual Report by Dealers of Fur Transfers.
Each licensed fur dealer shall submit an annual report to the department on the sale, exchange, barter, or gift of raw furs, on forms furnished by the department. No license shall be renewed until such a report is received.

§ 4041. Confidentiality of Receipts, Records and Reports.
The receipts, records, and reports required by this article and the information contained therein, shall be confidential, and the records shall not be public records. Any information which is published shall be published in such a manner as to preserve confidentiality of the persons involved.

§ 4042. Regulation of Raw Fur Business by Commission.
The commission may regulate the business of buying, selling, trading, or dealing in raw furs, or parts thereof, of all fur-bearing mammals or nongame mammals under a fur dealer license.

§ 4043. License Revocation.
Any license issued under this chapter may be revoked by the commission at one of the commission's regularly scheduled meetings, upon the licensee's conviction of a violation of this article.

§ 4150. Definition of Nongame Mammals; Take or Possess.
All mammals occurring naturally in California which are not game mammals, fully protected mammals, or fur-bearing mammals, are nongame mammals. Nongame mammals or parts thereof may not be taken or possessed except as provided in this code or in accordance with regulations adopted by the commission.

§ 4152. Taking of Nongame Mammals Found Injuring Crops or Property.
(a) Except as provided in Section 4005, nongame mammals and black-tailed jackrabbits, muskrats, subspecies of red fox that are not the native Sierra Nevada red fox (Vulpes vulpes necator), and red fox squirrels that are found to be injuring growing crops or other property may be taken at any time or in any manner in accordance with this code and regulations adopted pursuant to this code by the owner or tenant of the premises or

employees and agents in immediate possession of written permission from the owner or tenant thereof. They may also be taken by officers or employees of the Department of Food and Agriculture or by federal, county, or city officers or employees when acting in their official capacities pursuant to the Food and Agricultural Code pertaining to pests, or pursuant to Article 6 (commencing with Section 6021) of Chapter 9 of Part 1 of Division 4 of the Food and Agricultural Code. Persons taking mammals in accordance with this section are exempt from Section 3007, except when providing trapping services for a fee. Raw furs, as defined in Section 4005, that are taken under this section, shall not be sold.
(b) Traps used pursuant to this section shall be inspected and all animals in the traps shall be removed at least once daily. The inspection and removal shall be done by the person who sets the trap or the owner of the land where the trap is set or an agent of either.

§ 4180. Take Fur-bearing Mammals; Conditions; Use of Leghold Steel-jawed Traps; Removal of Animals in the Trap.
(a) Except as provided for in Section 4005, fur-bearing mammals that are injuring property may be taken at any time and in any manner in accordance with this code or regulations made pursuant to this code. Raw furs, as defined in Section 4005, that are taken under this section, shall not be sold.
(b) Traps used pursuant to this section shall be inspected and all animals in the traps shall be removed at least once daily. The inspection and removal shall be done by the person who sets the trap or the owner of the land where the trap is set or an agent of either.

§ 4180.1. Manners of Taking Immature Depredator Mammals.
It is unlawful to use snares, hooks, or barbed wire to remove from the den, or fire to kill in the den, any immature depredator mammal. Nothing in this section shall prohibit the use of fire-ignited gas cartridges or other products registered or permitted under the Federal Insecticide, Rodenticide, and Fungicide Act (7 U.S.C. 135 et seq.).

§ 4181. Kill Elk, Bear, Beaver, Wild Pig, or Gray Squirrels Damaging Property; Permit Required.
(a) Except as provided in Section 4181.1, any owner or tenant of land or property that is being damaged or destroyed or is in danger of being damaged or destroyed by elk, bear, beaver, wild pig, wild turkeys, or gray squirrels, may apply to the department for a permit to kill the animals. Subject to the limitations in subdivisions (b) and (d), the department, upon satisfactory evidence of the damage or destruction, actual or immediately threatened, shall issue a revocable permit for the taking and disposition of the animals under regulations adopted by the commission. The permit shall include a statement of the penalties that may be imposed for a violation of the permit conditions. Animals so taken shall not be sold or shipped from the premises on which they are taken except under instructions from the department. No iron-jawed or steel-jawed or any type of metal-jawed trap shall be used to take any bear pursuant to this section. No poison of any type may be used to take any gray squirrel or wild turkey pursuant to this section. The department shall designate the type of trap to be used to ensure the most humane method is used to trap gray squirrels. The department may require trapped squirrels to be released in parks or other nonagricultural areas. It is unlawful for any person to violate the terms of any permit issued under this section.

(b) The permit issued for taking bears pursuant to subdivision (a) shall contain the follwing facts: (1) Why the issuance of the permit was necessary. (2) What efforts were made to solve the problem without killing the bears. (3) What corrective actions should be implemented to prevent reoccurrence.
(c)With respect to wild pigs, the department shall provide an applicant for a depredation permit to take wild pigs or a person who reports taking wild pigs pursuant to subdivision (b) of Section 4181.1 with written information that sets forth available options for wild pig control, including, but not limited to, depredation permits, allowing periodic access to licensed hunters, and holding special hunts authorized pursuant to Section 4188. The department may maintain and make available to these persons lists of licensed hunters interested in wild pig hunting and lists of nonprofit organizations that are available to take possession of depredating wild pig carcasses.
(d) With respect to elk, the following procedures shall apply: (1) Prior to issuing a depredation permit pursuant to subdivision (a) the department shall do all of the following: (A) Verify the actual or immediately threatened damage or destruction. (B) Provide a written summary of corrective measures necessary to immediately alleviate the problem. (C) Determine the viability of the local herd, and determine the minimum population level needed to maintain the herd. (D) Ensure the permit will not reduce the local herd below the minimum. (E) Work with affected landowners to develop measures to achieve long-term resolution, while maintaining viability of the herd. (2) After completing the statewide elk management plan pursuant to Section 3952, the department shall use the information and methods contained in the plan to meet the requirements of subparagraphs (C), (D), and (E) of paragraph (1).

§ 4700. Take or Possess Fully Protected Mammals Prohibited.
(a)(1) Except as provided in Section 2081.7, fully protected mammals or parts thereof may not be taken or possessed at any time. No provision of this code or any other law shall be construed to authorize the issuance of permits or licenses to take any fully protected mammal, and no permits or licenses heretofore issued shall have any force or effect for that purpose. However, the department may authorize the taking of those species for necessary scientific research, including efforts to recover fully protected, threatened, or endangered species. Prior to authorizing the take of any of those species, the department shall make an effort to notify all affected and interested parties to solicit information and comments on the proposed authorization. The notification shall be published in the California Regulatory Notice Register and be made available to each person who has notified the department, in writing, of his or her interest in fully protected species and who has provided an e-mail address, if available, or postal address to the department. Affected and interested parties shall have 30 days after notification is published in the California Regulatory Notice Register to provide any relevant information and comments on the proposed authorization. (2) As used in this subdivision, "scientific research" does not include any actions taken as part of specified mitigation for a project, as defined in Section 21065 of the Public Resources Code. (3) Legally imported fully protected mammals or parts thereof may be possessed under a permit issued by the department.
(b) The following are fully protected mammals: (1) Morro Bay kangaroo rat (Dipodomys heermanni morroensis). (2) Bighorn sheep (Ovis canadensis), except Nelson bighorn

sheep (subspecies Ovis canadensis nelsoni) as provided by subdivision (b) of Section 4902. (3) Northern elephant seal (Mirounga angustirostris). (4) Guadalupe fur seal (Arctocephalus townsendi). (5) Ring-tailed cat (genus Bassariscus). (6) Pacific right whale (Eubalaena sieboldi). (7) Salt-marsh harvest mouse (Reithrodontomys ravive ntris). (8) Southern sea otter (Enhydra lutris nereis).(9) Wolverine (Gulo luscus).

§ 5652. Refuse Disposal into Waters; Exceptions.

(a) It is unlawful to deposit, permit to pass into, or place where it can pass into the waters of the state, or to abandon, dispose of, or throw away, within 150 feet of the high water mark of the waters of the state, any cans, bottles, garbage, motor vehicle or parts thereof, rubbish, litter, refuse, waste, debris, or the viscera or carcass of any dead mammal, or the carcass of any dead bird.

(b) The abandonment of any motor vehicle in any manner that violates this section shall constitute a rebuttable presumption affecting the burden of producing evidence that the last registered owner of record, not having complied with Section 5900 of the Vehicle Code, is responsible for that abandonment and is thereby liable for the cost of removal and disposition of the vehicle. This section prohibits the placement of a vehicle body on privately owned property along a streambank by the property owner or tenant for the purpose of preventing erosion of the streambank.

(c) This section does not apply to a refuse disposal site that is authorized by the appropriate local agency having jurisdiction or to the depositing of those materials in a container from which the materials are routinely removed to a legal point of disposal.

(d) This section shall be enforced by all law enforcement officers of this state.

Infectious Wildlife Diseases and Parasites

This section contains information on some of the more common wildlife diseases and parasites possibly carried by furbearers and nongame mammals that may affect humans. It is provided by either the United States Department of Health and Human Services or the California Department of Health Services. Additional information can be obtained at their respective internet websites: http://www.hhs.gov/ or http://www.dhs.ca.gov/.

Illnesses or diseases that are transmitted to people from vertebrate animals or their habitats are identified as "zoonotic diseases" or "zoonoses." There are approximately 200 reported zoonotic diseases. Furbearers and nongame mammals can serve as reservoirs for various zoonotic diseases. People can catch zoonoses either directly by contacting the animal, its urine or feces, parasites or vectors, or indirectly by contacting the animal's habitat (contaminated air, soil, and water). Wildlife can also transmit the infectious agent to domestic animals which would then comprise an additional reservoir for human exposure.

This section focuses on the identification, treatment, prevention, and cleanup to protect against common zooonotic diseases. The following informational fact sheets are intended to educate trappers of the preventative actions that should be undertaken to avoid infection. Some of these diseases can be fatal if due diligence is not exercised in their prevention or treatment. *Your private physician and public health officials should be consulted immediately whenever exposure to a zoonotic disease is suspected.*

Alveolar Echinococcosis
(al-VEE-oh-ler ee-keye-ni-kah-KOH-sis)

What is Alveolar Echinococcosis (AE)?
AE disease results from being infected with the larval stage of *Echinococcus multilocularis*, a microscopic tapeworm (1-4 millimeters) found in foxes, coyotes, dogs, and cats. Although human cases are rare, infection in humans causes parasitic tumors to form in the liver, and, less commonly, the lungs, brain, and other organs. If left untreated, infection with AE can be fatal.

Where has AE been found?
AE is found worldwide, mostly in northern latitudes. Cases have been reported in central Europe, Russia, China, Central Asia, Japan, and North America. In North America *E. multilocularis* is found primarily in the north central region from eastern Montana to central Ohio, as well as Alaska and Canada. Human cases have been reported in Alaska, the province of Manitoba, and Minnesota. Prevalence among wild foxes and coyotes is high, and may reach over 50% in some areas; however, even in these areas, transmission to humans has been low.

How does infection occur in foxes, coyotes, dogs, and other cats?
Wild foxes, coyotes, and cats get infected when they eat *Echinococcus multilocularis* larvae in infected rodents, field mice, or voles. Cats are less susceptible than dogs, but because they catch and eat rodents often, may also become infected. Once the animal becomes infected, the tapeworm matures in its intestine, produces eggs, and the infected animal passes eggs in the stool. These tapeworm eggs, which are directly infectious to other animals, are too tiny to see, and will stick to anything with which they come in contact. Coyotes, foxes, dogs, and cats are not harmed by the tapeworm and do not have symptoms of AE.

Can animals be tested for *E. multilocularis* tapeworms?
Routine fecal examinations are not sufficient to diagnose *E. multilocularis* infection. Infection with the *E. multilocularis* tapeworm and other tapeworms may occur at the same time. Eggs of *Taenia* species tapeworms and *Echinococcus* tapeworms are similar in shape and size and are very difficult to tell apart. If you live in an area where this parasite occurs or you are concerned about your dog or cat being infected with *E. multilocularis* or other tapeworms, see your veterinarian who can answer your questions and assess the risk of possible infection.

How can I be infected with AE?
By accidentally swallowing the eggs of the *E. multilocularis* tapeworm. Humans can be exposed to these eggs in two main ways, both of which involve "hand-to-mouth" transfer or contamination: By directly ingesting food items contaminated with stool from foxes or coyotes. This might include grass, herbs, greens, or berries gathered from fields. By petting or handling household cats and dogs infected with the *E. multilocularis* tapeworm. These pets may shed the tapeworm eggs in their stool, and their fur may be contaminated. Some dogs "scent roll" in foreign material (such as wild animal feces) and may become contaminated this way.

How likely am I to be infected with AE?
For 50 years, *E. multilocularis* was thought to be confined to the Alaskan coast and Canada. Now, because wild coyotes, foxes, and wolves are being trapped and transported to states where *E. multilocularis* has not previously been found, there is increased risk of spreading the disease to animals and humans. Wild animals carrying the tapeworm could set up the transmission cycle and expose animals not already infected. Many states prohibit this movement of wild animals, but trapping and movement of infected wild canines still occurs. If the transportation and relocation of these animals continues, the risk of human transmission will increase. Although the chances of contracting AE are low, certain groups may be at greater risk. You may be at greater risk if you live in an area where *E. multilocularis* is found (see above). People at high risk include trappers, hunters, veterinarians, or others who contact wild foxes, coyotes, or their stool, or household cats and dogs who have the opportunity to eat wild rodents infected with AE.

What are the symptoms of AE?
AE is caused by tumor-like or cyst-like tapeworm larvae growing in the body. AE usually involves the liver, but can spread to other organs of the body. Because the cysts are slow-growing, infection with AE may not produce any symptoms for many years. Pain or discomfort in the upper abdominal region, weakness, and weight loss may occur as a result of the growing cysts. Symptoms may mimic those of liver cancer and cirrhosis of the liver.

How can I find out if I have AE?
See your health care provider if you think you may have been exposed to AE by one of the ways listed above. He or she can order a blood test for the presence of the parasite or antibodies to *E. multilocularis*.

What is the treatment for AE?
Surgery is the most common form of treatment for AE, although removal of the entire parasite mass is not always possible. After surgery, medication may be necessary to keep the cyst from growing back.

How can I prevent AE?
If you live in an area where *E. multilocularis* is found in rodents and wild canines, take the following precautions to avoid infection: Don't touch a fox, coyote, or other wild canine, dead or alive, unless you are wearing gloves. Hunters and trappers should use plastic gloves to avoid exposure. Don't keep wild animals, especially wild canines, as pets or encourage them to come close to your home. Don't allow your cats and dogs to wander freely or to capture and eat rodents. If you think that your pet may have eaten rodents, consult your veterinarian about the possible need for preventive treatments. After handling pets, always wash your hands with soap and warm water. Fence in gardens to keep out wild animals. Do not collect or eat wild fruits or vegetables picked directly from the ground. All wild-picked foods should be washed carefully or cooked before eating.

BRUCELLOSIS
(UNDULANT FEVER, MEDITERRANEAN FEVER)

What is brucellosis?
Brucellosis is a bacterial infection caused by Brucella bacteria. There are several species of Brucella. Each species is commonly associated with a specific animal host; for example, Brucella abortus with cattle, Brucella melitensis with sheep and goats, Brucella canis with dogs, and Brucella suis with pigs.

How do people become infected with brucellosis?
Currently, consuming unpasteurized dairy products causes most cases of brucellosis. There are occasional infections among laboratory workers handling Brucella cultures. Historically, most human infections were associated with direct contact with infected animals or through mucous membranes or cuts and abrasions in the skin coming in direct contact with animal fluids. Therefore, farmers, veterinarians, and abattoir workers were at highest risk.

How is Brucella maintained in nature?
Brucella is found in domestic and wild animals. It causes a chronic infection that lasts for the life of the animal. The organism is usually found in the reproductive organs and causes abortion and sterility. Animals can release a large number of organisms in their milk, urine, and aborted fetuses, allowing for transmission between animals and to humans.

Who gets brucellosis?
Brucellosis occurs most often in people who have contact with livestock and in people who consume unpasteurized dairy products.

What are the symptoms of brucellosis?
The length of time between exposure and appearance of symptoms of brucellosis is usually one to three weeks, but can be as long as several months. The symptoms of brucellosis are nonspecific. They include fever, sweats, malaise, headache, and back pain. A recurring fever and arthritis is observed if patients go untreated for long periods. Infections that last for more than 12 months can result in infections in bones, joints, liver, kidney, spleen, or heart valves.

How is brucellosis diagnosed?
Since the symptoms of brucellosis are nonspecific, it is often difficult to diagnose. Growing the organism from a blood sample or tissue sample is the best laboratory method for diagnosis. Presence of antibodies in the blood can also indicate whether Brucella might be the cause of infection.

How is brucellosis treated?
It is necessary to treat patients with an appropriate antibiotic for prolonged periods. If therapy is discontinued too early, relapse of symptoms may occur. Best results are obtained when a combination of two or more antibiotics are used.

How can infection with brucellosis be prevented?
Elimination of the disease in domestic animals is the best prevention for brucellosis. Brucellosis control programs are based on vaccination and/or test-and-slaughter of infected animals. These programs have greatly reduced the incidence of animal disease in developed countries, and have resulted in a reduction in the number of human cases. Avoiding consumption of unpasteurized milk and dairy products and limiting exposure to infected domestic animals will prevent most human infections.

Where can I find more information about brucellosis?
The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/dbmd/diseaseinfo/brucellosis_t.htm.
The World Health Organization also has an informational website at:
http://www.who.int/inf-fs/en/fact173.html.

EHRLICHIOSIS

What is ehrlichiosis?
Ehrlichiosis ("air-lick-ee-oh-sus") is a disease of white blood cells caused by very small bacteria called rickettsiae. Two kinds of ehrlichiosis are recognized in humans: human monocytic ehrlichiosis (HME), which infects blood cells called "monocytes", and human granulocytic ehrlichiosis (HGE), which is an infection of "granulocytes."

How common is ehrlichiosis?
Ehrlichiosis is far less common in California than in other parts of the country. Of the approximately 1,000 cases identified in the United States (U.S.), fewer than a dozen cases have been in California. Most cases of HME occur in the southcentral U.S., whereas most cases of HGE occur in the upper Midwest and northeastern U.S.

How is ehrlichiosis transmitted?
The bacteria that cause ehrlichiosis are carried by ticks and can be transmitted to a person when a tick bites them. In California, the same tick that carries Lyme disease, the western black-legged tick, can also transmit HGE. Zero to ten percent of western black-legged ticks carry the agent of HGE. It remains uncertain whether this same tick or another species transmits HME in California.

What are the symptoms of ehrlichiosis?
Most individuals infected with the bacteria that cause ehrlichiosis experience no or mild symptoms. When symptoms occur, they resemble influenza, with fever, headache, fatigue, muscle aches, and nausea. Some individuals may also have vomiting, cough, or a rash. More severe illness may occur in some patients, particularly elderly persons or those with weakened immune systems. The disease is rarely fatal.

How is ehrlichiosis treated?
Ehrlichiosis can be successfully treated with antibiotics. Persons with ehrlichiosis generally begin to feel better within one to two days of starting antibiotic treatment.

How do I know if I have ehrlichiosis?
If you experience flu-like symptoms within two to three weeks after receiving a tick bite, or after having been in an area where ticks are prevalent, consult your health care provider. Several different blood tests are available to your physician to help determine whether your illness is ehrlichiosis.

How can I prevent ehrlichiosis?
Taking appropriate precautions to avoid tick bites can reduce the risk of infection with ehrlichiosis, as well as other diseases transmitted by ticks. If possible, avoid areas where ticks are known to occur. When in these areas, wear light-colored long pants and long sleeve shirts. Repellents applied to clothing can further deter ticks from

attaching. When outdoor activities are completed, thoroughly examine yourself and promptly remove any ticks that may be attached.

Where can I find more information on ehrlichiosis?

The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/dvrd/ehrlichia/index.htm.

Giardiasis

(GEE-are-DYE-uh-sis)

What is giardiasis?

Giardiasis (GEE-are-DYE-uh-sis) is a diarrheal illness caused by a one-celled, microscopic parasite, *Giardia intestinalis* (also known as *Giardia lamblia*). Once an animal or person has been infected with *Giardia intestinalis*, the parasite lives in the intestine and is passed in the stool. Because the parasite is protected by an outer shell, it can survive outside the body and in the environment for long periods of time.

During the past 2 decades, *Giardia* infection has become recognized as one of the most common causes of waterborne disease (found in both drinking and recreational water) in humans in the United States. *Giardia* are found worldwide and within every region of the United States.

How do you get giardiasis and how is it spread?

The *Giardia* parasite lives in the intestine of infected humans or animals. Millions of germs can be released in a bowel movement from an infected human or animal. *Giardia* is found in soil, food, water, or surfaces that have been contaminated with the feces from infected humans or animals. You **can** become infected after accidentally swallowing the parasite; you **cannot** become infected through contact with blood. *Giardia* can be spread by:

- Accidentally putting something into your mouth or swallowing something that has come into contact with feces of a person or animal infected with *Giardia*.
- Swallowing recreational water contaminated with *Giardia*. Recreational water includes water in swimming pools, hot tubs, jacuzzis, fountains, lakes, rivers, springs, ponds, or streams that can be contaminated with sewage or feces from humans or animals.
- Eating uncooked food contaminated with *Giardia*.
- Accidentally swallowing *Giardia* picked up from surfaces (such as bathroom fixtures, changing tables, diaper pails, or toys) contaminated with feces from an infected person.

What are the symptoms of giardiasis?

Giardia infection can cause a variety of intestinal symptoms, which include:

- Diarrhea
- Gas or flatulence
- Greasy stools that tend to float Stomach cramps
- Upset stomach or nausea.

These symptoms may lead to weight loss and dehydration. Some people with giardiasis have no symptoms at all.

How long after infection do symptoms appear?

Symptoms of giardiasis normally begin 1 to 2 weeks (average 7 days) after becoming infected.

How long will symptoms last?
In otherwise healthy persons, symptoms of giardiasis may last 2 to 6 weeks. Occasionally, symptoms last longer.

Who is most likely to get giardiasis?
Anyone can get giardiasis. Persons more likely to become infected include:

- Children who attend day care centers, including diaper-aged children
- Child care workers
- Parents of infected children
- International travelers
- People who swallow water from contaminated sources
- Backpackers, hikers, and campers who drink unfiltered, untreated water Swimmers who swallow water while swimming in lakes, rivers, ponds, and streams
- People who drink from shallow wells.

Contaminated water includes water that has not been boiled, filtered, or disinfected with chemicals. Several community-wide outbreaks of giardiasis have been linked to drinking municipal water or recreational water contaminated with *Giardia* .

What should I do if I think I may have giardiasis?
See your health care provider.

How is a *Giardia* infection diagnosed?
Your health care provider will likely ask you to submit stool samples to check for the parasite. Because *Giardia* can be difficult to diagnose, your provider may ask you to submit several stool specimens over several days.

What is the treatment for giardiasis?
Several prescription drugs are available to treat *Giardia*. Although *Giardia* can infect all people, young children and pregnant women may be more susceptible to dehydration resulting from diarrhea and should, therefore, drink plenty of fluids while ill.

My child does not have diarrhea, but was recently diagnosed as having giardiasis. My health care provider says treatment is not necessary. Is this true?
Treatment is not necessary when the child has no symptoms. However, there are a few exceptions. If your child does not have diarrhea, but is having nausea, fatigue (very tired), weight loss, or a poor appetite, you and your health care provider may wish to consider treatment. If your child attends a day care center where an outbreak is continuing to occur despite efforts to control it, screening and treating children who have no obvious symptoms may be a good idea. The same is true if several family members are ill, or if a family member is pregnant and therefore not able to take the most effective anti- *Giardia* medications.

If I have been diagnosed with giardiasis, should I worry about spreading the infection to others?
Yes, a *Giardia* infection can be very contagious. Follow these guidelines to avoid spreading giardiasis to others: Wash your hands with soap and water after using the toilet, changing diapers, and before eating or preparing food. Do not swim in recreational water (pools, hot tubs, lakes or rivers, the ocean, etc.) if you have *Giardia* and for at least 2 weeks after diarrhea stops. You can pass *Giardia* in your stool and contaminate water for several weeks after your symptoms have ended. This has resulted in outbreaks of *Giardia* among recreational water users. Avoid fecal exposure during sexual activity.

How can I prevent a *Giardia* infection?
Practice good hygiene.

1. Wash hands thoroughly with soap and water.
    a. Wash hands after using the toilet and before handling or eating food (especially for persons with diarrhea).
    b. Wash hands after every diaper change, especially if you work with diaper-aged children, even if you are wearing gloves. Protect others by not swimming if you are experiencing diarrhea (essential for children in diapers).

Avoid water that might be contaminated.

1. Do not swallow recreational water.
2. Do not drink untreated water from shallow wells, lakes, rivers, springs, ponds, and streams.
3. Do not drink untreated water during community-wide outbreaks of disease caused by contaminated drinking water.
4. Do not use untreated ice or drinking water when traveling in countries where the water supply might be unsafe.

For information on recreational water-related illnesses, visit CDC's Healthy Swimming website at http://www.cdc.gov/healthyswimming.
In the United States, nationally distributed brands of bottled or canned carbonated soft drinks are safe to drink. Commercially packaged non-carbonated soft drinks and fruit juices that do not require refrigeration until after they are opened (those that are stored unrefrigerated on grocery shelves) also are safe. For information on choosing safe bottled water, see the CDC fact sheet entitled “Preventing Cryptosporidiosis: A Guide to Water Filters and Bottled Water,” available by visiting http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/ factsht_crypto_prevent_water.htm.

If you are unable to avoid using or drinking water that might be contaminated, then you can make the water safe to drink by doing one of the following:

- Heat the water to a rolling boil for at least 1 minute. **OR**
- Use a filter that has an absolute pore size of at least 1 micron or one that has been NSF rated for "cyst removal."
- If you cannot heat the water to a rolling boil or use a recommended filter, then try chemically treating the water by chlorination or iodination. Using chemicals may be less effective than boiling or filtering because the amount of chemical required

to make the water safe is highly dependent on the temperature, pH, and cloudiness of the water.

For information on choosing a water filter, see the CDC fact sheet entitled "Preventing Cryptosporidiosis: A Guide to Water Filters and Bottled Water," available by visiting http://www.cdc.gov/ncidod/dpd/ parasites/cryptosporidiosis/factsht_crypto_prevent_water.htm.

Avoid food that might be contaminated.

1. Wash and/or peel all raw vegetables and fruits before eating.
2. Use safe, uncontaminated water to wash all food that is to be eaten raw.
3. Avoid eating uncooked foods when traveling in countries with minimal water treatment and sanitation systems.

Avoid fecal exposure during sexual activity.

If my water comes from a well, should I have my well water tested?

It depends. You should consider having your well water tested if you can answer "yes" to any of the following questions:

- **Are members of your family or others who use your well water becoming ill?** If yes, your well may be the source of infection.
- **Is your well located at the bottom of a hill or is it considered shallow?** If so, runoff from rain or flood water may be draining directly into your well causing contamination.
- **Is your well in a rural area where animals graze?** Well water can become contaminated with feces if animal waste seepage contaminates the ground water. This can occur if your well has cracked casings, is poorly constructed, or is too shallow.

Tests used to specifically identify *Giardia* are often expensive, difficult, and usually require hundreds of gallons of water to be pumped through a filter. If you answered "yes" to the above questions, consider generally testing your well for fecal contamination by testing it for the presence of coliforms or *E. coli* instead of *Giardia*. Although tests for fecal coliforms or *E. coli* do not specifically tell you whether *Giardia* is present, these tests will show whether your well water has been contaminated by fecal matter.

These tests are only useful if your well is not routinely disinfected with chlorine, since chlorine kills fecal coliforms and *E. coli*. If the tests are positive, it is possible that the water may also be contaminated with *Giardia* or other harmful bacteria and viruses. Contact your county health department, your county cooperative extension service, or a local laboratory to find out who offers water testing in your area. If the fecal coliform test comes back positive, indicating that your well is fecally contaminated, stop drinking the well water and contact your local water authority for instructions on how to disinfect your well. *This fact sheet is for information only and is not meant to be used for self-diagnosis or as a substitute for consultation with a health care provider. If you have any questions about the disease described above or think that you may have a parasitic infection, consult a health care provider.*

HANTAVIRUS PULMONARY SYNDROME

What is hantavirus pulmonary syndrome (HPS)?
HPS is a potentially severe disease of the lungs which was first recognized in 1993 in the "Four Corners" area (where Utah, Colorado, Arizona, and New Mexico meet) of the southwestern United States (U.S.). The disease is caused by hantaviruses, most frequently Sin Nombre virus which causes HPS in the western U.S. Cases of HPS occur throughout the U.S. but are most common in the Southwest. HPS is a rare, but often fatal, disease.

How are hantaviruses maintained in nature?
In the U.S., the hantaviruses that cause HPS are maintained in nature in wild rodents--deer mice in the West, cotton rats and rice rats in the Southeast, and the white-footed mouse in the Northeast. Other rodents, including squirrels, chipmunks, and house mice, are rarely, if ever, infected and do not pose a risk of HPS to humans.

How do you get HPS?
Infected rodents shed hantavirus in their urine, droppings, and saliva. Most patients become infected by breathing air contaminated with rodent urine or droppings, such as when cleaning out a rodent-infested space. Individuals can also be infected by: 1) consuming food contaminated with rodent urine or droppings; 2) touching surfaces where rodents have been, and then putting their hand in their mouth; 3) being bitten by an infected rodent.

What are the signs and symptoms of HPS?
Typically, infected persons develop symptoms one to two weeks after exposure. Early symptoms of HPS include fever, headache, and muscle aches, especially the thighs, hips, back, and shoulders. Other early symptoms include dizziness, chills, nausea, vomiting, diarrhea, and abdominal pain. After two to seven days of these symptoms, patients develop breathing difficulties that range from cough and shortness of breath to severe respiratory failure. Approximately 40 percent of HPS patients die from the disease.

How is HPS diagnosed?
Persons with HPS can be readily diagnosed by specific blood tests.

What treatment is recommended for HPS patients?
Currently, there is no specific treatment for HPS. However, if infected individuals are recognized and hospitalized early, supportive care can increase their chance for survival. Patients with severe respiratory disease can require intensive support of their heart and lung function.

How can I avoid getting HPS?
Avoid contact with all wild rodents, their droppings, and nesting materials. Store all food items securely in rodent-proof containers. Examine the outside of all buildings and block up any holes or other areas that would let rodents get inside. Before entering an enclosed area that may be contaminated with rodent material, allow it to air out for several hours. Surfaces where rodents may have been should be wetted with a dilute bleach solution before mopping up. Do not use a broom or vacuum to clean these areas. Promptly dispose of all cleaning materials when done, and wash hands and clothes.

Where can I find more information about HPS?
The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/diseases/hanta/hantvrus.htm.

Histoplasmosis

What is histoplasmosis?
Histoplasmosis is a disease caused by the fungus *Histoplasma capsulatum*. Its symptoms vary greatly, but the disease primarily affects the lungs. Occasionally, other organs are affected. This form of the disease is called disseminated histoplasmosis, and it can be fatal if untreated.

Can anyone get histoplasmosis?
Yes. Positive histoplasmin skin tests occur in as many as 80% of the people living in areas where H. capsulatum is common, such as the eastern and central United States. Infants, young children, and older persons, in particular those with chronic lung disease are at increased risk for severe disease. Disseminated disease is more frequently seen in people with cancer or AIDS.

How is someone infected with H. capsulatum?
H. capsulatum grows in soil and material contaminated with bat or bird droppings. Spores become airborne when contaminated soil is disturbed. Breathing the spores causes infection. The disease is not transmitted from an infected person to someone else.

What are the symptoms of histoplasmosis?
Most infected persons have no apparent ill effects. The acute respiratory disease is characterized by respiratory symptoms, a general ill feeling, fever, chest pains, and a dry or nonproductive cough. Distinct patterns may be seen on a chest x-ray. Chronic lung disease resembles tuberculosis and can worsen over months or years. The disseminated form is fatal unless treated.

When do symptoms start?
If symptoms occur, they will start within 3 to 17 days after exposure; the average is 10 days.

Is histoplasmosis treatable?
Yes. Antifungal medications are used to treat severe cases of acute histoplasmosis and all cases of chronic and disseminated disease. Mild disease usually resolves without treatment. Past infection results in partial protection against ill effects if reinfected.

Where is H. capsulatum found?
H. capsulatum is found throughout the world and is endemic in certain areas of the United States. The fungus has been found in poultry house litter, caves, areas harboring bats, and in bird roosts.

What can be done to prevent histoplasmosis?
It is not practical to test or decontaminate most sites that may be contaminated with H. capsulatum, but the following precautions can be taken to reduce a person's risk of exposure: Avoid areas that may harbor the fungus, e.g., accumulations of bird or bat droppings. Before starting a job or activity having a risk for exposure to H. capsulatum, consult the NIOSH/NCID Document Histoplasmosis: Protecting Workers at Risk.

LEPTOSPIROSIS

What is leptospirosis?
Leptospirosis ("lepto") is an infection caused by bacteria from the genus Leptospira. It can infect both humans and animals.

How do people get infected with lepto?
The most common route of infection is through contact of broken skin or the mucous membranes (nose, mouth, eyes) with contaminated water. Water becomes contaminated by the urine of infected domestic or wild animals or people. People who come in contact with urine or tissues of infected animals can also contract the infection.

How is lepto maintained in nature?
Wild and domestic animals are infected with Leptospira, and excrete the bacteria in their urine. Some animals can be infected and shed Leptospira bacteria for long periods without showing signs of illness.

Who is at greatest risk of becoming infected with lepto?
Farmers, sewer workers, veterinarians, and fish workers can be exposed at work. In infected areas, the disease is a recreational hazard to bathers, campers, hunters, and fishing enthusiasts.

What are the symptoms of lepto infection?
The time between a person's exposure to the bacteria and becoming sick can range from two days to four weeks. Many people show no signs of infection, others have fever, headache, chills, red eyes, and sore muscles. Severe infections result in anemia, jaundice, liver failure, kidney failure, meningitis, and respiratory distress.

How is lepto infection diagnosed?
Blood or urine tests are used to see if a person is infected.

How is lepto treated?
Leptospirosis is treated with antibiotics, such as doxycycline or penicillin. These should be given early in the disease. Intravenous antibiotics may be needed for persons with more severe symptoms.

How can infection be prevented?
The chances of getting leptospirosis can be greatly reduced by avoiding swimming or wading in water that might be contaminated with animal urine. People whose job or recreational activities exposes them to contaminated water or soil should wear protective clothing or footwear. Because rodents are common carriers of Leptospira, proper control of rodents around homes and buildings is important. Keep your dogs'

vaccination against leptospirosis current to reduce the potential for your dog to become infected and pass the infection to you.

Where can I get more information about leptospirosis?

The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/dbmd/diseaseinfo/leptospirosis_g.htm.
Another good website is: http://www.astdhpphe.org/infect/lepto.html.

LYME DISEASE

What is Lyme disease?
Lyme disease is an infectious disease caused by a bacterium known as a spirochete. People get Lyme disease when a tick infected with the Lyme disease bacterium attaches and feeds on them. Lyme disease was first recognized in the northeastern United States in the 1970s. Lyme disease has been reported from many areas of the country, including California.

What are the symptoms of Lyme disease?
Lyme disease can affect many body systems. Symptoms can vary and diagnosis can be difficult. Lyme disease can start as a mild flu-like illness and, over time, develop into severe chronic health problems. The early stages of the disease can include a red, expanding skin rash (called erythema migrans or EM), chills and fever, headache, swollen lymph nodes, muscle and joint pain, weakness of some muscles in the face, and heart irregularities. The EM rash appears up to 30 days after the bite of an infected tick. One or more EM rashes can occur, not necessarily at the tick bite. The rash can precede, accompany, or follow flu-like symptoms. The rash may not be noticed in some instances due to skin tone or occurrence on the body in locations difficult to see. Occasionally, an allergic reaction to the tick bite can occur on the skin and may be mistaken for an EM. The allergic reaction is different from an EM rash because it happens within minutes to hours after the tick bite and does not spread.

If left untreated, arthritis or nervous system signs can develop in some Lyme disease patients. Arthritis is most likely to appear as bouts of pain and swelling, usually in one or more large joints, especially the knees. Nervous system abnormalities can include numbness, tingling, or pain in the arms and legs, or difficulties in memory and the ability to concentrate.

Lyme disease can be successfully treated with antibiotics, especially in the early stages. The potential for long-term complications increases if the disease progresses untreated.

How does one get Lyme disease?
The western blacklegged tick, Ixodes pacificus, transmits the bacteria that cause Lyme disease to humans in California. The tick has three life stages: larva, nymph, and adult. The larvae and nymphs feed on the blood of small rodents, rabbits, lizards, birds, and occasionally large mammals. Adults feed on the blood of large mammals, principally deer.

Both nymphs and adults of the western blacklegged tick can transmit the infection to humans. Nymphs likely play a greater role in transmission of Lyme disease to humans because they are small (<1mm or about the size of a poppy seed) and thus difficult to see. Also, in some areas, a higher percentage of nymphal ticks carry the Lyme disease

organism than adult ticks. An infected tick must be attached and feeding for at least a day before it can transmit the spirochetes.

Where is the risk of getting Lyme disease greatest in California?

The western black-legged tick has been found in 55 of the 58 counties in California. It is abundant in the humid coastal areas and on the western slope of the Sierra Nevada range. Ticks prefer cool, moist environments and can be found on wild grasses and low vegetation in both urban and rural areas. Adult ticks climb to the tip of vegetation along animal trails and wait for a host to brush against them. Nymphs are found in low, moist vegetation such as leaf litter. Adults are most active from November through March and the nymphs are active primarily from March through August.

What can be done to keep from getting Lyme disease?

- Avoid areas where ticks are known to occur.
- Stay in the middle of the trail; avoid trail margins, brush, and grassy areas.
- Tuck pants into boots or socks, and shirt into pants.
- Wear light-colored clothing and long-sleeved shirts so ticks can be more easily seen.
- Apply insect repellents labeled for ticks to clothing.
- Thoroughly check yourself and others for ticks during and after activities in tick-infested areas.
- Keep grass along trails, buildings, and camping areas mown.

How should attached ticks be removed?

- Using tweezers, grasp the tick's mouthparts as close to the skin as possible.
- Gently pull the tick straight out, using a firm steady motion.
- Wash your hands and the bite site with soap and water. Apply an antiseptic to the bite site.
- Note: Prompt tick removal can prevent transmission of infection.
- Consult with your physician if you develop any symptoms, especially a rash, within 30 days of the tick bite.

Where can I get more information on Lyme disease?

The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/diseases/submenus/sub_lyme.htm.

PLAGUE

What is plague?
Plague is an infectious disease caused by the bacteria Yersinia pestis. Historically, plague caused thousands of deaths throughout Europe during the 6th and 14th Centuries. Today, plague in humans is rare in the United States and can be treated effectively with antibiotics if diagnosed early.

Is plague present in California?
Yes. Rodents and their fleas maintain plague in nature. In California, the primary rodents involved are wild squirrels and chipmunks. Transmission of plague from urban rodents (rats) to humans has not been seen in California since the 1920s. The major threat of plague is from wild rodents in rural recreational and wilderness parts of the State. Rodents in the suburban foothills of some larger cities pose a threat. Plague is most common in the foothills, plateaus, mountains, and coast. It is absent from the southeastern desert region and the San Joaquin Valley.

How is plague transmitted?
Plague is transmitted to people most commonly through the bite of an infected flea. Infection is also possible when the blood or other body fluids of an infected animal enter through cuts or breaks in the skin or mucous membranes. Finally, plague can be contracted by inhaling bacteria from the cough or sneeze of an infected person or animal, especially cats. Cats are especially susceptible to plague and represent a serious source of potential human exposure. Cats may also transport infected rodent fleas into a home or campsite.

What are the symptoms of plague?
The initial symptoms of plague usually develop two to six days after exposure and include nausea, vomiting, fever, chills, muscle aches, headache, and weakness. Three forms of plague are known: bubonic, septicemic, and pneumonic. Bubonic plague, the most common form, is characterized by swollen and tender lymph nodes (called "buboes") in the groin, neck, or armpit. In septicemic plague, plague bacteria infect the bloodstream, causing high fever, fatigue, weakness, and bleeding disorders. Pneumonic plague can follow bubonic or septicemic plague, or occur directly from inhalation of infectious bacteria. Patients with pneumonic plague have difficulty breathing, develop a cough, and may spit up blood-tinged saliva.

How is plague diagnosed?
Diagnosis is based on finding the bacteria in blood, saliva or mucus from the throat, or material from enlarged lymph nodes. Blood tests are also available.

Is plague treatable?
A patient who possibly has plague should be hospitalized and placed in isolation. Antibiotic treatment should begin as soon as possible. Most bubonic plague patients recover following antibiotic treatment. Septicemic and pneumonic plague are often fatal if antibiotic treatment is not started within the first 24 hours of illness. Persons who have been in close contact with a patient who has plague pneumonia should be identified and evaluated by a physician.

How can I decrease my chances of getting plague?
Be aware of areas in which plague-infected rodents might exist. Follow the instructions on notices regarding plague that are posted at camping and recreation areas. Avoid all contact with rodents and their fleas, especially sick or dead rodents. Store food and garbage in rodent-proof containers. Do not feed rodents in campgrounds and picnic areas. Do not place chairs, tents, or sleeping bags near rodent burrows. Wear long pants tucked into boots and use insect repellent to avoid flea exposure. Do not allow pets to approach sick or dead rodents, or to explore rodent burrows. Be cautious when handling ill cats which have potential contact with wild rodents; take them to your veterinarian for examination. If you become ill within seven days after being in a plague area, contact a physician immediately.

Where can I find more information on plague?
The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/health/plague.htm.

RABIES

What is rabies?
Rabies is a viral disease that affects the central nervous system. The virus is usually passed to humans via the bite of a rabid animal. Occasionally rabies can be transmitted if the saliva of an infected animal gets into a fresh scratch, break in the skin, or contact with mucous membranes (eyes, mouth, nose).

Who gets rabies?
Human rabies is rare in the United States (U.S.). The latest human rabies case in California occurred in April 2002. Currently in the U. S., the majority of human cases are caused by rabid bats. Any mammal can contract rabies. In California, most cases of rabies occur in skunks and bats. Domestic animals account for three percent of animal rabies, and the rest occurs in a variety of wild animals, including foxes. Independent transmission cycles in skunks and bats maintain the virus in nature in California.

What are the symptoms of rabies in humans?
In humans, symptoms of rabies appear an average of three to eight weeks after exposure to the virus. Symptoms may appear as soon as nine days and as long as a year or more after a bite or other exposure. Early signs in humans are nonspecific and include fever, headache, and general malaise. As the disease progresses, neurological symptoms appear, including insomnia, anxiety, confusion, partial paralysis, excitation, hallucination, hypersalivation, and difficulty swallowing due to paralysis of throat muscles. Death usually occurs within days of the onset of symptoms.

How can I tell if an animal has rabies?
Symptoms in animals vary with the species and stage of the disease, but abnormal behavior is the most obvious sign to people. Special signs to watch for include:

- Wild animals that seem unusually tame or unafraid, and approach people in an uncharacteristic manner.
- Nocturnal animals such as skunks, foxes or bats, that are active during daylight.
- Pets that have difficulty walking, eating, or drinking. Or pets whose personalities change, or whose voice tone changes.
- Signs of excitement or viciousness in normally quiet animals.
- Bats that are unable to fly or have been caught by a domestic dog or cat.
- Cattle that "strain" for a long period of time or “bellow” (vocalize) excessively.

The sick animal may go through one or more stages: 1) "furious" stage (viciousness, vocalization, snapping, drooling, chewing on fences, or swallowing strange objects such as stones); 2) "dumb" or "paralytic" stage (difficulty swallowing, drinking or walking, choking or flaccid paralysis); and 3) a combination of both stages. Finally the whole body becomes paralyzed and the animal dies.

If an animal displays suspicious behavior, avoid contact with it. Notify your local animal control agency immediately.

What control measures are in place to prevent rabies?
The California Rabies Prevention and Control Program requires vaccination and licensing of dogs. The program works to control stray domestic animals. Trained professionals follow up on potential human exposures. Because cats are the most frequently reported rabid domestic animal in the U.S., vaccination of all cats is also strongly advised. There are vaccines for other domestic animals as well. The program also keeps track of animal rabies throughout the State.

What can I do if I think I have been exposed to rabies?
If you are bitten or scratched by a rabid or possibly rabid animal, wash the wound thoroughly with soap and warm water and immediately consult a physician. The physician will decide if anti-rabies treatment is necessary. If so, the treatment should be started as soon as possible. Veterinarians and their staff, animal control workers, and wildlife rehabilitators are at high risk and should be vaccinated as a preventive measure against rabies. Local health departments can be consulted to help evaluate the need for rabies immunization.

What if a wild animal bites my pet?
If a wild animal bites your pet, use gloves to prevent contacting the wild animal's saliva. Contact your veterinarian and local animal control officer as soon as possible. Any animal bitten by a wild animal that is not available for testing is considered as having been exposed to rabies. Unvaccinated dogs and cats exposed to a rabid animal should be euthanized immediately. If you are unwilling to do this, the animal must be immediately vaccinated and put in strict isolation for six months. Dogs and cats with rabies vaccination need immediate re-vaccination and then strictly isolated for 30 days.

What if my pet bites someone?
Immediately notify the local health officer or designee. The law requires that the local health officer be contacted when any person or animal is bitten by, or potentially exposed to, a rabid or suspected rabid animal. In addition, the local health officer must be notified when an animal bites any person. People possibly exposed to rabies are evaluated and the decision is made whether or not anti-rabies treatment is necessary. Domestic dogs or cats that bite humans must be placed in strict confinement. (The local health officer defines strict confinement.) The animal is observed daily for ten days following the bite for signs of rabies, regardless of the animal's vaccination status. Alternatively, biting animals may be immediately euthanized and tested for rabies at an approved public health laboratory. If the isolated dog or cat is healthy after ten days, there is no risk of a rabies exposure from the original bite wound.

What can I do to help prevent the spread of rabies?
Be a responsible pet owner. Keep rabies vaccinations up-to-date for all cats and dogs. Take your pet to your veterinarian on a regular basis. Maintain control of your pets by

keeping them under direct supervision. Spay or neuter your pets to help reduce the number of unwanted pets that may not be properly cared for or vaccinated regularly. Lastly, call animal control to remove all stray animals from your neighborhood since these animals may be unvaccinated or ill.

Avoid contact with unfamiliar animals. Enjoy wild animals from a distance. Do not handle, feed, or attract wild animals. Place litter in closed garbage cans. Never adopt or bring wild animals into your home. Teach your children to never handle unfamiliar animals, wild or domestic, even if they appear friendly. Prevent bats from entering areas where they might come in contact with people or pets. When travelling abroad, take extra care to avoid animals, especially dogs in developing countries, where rabies is common.

Where can I get more information regarding rabies?

The California Compendium of Rabies Control and Prevention is available on the Department of Health Services' website, under the Veterinary Public Health Section http://www.dhs.ca.gov/ps/dcdc/disb/disbindex.htm.

The Centers for Disease Control and Prevention also has a useful website: http://www.cdc.gov/ncidod/dvrd/rabies.

ROCKY MOUNTAIN SPOTTED FEVER

What is Rocky Mountain spotted fever (RMSF)?
RMSF is a bacterial disease caused by a bacterium, Rickettsia rickettsii. Contrary to its name, most cases of RMSF occur in the southeastern and south-central United States. Cases occur most frequently between April and September. In California, only a few cases are reported each year.

How do you get RMSF?
RMSF bacteria are transmitted by the bite of an infected tick. A tick must be attached to the skin for at least four to six hours before it can infect a person. Infection can also occur if crushed tissues or feces of the tick contaminate breaks in the skin or mucous membranes. The tick that most commonly transmits the RMSF bacteria in California is the Pacific Coast tick, Dermacentor occidentalis. The Rocky Mountain wood tick, Dermacentor andersoni may also transmit the bacteria in California.

How is RMSF maintained in nature?
Ticks become infected when they feed on infected rodents or rabbits. Although dogs may acquire RMSF, they do not transmit RMSF; however, they may bring infected ticks into the human environment.

What are the symptoms of RMSF?
RMSF is characterized by sudden onset of moderate to high fever 2-14 days after a tick bite. Without treatment, the fever can persist for two to three weeks and lead to other symptoms, such as weakness, deep muscle pain, severe headache, chills, blood-shot eyes, and a painful abdomen. In at least half of the reported cases in California, a rash appears that rapidly spreads to much of the body, including the palms of the hands and soles of the feet. Severe cases can result in kidney failure and death.

How is RMSF diagnosed?
Early diagnosis of RMSF relies on symptoms and history or suspicion of a tick bite. Blood tests are not useful within the first week of illness. During the early stages of the disease, the bacteria may also be seen microscopically in skin or in blood. Blood tests later in the illness can show the body's immune response to infection with the RMSF bacteria.

What treatment is recommended for RMSF patients?
RMSF patients are treated with antibiotics. Up to 25 percent of patients who receive delayed or no treatment may die.

Where can I find more information on RMSF?
The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/dvrd/rmsf/index.htm.

ROUNDWORMS
(LARVA MIGRANS)

What are roundworms?
Roundworms are intestinal parasites. They are common in a number of different animal species, including dogs and cats. Each animal has a roundworm that is specific to that species. There is a roundworm specific to humans, but this parasite is rarely found in developed countries. Humans can become infected with animal roundworms by accidentally ingesting eggs or larvae. Having direct skin contact with larvae of certain types of roundworms may also cause an infection.

How are roundworms maintained in nature?
Puppies and kittens are often infected with roundworm larvae from their mother. This can happen before birth (puppies) or from the mother's milk (puppies and kittens). The larvae travel into the lungs, are coughed up, and swallowed. Larvae also get into the intestine after hatching out of ingested eggs. Larvae then mature into adult worms and begin to lay eggs, which are excreted in feces. The eggs contaminate the environment. Puppies can be infected with several hundred worms. Because each worm can produce thousands of eggs per day, the environment can be contaminated with millions of eggs over a short period of time. The eggs can survive for months or even years in the environment. Some wild animals are also infected with roundworms that can infect humans. A roundworm of raccoons can cause a very severe disease in humans. Extra care must be taken when pets, raccoons, and other wild animals are in your area.

What happens when you become infected with roundworms?
When humans become infected, usually from accidentally or unknowingly ingesting eggs, the eggs hatch and larval worms usually travel (migrate) within the persons' tissues. This is called larva migrans. The larvae may travel through the liver, lungs, other organs, and tissues, causing damage. Small children are especially at risk because they may put egg-contaminated objects or dirt into their mouths.

What are the symptoms of roundworm infection?
In most cases, signs are mild to non-existent. In children the disease can be more severe, with fever, coughing, nausea, vomiting, and sore muscles. Sometimes infections occur in the eye or brain. Hookworms, a type of roundworm, may cause a severely itchy skin condition.

How are roundworm infections treated?
Anti-parasitic drugs, often in combination with anti-inflammatory medications, are usually successful in treating roundworm infections. Eye and brain infections are more difficult to treat, and treated persons may not fully recover.

How can I prevent infection with roundworms?

There are a number of steps that can be taken to prevent infection of you and your children:

- Periodic deworming of dogs and cats. Consult with your veterinarian for a recommended schedule for your area. It is especially important to treat puppies and kittens because they are most susceptible to infection.
- Wash your hands well with soap and water after playing with your pets and after outdoor activities, especially before you eat. Teach children to always wash their hands after playing with dogs and cats and after playing outdoors.
- Do not allow children to play in areas that are soiled with pet or other animal stool.
- Clean your pet's living area at least once a week. Feces should be either buried or bagged and disposed of in the trash.
- Teach children that it is dangerous to eat dirt or soil.
- Take extreme care when disposing of raccoon feces. Wear a mask or respirator with a HEPA filter, dampen the area being cleaned, wear disposable gloves, double bag and dispose of contaminated materials. Contaminated clothes should either be discarded in double bags, or washed in near boiling water with bleach added.

Where can I find more information about roundworms?

The Centers for Disease Control and Prevention has information available at their website http://www.cdc.gov/ncidod/dpd/parasites/toxocara/factsht_toxocara.htm.

SALMONELLOSIS

What is salmonellosis?
Salmonellosis is an infection with a bacteria called Salmonella. Most persons infected with Salmonella develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The illness usually lasts 4 to 7 days, and most persons recover without treatment. However, in some persons the diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the Salmonella infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

What sort of germ is Salmonella?
The Salmonella germ is actually a group of bacteria that can cause diarrheal illness in humans. They are microscopic living creatures that pass from the feces of people or animals, to other people or other animals. There are many different kinds of Salmonella bacteria. Salmonella serotype Typhimurium and Salmonella serotype Enteritidis are the most common in the United States. Salmonella has been known to cause illness for over 100 years. They were discovered by a American scientist named Salmon, for whom they are named.

How can Salmonella infections be diagnosed?
Many different kinds of illnesses can cause diarrhea, fever, or abdominal cramps. Determining that Salmonella is the cause of the illness depends on laboratory tests that identify Salmonella in the stools of an infected person. These tests are sometimes not performed unless the laboratory is instructed specifically to look for the organism. Once Salmonella has been identified, further testing can determine its specific type, and which antibiotics could be used to treat it.

How can Salmonella infections be treated?
Salmonella infections usually resolve in 5-7 days and often do not require treatment unless the patient becomes severely dehydrated or the infection spreads from the intestines. Persons with severe diarrhea may require rehydration, often with intravenous fluids. Antibiotics are not usually necessary unless the infection spreads from the intestines, then it can be treated with ampicillin, gentamicin, trimethoprim/sulfamethoxazole, or ciprofloxacin. Unfortunately, some Salmonella bacteria have become resistant to antibiotics, largely as a result of the use of antibiotics to promote the growth of feed animals.

Are there long term consequences to a Salmonella infection?
Persons with diarrhea usually recover completely, although it may be several months before their bowel habits are entirely normal. A small number of persons who are infected with Salmonella, will go on to develop pains in their joints, irritation of the eyes, and painful urination. This is called Reiter's syndrome. It can last for months or years, and can lead to chronic arthritis which is difficult to treat. Antibiotic treatment does not make a difference in whether or not the person later develops arthritis.

How do people catch Salmonella?
Salmonella live in the intestinal tracts of humans and other animals, including birds. Salmonella are usually transmitted to humans by eating foods contaminated with animal feces. Contaminated foods usually look and smell normal. Contaminated foods are often of animal origin, such as beef, poultry, milk, or eggs, but all foods, including vegetables may become contaminated. Many raw foods of animal origin are frequently contaminated, but fortunately, thorough cooking kills Salmonella. Food may also become contaminated by the unwashed hands of an infected food handler, who forgot to wash his or her hands with soap after using the bathroom.

Salmonella may also be found in the feces of some pets, especially those with diarrhea, and people can become infected if they do not wash their hands after contact with these feces. Reptiles are particularly likely to harbor Salmonella and people should always wash their hands immediately after handling a reptile, even if the reptile is healthy. Adults should also be careful that children wash their hands after handling a reptile.

What can a person do to prevent this illness?
There is no vaccine to prevent salmonellosis. Since foods of animal origin may be contaminated with Salmonella, people should not eat raw or undercooked eggs, poultry, or meat. Raw eggs may be unrecognized in some foods such as homemade hollandaise sauce, caesar and other homemade salad dressings, tiramisu, homemade ice cream, homemade mayonnaise, cookie dough, and frostings. Poultry and meat, including hamburgers, should be well-cooked, not pink in the middle. Persons also should not consume raw or unpasteurized milk or other dairy products. Produce should be thoroughly washed before consuming.

Cross-contamination of foods should be avoided. Uncooked meats should be keep separate from produce, cooked foods, and ready-to-eat foods. Hands, cutting boards, counters, knives, and other utensils should be washed thoroughly after handling uncooked foods. Hand should be washed before handling any food, and between handling different food items.

People who have salmonellosis should not prepare food or pour water for others until they have been shown to no longer be carrying the Salmonella bacterium.

People should wash their hands after contact with animal feces. Since reptiles are particularly likely to have Salmonella, everyone should immediately wash their hands after handling reptiles. Reptiles (including turtles) are not appropriate pets for small children and should not be in the same house as an infant.

How common is salmonellosis?
Every year, approximately 40,000 cases of salmonellosis are reported in the United States. Because many milder cases are not diagnosed or reported, the actual number of infections may be thirty or more times greater. Salmonellosis is more common in the summer than winter.

Children are the most likely to get salmonellosis. Young children, the elderly, and the immunocompromised are the most likely to have severe infections. It is estimated that approximately 600 persons die each year with acute salmonellosis.

What else can be done to prevent salmonellosis?
It is important for the public health department to know about cases of salmonellosis. It is important for clinical laboratories to send isolates of Salmonella to the City, County, or State Public Health Laboratories so the specific type can be determined and compared with other Salmonella in the community. If many cases occur at the same time, it may mean that a restaurant, food or water supply has a problem which needs correction by the public health department.

Some prevention steps occur everyday without you thinking about it. Pasteurization of milk and treating municipal water supplies are highly effective prevention measures that have been in place for many years. In the 1970s, small pet turtles were a common source of salmonellosis in the United States, and in 1975, the sale of small turtles was halted in this country. Improvements in farm animal hygiene, in slaughter plant practices, and in vegetable and fruit harvesting and packing operations may help prevent salmonellosis caused by contaminated foods. Better education of food industry workers in basic food safety and restaurant inspection procedures, may prevent cross-contamination and other food handling errors that can lead to outbreaks. Wider use of pasteurized egg in restaurants, hospitals, and nursing homes is an important prevention measure. In the future, irradiation or other treatments may greatly reduce contamination of raw meat.

What is the government doing about salmonellosis?
The Centers for Disease Control and Prevention (CDC) monitors the frequency of Salmonella infections in the country and assists the local and State Health Departments to investigate outbreaks and devise control measures. CDC also conducts research to better identify specific types of Salmonella. The Food and Drug Administration inspects imported foods, milk pasteurization plants, promotes better food preparation techniques in restaurants and food processing plants, and regulates the sale of turtles. The FDA also regulates the use of specific antibiotics as growth promotants in food animals. The US Department of Agriculture monitors the health of food animals, inspects egg pasteurization plants, and is responsible for the quality of slaughtered and processed meat. The US Environmental Protection Agency regulates and monitors the safety of our drinking water supplies.

How can I learn more about this and other public health problems?
You can discuss any medical concerns you may have with your doctor or other heath care provider. Your local City or County Health Department can provide more information about this and other public health problems that are occurring in your area. General information about the public health of the nation is published every week in the "Morbidity and Mortality Weekly Report", by the CDC in Atlanta, GA. Epidemiologists in your local and State Health Departments are tracking a number of important public health problems, investigating special problems that arise, and helping to prevent them from occurring in the first place, or from spreading if they do occur.

What can I do to prevent salmonellosis?
Cook poultry, ground beef, and eggs thoroughly before eating. Do not eat or drink foods containing raw eggs, or raw unpasteurized milk. If you are served undercooked meat, poultry or eggs in a restaurant, don't hesitate to send it back to the kitchen for further cooking. Wash hands, kitchen work surfaces, and utensils with soap and water immediately after they have been in contact with raw meat or poultry. Be particularly careful with foods prepared for infants, the elderly, and the immunocompromised. Wash hands with soap after handling reptiles or birds, or after contact with pet feces. Avoid direct or even indirect contact between reptiles (turtles, iguanas, other lizards, snakes) and infants or immunocompromised persons. Don't work with raw poultry or meat, and an infant (e.g., feed, change diaper) at the same time. Mother's milk is the safest food for young infants. Breast-feeding prevents salmonellosis and many other health problems.

TULAREMIA
(RABBIT FEVER, DEER-FLY FEVER)

What is tularemia?
Tularemia is an infectious bacterial disease. Tularemia is usually a disease of wild animals, but severe illness and death may also occur in humans.

How is tularemia spread?
The bacterium that causes tularemia is common in various kinds of ticks and in small and medium-sized mammals, especially rabbits, hares, beavers, muskrats, and voles. In the United States, there are two main sources of infection for humans: 1) bites by ticks or biting flies, and 2) contact with infected animals or their carcasses, especially the cottontail rabbit. People may also become infected from eating improperly cooked rabbit or hare meat or from contact with contaminated water, dust, hay, mud, or animal bites. The disease is not spread from human-to-human.

Who gets tularemia?
Hunters, trappers, wildlife specialists, and others who handle or eat infected animals are most likely to become infected. Persons exposed to bites of certain ticks and some species of biting flies are also at some risk of becoming infected. Tularemia can occur at any age.

What are the symptoms of tularemia?
Symptoms of tularemia in humans appear about three to five days after infection. They may include chills, fever, headache, generalized body ache, cough, and chest pain or tightness. The bacteria multiply in the skin at the bite or wound site, usually causing an ulcer to form. From this site, bacteria spread to lymph nodes and may spread further if bacterial growth has not slowed. Without treatment, symptoms usually last for several weeks. Occasionally, tularemia will spread to other sites in the body, resulting in pneumonia, sepsis (blood infection), or meningitis.

How is tularemia diagnosed?
Tularemia is diagnosed by a blood test for antibodies to the bacterium. Tularemia can also be identified by growing the bacteria under special conditions in a laboratory.

What is the treatment for tularemia?
Antibiotics are used to treat people with tularemia.

How can tularemia be prevented?
To prevent infections, avoid exposure to bites by ticks and blood-feeding flies and avoid direct contact with wild animal tissues. When you enter areas infested with biting flies and ticks, wear protective clothing, tuck pants into socks, and apply insect repellants as directed by the manufacturer. Examine clothing and skin frequently for ticks. Remove

attached ticks promptly. Hunters and trappers need to wear gloves, masks, and protective eye covers when handling animal carcasses. Animals that appear ill should not be skinned or dressed. Teach children to not handle any sick or dead animals.

Where can I get more information about tularemia?
Websites with good information about tularemia are:
http://www.cdc.gov/ncidod/diseases/submenus/sub_tularemia.htm
http://www.ci.nyc.ny.us/html/doh/html/cd/cdtul.html
http://hlunix.hl.state.ut.us/els/epidemiology/epifacts/tularem.html

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BADGERS

Fig. 1. Badger, *Taxidea taxus*

Damage Prevention and Control Methods

Exclusion

Generally not practical.

Habitat Modification

Controlling rodent populations may make habitats less suitable for badgers.

Frightening

Bright lights.

Repellents

None are registered.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting

Where permitted, shooting with a rifle, handgun, or shotgun is effective.

Identification

The badger (*Taxidea taxus*) is a stocky, medium-sized mammal with a broad head, a short, thick neck, short legs, and a short, bushy tail. Its front legs are stout and muscular, and its front claws are long. It is silver-gray, has long guard hairs, a black patch on each cheek, black feet, and a characteristic white stripe extending from its nose over the top of its head. The length of this stripe down the back varies. Badgers may weigh up to 30 pounds (13.5 kg), but average about 19 pounds (8.6 kg) for males and 14 pounds (6.3 kg) for females. Eyeshine at night is green.

PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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

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

Great Plains Agricultural Council
Wildlife Committee

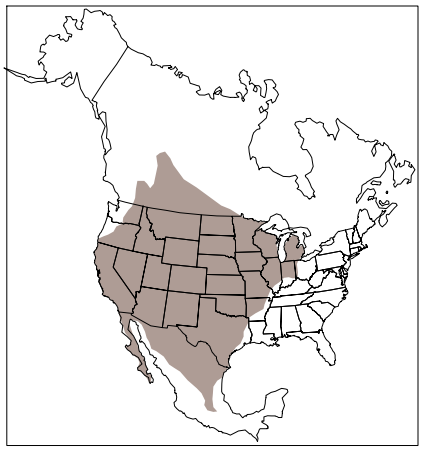


Fig. 2. Range of the badger in North America.

Range

The badger is widely distributed in the contiguous United States. Its range extends southward from the Great Lakes states to the Ohio Valley and westward through the Great Plains to the Pacific Coast, though not west of the Cascade mountain range in the Northwest (Fig. 2). Badgers are found at elevations of up to 12,000 feet (3,600 m).

Habitat

Badgers prefer open country with light to moderate cover, such as pastures and rangelands inhabited by burrowing rodents. They are seldom found in areas that have many trees.

Food Habits

Badgers are opportunists, preying on ground-nesting birds and their eggs, mammals, reptiles, amphibians, and insects. Common dietary items are ground squirrels, pocket gophers, prairie dogs, and other smaller rodents. Occasionally they eat vegetable matter. Metabolism studies indicate that an average badger must eat about two ground squirrels or pocket gophers daily to maintain its weight. Badgers may occasionally kill small lambs and young domestic turkeys, parts of which they often will bury.

General Biology, Reproduction, and Behavior

Badgers are members of the weasel family and have the musky odor characteristic of this family. They are especially adapted for burrowing, with strong front legs equipped with long, well-developed claws. Their digging capability is used to pursue and capture ground-dwelling prey. Typical burrows dug in pursuit of prey are shallow and about 1 foot (30 cm) in diameter. A female badger will dig a deeper burrow (5 to 30 feet long [1.5 to 9 m]) with an enlarged chamber 2 to 3 feet (0.6 to 0.9 m) below the surface in which to give birth. Dens usually have a single, often elliptical entrance, typically marked by a mound of soil in the front.

Badgers have a rather ferocious appearance when confronted, and often make short charges at an intruder. They may hiss, growl, or snarl when fighting or cornered. Their quick movements, loose hide, muscular body, and tendency to retreat quickly into a den provide protection from most predators. Larger predators such as mountain lions, bears, and wolves will kill adult badgers. Coyotes and eagles will take young badgers.

Badgers are active at night, remaining in dens during daylight hours, but are often seen at dawn or dusk. During winter they may remain inactive in their burrows for up to a month, although they are not true hibernators. Male badgers are solitary except during the mating season, and females are solitary except when mating or rearing young. Densities of badgers are reported to be about 1 per square mile (0.4/km ^{2}) although densities as high as 5 to 15 badgers per square mile (1.9 to 5.8/km ^{2}) have been reported. An adult male's home range may be as large as 2.5 square miles (6.5 km ^{2}); the home range of adult females is typically about half that size. Badgers may use as little as 10% of their range during the winter.

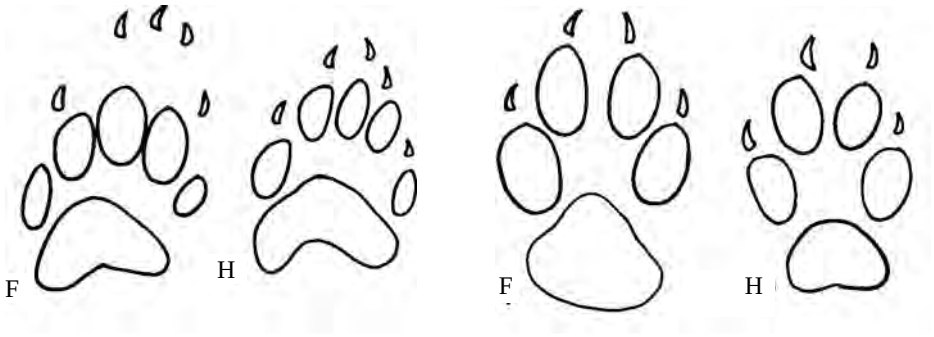
Badgers breed in summer and early fall, but have delayed implantation, with active gestation beginning around February. Some yearling females may breed, but yearling males do not. As many as 5 young, but usually 2 or 3, are born in early spring. Young nurse for 5 to 6 weeks, and they may remain with the female until midsummer. Most young disperse from their mother's range and may move up to 32 miles (52 km). Badgers may live up to 14 years in the wild; a badger in a zoo lived to be 15 1/2 years of age.

Damage and Damage Identification

Most damage caused by badgers results from their digging in pursuit of prey. Open burrows create a hazard to livestock and horseback riders. Badger diggings in crop fields may slow harvesting or cause damage to machinery. Digging can also damage earthen dams or dikes and irrigation canals, resulting in flooding and the loss of irrigation water. Diggings on the shoulders of roads can lead to erosion and the collapse of road surfaces. In late summer and fall, watch for signs of digging that indicate that young badgers have moved into the area.

Badgers will occasionally prey on livestock or poultry, gaining access to protected animals by digging under fences or through the floor of a poultry house. Tracks can indicate the presence of badgers, but to the novice, badger tracks may appear similar to coyote tracks (see **Coyotes**). Claw marks are farther from the toe pad in badger tracks, however, and the front tracks have a pigeon-toed appearance (Fig. 3).

Badgers usually consume all of a prairie dog except the head and the fur along the back. This characteristic probably holds true for much of their prey; however, signs of digging near the remains of prey are the best evidence of predation by a badger. Because badgers will kill black-footed ferrets, their presence is of concern in reintroduction programs for this endangered species.



Badger Coyote

Fig. 3. Badger tracks compared to coyote tracks.

Legal Status

In California, badgers are designated as furbearing mammals. See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Exclusion

Mesh fencing buried to a depth of 12 to 18 inches (30 to 46 cm) can exclude most badgers. The cost and effort to construct such fences, however, preclude their use for large areas.

Habitat Modification

Control of rodents, particularly burrowing rodents, offers the greatest potential for alleviating problems resulting from badger diggings. For example, controlling ground squirrels or pocket gophers in alfalfa fields will likely result in badgers hunting elsewhere.

Frightening

Badgers may be discouraged from a problem area by the use of bright lights at night. High-intensity lamps used to light up a farmyard may discourage badger predation on poultry.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares,except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Badgers can be removed by using live traps. Snares have been used with mixed success. Badgers often return to old diggings. A good bait for badgers is a dead chicken placed within a recently dug burrow. Fur trapping may reduce badger populations locally, but badger pelts are generally of little value and most badgers are caught incidentally.

Shooting

Badgers can be controlled by shooting. Incidental shooting has contributed to reducing their numbers in some areas.

Acknowledgments

This chapter is a revision of the chapter on badgers by Norman C. Johnson in the 1983 edition of *Prevention and Control of Wildlife Damage.* F. Robert Henderson and Steve Minta provided information included in this chapter.

Figures 1 and 2 from Schwartz and Schwartz (1981).

Figure 3 from Wade (1973).

For Additional Information

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BATS

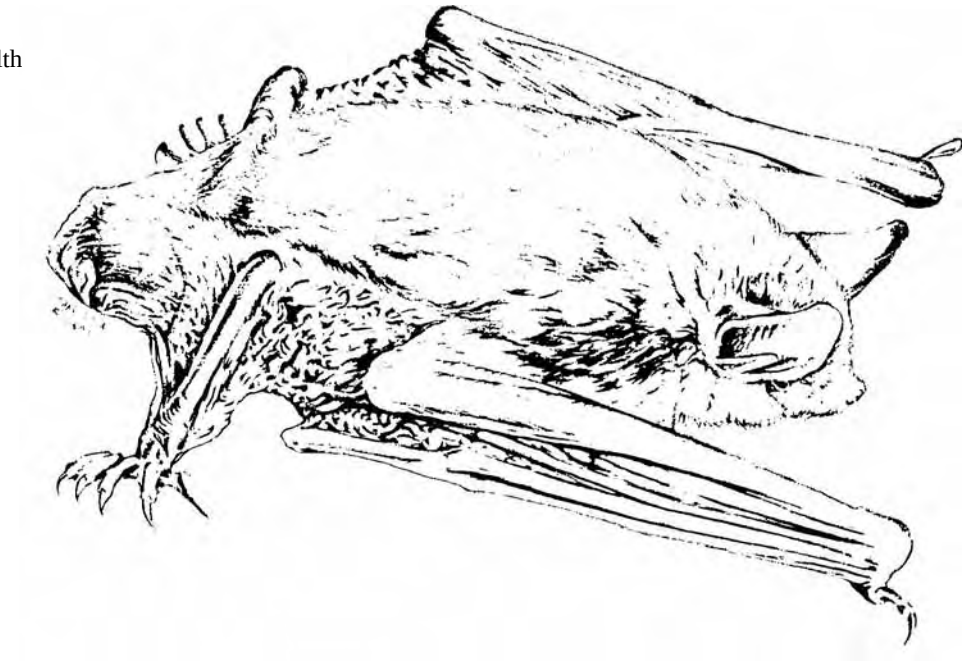

Fig. 1. Little brown bat, *Myotis lucifugus*

Damage Prevention and Control Methods

Exclusion

Polypropylene netting checkvalves simplify getting bats out.

Quality bat-proofing permanently excludes bats.

Initiate control before young are born or after they are able to fly.

Repellents

Naphthalene: limited efficacy.

Illumination.

Air drafts/ventilation.

Ultrasonic devices: not effective.

Sticky deterrents: limited efficacy.

Trapping

Available, but unnecessarily complicated compared to exclusion and bat-proofing.

Other Methods

Sanitation and cleanup.

Artificial roosts.

Removal of Occasional Bat Intruders

When no bite or contact has occurred, help the bat escape (otherwise submit it for rabies testing).

Conservation and Public Education

Information itself functions as a management technique.

PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal DamageControl

Great Plains Agricultural Council
Wildlife Committee

Introduction

Conservation and Public Education

Despite their ecological value, bats are relentlessly and unjustifiably persecuted. Bats are often killed because they live near people who needlessly fear them. These actions emphasize the need to educate the public on the reasons for bat conservation and why it is important to use safe, nondestructive methods to alleviate conflicts between people and bats. General sources of information on bats include states' Cooperative Extension Services, universities, government environmental conservation and health departments, and Bat Conservation International (Austin, Texas). Except where control is necessary, bats should be appreciated from a distance — and not disturbed.

Identification and Range

Bats, the only mammals that truly fly, belong to the order Chiroptera. Their ability to fly, their secretiveness, and their nocturnal habits have contributed to bat folklore, superstition, and fear. They are worldwide in distribution and include about 900 species, second in number only to Rodentia (the rodents) among the mammals.

Among the 40 species of bats found north of Mexico, only a few cause problems for humans (note that vampire bats are not found in the United States and Canada). Bats congregating in groups are called colonial bats; those that live a lone existence are known as solitary bats.

The colonial species most often encountered in and around human buildings in the United States are the little brown bat, (*Myotis lucifugus*, Fig. 2), the big brown bat (*Eptesicus fuscus*, Fig. 3), the Mexican free-tailed bat (*Tadarida brasiliensis*, Fig. 4), the pallid bat (*Antrozous pallidus*), the Yuma myotis (*Myotis yumanensis*), and the evening bat (*Nycticeius humeralis*).

Solitary bats typically roost in tree foliage or under bark, but occasionally are found associated with buildings, some only as transients during migration.

Fig. 2. Little brown bat, *Myotis lucifugus*

Fig. 3. Big brown bat, *Eptesicus fuscus*

Fig. 4. Mexican free-tailed bat, *Tadarida brasiliensis*

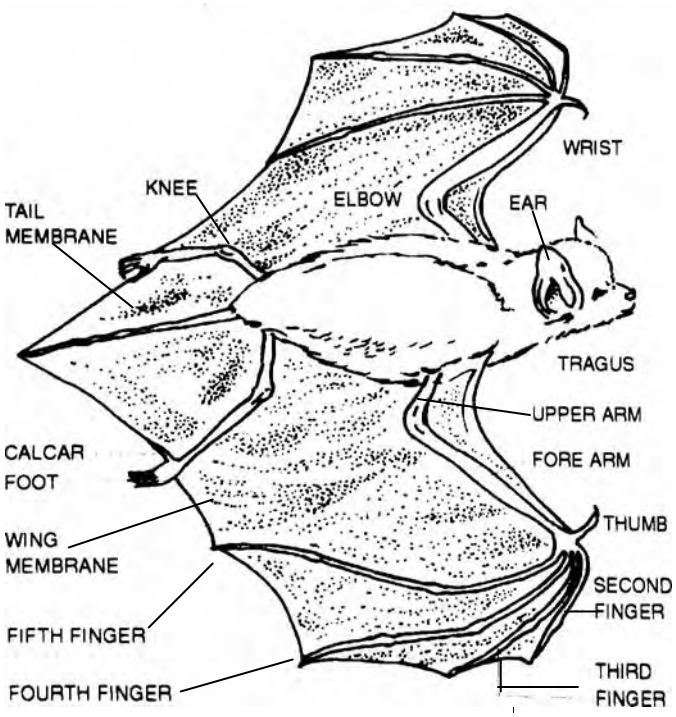

Fig. 5. Anatomy of a typical bat

These include Keen's bat (*Myotis keenii*), the red bat (*Lasiurus borealis*), the silver-haired bat (*Lasionycteris noctivagans*), and the hoary bat (*Lasiurus cinereus*). Excellent illustrations of all bats discussed herein can be found in Barbour and Davis (1979), Tuttle (1988), Geluso et al. (1987), and Harvey (1986).

Several species of bats have been included here, with significant interspecific differences that need to be clarified if well-planned, comprehensive management strategies are to be developed. Any problems caused by bats are limited to species distribution; thus animal damage control personnel need not be concerned with every species.

Colonial and solitary bats have obvious differences that serve to separate the species into groups (refer to Fig. 5). Much of the descriptive material that follows is adapted from Barbour and Davis (1979).

Colonial Bats

Little brown bat *(Myotis lucifugus)*

Recognition

forearm — 1.34 to 1.61 inches (3.4 to 4.1 cm)
wingspan — 9.02 to 10.59 inches (22.9 to 26.9 cm)
ears — 0.55 to 0.63 inches (1.4 to 1.6 cm)
foot — approximately 0.39 inches (1.0 cm); long hairs on toes extend beyond claws.

Distribution (Fig. 6a)

Color

Pale tan through reddish brown to dark brown, depending on geographic location. The species is a rich dark brown in the eastern United States and most of the west coast. Fur is glossy and sleek.

Confusion may occur with a few other "house" bat species. In the East, it may be confused with Keen's bat (*M. keenii*), which has longer ears [0.69 to 0.75 inches (1.7 to 1.9 cm)] and a longer, more pointed tragus (the appendage at the base of the ear). In the West, it resembles the Yuma myotis (*M. yumanensis*), which has dull fur and is usually smaller. However, the Yuma myotis and little brown may be indistinguishable in some parts of the northwestern United States where they may hybridize.

Habits

This is one of the most common bats found in and near buildings, often located near a body of water where they forage for insect prey. Summer colonies are very gregarious, commonly roosting in dark, hot attics and associated roof spaces where maternity colonies may include hundreds to a few thousand individuals. Colonies may also form beneath shingles and siding, in tree hollows, beneath bridges, and in caves. Litter size is 1 in the Northeast; twins occasionally occur in some other areas. The roost is often shared with the big brown bat (*E. fuscus*) though the latter is less tolerant of high temperatures; *M. keenii* may also share the same site. Separate groups of males tend to be smaller and choose cooler roosts within attics, behind shutters, under tree bark, in rock crevices, and within caves.

In the winter, little brown bats in the eastern part of their range abandon buildings to hibernate in caves and mines. Such hibernacula may be near summer roosts or up to a few hundred miles (km) away. Little is known of the winter habits of *M. lucifugus* in the western United States.

The life span of little brown bats has been established to be as great as 31 years. The average life expectancy, however, is probably limited to only a few years.

Big brown bat (*Eptesicus fuscus*)

Recognition

forearm — 1.65 to 2.01 inches (4.2 to 5.1 cm)
wingspan — 12.80 to 13.78 inches (32.5 to 35.0 cm)
ears — with rounded tragus

Distribution (Fig. 6b)

Color

From reddish brown, copper colored, to a dark brown depending on geographic location. This is a large bat without distinctive markings.

Confusion may occur with the evening bat (*Nycticeius humeralis)* though the latter is much smaller.

Habits

This hardy, rather sedentary species appears to favor buildings for roosting. Summer maternity colonies may include a dozen or so and up to a few hundred individuals, roosting behind chimneys, in enclosed eaves, in hollow walls, attics, barns, and behind shutters and unused sliding doors. They also form colonies in rock crevices, beneath bridges, in hollow trees, and under loose bark. Litter size is 2 in the East to the Great Plains; from the Rockies westward 1 young is born. *E. fuscus* frequently shares roosts with *M. lucifugus* in the East, and with *M. yumanensis, Taderida*, and *Antrozous* in the West. Males typically roost in smaller groups or alone during the summer.

The big brown bat is one of the most widely distributed of bats in the United States and is probably familiar to more people than any other species. This is partially due to its large, easy-to-observe size, but also to its ability to overwinter in buildings (attics, wall spaces, and basements). Its close proximity to humans, coupled with its tendency to move about when temperature shifts occur, often brings this bat into human living quarters and basements in summer and winter. Big browns also hibernate in caves, mines, storm sewers, burial vaults, and other underground harborage. While *E. fuscus* will apparently travel as far as 150 miles (241 km) to hibernacula, the winter quarters of the bulk of this species are largely unknown.

Big brown bats may live as long as 18 years.

Mexican free-tailed bat (*Tadarida brasiliensis*)

Recognition

forearm — 1.42 to 1.81 inches (3.6 to 4.6 cm)
wingspan — 11.42 to 12.80 inches (29.0 to 32.5 cm); long narrow wings
tail (interfemoral) membrane — does not enclose the lower one-third to one-half of the tail, hence the name free-tailed
foot — long, stiff hairs as long as the foot protrude from the toes.

Distribution (Fig. 6c)

Color

Dark brown or dark gray. Fur of some individuals may have been bleached to a pale brown due to ammonia fumes from urine and decomposing guano.

Confusion is not likely to occur with other species that commonly inhabit human buildings.

Habits

T. brasiliensis forms the largest colonies of any warm-blooded animal, establishing sizable colonies in buildings, particularly on the West Coast and in the Gulf states from Texas east. Hundreds to thousands may be found in buildings or under bridges. It is primarily a cave bat in Arizona, New Mexico, Oklahoma, and Texas; buildings are used as temporary roosts during migrations. Litter size is 1.

Taderida often share roosts with other species. In the West, for example, they may be found in buildings with *A. pallidus, M. yumanensis,* and *E. fuscus*. Some males are always present in the large maternity colonies, but they tend to segregate in separate caves.

A few *Taderida* may overwinter in buildings as far north as South Carolina in the East and Oregon in the West. Most of this species migrate hundreds of miles to warmer climes (largely to Mexico) for the winter.

Pallid bat (*Antrozous pallidus*)

Recognition

forearm — 1.89 to 2.36 inches (4.8 to 6.0 cm)
wingspan — 14.17 to 15.35 inches (36.0 to 39.0 cm)
ears — large; widely separated and more than half as broad as long. The ears are nearly half as long as the combined length of the bat's head and body.
eyes — large

Distribution (Fig. 6d)

Color

Pale, upper parts are light yellow, the hairs tipped with brown or gray. Underparts are pale creamy, almost white. This large, light-colored bat is relatively easy to recognize.

Confusion with other species that commonly inhabit human buildings is not likely to occur.

Habits

Maternity colony size ranges from about 12 to 100 individuals. Roost sites include buildings, bridges, and rock crevices; less frequently, tree cavities, caves, and mines. Litter size is most commonly 2. The roost is frequently shared with *T. brasiliensis* and *E. fuscus* in the West. While groups of males tend to segregate during the nursery period (sometimes in the same building), other males are found within the maternity colony.

An interesting feature of pallid bats is that they fly close to the ground, may hover, and take most prey on the ground, not in flight. Prey includes crickets, grasshoppers, beetles, and scorpions. They will also forage among tree foliage.

Pallid bats are not known to make long migrations, though little is known of their winter habits.

Yuma myotis (*Myotis yumanensis*)

Recognition

forearm — 1.26 to 1.50 inches (3.2 to 3.8 cm)
wingspan — about 9.25 inches (23.5 cm)
ears — 0.55 to 0.59 inches (1.4 to 1.5 cm)
foot — 0.39 inches (1.0 cm)

Distribution (Fig. 6e)

Color

Light tan to dark brown; underside is whitish to buffy.

Confusion may occur in the West with *M. lucifugus*, though the latter tends to have longer, glossier fur, and is larger. In the Northwest, hybridization occurs with *M. lucifugus*, making the species indistinguishable.

Habits

Maternity colonies, up to several thousand individuals, form in the summer in attics, belfries, under bridges, and in caves and mines. Litter size is 1. Males typically segregate during the nursery period and roost as solitary individuals in buildings and other suitable harborage.

M. yumanensis is more closely associated with water than is any other North American bat species. Nearly all roosts have open water nearby. This species is not as tolerant as *M. lucifugus* of high roost temperatures and will move to cooler niches within a building when temperatures rise much above 100 F° (37.8°C).

M. yumanensis abandons maternity colonies in the fall, but its winter habitat is not known.

Evening bat (*Nycticeius humeralis*)

Recognition

forearm — 1.30 to 1.54 inches (3.3 to 3.9 cm)
wingspan — 10.24 to 11.02 inches (26.0 to 28.0 cm)
ears — with short, curved, and rounded tragus

Confusion may occur with the big brown bat (*E. fuscus*), which can be readily distinguished by its larger size. It bears some resemblance to the somewhat smaller little brown bat (*M. lucifugus*) but can be identified by its characteristic blunt tragus.

Distribution (Fig. 6f)

Color

Medium brown with some variation to yellow-brown in subtropical Florida. No distinctive markings.

Habits

Summer maternity colonies in buildings may consist of hundreds of individuals. Litter size is usually 2. Colonies also form in tree cavities and under loose tree bark. In the Southeast, *T. brasiliensis* commonly inhabits the same building with *N. humeralis*. This is one of the most common bats in towns throughout the southern coastal states. Very little is known about this species, and virtually nothing is known of its winter habitat except that it almost never enters caves.

Solitary Bats

Keen's bat (*Myotis keenii*)

Recognition

forearm — 1.26 to 1.54 inches (3.2 to 3.9 cm)
wingspan — 8.98 to 10.16 inches (22.8 to 25.8 cm)
ears — 0.67 to 0.75 inches (1.7 to 1.9 cm); with a long, narrow, pointed tragus

Distribution (Fig. 6g)

Color

Brown, but not glossy; somewhat paler in the East.

Confusion may occur with *M. lucifugus,* which has glossy fur, shorter ears, and does not have the long, pointed tragus.

Habits

Excluding small maternity colonies (up to 30 individuals are on record), *M. keenii* are generally found singly in the East. Roosting sites include: behind shutters,under wooden shingles, sheltered entryways of buildings, in roof spaces, in barns, and beneath tree bark. In the West, this bat is known as a solitary species, roosting in tree cavities and cliff crevices. Litter size is probably 1. The roost is sometimes shared with *M. lucifugus*. The sexes probably segregate during the nursery period. In winter, these bats hibernate in caves and mines.

Red Bat (*Lasiurus borealis*)

Recognition

forearm — 1.38 to 1.77 inches (3.5 to 4.5 cm)
wingspan — 11.42 to 13.07 inches (29.0 to 33.2 cm); long, pointed wings
ears — short rounded
tail membrane — heavily furred on upper surface, with a distinctive long tail.

Distribution (Fig. 6h)

Color

Bright orange to yellow-brown; usually with a distinctive white mark on the shoulders.

Confusion may occur with the hoary bat (*L. cinereus*), which is frosted-gray in appearance and larger.

Habits

Red bats live solitary lives, coming together only to mate and migrate. Fewpeoplearefamiliarwiththis species. They typically spend summer days hidden in the foliage of deciduoustrees.Thenumberofyoungranges from 1 to 4, averaging 2.3.

These bats often chase insects that are attracted to lights, such as street lamps. It is this behavior that most likely brings them in close proximity to people.

L. borealis is well-adapted for surviving drastic temperature fluctuations; it does not hibernate in caves, but apparently in trees. Some migrate long distances. During migration, red bats have been known to land on high-rise buildings and on ships at sea.

Silver-haired bat (*Lasionycteris noctivagans*)

Recognition

forearm — 1.46 to 1.73 inches (3.7 to 4.4 cm)
wingspan — 10.63 to 12.20 inches (27.0 to 31.0 cm)
ears — short, rounded, hairless
tail membrane — upper surface is sparsely furred on the anterior one-half.

Distribution (Fig. 6i)

Color

Usually black with silver-tipped fur; some individuals with dark brown, yellowish-tipped fur.

Confusion sometimes occurs with the larger hoary bat (*Lasiurus cinereus*), which has patches of hair on the ears and wings, heavy fur on the entire upper surface of the tail membrane, and has a distinctive throat "collar."

Habits

The silver-haired bat roosts in a wide variety of harborages. A typical roost might be behind loose tree bark; other sites include tree hollows and bird nests. This species is solitary except when with young. Additionally, there are unconfirmed reports that it is sometimes colonial (Dalquest and Walton 1970) and may roost in and on buildings. The litter size is 2. The sexes segregate through much of the summer range.

*L. noctivagans*hibernates in tree crevices, under loose bark, in buildings (includingchurches,skyscrapers,and wharf houses), hulls of ships, rock crevices, silica mines, and non-limestone caves. It also may migrate, during which time it is encountered in buildings (they favor open sheds, garages,andoutbuildingsratherthan enclosed attics), in lumber piles, and on ships at sea.

Hoary bat (*Lasiurus cinereus*)

Recognition

forearm — 1.81 to 2.28 inches (4.6 to 5.8 cm)
wingspan — 14.96 to 16.14 inches (38.0 to 41.0 cm)
ears — relatively short, rounded, edged with black, and with fur
tail membrane — completely furred on upper surface

Distribution (Fig. 6j)

Color

Dark, but many hairs are tipped in white, giving it a frosted appearance. This bat also has a yellowish or orangish throat "collar."

Confusion may sometimes occur with the much smaller silver-haired bat (*Lasionycteris noctivagans*), which lacks the fur patches and markings on the ears, markings on the throat, and has a tail membrane that is only lightly furred on the upper surface.

Habits

Hoary bats generally spend summer days concealed in tree foliage (often in evergreens), rarely enter houses, and are not commonly encountered by people. *L. cinereus* at their day roosts are usually solitary except when with young. The litter size is 2. The sexes segregate through most of the summer range.

This is one of the largest bats in North America, a powerful flier, and an accomplished migrant. Records indicate that some *L. cinereus* may hibernate in northern parts of their range.

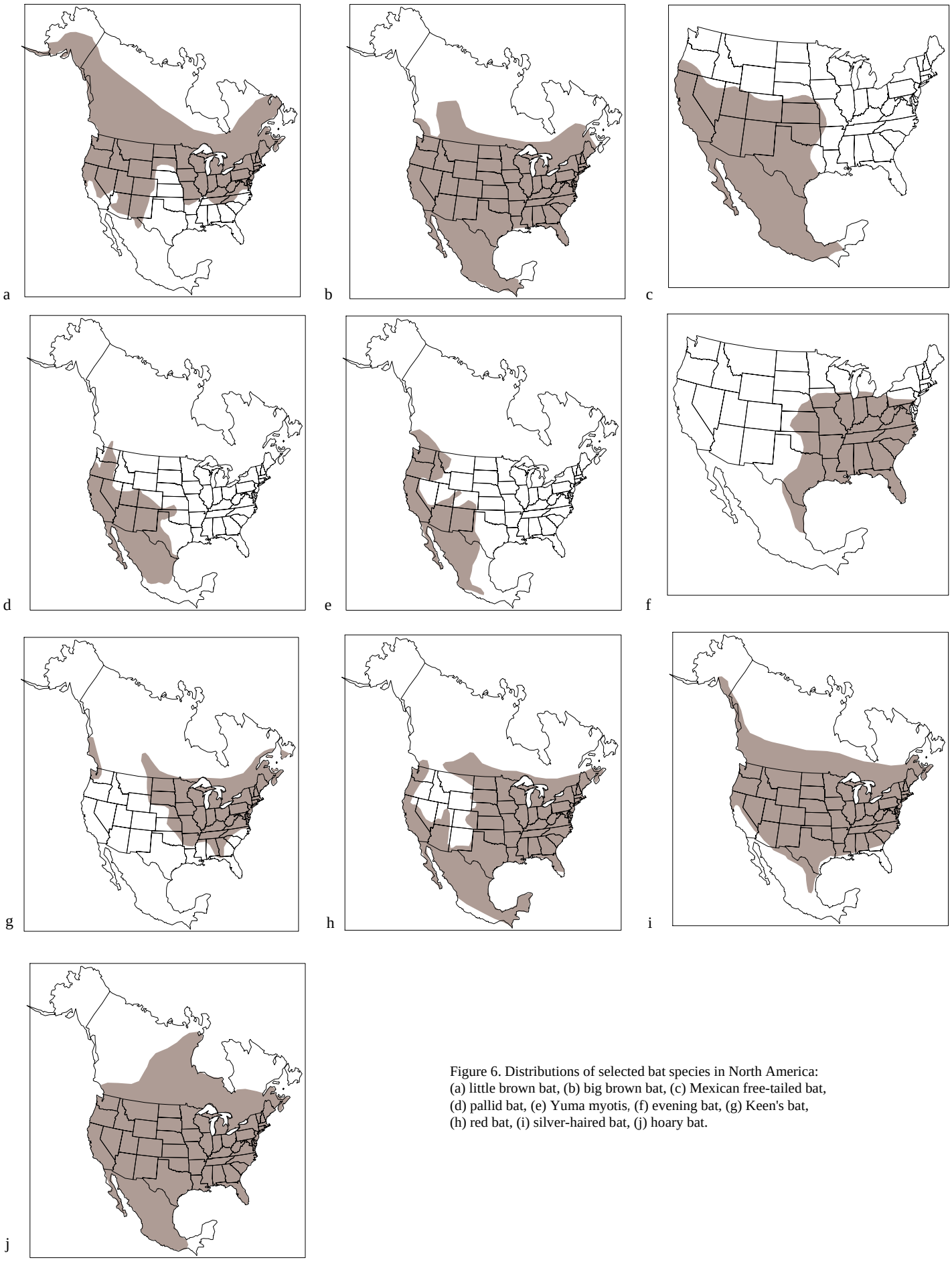

Figure 6. Distributions of selected bat species in North America: (a) little brown bat, (b) big brown bat, (c) Mexican free-tailed bat, (d) pallid bat, (e) Yuma myotis, (f) evening bat, (g) Keen's bat, (h) red bat, (i) silver-haired bat, (j) hoary bat.

Food Habits

Bats in North America are virtually all insectivorous, feeding on a variety of flying insects (exceptions among house bats were noted previously). Many of the insects are harmful to humans. While there must be some limitations based on such factors as bats' body size, flight capabilities, and jaw opening, insectivorous bats apparently consume a wide range of prey (Barbour and Davis 1979). The little brown bat's diet includes mayflies, midges, mosquitoes, caddis flies, moths, and beetles. It can consume insects equal to one-third of its body weight in 1/2 hour of foraging. The big brown bat may fill its stomach in about 1 hour (roughly 0.1 ounce per hour [2.7 g/hr]) with prey including beetles, moths, flying ants, true bugs, mayflies, caddis flies, and other insects. The nightly consumption of insects by a colony of bats can be extremely large.

General Biology, Reproduction, and Behavior

Most North American bats emit high frequency sounds (ultrasound) inaudible to humans and similar to sonar, in order to avoid obstacles, locate and capture insect prey, and to communicate. Bats also emit audible sounds that may be used for communication between them.

Bats generally mate in the fall and winter, but the female retains the sperm in the uterus until spring, when ovulation and fertilization take place. Pregnant females may congregate in maternity colonies in buildings, behind chimneys, beneath bridges, in tree hollows, caves, mines, or other dark retreats. No nests are built. Births typically occur from May through July. Young bats grow rapidly and are able to fly within 3 weeks. Weaning occurs in July and August, after which the nursery colonies disperse.

Bats prepare for winter around the time of the first frost. Some species migrate relatively short distances, whereas certain populations of the Mexican free-tailed bat may migrate up to 1,000 miles (1,600 km). Bats in the northern United States and Canada may hibernate from September through May. Hibernation for the same species in the southern part of their range may be shorter or even sporadic. Some may fly during warm winter spells (as big brown bats may in the northeastern part of the United States). Bats often live more than 10 years.

In response to a variety of human activities, direct and indirect, several bat species in the United States have declined in number during the past few decades. Chemical pesticides (particularly the use of persistent and bioaccumulating organic pesticides) have decreased the insect supply, and contaminated insects ingested by bats have reduced bat populations. Many bats die when people disturb summer maternity roosts and winter hibernacula. Vandals and other irresponsible individuals may deliberately kill bats in caves and other roosts. Even the activities of speleologists or biologists may unintentionally disturb hibernating bats, which depletes fat reserves needed for hibernation.

Modification and destruction of roost sites has also decreased bat numbers. Sealing and flooding of mineshafts and caves and general quarrying operations may inadvertently ruin bat harborages. Forestry practices have reduced the number of hollow trees available. Some of the elimination of natural bat habitat may contribute to bats roosting in buildings.

Damage and Damage Identification

Bat Presence

Bats often fly about swimming pools, from which they drink or catch insects. White light (with an ultraviolet component), commonly used for porch lights, building illumination, street and parking-lot lights, may attract flying insects, which in turn attract bats. Unfortunately, the mere presence of a bat outdoors is sometimes beyond the tolerance of some uninformed people. Information is a good remedy for such situations.

Bats commonly enter buildings through openings associated with the roof edge and valleys, eaves, apex of the gable, chimney, attic or roof vent, dormers, and siding (see Fig. 7). Other

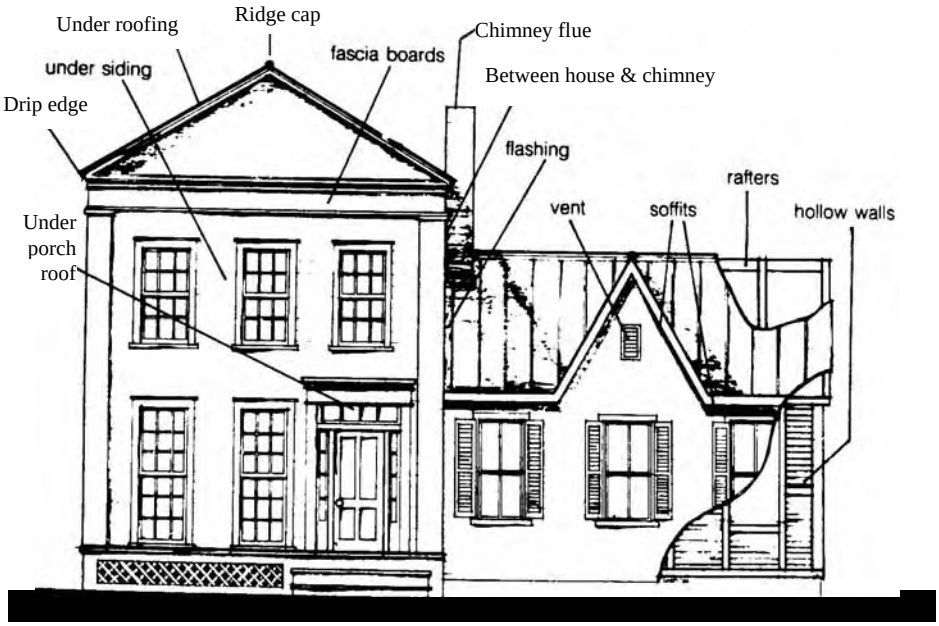

Fig. 7. Common points of entry and roosting sites of house bats.

openings may be found under loose-fitting doors, around windows, gaps around various conduits (wiring, plumbing, air conditioning) that pass through walls, and through utility vents.

Bats are able to squeeze through narrow slits and cracks. For purposes of bat management, one should pay attention to any gap of approximately 1/4 x 1 1/2 inches (0.6 x 3.8 cm) or a hole 5/8 x 7/8 inch (1.6 x 2.2 cm). Such openings must be considered potential entries for at least the smaller species, such as the little brown bat. The smaller species require an opening no wider than 3/8 inch (0.95 cm), that is, a hole the diameter of a US 10-cent coin (Greenhall 1982). Openings of these dimensions are not uncommon in older wood frame structures where boards have shrunk, warped, or otherwise become loosened.

The discovery of one or two bats in a house is a frequent problem. In the Northeast, big brown bats probably account for most sudden appearances (see Figs. 3 and 8). Common in urban areas, they often enter homes through open windows or unscreened fireplaces. If unused chimneys are selected for summer roosts, bats may fall or crawl through the open damper into the house. Sometimes bats may appear in a room, then disappear by crawling under a door to another room, hallway, or closet. They may also disappear behind curtains, wall hangings, bookcases, under beds, into waste baskets, and so forth. Locating and removing individual bats from living quarters can be laborious but is important. If all else fails, wait until dusk when the bat may appear once again as it attempts to find an exit. Since big brown bats may hibernate in the cooler recesses of heated buildings, they may suddenly appear (flying indoors or outdoors) in midwinter during a warm spell or a cold snap as they move about to adjust to the temperature shift.

Roosting Sites

Bats use roosting niches that are indoors (human dwellings, outbuildings, livestock quarters, warehouses), semi-enclosed (loading docks, entrance foyers), partially sheltered (porches, carports, pavilions, highway underpasses, bridges), and open structural areas (window shutters, signs). Once there, active bats in and on buildings can have several economic and aesthetic effects, often intertwined with public health issues (Frantz, 1988). Unusual roosting areas include wells, sewers, and graveyard crypts. Before considering control measures, verify that bats are actually the cause of the problem.

Rub Marks

Surface areas on walls, under loose woodwork, between bricks and around other bat entryways often have a smooth, polished appearance. The stained area is slightly sticky, may contain a few bat hairs, and is yellow-brown to blackish brown in color. The smooth gloss of these rub marks is due to oils from fur and other bodily secretions mixed with dust, deposited there as many animals pass repeatedly for a long period over the same surface. Openings marked in this way have been used heavily by bats.

Noise

Disturbing sounds may be heard from vocalizations and grooming, scratching, crawling, or climbing in attics, under eaves, behind walls, and between floors. Bats become particularly noisy on hot days in attics, before leaving the roost at dusk, and upon returning at dawn. Note that rustling sounds in chimneys may be caused by birds or raccoons and scratching and thumping sounds in attics and behind walls may indicate rats, mice, or squirrels.

Guano and Urine

Fecal pellets indicate the presence of animals and are found on attic floors, in wall recesses, and outside the house at its base. Fecal pellets along and inside walls may indicate the presence of mice, rats, or even roaches. Since most house bats north of Mexico are insectivorous, their droppings are easily distinguished from those of small rodents. Bat droppings tend to be segmented, elongated, and friable. When crushed, they become powdery and reveal shiny bits of undigested insect remains. In contrast, mice and rat droppings tend to taper, are unsegmented, are harder and more fibrous, and do not become powdery when crushed (unless extremely aged).

The droppings of some birds and lizards may occasionally be found along with those of bats. However, bat droppings never contain the white chalky material characteristic of the feces of these other animals.

Bat excrement produces an unpleasant odor as it decomposes in attics, wall spaces, and other voids. The pungent, musty, acrid odor can often be detected from outside a building containing a large or long-term colony. Similar odor problems occur when animals die in inaccessible locations. The odor also attracts arthropods which may later invade other areas of a building.

Bat guano may provide a growth medium for microorganisms, some of which are pathogenic (histoplasmosis, for example) to humans. Guano accumulations may fill spaces between walls, floors, and ceilings. It may create a safety hazard on floors, steps, and ladders, and may even collapse ceilings. Accumulations also result in the staining of ceilings, soffits, and siding, producing unsightly and unsanitary conditions.

Bats also urinate and defecate in flight, causing multiple spotting and staining on sides of buildings, windows, patio furniture, automobiles, and other objects at and near entry/exit holes or beneath roosts. Bat excrement may also contaminate stored food, commercial products, and work surfaces.

Bat urine readily crystallizes at room temperature. In warm conditions under roofs exposed to sun and on chimney walls, the urine evaporates so quickly that it crystallizes in great accumulations. Boards and beams saturated with urine acquire a whitish powderlike coating. With large numbers of bats, thick and hard stalactites and stalagmites of crystallized bat urine are occasionally formed.

Although the fresh urine of a single bat is relatively odorless, that of any moderate-sized colony is obvious, and the odor increases during damp weather. Over a long period of time urine may cause mild wood deterioration (Frantz and Trimarchi 1984). As the urine saturates the surfaces of dry wood beams and crystallizes, the wood fibers expand and separate. These fibers then are torn loose by the bats crawling over such surfaces, resulting in wood fibers being mixed with guano accumulations underneath.

The close proximity of bat roosts to human living quarters can result in excreta, animal dander, fragments of arthropods, and various microorganisms entering air ducts as well as falling onto the unfortunate residents below. Such contaminants can result in airborne particles of public health significance (Frantz 1988).

Ectoparasites and other Arthropods

Several arthropods (fungivores, detritivores, predators, and bat ectoparasites) are often associated with colonies of bats in buildings. Their diversity depends on the number of bats, age and quantity of excreta deposits, and season. Arthropods such as dermestid beetles (*Attagenus megatoma)* contribute to the decomposition of guano and insect remnants, but may also become a pest of stored goods and/or a nuisance within the living quarters. Cockroaches (for example, *Blatta orientalis*) attracted to guano may invade other parts of a building. Bat bugs (*Cimex* spp.) are sometimes found crawling on the surface of beams or around holes leading to secluded recesses used by bats. Bat ectoparasites (ticks, mites, fleas, and bugs) rarely attack humans or pets and quickly die in the absence of bats. Ectoparasites may become a nuisance, however, following exclusion of large numbers of bats from a well-established roost site. Area fumigation with a total release pyrethrum-based aerosol may be an appropriate solution for arthropod knockdown within an enclosed space, but only after bats have departed. For long-term arthropod control, lightly dust appropriate surfaces (affected attic beams, soffits) with boric acid powder or diatomaceous earth; carefully read all product labels before using any pesticide. Note that neither rabies nor Lyme disease is transmitted by any arthropods associated with bats.

Public Health Issues

Rabies—*General Epidemiology.*

Bats are distinct from most vertebrate pests that inhabit human dwellings because of the potential for transmitting rabies — a viral infection of mammals that is usually transmitted via the bite of an infected animal. Rabies does not respond to antibiotic therapy and is nearly always fatal once symptoms occur. However, because of the long incubation period (from 2 weeks to many months), prompt vaccination following exposure can prevent the disease in humans. Dogs, cats, and livestock also can be protected by periodic vaccinations.

Bats are not asymptomatic carriers of rabies. After an incubation period of 2 weeks to 6 months, they become ill with the disease for as long as 10 days. During this latter period, a rabid bat's behavior is generally not normal—it may be found active during the daytime or on the ground incapable of flying. Most human exposures are the result of accidental or careless handling of grounded bats. Even less frequently, bats in this stage of illness may be involved in unprovoked attacks on people or pets (Brass, pers. commun; Trimarchi et al. 1979). It is during this stage that the rabid bat is capable of transmitting the disease by biting another mammal. As the disease progresses the bat becomes increasingly paralyzed and dies as a result of the infection. The virus in the carcass is reported to remain infectious until decomposition is well advanced.

Significance. Rabies is the most important public health hazard associated with bats. Infection with rabies has been confirmed in all 40 North American species of bats that have been adequately sampled in all of the contiguous United States and in most provinces of Canada. Figure 8 shows the frequency of bat species submitted for rabies testing in New York State over the last 12 years. While not a nationwide measure of human encounters with bats, Figure 8 illustrates that bat species are not encountered equally. Note that bats submitted for testing are often ill and/or easily captured. The numbers and species encountered will vary with the region of the country; data are generally available from local and state health authorities.

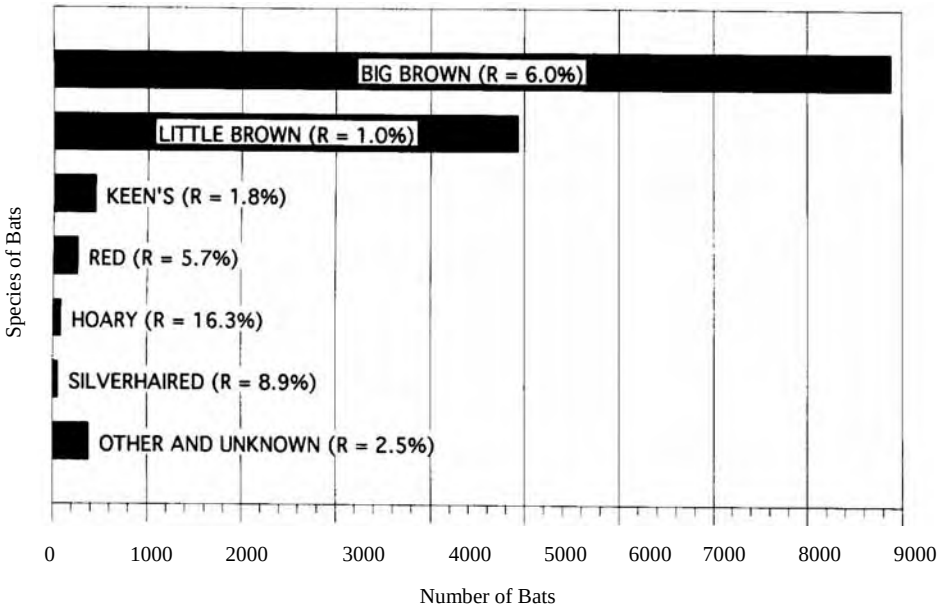

Fig. 8. Profile of bat species submitted to the New York State Rabies Laboratory, 1981-1992.

Random sampling of bats (healthy and ill) indicates an overall infection rate of less than 1%. Finding a rabid bat in a colony does not imply that the remaining animals are rabid. In fact, the probability of immediately finding more than one additional infected bat in that colony is small.

Bats rank third (behind raccoons and skunks) in incidence of wildlife rabies in the United States (Krebs et al. 1992). In the last 20 years, however, there have been more human rabies cases of bat origin in the United States than of any other wildlife group. Furthermore, the disease in bats is more widely distributed (in all 48 contiguous states in 1989) than in any other species. In Canada, bats also rank third (behind foxes and skunks) in the incidence of wildlife rabies. Therefore, every bat bite or contact must be considered a potential exposure to rabies. While aerosol transmission of the rabies virus from bats in caves to humans and some other mammals has been reported, this is not a likely route of infection for humans entering bat roosts in buildings in temperate North America. Note that vampire bats are not a threat north of Mexico.

Histoplasmosis—*General Epidemiology.* Histoplasmosis is a very common lung disease of worldwide distribution caused by a microscopic fungus, *Histoplasma capsulatum*. *Histoplasma* exists in nature as a saprophytic mold that grows in soil with high nitrogen content, generally associated with the guano and debris of birds (particularly starlings, *Sturnus vulgaris*, and chickens) and bats. Wind is probably the main agent of dispersal, but the fungus can survive and be transmitted from one site to another in the intestinal contents of bats, and also in the dermal appendages of both bats and birds. The disease can be acquired by the casual inhalation of windblown spores, but infections are more likely to result from visits to point sources of growth of the fungus. Relative to bats, such sources include bat roosts in caves, barns, attics, and belfries, and soil enriched with bat guano.

Numerous wild and domestic animals are susceptible to histoplasmosis, but bats (and perhaps the armadillo) are the only important animal vectors. Unlike bats, birds do not appear to become infected with the fungus. Both the presence of guano and particular environmental conditions are necessary for *H. capsulatum* to proliferate. In avian habitats, the organism apparently grows best where the guano is in large deposits, rotting and mixed with soil rather than in nests or in fresh deposits. Specific requirements regarding bats have not been described, though bat roosts with long-term infestation are often mentioned in the literature.

While histoplasmosis in the United States is particularly endemic to the Ohio-Mississippi Valley region (which is also an area with the greatest starling concentration) and areas along the Appalachian Mountains, it is also found in the lake and river valleys of other states. Outside areas with "appropriate" environmental conditions, there also occur scattered foci with high infection rates usually associated with caves inhabited by bats or birds.

Significance. When soil or guano containing *H. capsulatum* is physically disturbed, the spores become airborne. Persons at particular risk of histoplasmosis of bat origin include spelunkers, bat biologists, pest control technicians, people who clean out or work in areas where bats have habitually roosted, and people in contact with guano-enriched soil — such as around the foundation of a building where guano has sifted down through the walls.

Infection occurs upon inhalation of spores and can result in a variety of clinical manifestations; severity partially depends on the quantity of spores inhaled. The infection may remain localized in the lungs where it may resolve uneventfully; this is the case for about 95% of the 500,000 infections occurring annually in the United States. Such infections are identified only by the presence of a positive histoplasmin skin test and/or calcified lesions on routine radiographs. Other individuals may have chronic or progressive lung disease requiring treatment. Less severe forms of these infections may be accompanied by fever, cough, and generalized symptoms similar to a prolonged influenza. Resolution of the disease confers a degree of immunity to reinfection. In addition, resolution confers varying degrees of hypersensitivity to *H. capsulatum*; as a consequence, massive reinfection in highly sensitized lungs may result in a fatal acute allergic reaction.

In a small percentage of chronic histoplasmosis cases, the fungus disseminates to involve multiple organ systems and may be fatal. This form is usually seen in young children (1 year or older) and in immunocompromised adults. In recent years, systemic infections have been increasing in frequency globally as an opportunistic infection of AIDS patients.

Legal Status

The California Fish and Game Code designates bats as nongame mammals with eleven species also designated Species of Special Concern. Please refer to Appendix A for a thorough listing of species involved. See California statutes and regulations regarding the take of furbearing and nongame mammals. For more information on bats, please refer to appendices E and F.

Damage Prevention and Control Methods

Premanagement Considerations

Bat Watch for Infestation Confirmation. To confirm that bats are actually roosting in or on a building, look for bats flying in and out of a site and/or for signs of infestation. A bat watch can be conducted by two people (more may be necessary to observe large or complex sites) posted at opposite corners of a structure. An evening watch begins about 30 minutes before dark and a morning watch begins about 1 hour before dawn. Observations should continue for approximately 1 hour.

Such observations can indicate exit/entry points and the number of bats. With practice, distinguishing some bat species may also be possible. For example, compared to the big brown bat, the little brown bat is noticeably smaller in size, and its flight has more rapid wing beats, and more rapid turning and darting.

It may be necessary to watch for more than one night to compensate for weather conditions, bats' sensitivity to observers, noisy or inexperienced observers, and improper use of light. Observations can be enhanced with a standard flashlight, but be certain to keep the bright part of the beam as far as possible away from the exit hole being observed. Bright light will increase bats' reluctance to exit and may result in an incomplete exit of the colony. A valuable observation aid is a powerful, rechargeable flashlight equipped with a plastic, red pop-off filter (similar to the Kodak Wratten 89B). Also, an electric headlamp, supplied with rechargeable batteries and fitted to a climbing or spelunking helmet, allows hands-off illumination outdoors as well as indoors when exploring roost locations. Bats are sensitive to light intensity and can visually discriminate shapes and patterns in extremely low light situations. They can only see in black and white; hence, the low-contrast illumination and soft shadows produced by red light has little effect on bats.

Locating the Roost(s). It is not always possible or convenient to conduct a bat watch. Thus, a detailed inspection inside the building for bats or bat sign may be necessary to find specific roosts. Daytime is best, especially during the warmer part of the day. Bats roost in the most varied kinds of buildings and in every part from cellar to attic. Some types of buildings appear preferable (older houses, churches, barns, proximity to water) as do certain roost locations therein, especially areas with little disturbance, low illumination, little air circulation, and high temperatures. Often it is easy to locate bats, especially in warm weather in attics or lofts, where they may hang in clusters or side-by-side from the sloping roof lath, beams, and so forth. However, bats have the ability to find crevices and cavities, and if disturbed may rapidly disappear into the angles between converging beams, behind such beams or wallboards, into mortise holes on the underside of beams, and into the multilayered wall and roof fabrications. If bats cannot be openly observed, usually there are various interior and exterior signs of their presence. Often there are multiple roost sites within or on a single building.

Problem Assessment. Once it has been confirmed that bats are present, one must determine if there is damage, if there is a health risk, and if some intervention is warranted. There are circumstances in which "no action" is the correct action because of the beneficial role of bats. In cases where there is risk of contact, damage from excreta accumulations, stains, and so on, intervention may be necessary.

Timing. With the exception of disease treatment and removal of the occasional bat intruder, timing becomes an important planning consideration. Management procedures must not complicate an already existing problem and should emphasize bat conservation. Therefore, all interventions should be initiated before the young are born or after they are weaned and able to fly. Thus, the annual opportunity extends from about mid-August to mid-May for much of North America. Treatments might otherwise result in the unnecessary death of animals (especially young unable to fly) trapped inside, offensive odors, and attraction of arthropod scavengers.

Disease Considerations

Rabies — *Preventive Measures.* It should be noted that newspapers, television, and other mass media sometimes misrepresent the role of rabid bats as a risk to humans. However, the unfortunate recent (1983 to 1993) deaths of a 22-year-old man in Texas, a 30-year-old bat scientist in Finland, a university student in British Columbia, a 5-year-old girl in Michigan, a man in Arkansas, an 11-year-old girl in New York, and a woman in Georgia amply underscore the need to pay prompt attention to bat bites and other exposures.

Many rabies exposures could be avoided if people simply refrained from handling bats. Adults and children should be strongly cautioned never to touch bats with bare hands. All necessary measures should be taken to ensure that bats cannot enter living quarters in houses and apartments. Pet cats and dogs should be kept up-to-date in rabies vaccinations. This is also true for pets confined indoors, because contact with bats frequently occurs indoors. Valuable livestock also should be vaccinated if kept in buildings harboring bats or if in a rabies outbreak area (NASPHV 1993). While transmission of rabies from bats to terrestrial mammals apparently is not common, such incidents have been reported (Reid-Sanden et al. 1990, Trimarchi 1987). Dogs, cats, and livestock that have been exposed to a rabid or suspected-rabid animal, but are not currently vaccinated, must be either quarantined or destroyed.

Lastly, pest control technicians, nuisance wildlife control personnel, wildlife biologists, and other individuals at particular risk of contact with rabid bats (or other wildlife) should receive a rabies pre-exposure vaccination. This effective prophylaxis involves only three injections of rabies vaccine, which are administered in the arm during a month's time.

Rabies — *Treatment for Exposure.* If a person is bitten or scratched by a bat, or there is any suspicion that bat saliva or nervous tissue has contaminated an open wound or mucous membrane, wash the affected area thoroughly with soap and water, capture the bat without damaging the head, and seek immediate medical attention. The incident should be reported promptly to local health authorities in order to arrange rabies testing of the bat.

If the bat is captured and immediate transportation to the testing laboratory is possible, and if immediate testing can be arranged, postexposure treatment may be delayed several hours until the test results are known. Postexposure prophylaxis must be administered immediately, however, if the bat cannot be captured, if prompt transportation to the laboratory is not possible, if the specimen is not suitable for reliable diagnosis, or if the test results prove positive for rabies.

The prophylaxis has little resemblance to that of many years ago. Today, it consists of one dose of rabies immune globulin (human origin) and one dose of rabies vaccine (human diploid cell) administered preferably on the day of exposure, followed by additional single doses of rabies vaccine on days 3, 7, 14, and 28 following the initial injection. This treatment is normally safe, relatively painless, and very effective.

Histoplasmosis — *Preventive Measures.* Histoplasmosis can most easily be prevented by avoiding areas that harbor *H. capsulatum*. Since this is not practical for individuals who must work in and around active/inactive bat roosting sites, other measures can be recommended to reduce the risk of infection during cleaning, field study, demolition, construction, and other activities.

Persons working in areas known or suspected to be contaminated with *H. capsulatum* should always wear protective masks capable of filtering out particles as small as 2 microns in diameter or use a self-contained breathing apparatus. In areas known to be contaminated, wear protective clothing and gloves that can be removed at the site and placed in a plastic bag for later decontamination via formalin and washing. Also, clean footwear before leaving the site to prevent spore dissemination in cars, the office, at home, and elsewhere.

Guano deposits and guano-enriched soils should not be unnecessarily disturbed. Dampening with water or scheduling outdoor work at a time when the ground is relatively wet will minimize airborne dust. Chemically decontaminate known infective foci with a spray of 3% formalin (see CDC 1977). To protect the environment, decontamination must be conducted in accordance with state and local regulations. Chemical decontamination of an "active" bat roost should be conducted only after the bats have been excluded or after bats have departed for hibernation.

Histoplasmosis — *Treatment.* Most infections in normally healthy individuals are benign and self-limiting and do not require specific therapy (George and Penn 1986; Rippon 1988). Treatment with an antifungal agent may be prescribed in more severe cases; amphotericin B and/or oral imidazole ketoconazole are typically recommended depending on the specific nature of the infection.

Removal of Occasional Bat Intruders

A bat that has blundered into the living quarters of a house will usually find its way out by detecting air movement. When no bite or contact with people or pets has occurred, the simplest solution for "removing" the bat is to try to confine it to one room, then open windows and doors leading outdoors and allow it to escape. If the bat is present at night, the lights should be dimmed to allow the animal to find open doors and windows; some light is necessary if an observer is to insure that the bat finds its way out. If bright lights are kept on, the bat may become confused and may seek refuge behind shelving, curtains, hanging pictures, or under furniture.

Healthy bats normally will not attack people even when chased. Chasing a flying bat with a folded newspaper, tennis racket, or stick will cause the bat to take evasive action, and a bat's flight reversal to avoid a wall is often misinterpreted as an attack. These flailings, often futile, will cause a bat to seek safety wherever possible, making escape more difficult for the bat and more frustrating for the human.

If the bat has difficulty escaping, it can be captured in a hand net (for example, an insect net [Fig. 9]). Otherwise,

Fig. 9. Using an insect net to remove a bat from a building.

wait for it to come to rest, quickly cover it with a coffee can or similar container, and slide a piece of cardboard or magazine under the can to trap the bat inside (NYSDH 1990). Take the captured bat outdoors and release it away from populated areas, preferably after dark. Note that reasonably thick work gloves should be worn at all times when trying to capture a bat. Also, if a bite or physical contact occurs, capture the bat without damaging its head and immediately contact a physician (see previous section regarding rabies treatment). Management of problems involving bat colonies require more complicated procedures and a greater time commitment.

Exclusion

Preventive Aspects. The most satisfactory and permanent method of managing nuisance bats is to exclude them from buildings. Locate bats and their points of exit/entry through bat watches or other inspection methods. This is a tedious process to locate all openings in use, and bats may switch to alternate ones when normal routes become unavailable. Thus, consider "potential" as well as "active" points of access.

Often it is apparent where bats might gain entrance even when such openings are not directly observable. By standing in various locations of a darkened attic during daylight hours, one often can find leaks of light at the extreme parts of eaves, in layers of subroofing, and below chimney flashings. Seal all gaps of 1/4 x 1 1/2 inches (0.6 x 3.8 cm) and openings 5/8 x 7/8 inch (1.6 x 2.2 cm) or greater.

Bats will also use some of the same obscure holes in buildings through which heat (or cooled air) is lost; thus, bat-proofing often conserves energy. Simple, homemade devices can be used to locate air leaks. Bathroom tissue or very thin plastic film bags can be taped to a clothes hanger. When placed in front of an area with an air leak (for example, around window frames and sashes where caulking or weatherstripping are needed), the tissue or plastic will wave and flutter from air movements (Fig. 10). Indoor air leaks can be found easily by the use of an air flow indicator (Fig. 11). Small-volume smoke generators can be used to locate openings in the floor, ceiling, attic, and basement. Obscure openings also may be located from outside the house by activating smoke candles or smoke bombs (as within an attic), which will produce easily observed dense smoke. Be careful of any fire hazards.

The easiest time to seal bats out of buildings in northern latitudes is during the cooler part of the year when colonies are not resident. During this period, many homeowners need to be reminded that bats, and bat problems, return each summer. Basic carpentry, masonry, and tinsmith skills are valuable in bat exclusion and other pestproofing interventions.

Devices and Methods. Exclusion becomes "denial of reentry" once the bats have returned to establish maternity colonies (and before the young are born), usually from April through mid-May in the Northeast. Denial of reentry is also appropriate anytime after mid-August when young are capable of flying, as long as bats continue to utilize the roost.

Fig. 10. Using a clothes hanger/plastic film combination to detect air leaks.

The traditional way to exclude bats from an occupied roost involves five basic steps: (1) identify and close all indoor openings through which bats might gain access to human living quarters; (2) close most confirmed and all unused potential exterior exits, leaving only a few major openings (it's best to complete this within 1 to 2 days); (3) at night shortly after the bats

Fig. 11. Smoke from the Sensidyne Air Indicator makes it possible to visually determine the directional pattern of air currents.

have departed to feed, temporarily close the few remaining, major exits; (4) check the roost for presence of bats and, if any remain, unplug the temporarily closed exits early the next evening to allow the bats to escape, then temporarily replug the exits (it may be necessary to repeat this step more than once); and (5) when the bats are all out, permanently seal the holes (Frantz and Trimarchi 1984, Greenhall 1982).

Patience and timing are very important in this process. Much of this work can be done during daylight hours except steps 3 and 4, which require climbing on ladders and roofs at night, sometimes with bats flying nearby. The danger of such work is obvious and discouraging.

Some of these difficulties have been overcome by use of the Constantine one-way valvelike device which is installed in the last exit(s) during the day, and permits bats to leave after dark but prevents their reentry (Constantine 1982). Eventually the valve should be removed and the hole(s) sealed. Another device, the EX-100 Hanks Bat Excluder, consists of a piece of nylon window screening, a wooden plate with a hole in the middle to which is attached a one-way plastic flappervalve, and a rigid plastic mesh cone (Anon. 1983). The screening, to which the wooden plate is attached, is used to cover an opening that bats use to exit a building. Both devices are designed to be used on the last few exit points. Installation instructions are available, and properly applied they will undoubtedly exclude bats from relatively small, discrete openings.

The devices of Constantine and Hanks involve a one-way, self-closing valve feature and can be readily installed during daylight hours. Such devices are not readily adaptable to situations with large, diffuse and/or widely distributed entryways. Also, bats can be inadvertently trapped inside if an important exit hole is mistakenly identified as a minor one and is sealed in an attempt to limit the number of holes requiring an exclusion device.

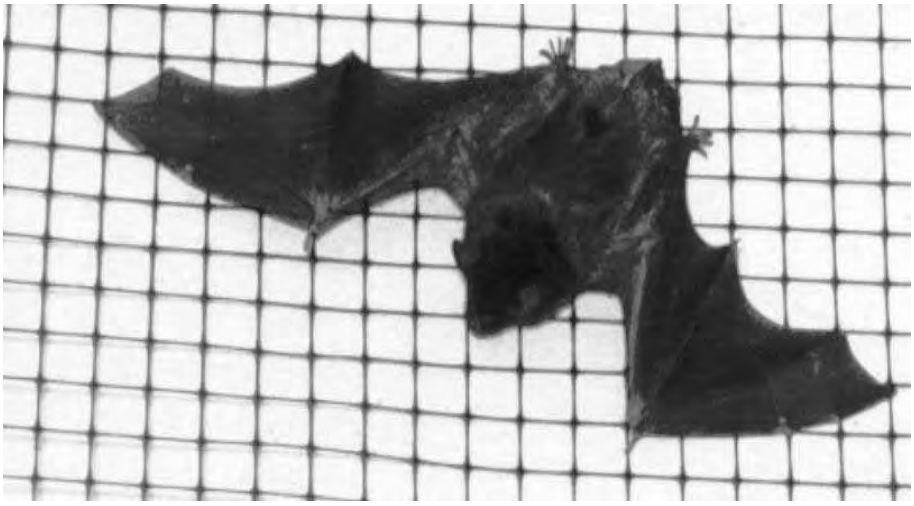

Fig. 12. Bat on birdnetting showing size relationships.

To overcome difficulties with exclusion devices, Frantz' checkvalve was developed using netting made of durable black polypropylene resin (Frantz 1984, 1986). Quality of product is important since the netting should not fray or become misshapen under hot summer conditions. Use only structural grade material that has openings no larger than 1/2 x 1/2 inch (1.3 x 1.3 cm), weighs about 1.3 ounces per square yard (44 g/m^2) and is flexible yet stiff enough to maintain the shape of the checkvalve fabricated (Fig. 12). Waterproof duct tape, common staples, and/or wooden lath strips are used to attach the netting to metal, slate, brick, wood, asphalt shingle, or other surfaces. Note that duct tape may stain or discolor painted/enameled surfaces if kept in contact for long periods of time.

Application of checkvalves follows the same two initial steps as traditional bat exclusion. Close interior openings, then close exterior openings except a few major exits. These latter openings will have been confirmed as important via bat watches, and it is here that checkvalves will be fitted during the daylight.

The basic design is to attach the netting around an exit hole except at the bottom where the bats will escape (see Frantz 1986, for details). The width and shape of checkvalves is highly variable so as to embrace the necessary exit point — a single hole, a series of holes, or a long slitlike opening (Fig. 13). Designs must be open enough not to impede the exiting bats. The top can be much larger than the bottom. It is probably best to restrict the bottom opening to no larger than about 1.6 x 1.6 feet (0.5 x 0.5 m). The length of a checkvalve, that is, the distance from the lowest enclosed point of egress to the bottom of the netting, should be about 3.3 feet (1 m).

The above specifications usually are sufficient to abort bats' reentry attempts. If netting is applied while young are still in the roost, the "evicted" mothers may be motivated to chew holes in the netting to reenter the roost. Applied at the correct time of year, however, netting will allow all bats to exit at dusk and thereafter deny them reentry.

Checkvalves should be kept in place for 3 to 5 days. It is best to verify (conduct a bat watch) that bats no longer exit at dusk before the checkvalves are dismantled and the holes are sealed permanently. As in any exclusion intervention, the excluded animals will go elsewhere. This shift may be to an alternative roost already in use such as a night roost, or one used in previous years.

Supplemental Materials and Methods. While specifications for Frantz' checkvalve have been

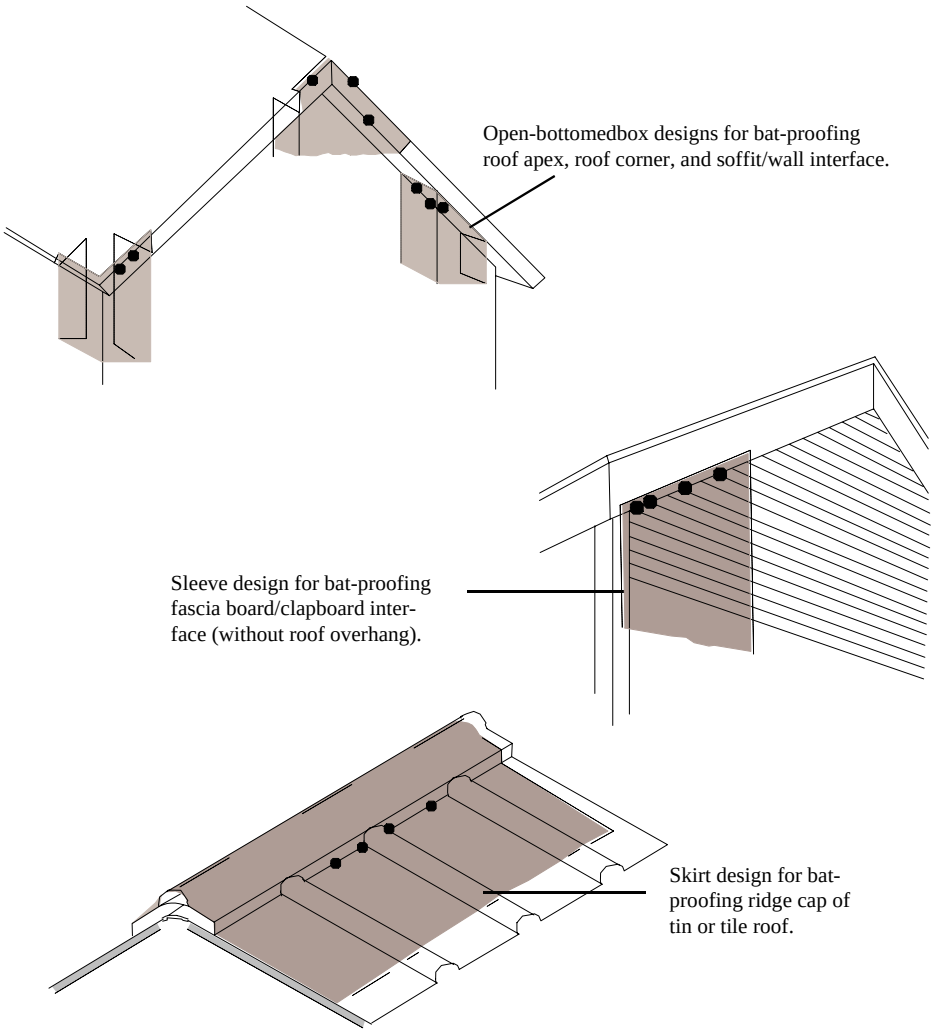

Fig. 13. Sample configurations for Frantz' checkvalve (Key: = birdnetting;..... = attaching to structure; • = exit/entry holes of bats).

provided, additional caulking, flashing, screening, and insulation materials often are needed. The combination of materials used will depend on the location, size, and number of openings, and the need for ventilation. Greenhall (1982) provides many details of bat-proofing methods and materials and is a practical guide. Weatherstripping, knitted wire mesh (Guard-All®, Stuf-fit®), waterproof duct tape, stainless steel wool, and wood lath may be used to block long, narrow openings. Caulk-ing compounds will seal cracks and crevices that develop in a house as it ages, and are best applied during dry periods when wood cracks are widest. Caulks that may be applied with a caulking gun (in gaps up to about 0.4 inch [1 cm] wide) include latex, butyl, and acrylic, which last about 5 years. Elastomeric caulks, such as silicone rubber, will last indefinitely, expand and contract, do not dry or crack, and tolerate temperature extremes. Oakum packs easily and firmly into small cracks. Other fillers include sponge rubber, glass fiber, knitted wire mesh, and quick-setting putty. Self-expanding polyurethane foam applied from pressurized containers can be used for openings larger than 3 inches (>7.5 cm). It must be applied with caution so as to not lift clapboards, shingles, and other surfaces. Exposed surfaces should be sealed with epoxy paint to prevent insect infestation and ultraviolet degradation.

Conventional draft sweeps (metal, rubber) and other weatherstripping supplies (felt, vinyl, metal) will seal the space between a door bottom and the threshold or around windows (Fig. 14). Remember to treat attic and basement doors whenever the gap exceeds 1/4 inch (0.6 cm). Flashing may be used to close gaps wherever joints occur; for example, where the roof meets a chimney. Materials commonly used include galvanized metal, copper, aluminum, and stainless steel. Self-adhesive stainless steel "tape" is also available. Insulation will provide some degree of barrier to bat movements. It is available in a number of forms and types including fiberglass, rock wool, urethane, vermiculite, polystyrene, and extruded polystyrene foam. Inorganic materials are fire and moisture resistant; the safest appear to be fiberglass and rock wool.

The mesh size of screening must be small enough to prevent access of bats and other species, where desired. Hardware cloth with 1/4-inch (0.6-cm) mesh will exclude bats and mice; screening with 16 meshes per inch (2.5 cm) will exclude most insects. Soffits (underside of overhanging eaves) usually have ventilators of various shapes and sizes. Regardless of type, the slots should not exceed 1/4 x 1 inch (0.6 cm x 2.5 cm) and should be covered inside with insect mesh. To prevent bats from entering chimney flues, completely enclose the flue discharge area with rust-resistant spark arresters or pest screens, secured to the top of the chimney. These should not be permanently attached (for example, with screws) in case they must be rapidly removed in the event of a chimney fire. Review fire codes before installing flue covers. Dampers should be kept closed except in the heating season.

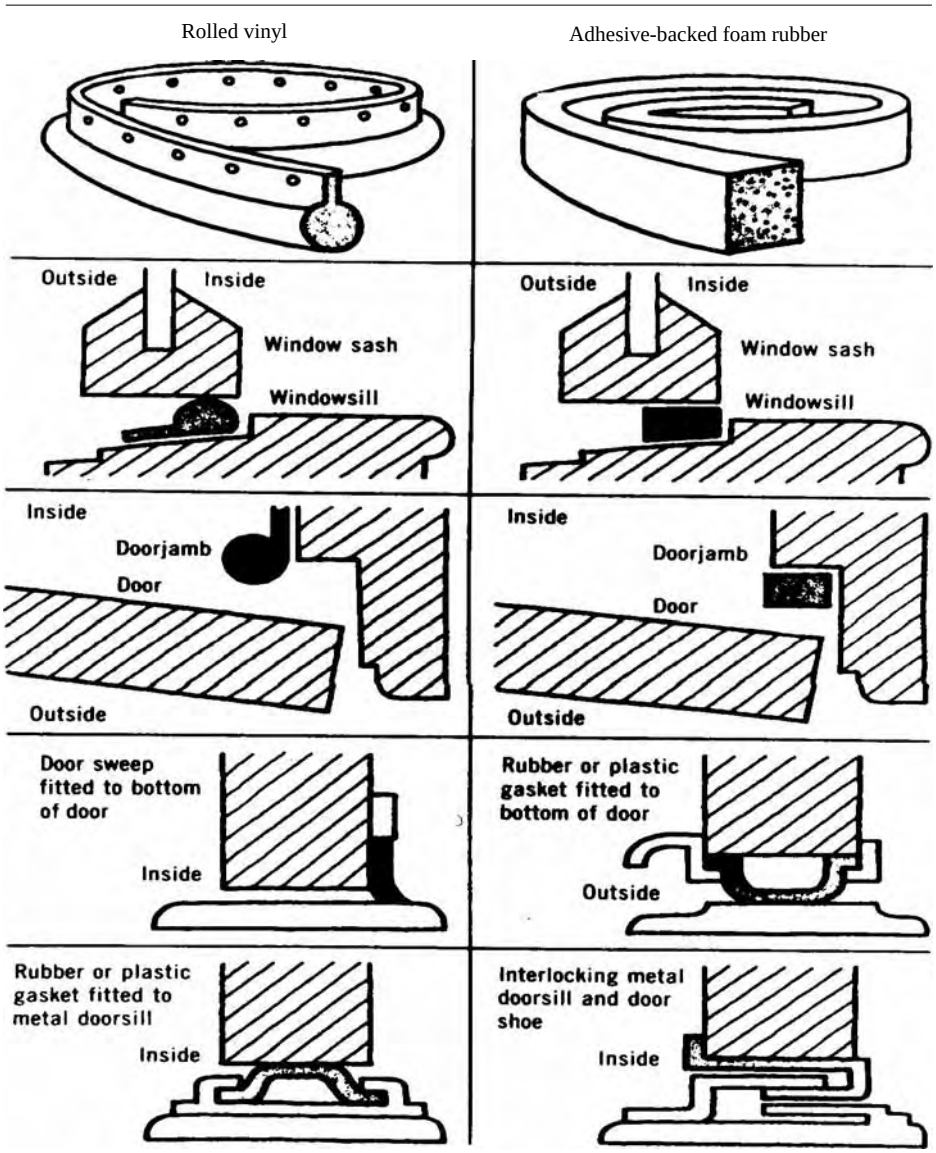

Fig. 14. Weatherstripping and door sweeps are very useful bat-proofing measures.

Fig. 15. Open ends of tile roofs may allow bat entry and provide roosting sites.

Roof Problems. Bats, particularly the Mexican free-tailed bat, often roost under Spanish or concrete tile roofing by entering the open ends at the lowermost row or where the tiles overlap (Fig. 15). Tight-fitting plugs are difficult to make due to the variation in opening sizes and thermal expansion and contraction. A solution was found by Constantine (1979) in which a layer of coarse fiberglass batting was laid under the tiles so that bats entering holes would contact the fiberglass and be repelled. A layer of knitted wire mesh would undoubtedly work well for this purpose (and would not hold moisture). Bats also may be excluded from the tiles if rain gutters are installed directly under the open ends. Gaps under corrugated and galvanized roofing may be closed with knitted wire mesh, self-expanding foam (avoid causing roofing to lift), or with fiberglass batting (may retain moisture).

Wall Problems. Fiberglass or rock wool insulation blown into wall spaces that are used by bats may be a deterrent, especially when it forms a physical barrier to passage. Such work must be done when bats are absent to avoid their entrapment.

Temporary Roosts. Bats will sometimes temporarily roost on porches and patios, in garages, and behind shutters, shingles, and roof gutters. Roosting behind shutters may also be long-term in duration. Actual control measures may not be necessary unless bat droppings become a problem or the risk of human contact is significant. Coarse fiberglass batting tacked to the surfaces where bats prefer to hang sometimes discourages them. A potentially useful intervention for the wall-ceiling interface is the application of a wide 45° molding strip to eliminate the 90° angle corner and force the bats to roost in a more exposed area.

Repellents

While many chemical aromatics and irritants have been proposed and tested for bat repellency, efficacy has been very limited thus far.

Naphthalene crystals and flakes are the only repellents registered by the US Environmental Protection Agency (EPA) for indoor bat control and are to be applied in attics or between walls. Sometimes the chemical may be placed in loose-mesh cloth bags and suspended from the rafters. About 2.5 pounds per 1,000 cubic feet (1.2 kg/30 m^3) is recommended to chronically repel bats as the chemical vaporizes. Dosages of 5 pounds per 1,000 cubic feet (2.4 kg/30 m^3) may dislodge bats in broad daylight. Bats will return, however, when the odor dissipates. The prolonged inhalation of naphthalene vapors may be hazardous to human health.

Illumination has been reported to be an effective repellent. Floodlights strung through an attic to illuminate all roosting sites may cause bats to leave. Large attics may require many 100-watt bulbs or 150-watt spotlights to be effective. Fluorescent bulbs may also be used. In some situations such lighting is difficult, costly, and may result in an electrical hazard. Where possible, the addition of windows to brighten an attic will help to reduce the desirability of the roost site and is not likely to introduce additional problems.

Air drafts have successfully repelled bats in areas where it is possible to open doors, windows, or create strong breezes by use of electric fans. Addition of wall and roof vents will enhance this effort, as well as lower roost temperature. These measures will increase the thermoregulatory burden on the bats, thus making the roost less desirable. In a similar fashion, colonies located in soffits, behind cornices, and other closed-in areas can be discouraged by opening these areas to eliminate dark recesses. Discourage bats from roosting behind shutters by removing the shutters completely or by adding small blocks at the corners to space them a few inches away from the wall.

Ultrasonic devices have been tested under natural conditions, both indoors and outdoors, to repel little brown and big brown bats either in the roost or as they fly toward an entrance hole (Frantz, unpublished data). The results have not been promising. Numerous ultrasonic devices have been removed from clients' homes because the bats remained in the roost after the devices were activated. Hurley and Fenton (1980) exposed little brown bats to ultrasound in seminatural roosts with virtually no effect. Largely because of this lack of known scientific efficacy for ultrasonic devices, the New York State Consumer Protection Board has cautioned against the use of such devices (NYSCPB 1988). Part of the concern is that such devices will provide consumers with a false sense of security and, thus, may prevent them from taking effective preventive actions.

Distress cries of bats recorded on tape and rebroadcast can be used to attract other bats to nets or traps, but they do not serve as an effective repellent. Little brown and big brown bats respond to their own distress cries but not to the cries of other species.

Contact repellents, such as sticky-type bird repellents and rodent glues, have been used successfully in situations where roost surfaces and bat accesses may be coated. Apply masking tape to the surface first if you desire to remove the repellent after treatment is finished. Replenish contact repellents occasionally, since dust accumulation causes them to lose their tackiness. Also, caution must be exercised so as to apply coatings that will be sticky, but will not entrap the bats.

Toxicants (not recommended)

No toxicants are registered for controlling bats. In 1987 the Centers for Disease Control, United States Department of Health and Human Services, voluntarily withdrew the last registration for DDT use against bats in the United States. Thus, DDT is no longer registered for any use in this country.

Although federally registered for rodents, chlorophacinone (RoZol) tracking powder, an anticoagulant, is not registered for bats. Furthermore, it can no longer be registered by individual states for restricted use under Section 24(c) of the Federal Insecticide, Fungicide, and Rodenticide Act D-18 (FIFRA). Lipha Tech, Inc. (the manufacturer of RoZol) has voluntarily cancelled its registration for "RoZol Tracking Powder for Control of Nuisance Bats" — effective December 16, 1991 (Fed. Reg., 1991).

Trapping

Kunz and Kurta (1988) reviewed an extensive variety of efficient methods for trapping bats from buildings and other roosting sites or foraging areas. For purposes of wildlife damage control, however, exclusion is less complicated to carry out, less time-consuming, more effective, and requires no handling of bats.

Other Methods

Sanitation and Cleanup. Once bats have been excluded, repelled, or have departed at the end of the summer, measures must be completed to make reinfestation less likely, and to eliminate odor and problematic bioaerosols. As a prelude to such work, it is sometimes useful to apply a pyrethrum-based, total-release aerosol insecticide to eliminate unwanted arthropods.

The safe handling and removal of bat guano has been discussed previously (see the histoplasmosis section in this chapter). In addition to the more bulky accumulations of excreta, there are often diffuse deposits of guano under/among insulation materials, caked urine and guano on roof beams, and splattered urine on windows. Such clean-up work during hot summer weather may be the least desirable activity of a management program, but it is necessary.

All caked, crystallized bat urine and droppings should be scraped and wire-brushed, as necessary, from all roof and attic beams. For this procedure, workers should take the same precautions as outlined for histoplasmosis-related work. Accumulated excreta and contaminated insulation should be sealed in plastic bags and removed for disposal. Remove all remaining droppings and debris with

Fig. 16. One of five bat houses constructed to provide an alternative roost for bats excluded from nearby structures.

a vacuum cleaner, preferably one that has a water filter to reduce the amount of dust that escapes from the cleaner's exhaust.

Where possible, wash with soap and water all surfaces contaminated with urine and guano. Allow the surfaces to dry, then disinfect them by misting or swabbing on a solution of 1 part household bleach and 20 parts tap water. Ventilate the roost site to allow odors and moisture to escape. Installation of tight-fitting window screens, roof and/or wall ventilators in attics will enhance this process. Remember, sanitation and cleanup accompanies bat-proofing and exclusion measures, it does not replace them.

Artificial Roosts. For more than 60 years, artificial bat roosts have been used in Europe. Only recently have they gained some popularity in the United States. Though the results are variable, it appears that artificial roosts, if properly constructed and located, can attract bats that are displaced or excluded from a structure. The Missouri Department of Conservation described a successful "bat refuge" that was quickly occupied by a displaced colony of little brown bats (LaVal and LaVal 1980). Bat houses of a similar design have been successfully used in Minnesota, New York, and elsewhere (see Fig. 16).

Development of an efficient method to relocate bats into alternative roosts after they have been excluded from buildings could be an important intervention in comprehensive bat management. Frantz (1989) found it helpful to "seed" newly constructed bat houses with several bats, a procedure that later resulted in full-scale colonization without further human interventions. Alternative roosts should be located away from human high-use areas. Thus, people can enjoy the benefits of bats without sharing their dwellings with them and with little risk of direct contact with them.

Economics of Damage and Control

Virtually all bats are of some economic importance; those north of Mexico are beneficial because of their insectivorous diet which eliminates many insect pests of humans. The accumulated bat droppings, called guano, is rich in nitrogen and is a good organic fertilizer. At one time, bat guano was commercially mined in the Southwest; but its importance has declined due to reduced bat populations and the development of inorganic fertilizers. Bat guano is still considered a valuable fertilizer resource in some parts of the world (such as Thailand and Mexico).

No figures are available to determine the extent of damage caused by nuisance bats or the cost for their control. The problem is widespread in this and other countries.

Costs for remedial services are highly variable, depending on the nature of the problem and who will do the work. For example, to fabricate a few Frantz' checkvalves on the "average" two-story house would probably require two workers about one-half day, mostly on stepladders, and less than $50 in materials. Much more time would be required to seal up all the other active and potential bat exit/entry holes. In addition, if a deteriorated roof, eaves, or other woodwork must be replaced, the costs can increase rapidly.

It is often difficult or expensive for the public to obtain the services of reliable, licensed pest control operators (PCOs). Many PCOs have limited knowledge of basic bat biology and are apprehensive to work with bats. They may want to avoid any liabilities should bat-human contact occur. Select a qualified professional service that concentrates on the exclusion of live bats from a structure rather than on use of lethal chemicals.

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Figures 2 through 4 from Barbour and Davis (1979).

Figure 5 adapted from Harvey (1986).

Figure 6 adapted from Tuttle (1988), except *Yuma myotis* and Keen's bat (from Barbour and Davis 1979).

Figure7 adapted fromT rimarchi and Frantz (1985).

Figure 8 by R. Suss.

Figures 12, 15, and 16 by S. C. Frantz.

Figures 9, 10, 11, and 14 from Greenhall (1982)

Figure 13 by S. C. Frantz

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BEAVERS

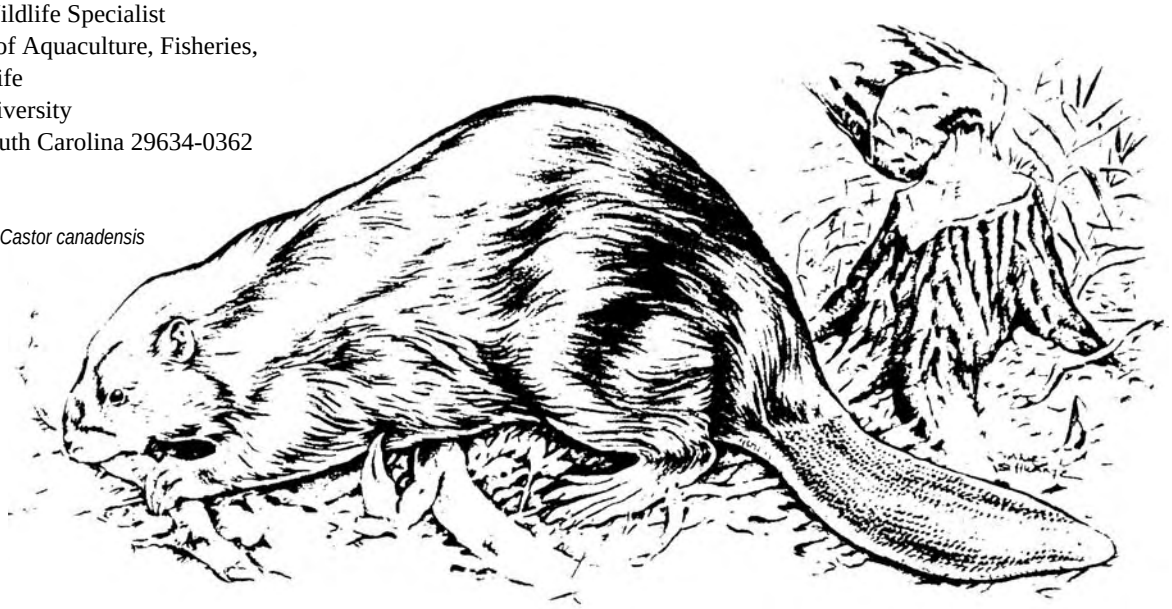


Fig. 1. Beaver, *Castor canadensis*

Damage Prevention and Control Methods

Exclusion

Fence small critical areas such as culverts, drains, or other structures.

Install barriers around important trees in urban settings.

Cultural Methods and Habitat Modification

Eliminate foods, trees, and woody vegetation where feasible.

Continually destroy dams and materials used to build dams.

Install a Clemson beaver pond leveler, three-log drain, or other structural device to maintain a lower pond level and avoid further pond expansion.

In California, property owners suffering damage from beavers must obtain a permit from the DFG before taking any animals, unless taking beavers under the authority of a hunting or trapping license.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Basket/suitcase type traps are primarily used for live trapping.

Snares can be useful, particularly in dive sets and slides where legal.

Shooting

Rarely effective (where legal) for complete control efforts.

Other Methods

Other methods rarely solve a beaver damage problem and may increase risks to humans and non target species.

PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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

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

Great Plains Agricultural Council
Wildlife Committee

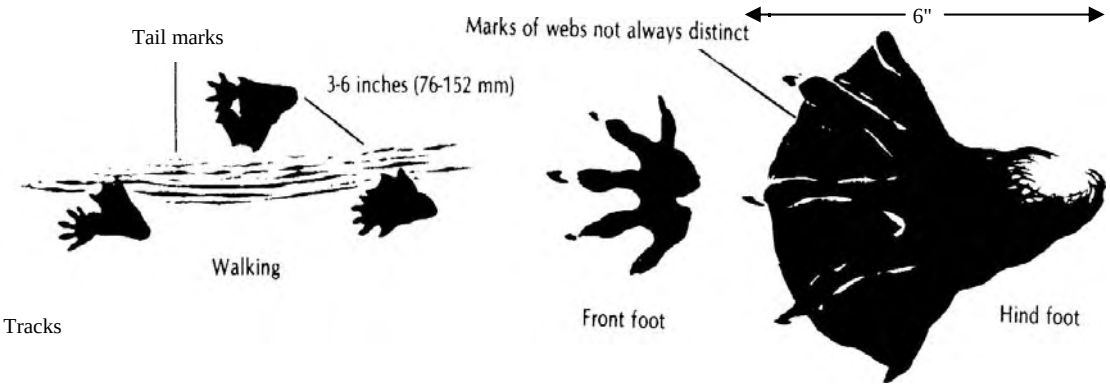


Fig. 2. Beaver Tracks

Identification

The beaver (*Castor canadensis*, Fig. 1) is the largest North American rodent. Most adults weigh from 35 to 50 pounds (15.8 to 22.5 kg), with some occasionally reaching 70 to 85 pounds (31.5 to 38.3 kg). Individuals have been known to reach over 100 pounds (45 kg). The beaver is a stocky rodent adapted for aquatic environments. Many of the beaver's features enable it to remain submerged for long periods of time. It has a valvular nose and ears, and lips that close behind the four large incisor teeth. Each of the four feet have five digits, with the hind feet webbed between digits and a split second claw on each hind foot. The front feet are small in comparison to the hind feet (Fig. 2). The underfur is dense and generally gray in color, whereas the guard hair is long, coarse and ranging in color from yellowish brown to black, with reddish brown the most common coloration. The prominent tail is flattened dorso-ventrally, scaled, and almost hairless. It is used as a prop while the beaver is sitting upright (Fig. 3) and for a rudder when swimming. Beavers also use their tail to warn others of danger by abruptly slapping the surface of the water. The beaver's large front (incisor) teeth, bright orange on the front, grow continuously throughout its life. These incisors are beveled so that they are continuously sharpened as the beaver gnaws and chews while feeding, girdling, and cutting trees. The only way to externally distinguish the sex of a beaver, unless the female is lactating, is to feel for the presence of a baculum (a bone in the penis) in males and its absence in females.

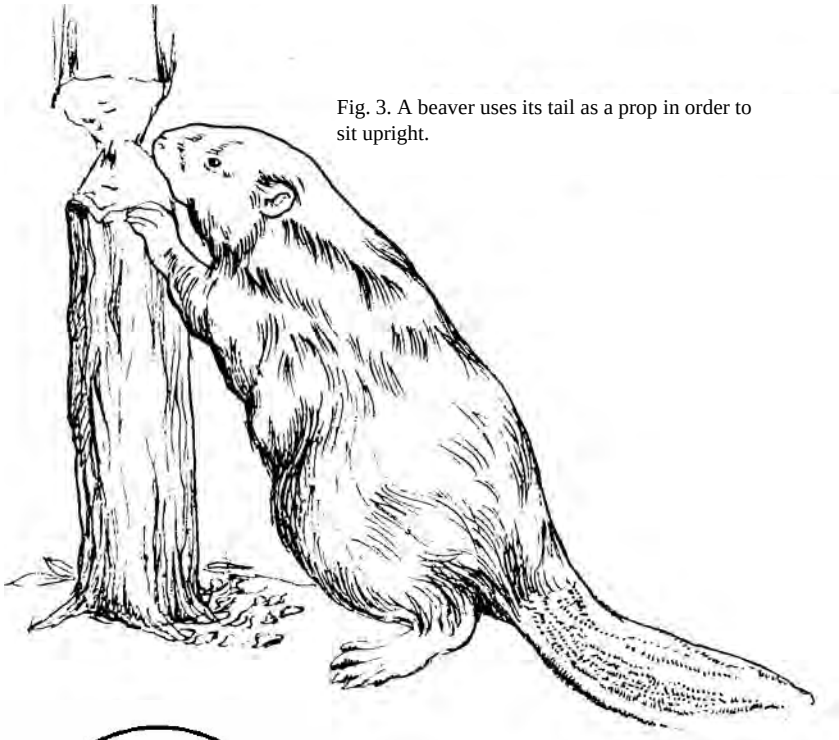
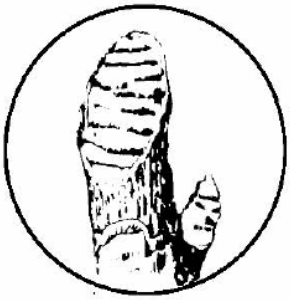


Fig. 3. A beaver uses its tail as a prop in order to sit upright.



Details of beaver cuttings.

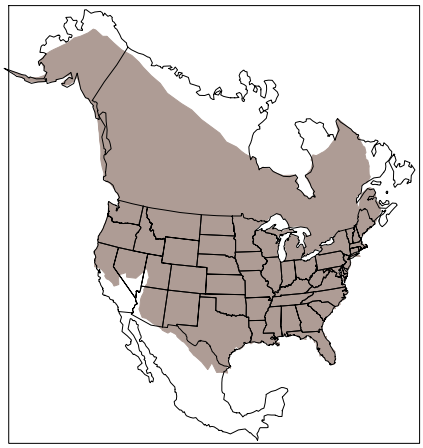


Fig. 4. Range of the beaver in North America.

Range

Beavers are found throughout North America, except for the arctic tundra, most of peninsular Florida, and the southwestern desert areas (Fig. 4). The species may be locally abundant wherever aquatic habitats are found.

Habitat

Beaver habitat is almost anywhere there is a year-round source of water, such as streams, lakes, farm ponds, swamps, wetland areas, roadside ditches, drainage ditches, canals, mine pits, oxbows, railroad rights-of-way, drains from sewage disposal ponds, and below natural springs or artesian wells. Beavers build dams to modify the environment more to their liking. Dam building is often stimulated by running water. The length or height of a dam generally depends upon what is necessary to slow the flow of water and create a pond. In areas of flat topography, the dam may not be over 36 inches (0.9 m) high but as much as 1/4 miles (0.4 km) long. In hilly or mountainous country, the dam may be 10 feet (3 m) high and only 50 feet (15 m) long. Beavers are adaptable and will use whatever materials are available to construct dams — fencing materials, bridge planking, crossties, rocks, wire, and other metal, wood, and fiber materials. Therefore, about the only available aquatic habitat beavers avoid are those systems lacking acceptable foods, lodge or denning sites, or a suitable dam site. Some of the surrounding timber is cut down or girdled by beavers to form dams. Subsequent flooding of growing timber causes it to die, and aquatic vegetation soon begins growing. Other pioneer species (for example, willow, sweetgum, and buttonbush) soon grow around the edges of the flooded area, adding to the available food supply. The beaver thus helps create its own habitat.

Food Habits

Beavers prefer certain trees and woody species, such as aspen, cottonwood, willow, sweetgum, blackgum, black cherry, tulip poplar, and pine, depending on availability. However, they can and will eat the leaves, twigs, and bark of most species of woody plants that grow near the water, as well as a wide variety of herbaceous and aquatic plants. Beavers often travel 100 yards (90 m) or more from a pond or stream to get to corn fields, soybean fields, and other growing crops, where they cut the plants off at ground level and drag them back to the water. They eat parts of these plants and often use the remainder as construction material in the dam.

General Biology, Reproduction, and Behavior

Beavers are active for approximately 12 hours each night except on the coldest of winter nights. The phrase "busy as a beaver" is appropriate. It is not uncommon, however, to see beavers during daylight hours, particularly in larger reservoirs.

Beavers are generally monogamous; copulation may take place either in the water or in the lodge or bank den.

After a gestation period of about 128 days, the female beaver generally gives birth to 3 or 4 kittens between March and June, and nurses them for 6 weeks to 3 months. The kittens are born fully furred with their eyes partially opened and incisors erupted through the gums. They generally become sexually mature by the age of 1 1/2 years.

Beaver communicate by vocalizations, posture, tail slapping, and scent posts or mud mounds placed around the bank and dam. The beaver's castor glands secrete a substance that is deposited on mud mounds to mark territorial boundaries. These scent posts are found more frequently at certain seasons, but are found year-round in active ponds.

Fig. 5. Cross section of a beaver lodge.

Beavers have a relatively long life span, with individuals known to have lived to 21 years. Most, however, do not live beyond 10 years. The beaver is unparalleled at dam building and can build dams on fast-moving streams as well as slow-moving ones. They also build lodges and bank dens, depending on the available habitat. All lodges and bank dens have at least two entrances and may have four or more. The lodge or bank den is used primarily for raising young, sleeping, and food storage during severe weather (Fig. 5).

The size and species of trees the beaver cuts is highly variable — from a 1-inch (2.5-cm) diameter at breast height (DBH) softwood to a 6-foot (1.8-m) DBH hardwood. In some areas beavers usually cut down trees up to about 10 inches (25 cm) DBH and merely girdle or partially cut larger ones, although they often cut down much larger trees. Some beavers seem to like to girdle large pines and sweetgums. They like the gum or storax that seeps out of the girdled area of sweetgum and other species.

An important factor about beavers is their territoriality. A colony generally consists of four to eight related beavers, who resist additions or outsiders to the colony or the pond. Young beavers are commonly displaced from the colony shortly after they become sexually mature, at about 2 years old. They often move to another area to begin a new pond and colony. However, some become solitary hermits inhabiting old abandoned ponds or farm ponds if available.

Beavers have only a few natural predators aside from humans, including coyotes, bobcats, river otters, and mink, who prey on young kittens. In other areas, bears, mountain lions, wolves, and wolverines may prey on beavers. Beavers are hosts for several ectoparasites and internal parasites including nematodes, trematodes, and coccidians. *Giardia lamblia* is a pathogenic intestinal parasite transmitted by beavers, which has caused human health problems in water supply systems. The Centers for Disease Control have recorded at least 41 outbreaks of waterborne Giardiasis, affecting more than 15,000 people. For more information about Giardiasis, see von Oettingen (1982).

Fig. 6. Pine plantation in Arkansas killed in flooding caused by beavers.

Damage and Damage Identification

The habitat modification by beavers, caused primarily by dam building, is often beneficial to fish, furbearers, reptiles, amphibians, waterfowl, and shorebirds. However, when this modification comes in conflict with human objectives, the impact of damage may far outweigh the benefits.

Most of the damage caused by beavers is a result of dam building, bank burrowing, tree cutting, or flooding. Some southeastern states where beaver damage is extensive have estimated the cost at $3 million to $5 million dollars annually for timber loss; crop losses; roads, dwellings, and flooded property; and other damage. In some states, tracts of bottomland hardwood timber up to several thousand acres (ha) in size may be lost because of beaver. Some unusual cases observed include state highways flooded because of beaver ponds, reservoir dams destroyed by bank den burrows collapsing, and train derailments caused by continued flooding and burrowing. Housing developments have been threatened by beaver dam flooding, and thousands of acres (ha) of cropland and young pine plantations have been flooded by beaver dams (Fig. 6). Road ditches, drain pipes, and culverts have been stopped up so badly that they had to be dynamited out and replaced. Some bridges have been destroyed because of beaver dam-building activity. In addition, beavers threaten human health by contaminating water supplies with *Giardia.*

Identifying beaver damage generally is not difficult. Signs include dams; dammed-up culverts, bridges, or drain pipes resulting in flooded lands, timber, roads, and crops; cut-down or girdled trees and crops; lodges and burrows in ponds, reservoir levees, and dams. In large watersheds, it may be difficult to locate bank dens. However, the limbs, cuttings, and debris around such areas as well as dams along tributaries usually help pinpoint the area.

Legal Status

In California, the beaver is designated as a furbearing mammal. In the taking of beaver must coincide with the furbearer season unless the animals are causing property damage. When property damage is occurring, the property owner or his agent may take the beaver but only when a permit has been issued from the DFG. See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Exclusion

It is almost impossible as well as cost-prohibitive to exclude beavers from ponds, lakes, or impoundments. If the primary reason for fencing is to exclude beavers, fencing of large areas is not practical. Fencing of culverts, drain pipes, or other structures can sometimes prevent damage, but fencing can also promote damage, since it provides beavers with construction material for dams. Protect valuable trees adjacent to waterways by encircling them with hardware cloth, woven wire, or other metal barriers. Construction of concrete spillways or other permanent structures may reduce the impact of beavers.

Cultural Methods

Because beavers usually alter or modify their aquatic habitat so extensively over a period of time, most practices generally thought of as cultural have little impact on beavers. Where feasible, eliminate food, trees, and woody vegetation that is adjacent to beaver habitat. Continual destruction of dams and removal of dam construction materials daily will (depending on availability of construction materials) sometimes cause a colony or individual beavers to move to another site. They might, however, be even more troublesome at the new location.

The use of a three-log drain or a structural device such as wire mesh culverts (Roblee 1983) or T-culvert guards (Roblee 1987) will occasionally cause beavers to move to other areas. They all prevent beavers from controlling water levels. However, once beavers have become abundant in a watershed or in a large contiguous area, periodic reinvasions of suitable habitat can be expected to occur. Three-log drains have had varying degrees of success in controlling water levels in beaver impoundments, especially if the beaver can detect the sound of falling water or current flow. All of these devices will stimulate the beavers to quickly plug the source of water drainage.

A new device for controlling beaver impoundments and keeping blocked culverts open is the Clemson beaver pond leveler. It has proven effective in allowing continual water flow in previously blocked culverts/drains and facilitating the manipulation of water levels in beaver ponds for moist-soil management for waterfowl (Wood and Woodward 1992) and other environmental or aesthetic purposes. The device (Fig. 7) consists of a perforated PVC pipe that is encased in heavy-gauge hog wire. This part is placed upstream of the dam or blocked culvert, in the main run or deepest part of the stream. It is connected to nonperforated sections of PVC pipe which are run through the dam or culvert to a water control structure downstream. It is effective because the beavers cannot detect the sound of falling or flowing water as the pond or culvert drains; therefore, they do not try to plug the pipe. The Clemson beaver pond leveler works best in relatively flat terrain where large volumes of water from watersheds in steep terrain are not a problem.

Repellents

There are no chemical repellents registered for beavers. Past research efforts have tried to determine the effectiveness of potential repellent materials; however, none were found to be effective, environmentally safe, or practical. One study in Georgia (Hicks 1978) indicated that a deer repellent had some potential benefit. Other studies have used a combination of dam blowing and repellent soaked (Thiram 80 and/or paradichlorobenzene) rags to discourage beavers with varying degrees of success (Dyer and Rowell 1985).

Additional research is needed on repellents for beaver damage prevention.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations). There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

The use of traps in most situations where beavers are causing damage is the most effective, practical, and environmentally safe method of control. The effectiveness of any type of trap for beaver control is dependent on the trapper's knowledge of beaver habits, food preferences, ability to read beaver signs, use of the proper trap, and trap placement. A good trapper with a dozen traps can generally trap all the beavers in a given pond (behind one dam) in a week of trap nights. Obviously in a large watershed with several colonies, more trapping effort will be required. Most anyone with trapping experience and some outdoor "savvy" can become an effective beaver trapper in a short time. In an area where beavers are common and have not been exposed to trapping, anyone experienced in trapping can expect good success. Additional expertise and improved techniques will be gained through experience.

A variety of trapping methods and types of traps are effective for beavers, depending on the situation. Fish and wildlife agency regulations vary from

Table 1. List of materials for the Clemson Beaver Pond Leveler.

Quantity	Item
1	10' section, 10" diameter PVC pipe (Schedule 40)
1	PVC cap for 10" diameter PVC pipe (Schedule 40)
1	10" x 8" PVC pipe reducer coupling (Schedule 40)
4	86" sections, 3/4" diameter plastic roll pipe (water pipe), 160 psi grade
4	3/4" metal couplings for roll pipe
16	1/4" x 2" galvanized eyebolts
16	1/4" galvanized nuts
16	1/4" galvanized washers
16	16" sections, 8 gauge galvanized wire (medium hardness)
2	96" sections, 2" x 4" 1/2 gauge galvanized welded wire
2 lbs	Crab trap clamps (fasteners)

The above materials are required to assemble the intake device. The carrying pipe (flow pipe) may consist of 20 to 40 feet of 8-inch diameter PVC, Schedule 40 with coupling sleeves and elbows appropriate to the desired configuration.

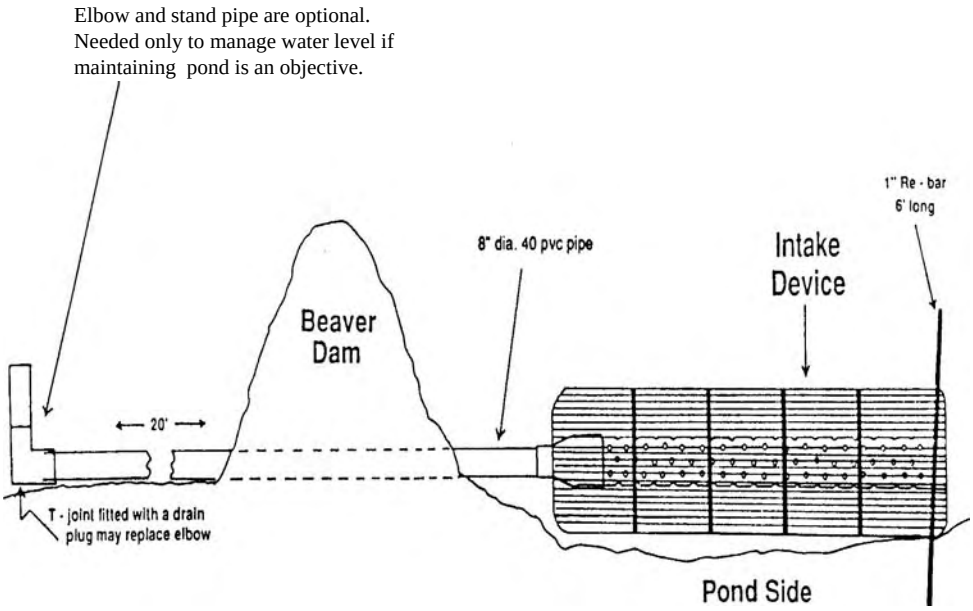


Fig. 7. Clemson beaver pond leveler.

state to state. Some types of traps and trapping methods, although effective, may be prohibited by law.

Of the variety of traps commonly allowed for use in beaver control, the Conibear® type, No. 330, is one of the most effective (Fig. 8). Not all trappers will agree that this type of trap is the most effective; however, it is the type most commonly used by professional trappers and others who are principally trapping beavers. This trap kills beavers almost instantly. When properly set, the trap also prevents any escape by a beaver, regardless of its size. Designed primarily for water use, it is equally effective in deep and shallow water. Only one trap per site is generally necessary, thus reducing the need for extra traps. The trap exerts tremendous pressure and impact when tripped. Appropriate care must be exercised when setting and placing the trap. Care should also be taken when using the Conibear® type traps in urban and rural areas where pets (especially dogs) roam free. Use trap sets where the trap is placed completely underwater.

Some additional equipment will be useful: an axe, hatchet, or large cutting tool; hip boots or waders; wire; and wire cutters. With the Conibear®-type trap, some individuals use a device or tool called "setting tongs." Others use a piece of 3/8- or 1/2-inch (9- or 13-mm) nylon rope. Most individuals who are experienced with these traps use only their hands. Regardless of the techniques used to set the trap, care should be exercised.

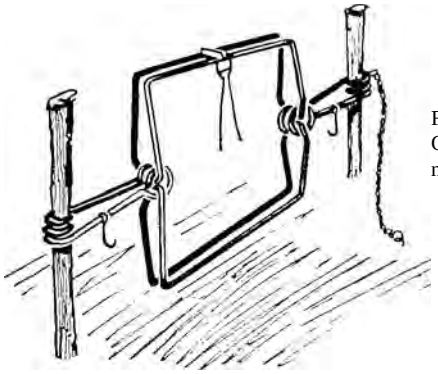


Fig. 8. Basic method of setting and staking a Conibear® 330 trap. Additional stakes are normally used (see Fig. 9).

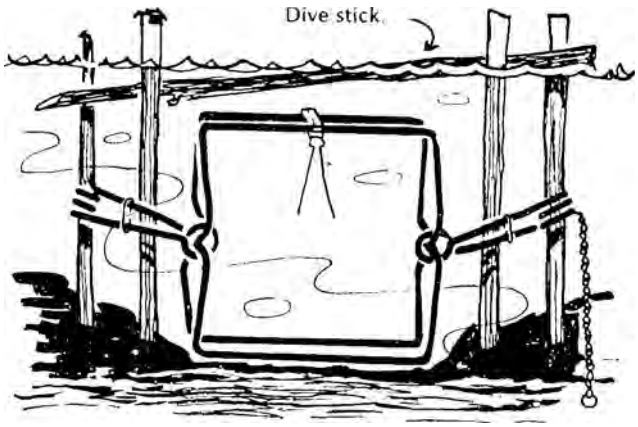


Fig. 9. Conibear trap in dive set.

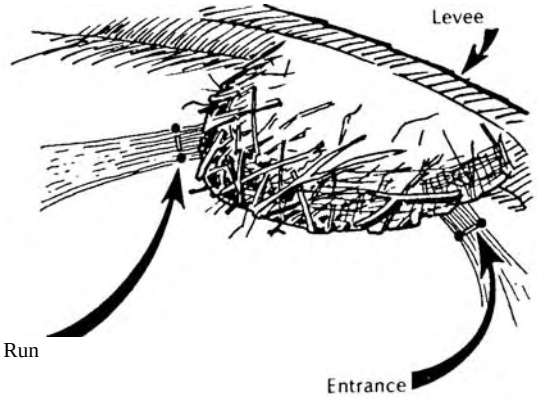


Fig. 10. Runs or underwater entrances to lodges are good places to set beaver traps.

Earlier models of the Conibear® type of trap came with round, heavy steel coils which were dangerous to handle unless properly used in setting the trap. They are not necessary to safely set the trap. However, the two safety hooks, one on each spring, must be carefully handled as each spring is depressed, as well as during trap placement. On newer models an additional safety catch (not attached to the springs) is included for extra precaution against inadvertent spring release. The last step before leaving a set trap is to lift the safety hook attached to each spring and slide the safety hook back from the trap toward the spring eye, making sure to keep hands and feet safely away from the center of the trap. If the extra (unattached) safety catch is used, it should be removed before the safety hooks that are attached to the springs to keep it from getting in the way of the movement of the safety hooks.

Conibear®-type traps are best set while on solid ground with dry hands. Once the springs are depressed and the safety hooks in place, the trap or traps can be carried into the water for proper placement. Stakes are needed to anchor the trap down. In most beaver ponds and around beaver dams, plenty of suitable stakes can be found. At least two strong stakes, preferably straight and without forks or snags, should be chosen to place through each spring eye (Fig. 8). Additional stakes may be useful to put between the spring arms and help hold the trap in place. Do not place stakes on the outside of spring arms. Aside from serving to hold the trap in place, these stakes also help to guide the beaver into the trap. Where needed, they are also useful in holding a dive stick at or just beneath the water surface (Fig. 9). If necessary, the chain and circle attached to one spring eye can be attached to another stake. In deep water sets, a chain with an attached wire should be tied to something at or above the surface so the trapper can retrieve the trap. Otherwise the trap may be lost.

Trap Sets.

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations). There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

There are many sets that can be made with a Conibear®-type trap (for example, dam sets, slide sets, lodge sets, bank den sets, "run"/trail sets, under log/dive sets, pole sets, under ice sets, deep water sets, drain pipe sets), depending on the trapper's capability and ingenuity. In many beaver ponds, however, most beavers can be trapped using dam sets, lodge or bank den sets, sets in "runs"/trails, dive sets or sets in slides entering the water from places where beavers are feeding. Beavers swim both at the surface or along the bottom of ponds, depending on the habitat and water depth. Beavers also establish runs or trails which they habitually use in traveling from lodge or den to the dam or to feeding areas, much like cow trails in a pasture.

Place traps directly across these runs, staked to the bottom (Fig. 10).

Use a good stake or "walking staff' when wading in a beaver pond to locate deep holes, runs, or trails. This will prevent stepping off over waders or hip boots in winter, and will help ward off cottonmouth snakes in the summer. The staff can also help locate good dive holes under logs as you walk out runs or trails. In older beaver ponds, particularly in bottomland swamps, it is not uncommon to find runs and lodge or bank den entrances where the run or hole is 2 to 3 feet (0.6 to 0.9 m) below the rest of the impoundment bottom.

Several other types of traps can be used, including basket/suitcase type live traps. These are rarely used, however, except by professionals in urban areas where anti-trap sentiment or other reasons prevent the killing of beavers. These traps are difficult and cumbersome to use, and will not be further discussed here for use in beaver damage control. Any type of traps used for beavers or other animals should be checked daily.

Snaring can be a very cost-effective method for capturing beavers. Snaring equipment costs far less than trapping equipment and is more convenient to use in many situations. In addition, beavers can be captured alive by snaring and released elsewhere if desired.

Snare placement is similar to trap placement. First, look for runways and fresh sign that indicate where beaver activities are focused. Find a suitable anchor such as a large tree, log, or root within 10 feet (3 m) of the runway where the snare will be set. If necessary, anchor snares by rods driven into the ground, but this is more time consuming and less secure. Attach three 14-gauge wires to the anchor so that each can swivel freely. Cut each wire to length so they reach about 1 foot (30 cm) past the runway. Twist the wires together to form a strong braided anchor cable. Drive a supporting stake into the ground near the runway and wrap the free end of the anchor cable around it twice. Prepare a new, dyed, No. 4 beaver or coyote snare, consisting of 42 inches (107 cm) of 3/32-inch (2.4-mm) steel cable with an attached wire swivel and slide lock. Twist the free ends of the three anchor wires around the wire swivel on the end of the snare cable. Wrap the longest anchor wire around the base of the wire swivel and crimp it onto the snare cable about 2 inches (5 cm) from the swivel. Use both the stake and the supporting anchor wire to suspend a full-sized loop about 4 inches (10 cm) above the runway. If necessary, use guide sticks or other natural debris to guide beaver into the snare.

The described snare set is very common, but there are several variations and sets that can be used. Snares are frequently placed under logs, near bank dens, and next to castor mounds. Drowning sets can be made using underwater anchors, slide cables, and slide locks.
Snared beavers should either be immediately
released or dispatched with a sharp blow or shot to the head.

Snares must be used with great care to avoid capturing nontarget animals. Avoid trails or areas that are used by livestock, deer, or dogs. Check with your local wildlife agency for regulations associated with trapping and snaring. Snaring is not allowed in some states.

For more information about the use of snares see *A Guide to Using Snares for Beaver Capture* (Weaver et al. 1985) listed at the end of this chapter.

Shooting

For information on legal ways of shooting beavers, see California laws and regulations pertaining to authorized methods of take.

Economics of Damage and Control

The economics of beaver damage is somewhat dependent on the extent of the damage before it has been discovered. Some beaver damage problems are *intensive*, such as damage caused by one or two beavers in a new pond, damming or stopping up a culvert or drain pipe, flooding roads, or crops. Other problems are *extensive*, such as several beaver colonies in a flatland area, responsible for the flooding of several hundred acres of marketable timber that will die unless the

water is removed quickly. Generally speaking, if a culvert or drain pipe can be unstopped, a knowledgeable trapper can remove one or two beavers in a night or two and eliminate further damage in an intensive damage situation. However, an extensive situation may require a concentrated effort with several trappers, dynamiting or pulling dams, and a month or more of trapping to get the water off the timber and reduce further timber losses.

Economic damage is estimated to have exceeded $40 billion in the Southeastern United States during a recent 40-year period (Arner and Dubose 1982). This would include all damage to crops, forests, roads, pastures, and other rural and urban properties.

Economically, one must assess the situation and weigh the tradeoffs: the potential loss of thousands of board feet of timber and years of regeneration versus the cost of trapping. The cost of a couple of nights' trapping and a half-day of labor to clear the culverts is much less than the cost of rebuilding a washed-out road or losing flooded crops or timber.

The most important point is that damage control should begin as soon as it is evident that a beaver problem exists or appears likely to develop. Once beaver colonies become well established over a large contiguous area, achieving control is difficult and costly. One of the most difficult situations arises when an adjacent landowner will not allow the control of beavers on their property. In this situation, one can expect periodic reinvasions of beavers and continual problems with beaver damage, even if all beavers are removed from the property where control is practiced.

Although benefits of beavers and beaver ponds are not covered in depth here, there are a number. Aside from creating fish, waterfowl, furbearer, shorebird, reptile, and amphibian habitat, the beaver in many areas is an important fur resource, as well as a food resource. For those who have not yet tried it, beaver meat is excellent table fare if properly prepared, and it can be used whether the pelts are worth skinning or not. It also makes good bait for trapping large predators.

Proper precautions, such as wearing rubber gloves, should be taken when skinning or eviscerating beaver carcasses, to avoid contracting transmissible diseases such as tularemia.

Acknowledgments

The authors thank, for their cooperation, past and present employees of the Fish and Wildlife Service, US Department of the Interior, county extension agents with the Cooperative Extension Service in various states, cooperators with the USDA-APHIS-ADC program in a number of states, and the many landowners with beaver problems across the South. The experience gained in efforts to assist landowners with wildlife damage problems provided most of the information contained herein.

Figures 1, 2, 4 and 5 from Schwartz and Schwartz (1981).

Figure 3 by Jill Sack Johnson.

Figure 6 and 7 by the authors.

Figures 8 through 10 from Miller (1978).

For Additional Information

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BOBCATS

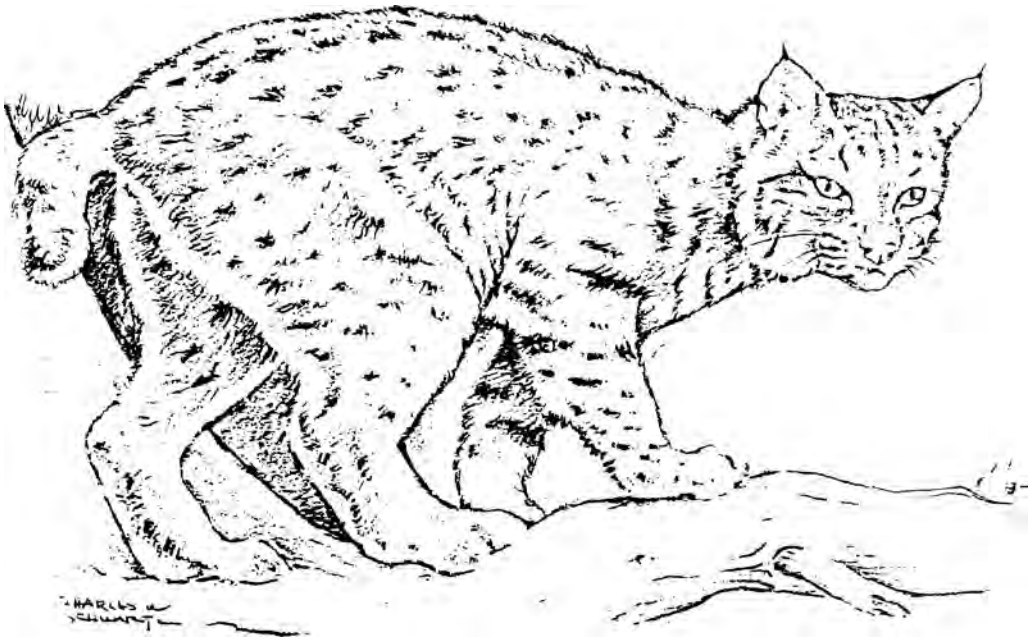

Fig. 1. Bobcat, *Lynx rufus*

Damage Prevention and Control Methods

Exclusion

Fence poultry and other small livestock located near human residence.

Cultural Methods

Clear brush and timber in and around farmsteads and between large expanses of bobcat habitat and farmsteads.

Frightening

Place flashing white lights, loud music, or dogs with livestock.

Repellents

None are registered.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting

Predator calls, experienced trail hounds, and centerfire rifles.

PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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

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

Great Plains Agricultural Council
Wildlife Committee

Identification

The bobcat (*Lynx rufus*), alias "wildcat," is a medium-sized member of the North American cat family. It can be distinguished at a distance by its graceful catlike movements, short (4- to 6-inches [10- to 15-cm]) "bobbed" tail, and round face and pointed ears (Fig. 1). Visible at close distances are black hair at the tip of the tail and prominent white dots on the upper side of the ears.

Body hair color varies, but the animal's sides and flanks are usually brownish black or reddish brown with either distinct or faint black spots. The back is commonly brownish yellow with a dark line down the middle. The chest and outside of the legs are covered with brownish to light gray fur with black spots or bars. Bobcats living at high elevations and in northern states and Canada have relatively long hair. In southern states, bobcats may have a yellowish or reddish cast on their backs and necks.

Similar Species. The bobcat is two to three times the size of the domestic cat and appears more muscular and fuller in the body. Also, the bobcat's hind legs are proportionately longer to its front legs than those of the domestic cat.

The Canada lynx appears more slender and has proportionately larger feet than the bobcat. At close distances, the ear tufts of the lynx can be seen. The tail of the lynx appears shorter than the bobcat's and its tip looks like it was dipped in black paint. The bobcat's tail is whitish below the tip. Lynx commonly occur in Canada's coniferous forests and, rarely, in the Rocky Mountains. Where both species occur, lynx occupy the more densely forested habitats with heavy snow cover.

Male bobcats tend to be larger than females. Adult males range from 32 to 40 inches (80 to 102 cm) long and weigh from 14 to 40 pounds (6 to 18 kg) or more. Bobcats in Wyoming average between 20 and 30 pounds (9 and 14 kg). Nationwide, adult females range from 28 to 32 inches (71 to 81 cm) long and weigh from 9 to 33 pounds (4 to 15 kg). Records indicate a tendency for heavier bobcats in the northern portions of their range and in western states at medium altitudes.

The skull has 28 teeth. Milk teeth are replaced by permanent teeth when kittens are 4 to 6 months old. Females have 6 mammae.

Range and Habitat

The bobcat occurs in a wide variety of habitats from the Atlantic to the Pacific ocean and from Mexico to northern British Columbia (Fig. 2). It occurs in the 48 contiguous states.

The bobcat is as adapted to subtropical forests as it is to dense shrub and hardwood cover in temperate climates. Other habitats include chaparral, wooded streams, river bottoms, canyonlands, and coniferous forests to 9,000 feet (2,743 m). Bobcats prefer areas where these native habitat types are interspersed with agriculture and escape cover (rocky outcrops) close by. The bobcat has thrived where agriculture is interspersed through the above native habitat types, as in southern Canada.

Food Habits

Bobcats are capable of hunting and killing prey that range from the size of a mouse to that of a deer. Rabbits, tree squirrels, ground squirrels, woodrats, porcupines, pocket gophers, and ground hogs comprise most of their diet. Opossums, raccoon, grouse, wild turkey, and other ground-nesting birds are also eaten. Occasionally, insects and reptiles can be part of the bobcat's diet. In Canada, the snowshoe hare is the bobcat's favorite fare. Bobcats occasionally kill livestock. They also resort to scavenging.

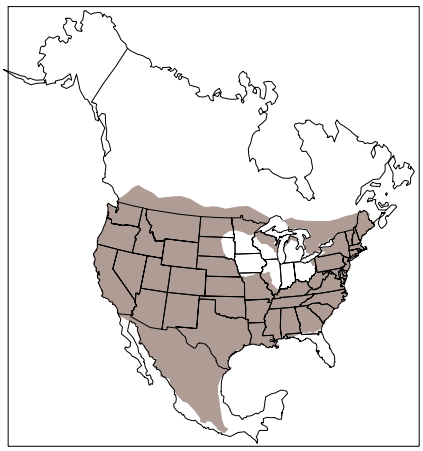

Fig. 2 Range of the bobcat in North America.

General Biology, Reproduction, and Behavior

Bobcats are secretive, shy, solitary, and seldom seen in the wild. They are active during the day but prefer twilight, dawn, or night hours. Bobcats tend to travel well-worn animal trails, logging roads, and other paths. They use their acute vision and hearing for locating enemies and prey.

Bobcats do not form lasting pair bonds. Mating can occur between most adult animals. In Wyoming, female bobcats reach sexual maturity within their first year but males are not sexually mature until their second year. Nationwide, breeding can occur from January to June. In Wyoming, breeding typically begins in February and the first estrus cycle in mid-March. The gestation period in bobcats ranges from 50 to 70 days, averaging 62 days.

Nationwide, young are born from March to July, with litters as late as October. The breeding season may be affected by latitude, altitude, and longitude, as well as by characteristics of each bobcat population. In Wyoming, births peak mid-May to mid-June and can occur as late as August or September. These late litters may be from recycling or late-cycling females, probably yearlings. In Utah, births may peak in April or May. In Arkansas, births may peak as early as March.

Bobcats weigh about 2/3 pound (300 g) at birth. Litters contain from 2 to 4 kittens. Kittens nurse for about 60 days and may accompany their mother through their first winter. Although young bobcats grow very quickly

during their first 6 months, males may not be fully grown until 1 1/2 years and females until 2 years of age. Bobcats may live for at least 12 years in the wild.

Bobcats reach densities of about 1 per 1/4 square mile (0.7 km^2) on some of the Gulf Coast islands of the southeastern United States. Densities vary from about 1 per 1/2 square mile (1.3 km^2) in the coastal plains to about 1 cat per 4 square miles (10.7 km^2) in portions of the Appalachian foothills. Mid-Atlantic and midwestern states usually have scarce populations of bobcats.

The social organization and home range of bobcats can vary with climate, habitat type, availability of food, and predators. Bobcats are typically territorial and will maintain the same territories throughout their lives. One study showed home ranges in south Texas to be as small as 5/8 square mile (1.0 km^2). Another study showed that individual bobcats in southeastern Idaho maintain home ranges from 2.5 square miles to 42.5 square miles (6.5 km^2 to 108 km^2) during a year. Females and yearlings with newly established territories tend to have smaller and more exclusive ranges than males. Females also tend to use all parts of their range more intensively than adult males.

Bobcats commonly move 1 to 4 miles (2 to 7 km^2) each day. One study found that bobcats in Wyoming moved from 3 to 7.5 miles (5 to 12 km) each day. Transient animals can move much greater distances; for example, a juvenile in one study moved 99 miles (158 km).

Adult bobcats are usually found separately except during the breeding season. Kittens may be seen with their mothers in late summer through winter. An Idaho study found adult bobcats and kittens in den sites during periods of extreme cold and snow. Females with kittens less than 4 months old generally avoid adult males because they kill kittens.

In Canada and the western United States, bobcat population levels tend to follow prey densities. Some biologists believe that coyote predation restricts bobcat numbers. Unfortunately, not enough is known about the relative importance of factors such as litter size, kitten survival, adult sex ratios, and survival rates to predict changes in local bobcat populations. Also, relatively low densities and variable trapping success hinder researchers from easily predicting changes in populations.

Since the late 1970s, state game agencies have been tagging bobcat pelts harvested in their states. Information from these pelts is being used to estimate bobcat population trends and factors that contribute to those changes.

Damage and Damage Identification

Bobcats are opportunistic predators, feeding on poultry, sheep, goats, house cats, small dogs, exotic birds and game animals, and, rarely, calves. Bobcats can easily kill domestic and wild turkeys, usually by climbing into their night roosts. In some areas, bobcats can prevent the successful introduction and establishment of wild turkeys or can deplete existing populations.

Bobcats leave a variety of sign. Bobcat tracks are about 2 to 3 inches (5 to 8 cm) in diameter and resemble those of a large house cat. Their walking stride length between tracks is about 7 inches (18 cm).

Carcasses of bobcat kills are often distinguishable from those of cougar, coyote, or fox. Bobcats leave claw marks on the backs or shoulders of adult deer or antelope. On large carcasses, bobcats usually open an area just behind the ribs and begin feeding on the viscera. Sometimes feeding starts at the neck, shoulders, or hindquarters. Bobcats and cougar leave clean-cut edges of tissue or bone while coyotes leave ragged edges where they feed.

Bobcats bite the skull, neck, or throat of small prey like lambs, kids, or fawns, and leave claw marks on their sides, back, and shoulders. A single bite to the throat, just behind the victim's jaws, leaves canine teeth marks 3/4 to 1 inch (2 to 2.5 cm) apart.

Carcasses that are rabbit-size or smaller may be entirely consumed at one feeding. Bobcats may return several times to feed on large carcasses.

Bobcats, like cougars, often attempt to cover unconsumed remains of kills by scratching leaves, dirt, or snow over them. Bobcats reach out about 15 inches (38 cm) in raking up debris to cover their kills, while cougars may reach out 24 inches (61 cm).

Bobcats also leave signs at den sites. Young kittens attempt to cover their feces at their dens. Females with young kittens may mark prominent points around den sites with their feces. Adult bobcats leave conspicuous feces along frequently traveled rocky ridges or other trails. These are sometimes used as territorial markings at boundaries.

Adult bobcats also mark trails or cave entrances with urine. This is sprayed on rocks, bushes, or snow banks. Bobcats may leave claw marks at urine or feces scent posts by scraping with their hind feet. These marks are 10 to 12 inches (25 to 30 cm) long by 1/2 inch (1.25 cm) wide.

Bobcats also occasionally squirt a pasty substance from their anal glands to mark areas. The color of this substance is white to light yellow in young bobcats but is darker in older bobcats.

Legal Status

In California, bobcats are classified as nongame mammals. There is a trapping and hunting season when bobcats may be harvested. Landowners suffering from property damage may take the bobcats without obtaining a permit from the DFG. However, there is a 30-day notification requirement in which the landowner must notify the DFG that a bobcat was taken. See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Exclusion

Use woven-wire enclosures to discourage bobcats from entering poultry and small animal pens at night. Bobcats can climb, so wooden fence posts or structures that give the bobcat footing may not be effective. Bobcats also have the ability to jump fences 6 feet (1.8 m) or more in height. Use woven wire overhead if necessary. Fences are seldom totally effective except in very small enclosures.

Cultural Methods

Bobcats prefer areas with sufficient brush, timber, rocks, and other cover, and normally do not move far from these areas. Keep brush cut or sprayed around ranches and farmsteads to eliminate routes of connecting vegetation from bobcat habitat to potential predation sites.

Frightening

Use night lighting with white flashing lights, or bright continuous lighting, to repel bobcats. You can also use blaring music, barking dogs, or changes in familiar structures to temporarily discourage bobcats.

Repellents

No chemical repellents are currently registered for bobcats. Commercial house cat repellents might be effective in some very unusual circumstances.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations). There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Bobcats are more easily trapped than are coyotes or foxes, but the bobcat's reclusiveness makes set locations difficult to find. When hunting, bobcats use their sense of smell less than coyotes do, so lures and baits are usually not effective. The bobcat's acute vision, hearing, and inquisitiveness however, can be capitalized upon.

Wire Cage Traps. Very large cage traps, made of wire mesh or metal, when properly set, are effective. Commercial traps from 15 x 15 x 40 inches (38 x 38 x 100 cm) up to 24 x 24 x 48 inches (60 x 60 x 120 cm) are available.

Use brush or grass on the top and sides of the cage to give the appearance of a natural "cubby" or recess in a rock outcrop or brush. Traps should be set in the vicinity of depredations, travelways to and from bobcat cover, and around bobcat trails, dens, and hunting sites. Cover the cage bottom with soil. Bait the cage with poultry, rabbit, or muskrat carcasses, or live animals. Check local and state laws for restrictions.

Snares. Snares are very effective for bobcats but require expertise and caution. When properly set, a snare can be used to either kill or restrain a bobcat. Snares can be placed in the same locations and situations as body-gripping traps. They are particularly effective in cubby sets, bobcat runways, and den entrances (Fig. 6). Properly placed, snares offer the advantages of body-gripping traps without the danger to pets and nontarget wildlife.

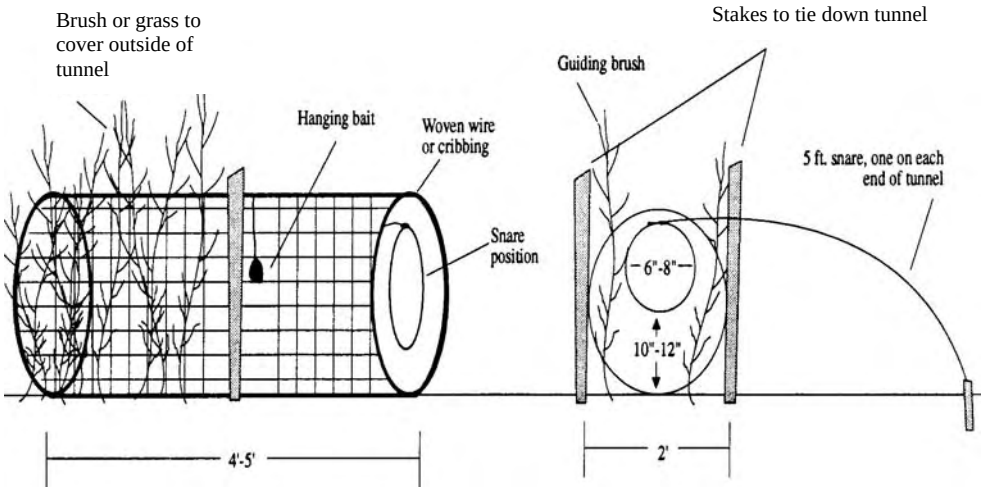

Fig. 6. Cubby set with snare.

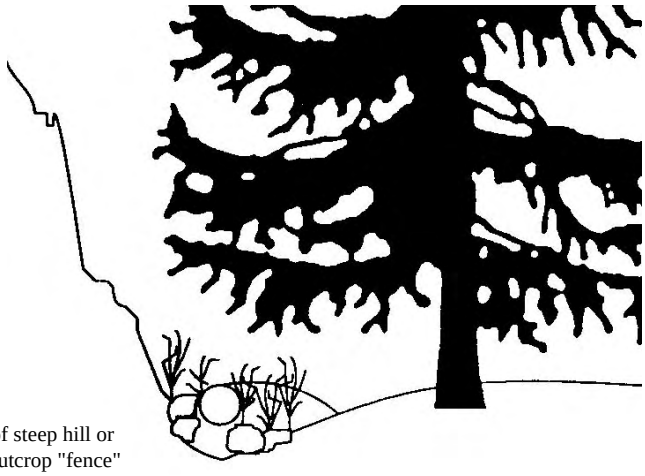

Fig. 7. Trail set with snare.

Set snares in trails where bobcats are known to travel (Fig. 7). Baits and lures are usually not used with snares and may hinder success. Use camouflage only to break up some of the outline of the snare, preferably with native material, like grasses. Do not tie camouflage material to the loop of the snare. Spring-loaded snares work best. Put "memory" into the snare by placing tension on the inside of the lock against the cable with your finger as you close the snare once or twice. This prevents a bobcat from walking through a snare. Cables respond to the memory by closing easily.

Kill snares actually kill the captured bobcat.
They are best made from fine steel cable, 1/16 inch (0.15 cm) or 5/64 inch (0.2 cm) in diameter. Positive locks work well. Set kill snares with the bottom of the loop about 10 to 12 inches (25 to 30 cm) off the ground with a loop 6 to 8 inches (15 to 20 cm) in diameter (Fig. 8). This loop must be set perpendicular to the trail.

Live snare sets capture and hold bobcats alive. They differ from kill snare sets by their cable size, locks, and entanglement precautions. Larger cables and relaxed locks on live snare sets can reduce injury if set properly. Relaxed locks tighten onto animals but relax as the animal stops struggling. This allows the animal to breath normally and regain composure.

Kill snares may be tied off to a 3-inch (7.5-cm) diameter tree or larger . To aid quick kills, hammer 2-foot (60-cm) stakes into the ground, leaving 6 to 8 inches (15 to 20 cm) aboveground.

The live snare set (Fig. 9) requires more expertise than the kill snare set. Also, capture and transport of bobcats is very dangerous. Use 3/32-inch (0.25-cm) steel cable 6 to 8 feet (1.9 to 2.5 m) long. Use snares with high quality swivels located midway or closer to the loop. Stake live snares to the ground with steel stakes, hammered to just below ground level. Use loop sizes as in the kill snare set. Clear brush and other entanglements from the area.
Use extreme caution when releasing a snared animal. Catch poles with adjustable steel nooses, thick leather gloves or gauntlets, and other protective clothing are necessary. Immobilizing drugs such as ketamine hydrochloride should be accessible. Two people should handle captures; one at the neck and the other at the back feet to remove the snare. Cut a 1/2- x 4-inch (1.2- x 10-cm) slot from the bottom up toward the center of a 3- x 3-foot (1- x 1-m), 5/8-inch (1.6-cm) or larger piece of plywood. A handle should be attached at the upper end. Place the plywood between you and the snared animal and let the cable run through the slot as you approach, keeping the cable tight. Check live snare sets frequently to avoid unnecessary stress and loss of captured bobcats to predators, such as eagles, coyotes, and mountain lions. Always ask for expert advice before attempting live captures. Extensive instructions on snaring can be found in Grawe (1981) and Krause (1981).

Shooting
Bobcats respond to predator calls at night and can be shot. Use a red, blue, or amber lens with an 80,000- to 200,000-candlepower (lumen) spotlight to locate bobcats.
Dogs trained to track bobcats can be useful in removing problem animals. Bobcats can be shot after being treed. Bobcats may develop a time pattern in their depredations on livestock or poultry. You can lie in wait and ambush the bobcat as it comes in for the kill. Rifles of .22 centerfire or larger, or shotguns with 1 1/4 ounces (35 g) or more of No. 2 or larger shot are recommended, since bobcats are rather large and require considerable killing power.

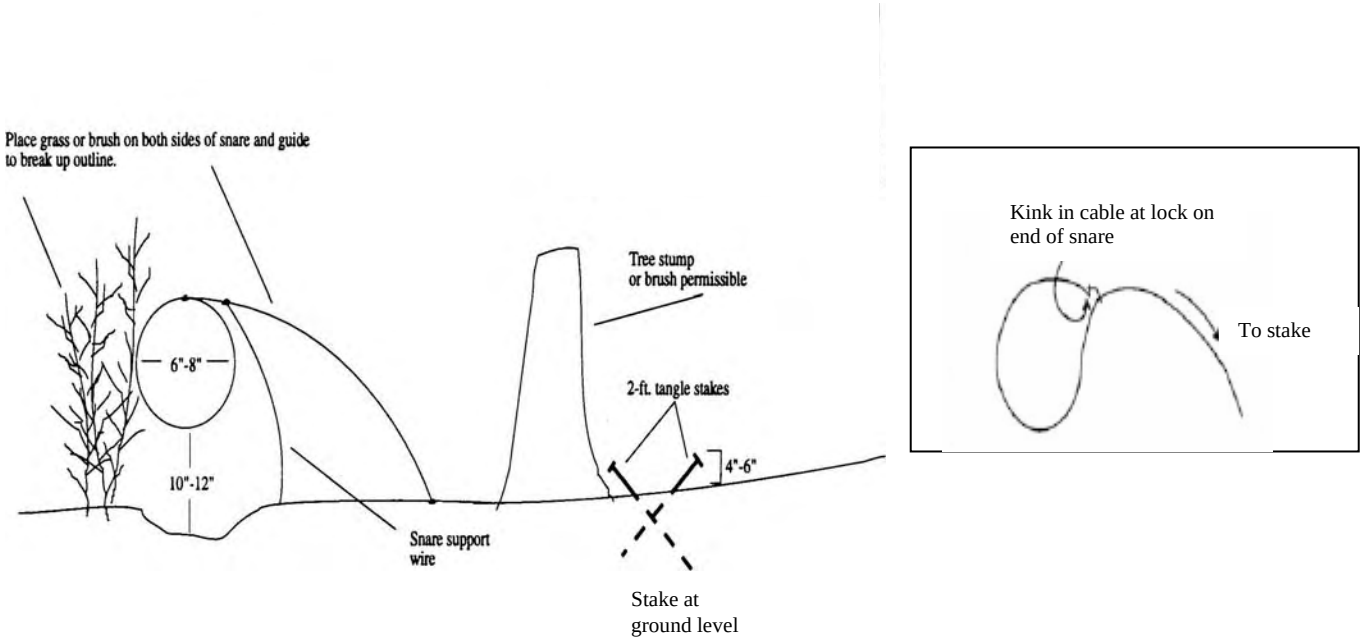

Fig. 8. Kill snare with washer lock.

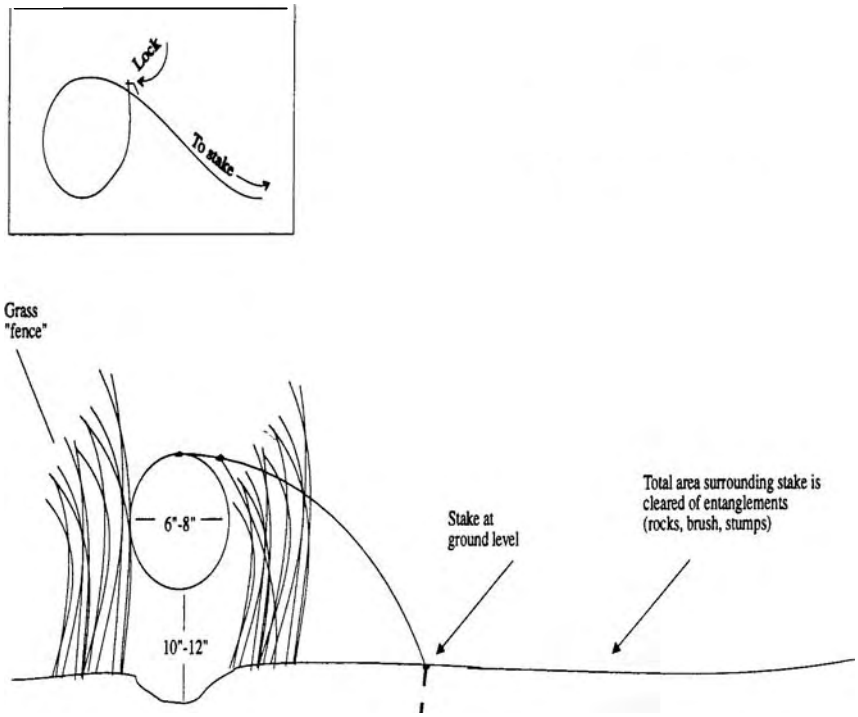

Fig. 9. Live snare with washer lock.

Economics of Damage and Control

Damage by bobcats is rather uncommon and statistics related to this damage are not well developed. In western states where data have been obtained, losses of sheep and goats have comprised less than 10% of all predation losses. Typical complaints of bobcat predation involve house cats and poultry allowed to roam at will in mountain subdivisions and ranches. Bobcats are taken by trappers and by hunters using hounds. The pelts are used for coats, trim, and accessories, the spotted belly fur being most valuable. Bobcat pelts are used for wall decorations and rugs. In recent years, North American bobcat harvests have produced about 25,000 pelts valued at $2.5 million annually. Aesthetically, the bobcat is a highly regarded carnivore. To many people the bobcat represents the essence of wildness in any habitat it occupies.

Acknowledgments

Thanks are due to Major Boddicker, who authored this chapter in the 1983 edition of this manual. The sections on identification, habitat, food habits, general biology, and economics were adapted from his work. Thanks also go to Bill Phillips, Arizona Game and Fish Department, and Chuck McCullough, Nebraska Game and Parks Commission, for their information.

Figure 1 from Schwartz and Schwartz (1981).

Figure 2 by Sheri Bordeaux.

Figures 6, 8 and 9 by Denny Hogeland, adapted

by Sheri Bordeaux.

Figure 7 adapted from M. L. Boddicker, 1980.

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COYOTES

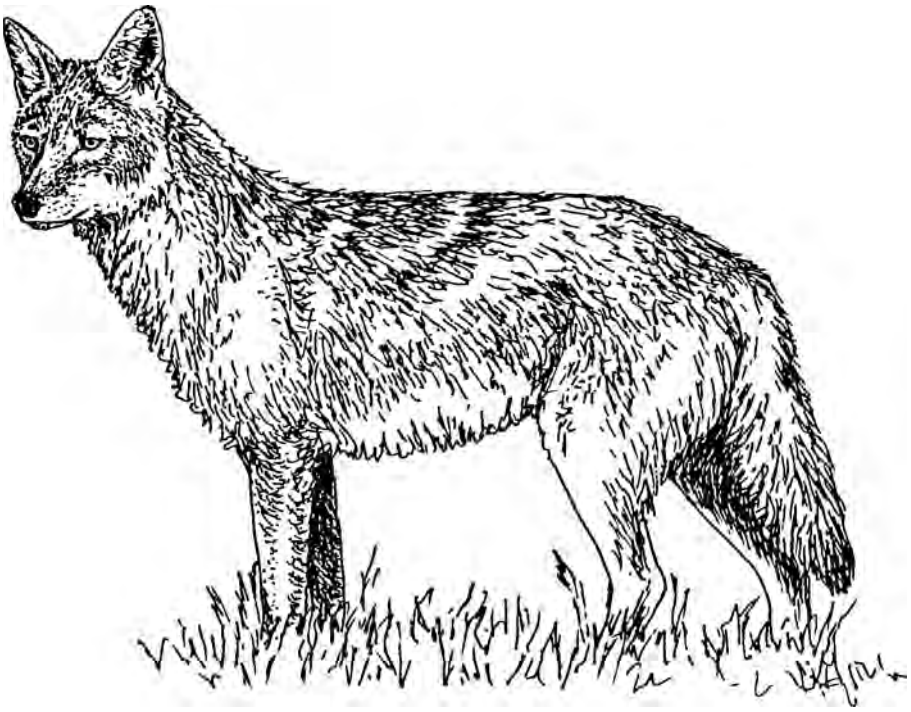


Fig. 1. Coyote, *Canis latrans*

Damage Prevention and Control Methods

Exclusion

Produce livestock in confinement.

Herd livestock into pens at night.

Exclusion fences (net-wire and/or electric), properly constructed and maintained, can aid significantly in reducing predation.

Cultural Methods and Habitat Modification

Select pastures that have a lower incidence of predation to reduce exposure of livestock to predation.

Herding of livestock generally reduces predation due to human presence during the herding period.

Change lambing, kidding, and calving seasons.

Shed lambing, kidding, and calving usually reduce coyote predation.

Remove carrion to help limit coyote populations.

Frightening Agents and Repellents

Guarding dogs: Some dogs have significantly reduced coyote predation.

Donkeys and llamas: Some are aggressive toward canines and have reduced coyote predation.

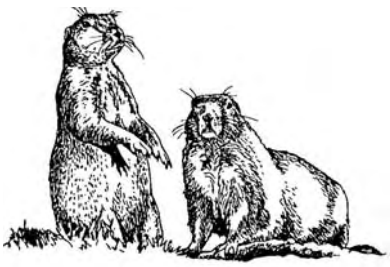
Sonic and visual repellents: Strobe lights, sirens, propane cannons, and others have reduced predation on both sheep and calves.

Chemical odor and taste repellents: None have shown sufficient effectiveness to be registered for use.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994
Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln
United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control
Great Plains Agricultural Council
Wildlife Committee

Shooting

Shooting from the ground is effective.

Use rabbit distress calls or mimic howling or other coyote sounds to bring coyotes within shooting distance.

Hunting with dogs is effective for trailing coyotes from kill sites, locating dens, running coyotes, and assisting with calling.

Other Methods

Denning: Remove adult coyotes and/or their young from dens.

Identification

In body form and size, the coyote (*Canis latrans*) resembles a small collie dog, with erect pointed ears, slender muzzle, and a bushy tail (Fig. 1). Coyotes are predominantly brownish gray in color with a light gray to cream-colored belly. Color varies greatly, however, from nearly black to red or nearly white in some individuals and local populations. Most have dark or black guard hairs over their back and tail. In western states, typical adult males weigh from 25 to 45 pounds (11 to 16 kg) and females from 22 to 35 pounds (10 to 14 kg). In the East, many coyotes are larger than their western counterparts, with males averaging about 45 pounds (14 kg) and females about 30 pounds (13 kg).

Coyote-dog and coyote-wolf hybrids exist in some areas and may vary greatly from typical coyotes in size, color, and appearance. Also, coyotes in the New England states may differ in color from typical western coyotes. Many are black, and some are reddish. These colorations may partially be due to past hybridization with dogs and wolves. True wolves are also present in some areas of coyote range, particularly in Canada, Alaska, Montana, northern Minnesota, Wisconsin, and Michigan. Relatively few wolves remain in the southern United States and Mexico.

Range

Historically, coyotes were most common on the Great Plains of North America. They have since extended their range from Central America to the Arctic, including all of the United States (except Hawaii), Canada, and Mexico.

Habitat

Many references indicate that coyotes were originally found in relatively open habitats, particularly the grasslands and sparsely wooded areas of the western United States. Whether or not this was true, coyotes have adapted to and now exist in virtually every type of habitat, arctic to tropic, in North America. Coyotes live in deserts, swamps, tundra, grasslands, brush, dense forests, from below sea level to high mountain ranges, and at all intermediate altitudes. High densities of coyotes also appear in the suburbs of Los Angeles, Pasadena, Phoenix, and other western cities.

Food Habits

Coyotes often include many items in their diet. Rabbits top the list of their dietary components. Carrion, rodents, ungulates (usually fawns), insects (such as grasshoppers), as well as livestock and poultry, are also consumed. Coyotes readily eat fruits such as watermelons, berries, and other vegetative matter when they are available. In some areas coyotes feed on human refuse at dump sites and take pets (cats and small dogs).

Coyotes are opportunistic and generally take prey that is the easiest to secure. Among larger wild animals, coyotes tend to kill young, inexperienced animals, as well as old, sick, or weakened individuals. With domestic animals, coyotes are capable of catching and killing healthy, young, and in some instances, adult prey. Prey selection is based on opportunity and a myriad of behavioral cues. Strong, healthy lambs are often taken from a flock by a coyote even though smaller, weaker lambs are also present. Usually, the stronger lamb is on the periphery and is more active, making it more prone to attack than a weaker lamb that is at the center of the flock and relatively immobile.

Coyote predation on livestock is generally more severe during early spring and summer than in winter for two reasons. First, sheep and cows are usually under more intensive management during winter, either in feedlots or in pastures that are close to human activity, thus reducing the opportunity for coyotes to take livestock. Second, predators bear young in the spring and raise them through the summer, a process that demands increased nutritional input, for both the whelping and nursing mother and the growing young. This increased demand corresponds to the time when young sheep or beef calves are on pastures or rangeland and are most vulnerable to attack. Coyote predation also may increase during fall when young coyotes disperse from their home ranges and establish new territories.

General Biology, Reproduction, and Behavior

Coyotes are most active at night and during early morning hours (especially where human activity occurs), and during hot summer weather. Where there is minimal human interference and during cool weather, they may be active throughout the day.

Coyotes bed in sheltered areas but do not generally use dens except when raising young. They may seek shelter underground during severe weather or when closely pursued. Their physical abilities include good eyesight and

hearing and a keen sense of smell. Documented recoveries from severe injuries are indicative of coyotes' physical endurance. Although not as fleet as greyhound dogs, coyotes have been measured at speeds of up to 40 miles per hour (64 km/hr) and can sustain slower speeds for several miles (km).

Distemper, hepatitis, parvo virus, and mange (caused by parasitic mites) are among the most common coyote diseases. Rabies and tularemia also occur and may be transmitted to other animals and humans. Coyotes harbor numerous parasites including mites, ticks, fleas, worms, and flukes. Mortality is highest during the first year of life, and few survive for more than 10 to 12 years in the wild. Human activity is often the greatest single cause of coyote mortality.

Coyotes usually breed in February and March, producing litters about 9 weeks (60 to 63 days) later in April and May. Females sometimes breed during the winter following their birth, particularly if food is plentiful. Average litter size is 5 to 7 pups, although up to 13 in a litter has been reported. More than one litter may be found in a single den; at times these may be from females mated to a single male. As noted earlier, coyotes are capable of hybridizing with dogs and wolves, but reproductive dysynchrony and behaviors generally make it unlikely. Hybrids are fertile, although their breeding seasons do not usually correspond to those of coyotes.

Coyote dens are found in steep banks, rock crevices, sinkholes, and underbrush, as well as in open areas. Usually their dens are in areas selected for protective concealment. Den sites are typically located less than a mile (km) from water, but may occasionally be much farther away. Coyotes will often dig out and enlarge holes dug by smaller burrowing animals. Dens vary from a few feet (1 m) to 50 feet (15 m) and may have several openings.

Both adult male and female coyotes hunt and bring food to their young for several weeks. Other adults associated with the denning pair may also help in feeding and caring for the young. Coyotes commonly hunt as singles or pairs; extensive travel is common in their hunting forays. They will hunt in the same area regularly, however, if food is plentiful. They occasionally bury food remains for later use.

Pups begin emerging from their den by 3 weeks of age, and within 2 months they follow adults to large prey or carrion. Pups normally are weaned by 6 weeks of age and frequently are moved to larger quarters such as dense brush patches and/or sinkholes along water courses. The adults and pups usually remain together until late summer or fall when pups become independent. Occasionally pups are found in groups until the breeding season begins.

Coyotes are successful at surviving and even flourishing in the presence of people because of their adaptable behavior and social system. They typically display increased reproduction and immigration in response to human-induced population reduction.

Damage and Damage Identification

Coyotes can cause damage to a variety of resources, including livestock, poultry, and crops such as watermelons. They sometimes prey on pets and are a threat to public health and safety when they frequent airport runways and residential areas, and act as carriers of rabies. Usually, the primary concern regarding coyotes is predation on livestock, mainly sheep and lambs. Predation will be the focus of the following discussion.

Since coyotes frequently scavenge on livestock carcasses, the mere presence of coyote tracks or droppings near a carcass is not sufficient evidence that predation has taken place. Other evidence around the site and on the carcass must be carefully examined to aid in determining the cause of death. Signs of a struggle may be evident. These may include scrapes or drag marks on the ground, broken vegetation, or blood in various places around the site. The quantity of sheep or calf remains left after a kill vary widely depending on how recently the kill was made, the size of the animal killed, the weather, and the number and species of predators that fed on the animal.

One key in determining whether a sheep or calf was killed by a predator is the presence or absence of subcutaneous (just under the skin) hemorrhage at the point of attack. Bites to a dead animal will not produce hemorrhage, but bites to a live animal will. If enough of the sheep carcass remains, carefully skin out the neck and head to observe tooth punctures and hemorrhage around the punctures. Talon punctures from large birds of prey will also cause hemorrhage, but the location of these is usually at the top of the head, neck, or back. This procedure becomes less indicative of predation as the age of the carcass increases or if the remains are scanty or scattered.

Coyotes, foxes, mountain lions, and bobcats usually feed on a carcass at the flanks or behind the ribs and first consume the liver, heart, lungs, and other viscera. Mountain lions often cover a carcass with debris after feeding on it. Bears generally prefer meat to viscera and often eat first the udder from lactating ewes. Eagles skin out carcasses on larger animals and leave much of the skeleton intact. With smaller animals such as lambs, eagles may bite off and swallow the ribs. Feathers and "whitewash" (droppings) are usually present where an eagle has fed.

Coyotes may kill more than one animal in a single episode, but often will only feed on one of the animals. Coyotes typically attack sheep at the throat, but young or inexperienced coyotes may attack any part of the body. Coyotes usually kill calves by eating into the anus or abdominal area.

Dogs generally do not kill sheep or calves for food and are relatively indiscriminate in how and where they attack. Sometimes, however, it is difficult to differentiate between dog and coyote kills without also looking at other sign, such as size of tracks (Fig. 2) and spacing and size of canine

tooth punctures. Coyote tracks tend to be more oval-shaped and compact than those of common dogs. Nail marks are less prominent and the tracks tend to follow a straight line more closely than those of dogs. The average coyote's stride at a trot is 16 to 18 inches (41 to 46 cm), which is typically longer than that of a dog of similar size and weight. Generally, dogs attack and rip the flanks, hind quarters, and head, and may chew ears. The sheep are sometimes still alive but may be severely wounded.

Accurately determining whether or not predation occurred and, if so, by what species, requires a considerable amount of knowledge and experience. Evidence must be gathered, pieced together, and then evaluated in light of the predators that are in the area, the time of day, the season of the year, and numerous other factors. Sometimes even experts are unable to confirm the cause of death, and it may be necessary to rely on circumstantial information.

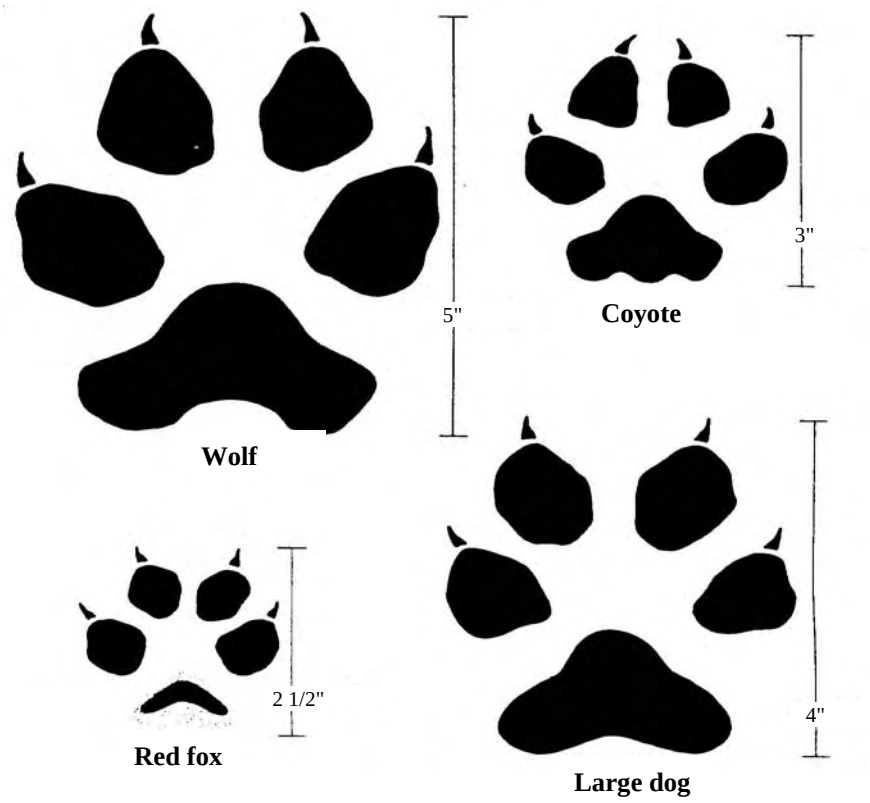


Fig. 2. Footprints of canid predators

Legal Status

In California, the coyote is designated as a nongame mammal. See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

For managing coyote damage, a variety of control methods must be available since no single method is effective in every situation. Success usually involves an integrated approach, combining good husbandry practices with effective control methods for short periods of time. Regardless of the means used to stop damage, the focus should be on damage prevention and control rather than elimination of coyotes. It is neither wise nor practical to kill all coyotes. It is important to try to prevent coyotes from killing calves or sheep for the first time. Once a coyote has killed livestock, it will probably continue to do so if given the opportunity. Equally important is taking action as quickly as possible to stop coyotes from killing after they start.

Exclusion

Most coyotes readily cross over, under, or through conventional livestock fences. A coyote's response to a fence is influenced by various factors, including the coyote's experience and motivation for crossing the fence. Total exclusion of all coyotes by fencing, especially from large areas, is highly unlikely since some eventually learn to either dig deeper or climb higher to defeat a fence. Good fences, however, can be important in reducing predation, as well as increasing the effectiveness of other damage control methods (such as snares, traps, or guarding animals). Recent developments in fencing equipment and design have made this technique an effective and economically practical method for protecting sheep from predation under some grazing conditions. Exclusion fencing may be impractical in western range sheep ranching operations.

Net-Wire Fencing. Net fences in good repair will deter many coyotes from entering a pasture. Horizontal spacing of the mesh should be less than 6 inches (15 cm), and vertical spacing less than 4 inches (10 cm). Digging under a fence can be discouraged by placing a barbed wire at ground level or using a buried wire apron (often an expensive option). The fence should be about 5 1/2 feet (1.6 m) high to discourage coyotes from jumping over it. Climbing can usually be prevented by adding a charged wire at the top of the fence or installing a wire overhang.

Barrier fences with wire overhangs and buried wire aprons were tested in Oregon and found effective in keeping coyotes out of sheep pastures (Fig. 3).

The construction and materials for such fencing are usually expensive. Therefore, fences of this type are rarely used except around corrals, feedlots, or areas of temporary sheep confinement.

Electric Fencing. Electric fencing, used for years to manage livestock, has recently been revolutionized by the introduction of new energizers and new fence designs from Australia and New Zealand. The chargers, now also manufactured in the United States, have high output with low impedance, are resistant to grounding, present a minimal fire hazard, and are generally safe for livestock and humans. The fences are usually constructed of smooth, high-tensile wire stretched to a tension of 200 to 300 pounds (90 to 135 kg). The original design of electric fences for controlling predation consisted of multiple, alternately charged and grounded wires, with a charged trip wire installed just above ground level about 8 inches (20 cm) outside the main fence to discourage digging. Many recent designs have every wire charged.

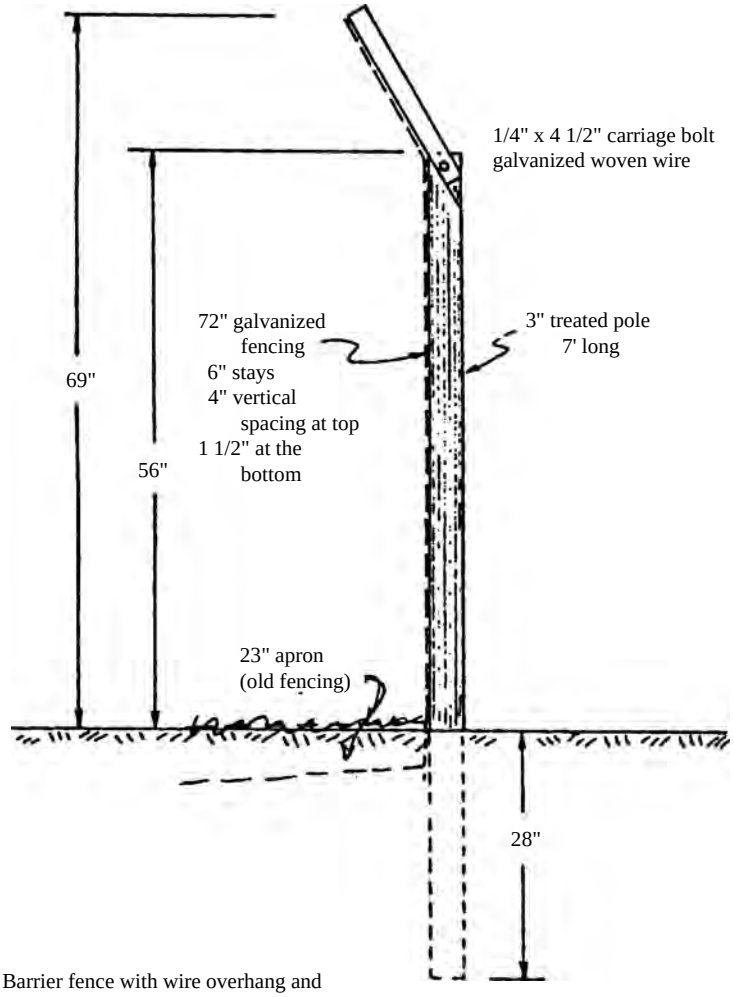


Fig. 3. Barrier fence with wire overhang and buried apron.

The number of spacings between wires varies considerably. A fence of 13 strands gave complete protection to sheep from coyote predation in tests at the USDA's US Sheep Experiment Station (Fig. 4). Other designs of fewer wires were effective in some studies, ineffective in others.

The amount of labor and installation techniques required vary with each type of fencing. High-tensile wire fences require adequate bracing at corners and over long spans. Electric fencing is easiest to install on flat, even terrain. Labor to install a high-tensile electric fence may be 40% to 50% less than for a conventional livestock fence.

Labor to keep electric fencing functional can be significant. Tension of the wires must be maintained, excessive vegetation under the fence must be removed to prevent grounding, damage from livestock and wildlife must be repaired, and the charger must be checked regularly to ensure that it is operational.

Coyotes and other predators occasionally become "trapped" inside electric fences. These animals receive a shock as they enter the pasture and subsequently avoid approaching the fence to escape. In some instances the captured predator may be easy to spot and remove from the pasture, but in others, particularly in large pastures with rough terrain, the animal may be difficult to remove.

Electric Modification of Existing Fences. The cost to completely replace old fences with new ones, whether conventional or electric, can be substantial. In instances where existing fencing is in reasonably good condition, the addition of one to several charged wires can significantly enhance the predator-deterring ability of the fence and its effectiveness for controlling livestock (Fig. 5). A charged trip wire placed 6 to 8 inches (15 to 230 cm) above the ground about 8 to 10 inches (20 to 25 cm) outside the fence is often effective in preventing coyotes from digging and crawling under. This single addition to an existing fence is often the most effective and economical way to fortify a fence against coyote passage.

If coyotes are climbing or jumping a fence, charged wires can be added to the top and at various intervals. These wires should be offset outside the fence. Fencing companies offer offset brackets to make installation relatively simple. The number of additional wires depends on the design of the original fence and the predicted habits of the predators.

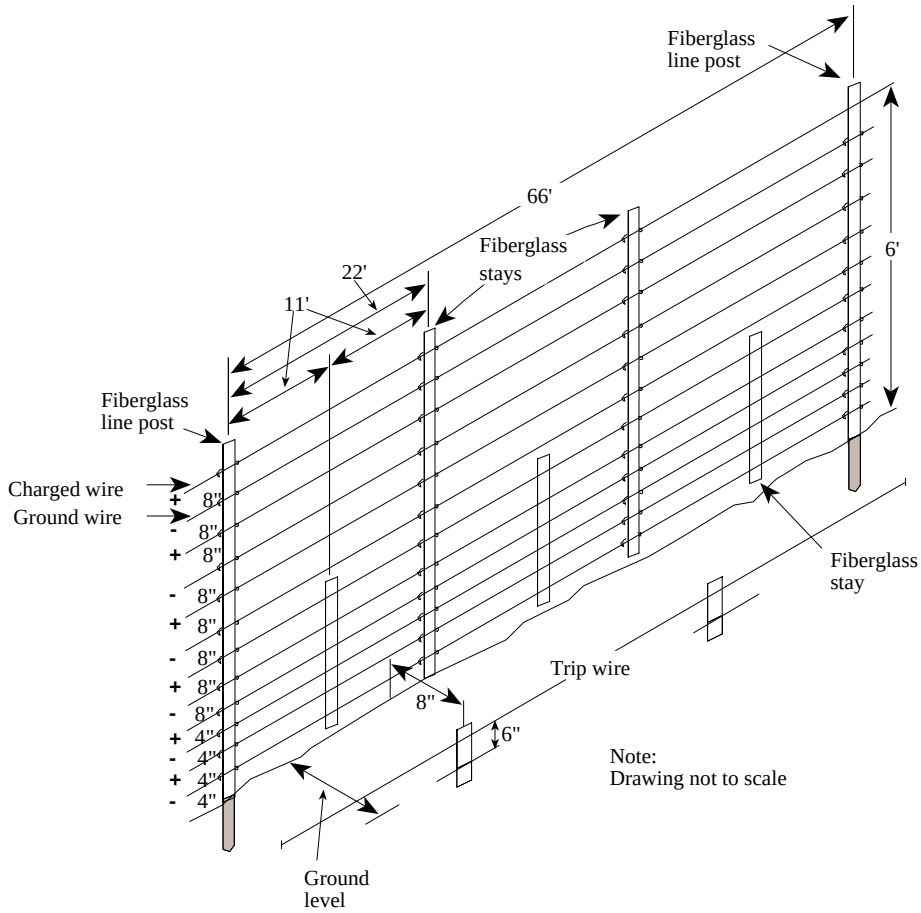


Fig. 4. High-tensile, electric, antipredator fence.

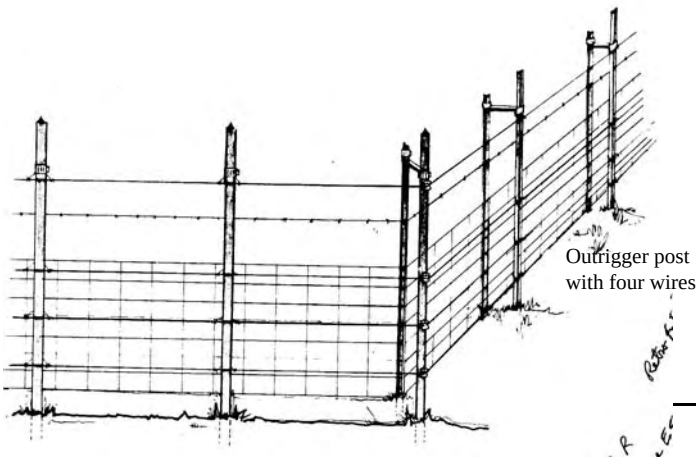


Fig. 5. Existing woven-wire livestock fence modified with electrified wire.

Portable Electric Fencing. The advent of safe, high-energy chargers has led to the development of a variety of portable electric fences. Most are constructed with thin strands of wire running through polyethylene twine or ribbon, commonly called polywire or polytape. The polywire is available in single and multiple wire rolls or as mesh fencing of various heights. It can be quickly and easily installed to serve as a temporary corral or to partition off pastures for controlled grazing.

Perhaps the biggest advantage of portable electric fencing is the ability to set up temporary pens to hold livestock at night or during other predator control activities. Portable fencing increases livestock management options to avoid places or periods of high predation risk. Range sheep that are not accustomed to being fenced, however, may be difficult to contain in a portable fence.

Fencing and Predation Management. The success of various types of fencing in keeping out predators has ranged from poor to excellent. Density and behavior of coyotes, terrain and vegetative conditions, availability of prey, size of pastures, season of the year, design of the fence, quality of construction, maintenance, and other factors all interplay in determining how effective a fence will be. Fencing is most likely to be cost-effective where the potential for predation is high, where there is potential for a high stocking rate, or where electric modification of existing fences can be used.

Fencing can be effective when incorporated with other means of predation control. For example, combined use of guarding dogs and fencing has achieved a greater degree of success than either method used alone. An electric fence may help keep a guarding dog in and coyotes out of a pasture. If an occasional coyote does pass through a fence, the guarding dog can keep it away from the livestock and alert the producer by barking.

Fencing can also be used to concentrate predator activity at specific places such as gateways, ravines, or other areas where the animals try to gain access. Traps and snares can often be set at strategic places along a fence to effectively capture predators. Smaller pastures are easier to keep free from predators than larger ones encompassing several square miles (km)^2.

Fencing is one of the most beneficial investments in predator damage control and livestock management where practical factors warrant its use.
As a final note, fences can pose problems for wildlife. Barrier fences in particular exclude not only predators, but also many other wildlife species. This fact should be considered where fencing intersects migration corridors for wildlife. Ungulates such as deer may attempt to jump fences, and they occasionally become entangled in the top wires.

Cultural Methods and Habitat Modification

At the present time, there are no documented differences in the vulnerability of various breeds of sheep to coyote or dog predation because there has been very little research in this area. Generally, breeds with stronger flocking behaviors are less vulnerable to predators.

A possible cause of increased coyote predation to beef cattle calves is the increased use of cattle dogs in herding. Cows herded by dogs may not be as willing to defend newborn calves from coyotes as those not accustomed to herding dogs.

Flock or Herd Health. Healthy sheep flocks and cow/calf herds have higher reproductive rates and lower overall death losses. Coyotes often prey on smaller lambs. Poor nutrition means weaker or smaller young, with a resultant increased potential for predation. Ewes or cows in good condition through proper nutrition will raise stronger young that may be less vulnerable to coyote predation.

Record Keeping. Good record-keeping and animal identification systems are invaluable in a livestock operation for several reasons. From the standpoint of coyote predation, records help producers identify loss patterns or trends to provide baseline data that will help determine what type and amount of coyote damage control is economically feasible. Records also aid in identifying critical problem areas that may require attention. They may show, for example, that losses to coyotes are high in a particular pasture in early summer, thus highlighting the need for preventive control in that area.

Counting sheep and calves regularly is important in large pastures or areas with heavy cover where dead livestock could remain unnoticed. It is not unusual for producers who do not regularly count their sheep to suffer fairly substantial losses before they realize there is a problem. Determining with certainty whether losses were due to coyotes or to other causes may become impossible.

Season and Location of Lambing or Calving. Both season and location of lambing and calving can significantly affect the severity of coyote predation on sheep or calves. The highest predation losses of sheep and calves typically occur from late spring through September due to the food requirements of coyote pups. In the Midwest and East, some lambing or calving occurs between October and December, whereas in most of the western states lambing or calving occurs between February and May. By changing to a fall lambing or calving program, some livestock producers have not only been able to diversify their marketing program, but have also avoided having a large number of young animals on hand during periods when coyote predation losses are typically highest.

Shortening lambing and calving periods by using synchronized or group breeding may reduce predation by producing a uniform lamb or calf crop, thus reducing exposure of small livestock to predation. Extra labor and facilities may be necessary, however, when birthing within a concentrated period. Some producers practice early weaning and do not allow young to go to large pastures, thus reducing the chance of coyote losses. This also gives orphaned and weak young a greater chance to survive.

The average beef cattle calf production is about 78% nationwide. First-calf heifers need human assistance to give birth to a healthy calf about 40% of the time. Cow/calf producers who average 90% to 95% calf crops generally check their first-calf heifers every 2 hours during calving. Also, most good producers place first-calf heifers in small pastures (less than 160 acres [64 ha]). When all cows are bred to produce calves in a short, discreet (e.g. 60-day) period, production typically increases and predation losses decrease. The birth weight of calves born to first-calf heifers can be decreased by using calving-ease bulls, thus reducing birthing complications that often lead to coyote predation.

Producers who use lambing sheds or pens for raising sheep and small pastures or paddocks for raising cattle have lower predation losses than those who lamb or calve in large pastures or on open range. The more human presence around sheep, the lower the predation losses. Confining sheep entirely to buildings virtually eliminates predation losses.

Corrals. Although predation can occur at any time, coyotes tend to kill sheep at night. Confining sheep at night is one of the most effective means of reducing losses to predation. Nevertheless, some coyotes and many dogs are bold enough to enter corrals and kill sheep. A "coyote-proof" corral is a wise investment. Coyotes are more likely to attack sheep in unlighted corrals than in corrals with lights. Even if the corral fence is not coyote-proof, the mere fact that the sheep are confined reduces the risk of predation. Penning

sheep at night and turning them out at mid-morning might reduce losses. In addition, coyotes tend to be more active and kill more sheep on foggy or rainy days than on sunny days. Keeping the sheep penned on foggy or rainy days may be helpful.

Aside from the benefits of livestock confinement, there are some problems associated it. Costs of labor and materials associated with building corrals, herding livestock, and feeding livestock must be considered. In addition, the likelihood of increased parasite and disease problems may inhibit adoption of confinement as a method of reducing damage.

Carrion Removal. Removal and proper disposal of dead sheep and cattle are important since livestock carcasses tend to attract coyotes, habituating them to feed on livestock. Some producers reason that coyotes are less likely to kill livestock if there is carrion available. This may be a valid preventative measure if an adequate supply of carrion can be maintained far away from livestock. If a coyote becomes habituated to a diet of livestock remains, however, it may turn to killing livestock in the absence of carcasses. Wherever there is easily accessible carrion, coyotes seem to gather and predation losses are higher. Conversely, where carrion is generally not available, losses are lower. A study in Canada showed that the removal of livestock carcasses significantly reduced overwinter coyote populations and shifted coyote distributions out of livestock areas.

Habitat Changes. Habitat features change in some areas, depending on seasonal crop growth. Some cultivated fields are devoid of coyotes during winter but provide cover during the growing season, and a corresponding increase in predation on nearby livestock may occur.

The creation of nearly 40 million acres (16 million ha) of Conservation Reserve Program (CRP) acres may benefit many species of wildlife, including predators. These acres harbor prey for coyotes and foxes, and an increase in predator populations can reasonably be predicted. Clearing away weeds and brush from CRP areas may reduce predation problems since predators usually use cover in their approach to livestock. Generally, the more open the area where livestock are kept, the less likely that coyote losses will occur. Often junk piles are located near farmsteads. These serve as good habitat for rabbits and other prey and may bring coyotes into close proximity with livestock, increasing the likelihood for opportunistic coyotes to prey on available livestock. Removing junk piles may be a good management practice.

Pasture Selection. If sheep or beef cattle are not lambed or calved in sheds or lots, the choice of birthing pastures should be made with potential coyote predation problems in mind. Lambs and calves in remote or rugged pastures are usually more vulnerable to coyote predation than those in closer, more open, and smaller pastures. In general, a relatively small, open, tightly fenced pasture that can be kept under close surveillance is a good choice for birthing livestock that are likely targets of coyotes. Past experience with predators as well as weather and disease considerations should also serve as guides in the selection of birthing pastures.

A factor not completely understood is that, at times, coyotes and other predators will kill in one pasture and not in another. Therefore, changing pastures during times of loss may reduce predation. There may seem to be a relationship between size of pasture and predator losses, with higher loss rates reported in larger pastures. In reality, loss rates may not be related as much to pasture size as to other local conditions such as slope, terrain, and human populations. Hilly or rugged areas are typically sparsely populated by humans and are characterized by large pastures. These conditions are ideal for coyotes.

Sheep pastures that contain or are adjacent to streams, creeks, and rivers tend to have more coyote problems than pastures without such features. Water courses serve as hunting and travel lanes for coyotes.

Herders. Using herders with sheep or cattle in large pastures can help reduce predation, but there has been a trend away from herders in recent years because of increasing costs and a shortage of competent help. Nevertheless, tended flocks or herds receive closer attention than untended livestock, particularly in large pastures, and problems can be solved before they become serious. We recommend two herders per band of range sheep. If herders aren't used, daily or periodic checking of the livestock is a good husbandry practice.

Frightening Devices and Repellents

Frightening devices are useful for reducing losses during short periods or until predators are removed. The devices should not be used for long periods of time when predation is not a problem. To avoid acclimation you can increase both the degree and duration of effectiveness by varying the position, appearance, duration, or frequency of the frightening stimuli, or using them in various combinations. Many frightening methods have been ridiculed in one way or another; nevertheless, all of the techniques discussed here have helped producers by saving livestock and/or buying some time to institute other controls.

Lights. A study involving 100 Kansas sheep producers showed that using lights above corrals at night had the most marked effect on losses to coyotes of all the devices examined. Out of 79 sheep killed by coyotes in corrals, only three were killed in corrals with lights. Nearly 40% of the producers in the study used lights over corrals. There was some indication in the study that sheep losses to dogs were higher in lighted corrals, but the sample size for dog losses was small and the results inconclusive. Most of the producers (80%) used mercury vapor lights that automatically turned on at dusk and off at dawn.

Another advantage of lighted corrals is that coyotes are more vulnerable when they enter the lighted area. Coyotes often establish a fairly predictable pat-

tern of killing. When this happens in a lighted corral, it is possible for a producer to wait above or downwind of the corral and to shoot the coyote as it enters. Red or blue lights may make the ambush more successful since coyotes appear to be less frightened by them than by white lights.

Revolving or flashing the lights may enhance their effectiveness in frightening away predators. There is some speculation that the old oil lamps used in highway construction repelled coyotes, presumably because of their flickering effect.

Bells and Radios. Some sheep producers place bells on some or all of their sheep to discourage predators. Where effects have been measured, however, no difference in losses was detected.
Some producers use a radio tuned to an all-night station to temporarily deter coyotes, dogs, and other predators.

Vehicles. Parking cars or pickups in the area where losses are occurring often reduces predation temporarily. Effectiveness can be improved or extended by frequently moving the vehicle to a new location. Some producers place a replica of a person in the vehicle when losses are occurring in the daylight. If predators continue to kill with vehicles in place, the vehicle serves as a comfortable blind in which to wait and shoot offending predators.

Propane Exploders. Propane exploders produce loud explosions at timed intervals when a spark ignites a measured amount of propane gas. On most models, the time between explosions can vary from about 1 minute to 15 minutes. Their effectiveness at frightening coyotes is usually only temporary, but it can be increased by moving exploders to different locations and by varying the intervals between explosions. In general, the timer on the exploder should be set to fire every 8 to 10 minutes, and the location should be changed every 3 or 4 days. In cattle pastures, these devices should be placed on rigid stands above the livestock. Normally, the exploder should be turned on just before dark and off at daybreak, unless coyotes are killing livestock during daylight hours. Motion sensors are now available and likely improve their effectiveness, though it is still only temporary. Exploders are best used to reduce losses until more permanent control or preventive measures can be implemented. In about 24 coyote depredation complaints over a 2-year period in North Dakota, propane exploders were judged to be successful in stopping or reducing predation losses until offending coyotes could be removed. "Success time" of the exploders appears to depend a great deal on how well they are tended by the livestock producer.

Strobe Lights and Sirens. The USDA's Denver Wildlife Research Center developed a frightening device called the Electronic Guard (EG) (Fig. 6). The EG consists of a strobe light and siren controlled by a variable interval timer that is activated at night with a photoelectric cell. In tests conducted in fenced pastures, predation was reduced by about 89%. The device is used in Kansas and other states to protect cows/calves from coyote predation. Most research on the effectiveness of this device, however, has been done on sheep operations. Suggestions for using the unit differ for pastured sheep and range operations.

To use the EG in fenced pastures (farm flocks):

1. Place EGs above the ground on fence posts, trees, or T-posts so they can be heard and seen at greater distances and to prevent livestock from damaging them.
2. Position EGs so that rain water cannot enter them and cause a malfunction.
3. Locate EGs so that light can enter the photocell port or window. If positioned in deep shade, they may not turn on or off at the desired times.

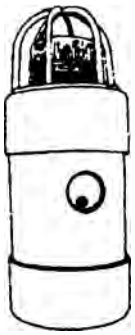


Fig. 6. Electronic Guard frightening device

4. The number of EGs used to protect sheep in fenced pastures depends on pasture size, terrain features, and the amount and height of vegetation in or around the pasture. In general, at least two units should be used in small (20 to 30 acres [8 to 12 ha]), level, short-grass pastures. Three to four units should be used in larger (40 to 100 acres [16 to 40 ha]), hilly, tall grass, or wooded pastures.
5. Don't use EGs in pastures larger than about 100 acres (40 ha) because their effective range is limited. The device could be useful in larger pastures when placed near areas where sheep congregate and bed at night.
6. EGs should be placed on high spots, where kills have been found, at the edge of wooded areas, near or on bedgrounds, or near suspected coyote travelways. They should be moved to different locations every 10 to 14 days to reduce the likelihood of coyotes getting used to them.

To use the EG in open range (herded or range sheep):

1. The number of EGs used will depend on the number of sheep in the band and the size of the bedground. Four units should be used to protect bands of 1,000 ewes and their lambs.
2. When possible, place one EG in the center of the bedground and the other three around the edge of the bedground. Try to place the units on coyote travelways.

3. EGs should be placed on high points, ridge tops, edges of clearings, or on high rocks or outcroppings. Hang the devices on tree limbs 5 to 7 feet (1.5 to 2.1 m) above ground level. If used above timberline or in treeless areas, hang them from a tripod of poles.
4. Herders who bed their sheep tightly will have better results than those who allow sheep to bed over large areas. Sheep that are bedded about 200 yards (166 m) or less in diameter, or are spread out not more than 200 to 400 yards (166 to 332 m) along a ridge top, can usually be protected with EGs.

Repellents. The notion of repelling coyotes from sheep or calves is appealing, and during the 1970s, university and government researchers tested a wide variety of potentially repellent chemical compounds on sheep. Both olfactory (smell) and gustatory (taste) repellents were examined. The underlying objective was to find a compound that, when applied to sheep, would prevent coyotes from killing them. Tests were conducted with various prey species including rabbits, chickens, and sheep. Some repellents were applied by dipping target animals in them, others were sprayed on, and some were applied in neck collars or ear tags.

Coyotes rely heavily on visual cues while stalking, chasing, and killing their prey. Taste and smell are of lesser importance in actually making the kill. These factors may in part account for the fact that the repellent compounds were not able to consistently prevent coyotes from killing, although some of the repellents were obviously offensive to coyotes and prevented them from consuming the killed prey. Several compounds were tested on sheep under field conditions, but none appeared to offer significant, prolonged protection.

If an effective chemical repellent were to be found, the obstacles in bringing it to industry use would be significant. The compound would not only need to be effective, but also persistent enough to withstand weathering while posing no undue risk to the sheep, other animals, or the environment. It would also have to withstand the rigorous Environmental Protection Agency (EPA) approval process.

Fig. 7. Livestock guarding dog (Akbash dog)

High-frequency sound has also been tested as a repellent for coyotes, but the results were no more encouraging than for chemical repellents. Coyotes, like dogs, responded to particular sound frequencies and showed some aversion to sounds broadcast within one foot (30 cm) of their ear. Researchers, however, were unable to broadcast the sound a sufficient distance to test the effects under field conditions. Aversive conditioning is well documented for averting rodents from food sources, but significant problems must be overcome before the method can be used to reduce coyote predation on sheep. Coyotes must be induced to eat sheep like baits that have been treated with the aversive chemical. The chemical must cause sufficient discomfort, such as vomiting, to cause coyotes to avoid other baits. Furthermore, the avoidance must be transferred to live sheep and must persist long enough without reinforcement for the method to offer realistic protection to sheep.

To date, pen and field tests with aversive conditioning have yielded conflicting and inconclusive results. It does not appear that aversive conditioning is effective in reducing predation, but additional field tests would be useful.

Guarding Animals.

Livestock Guarding Dogs. A livestock guarding dog is one that generally stays with sheep or cattle without harming them and aggressively repels predators. Its protective behaviors are largely instinctive, but proper rearing plays a part. Breeds most commonly used today include the Great Pyrenees, Komondor, Anatolian Shepherd, and Akbash Dog (Fig. 7). Other Old World breeds used to a lesser degree include Maremma, Sharplaninetz, and Kuvasz. Crossbreeds are also used.

The characteristics of each sheep operation will dictate the number of dogs required for effective protection from predators. If predators are scarce, one dog is sufficient for most fenced pasture operations. Range operations often use two dogs per band of sheep. The performance of individual dogs will differ based on age and experience. The size, topography, and habitat

of the pasture or range must also be considered. Relatively flat, open areas can be adequately covered by one dog. When brush, timber, ravines, and hills are in the pasture, several dogs may be required, particularly if the sheep are scattered. Sheep that flock and form a cohesive unit, especially at night, can be protected by one dog more effectively than sheep that are continually scattered and bedded in a number of locations.

The goal with a new puppy is to channel its natural instincts to produce a mature guardian dog with the desired characteristics. This is best accomplished by early and continued association with sheep to produce a bond between the dog and sheep. The optimum time to acquire a pup is between 7 and 8 weeks of age. The pup should be separated from litter mates and placed with sheep, preferably lambs, in a pen or corral from which it can't escape. This socialization period should continue with daily checks from the producer until the pup is about 16 weeks old. Daily checks don't necessarily include petting the pup. The primary bond should be between the dog and the sheep, not between the dog and humans. The owner, however, should be able to catch and handle the dog to administer health care or to manage the livestock. At about 4 months, the pup can be released into a larger pasture to mingle with the other sheep.

A guarding dog will likely include peripheral areas in its patrolling. Some have been known to chase vehicles and wildlife and threaten children and cyclists. These activities should be discouraged. Neighbors should be alerted to the possibility that the dog may roam onto their property and that some predator control devices such as traps, snares, and M-44s present a danger to it. Many counties enforce stringent laws regarding owner responsibility for damage done by roaming dogs. It is in the best interests of the owner, dog, and community to train the dog to stay in its designated area.

The use of guarding dogs does not eliminate the need for other predation control actions. They should, however, be compatible with the dog's behavior. Toxicants (including some insecticides and rodenticides) used to control various pest species can be extremely hazardous to dogs and are therefore not compatible with the use of guarding dogs.

If snares and traps are used where dogs are working, the producer should: (1) encourage the use of sets and devices that are likely not to injure the dog if it is caught, and (2) know where traps and snares are set so they can be checked if a dog is missing. Aerial hunting, as well as calling and shooting coyotes, should pose no threat to guarding dogs. Ensuring the safety of the dog is largely the producer's responsibility.

Dogs may be viewed as a first line of defense against predation in sheep and cow/calf operations in some cases. Their effectiveness can be enhanced by good livestock management and by eliminating predators with suitable removal techniques.

Donkeys. Although the research has not focused on donkeys as it has on guarding dogs, they are gaining in popularity as protectors of sheep and goat flocks in the United States. A recent survey showed that in Texas alone, over 2,400 of the 11,000 sheep and goat producers had used donkeys as guardians.

The terms *donkey* and *burro* are synonymous (the Spanish translation of *donkey* is *burro*) and are used interchangeably. Donkeys are generally docile to people, but they seem to have an inherent dislike of dogs and other canids, including coyotes and foxes. The typical response of a donkey to an intruding canid may include braying, bared teeth, a running attack, kicking, and biting. Most likely it is acting out of aggression toward the intruder rather than to protect the sheep. There is little information on a donkey's effectiveness with noncanid predators such as bears, mountain lions, bobcats, or birds of prey.

Reported success of donkeys in reducing predation is highly variable. Improper husbandry or rearing practices and unrealistic expectations probably account for many failures. Donkeys are significantly cheaper to obtain and care for than guarding dogs, and they are probably less prone to accidental death and premature mortality than dogs. They may provide a longer period of useful life than a guarding dog, and they can be used with relative safety in conjunction with snares and traps.

Researchers and livestock producers have identified several key points to consider when using a donkey for predation control:

1. Use only a jenny or a gelded jack. Intact jacks are too aggressive and may injure livestock. Some jennies and geldings may also injure livestock. Select donkeys from medium-sized stock.
2. Use only one donkey per group of sheep. The exception may be a jenny with a foal. When two or more adult donkeys are together or with a horse, they usually stay together, not necessarily near the sheep. Also avoid using donkeys in adjacent pastures since they may socialize across the fence and ignore the sheep.
3. Allow about 4 to 6 weeks for a naive donkey to bond to the sheep. Stronger bonding may occur when a donkey is raised from birth with sheep.
4. Avoid feeds or supplements containing monensin or lasolacid. They are poisonous to donkeys.
5. Remove the donkey during lambing, particularly if lambing in confinement, to avoid injuries to lambs or disruption of the lamb-ewe bond.

6. Test a new donkey's response to canids by challenging it with a dog in a pen or small pasture. Discard donkeys that don't show overt aggression to an intruding dog.
7. Use donkeys in smaller (less than 600 acres [240 ha]), relatively open pastures with not more than 200 to 300 head of livestock. Large pastures with rough terrain and vegetation and widely scattered livestock lessen the effectiveness of a donkey.

Llamas. Like donkeys, llamas have an inherent dislike of canids, and a growing number of livestock producers are successfully using llamas to protect their sheep. A recent study of 145 ranches where guard llamas were used to protect sheep revealed that average losses of sheep to predators decreased from 26 to 8 per year after llamas were employed. Eighty percent of the ranchers surveyed were "very satisfied" or "satisfied" with their llamas. Llamas reportedly bond with sheep within hours and offer advantages over guarding dogs similar to those described for donkeys.

Other Animals. USDA's Agricultural Research Service tested the bonding of sheep to cattle as a method of protecting sheep from coyote predation. There was clearly some protection afforded the sheep that remained near cattle. Whether this protection resulted from direct action by the cattle or by the coyotes' response to a novel stimulus is uncertain. Later studies with goats, sheep, and cattle confirmed that when either goats or sheep remained near cattle, they were protected from predation by coyotes. Conversely, goats or sheep that grazed apart from cattle, even those that were bonded, were readily preyed on by coyotes.

There are currently no research data available on the ideal ratio of cattle to sheep, the breeds of cattle, age of cattle most likely to be used successfully, or on the size of bonded groups to obtain maximum protection from predation. Multispecies grazing offers many advantages for optimum utilization of forage, and though additional study and experience is needed, it may also be a tool for coyote damage control.

Any animal that displays aggressive behavior toward intruding coyotes may offer some benefit in deterring predation. Other types of animals reportedly used for predation control include goats, mules, and ostriches. Coyotes in particular are suspicious of novel stimuli. This behavior is most likely the primary reason that many frightening tactics show at least temporary effectiveness.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations

There are zones throughout California where the use of Conibear-type traps an snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

There are many effective methods for trapping coyotes, and success can be enhanced by considering several key points. Coyotes learn from past events that were unpleasant or frightening, and they often avoid such events in the future. In spring and summer, most coyotes limit their movements to a small area, but in late summer, fall, and winter they may roam over a larger area. Coyotes follow regular paths and crossways, and they prefer high hills or knolls from which they can view the terrain. They establish regular scent posts along their paths, and they depend on their ears, nose, and ears to sense danger.

Snares

Snaring is the technique of setting a steel-cable loop in an animal's path to capture it by the neck, body, or leg. Snares usually consist of a 2.5- to 10-foot (0.75- to 3.0-m) long piece of galvanized aircraft cable containing a slide lock that forms a loop in the cable (Fig. 31). On short snares, a swivel to prevent twisting and breaking the cable is attached to the end of the cable opposite the loop. On longer snares, swivels can be located near the middle of the cable and at one end.

Snares offer several advantages over steel foothold traps. They are lightweight, compact, simple in function, affected little by weather, easy to set, low in cost, and offer a high degree of human safety. In a south Texas study, snares were 10 times more selective over steel foothold traps for target species of coyotes and bobcats. Snares, however, can be a greater hazard than traps to livestock. Recent research has produced deer stops and break-away or relaxing locks that have significantly improved snare specificity.

Preparation of Snares. New commercial snares and extension cables can be cleaned by boiling each dozen snares in a pan or bucket of water with 4 tablespoons (16 gm) of baking soda for one hour. The snares will turn a dull gray after being removed from this bath and hung up to dry outdoors. Darken snares by boiling them in brown logwood crystals and dye. After boiling, snares should be kept clean of foreign odors. Wear clean gloves when handling and setting snares.

How to Set Snares. Snares designed to capture predators by the neck or leg are set directly in the animal's path of movement and are held in place using various techniques. One support that works particularly well can be constructed from a 36-inch (0.9-m) piece of 12-gauge galvanized or 9-gauge soft

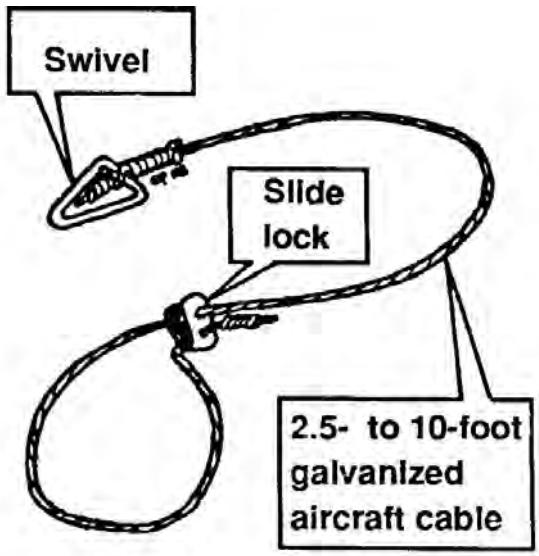


Fig. 31. Coyote snare

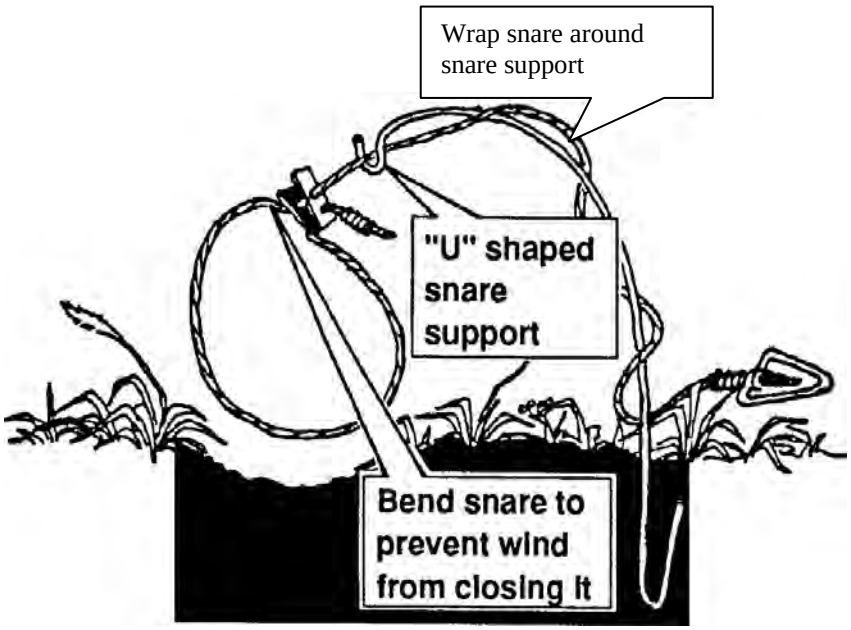


Fig. 33. Setting the snare

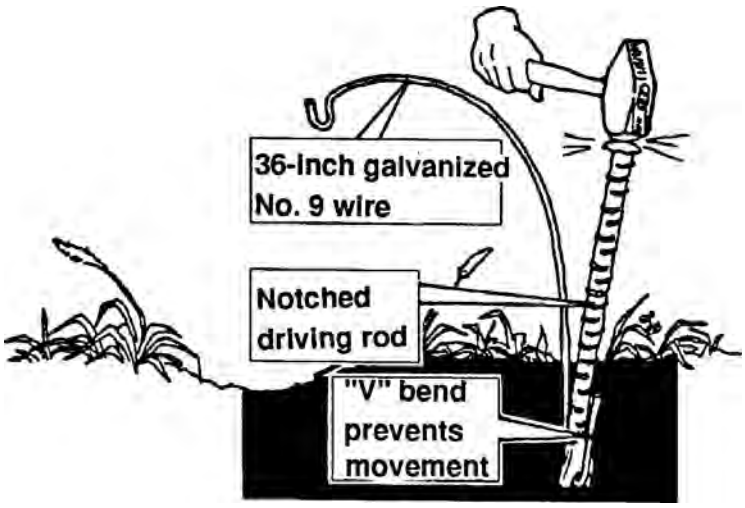


Fig. 32. Driving the support wire

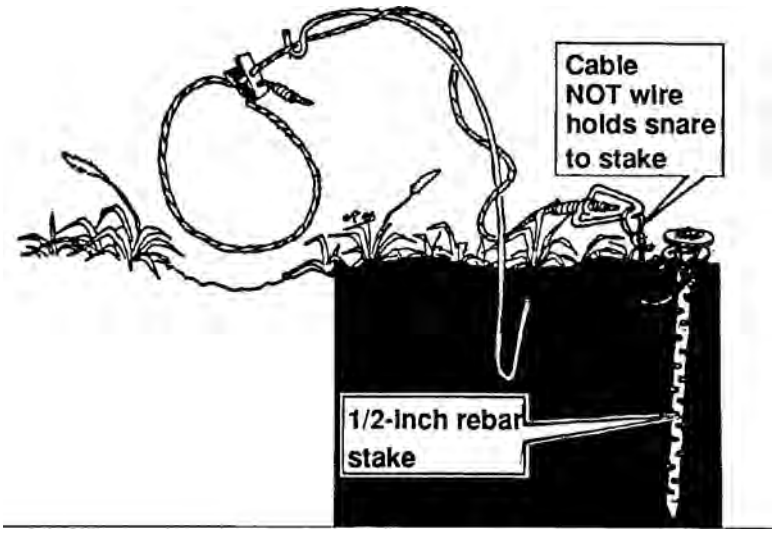


Fig. 34. Fastening the snare to the stake

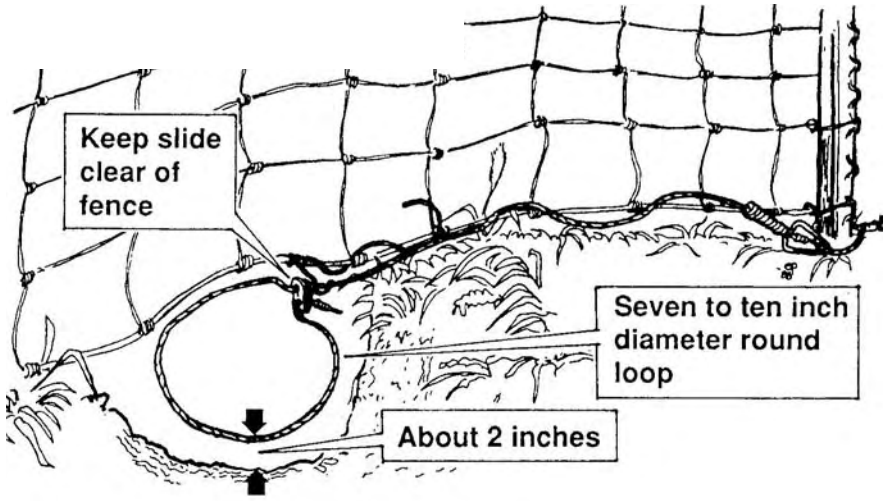


Fig. 35. Snare set for woven wire

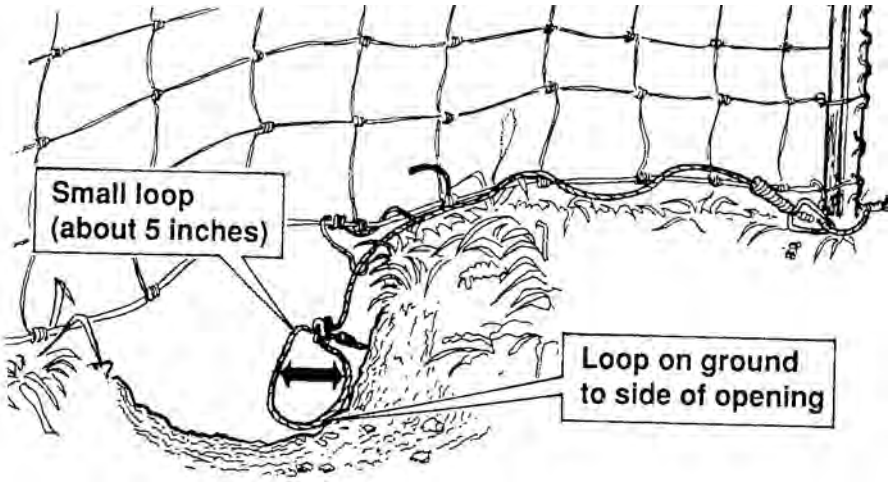


Fig. 36. Leg snare set

wire. Form a V bend in the support wire, about 4 inches (10 cm) from the end, and drive the wire into the ground with a notched rod (Fig. 32) to prevent the support from moving in the wind. Wrap the snare around the support about three times and hold it in place with a U bend formed in the upper end of the snare support. Bend the snare cable upward slightly, just inside the lock, to ensure that the snare loop is not closed by the wind (Fig. 33).

Snares should be attached to a solid object so that captured animals cannot escape (Fig. 34). A steel 1/2-inch (1.3-cm) diameter rebar, 24 to 30 inches (61 to 72 cm) long (depending on soil hardness), makes a good anchor for coyotes and smaller predators. Attach snares to the rebar with a strong swivel to prevent tangling and breaking. A lead cable that is at least as strong as the snare cable can be used to attach short snares to the rebar stake. Avoid using 9-gauge (0.38-cm) wire or several strands of 14-gauge (0.21-cm) wire to anchor snares to a rebar stake because they may bend back and forth, crystallize, and break.

When used for coyotes, snares also can be secured to a dead tree limb that is at least 6 inches (15 cm) in diameter and 6 feet (2 m) long.

Snares set in holes under woven-wire fences can be held in place about 1 to 2 inches (2.5 to 5 cm) from the fence with the snare support system (Fig. 35). The snare should be set far enough away from the fence to prevent the lock from catching on the bottom wire of the fence. The bottom of the loop should be about 2 inches (5 cm) above the bottom of the hole. The snares can be anchored to the heavy-gauge wire on the bottom of the fence. Two strands of baling wire or S hooks can be used to fasten the snare to the bottom wire.

If there is a chance of accidentally catching a pet dog, a leg snare set is recommended (Fig. 36). Set a small loop about 5 inches (13 cm) or less to one side of the opening, and set the bottom of the loop on the ground. When a coyote goes under a fence, it places both front feet firmly on the ground, and sticks its head just under the bottom wire. Once its head is past the bottom wire, the coyote begins to raise its head. The idea is to set the leg snare so that one front foot will pass through the snare.

Snares are usually set in the form of a round or oval loop. In a trail set (Fig. 37), a round loop that is 12 inches (30 cm) in diameter can form an oval loop that is about 14 inches (36 cm) high and 10 inches (25 cm) wide. Use a 5/64- or 3/32-inch (0.2- or 0.24-cm) diameter galvanized aircraft cable for snaring coyotes. Varying round loop diameters and heights above ground is recommended when snaring coyotes (Table 1). The loop size in a hole in a fence should vary depending upon the size of the hole.

Table 1.Specific loop dimensions for snaring coyotes.

Type of set	Round loop Diameter in inches	(cm)	Height of loop above ground in inches	(cm)
Trail	9-12	(23-30)	10-12	(25-30)
Under fence	7-10	(18-25)	2	(5)

Where to Set Snares. Animals usually follow the easiest route through heavy cover. These routes, which generally consist of trails, are excellent locations to snare predators. Snares are effective along trails leading to draw stations. Some effective locations for snaring coyotes include: (1) along trails in thickets or heavy vegetation leading to a carcass, (2) on trails under fences, (3) on livestock trails in vacant pastures, (4) in the bottoms of ravines, and 5) on narrow paths inside weeds or brush. Trails can be created by driving on weeds or stubble with a pickup, by walking in snow, or by mowing a trail through weeds or grass with a weed eater.

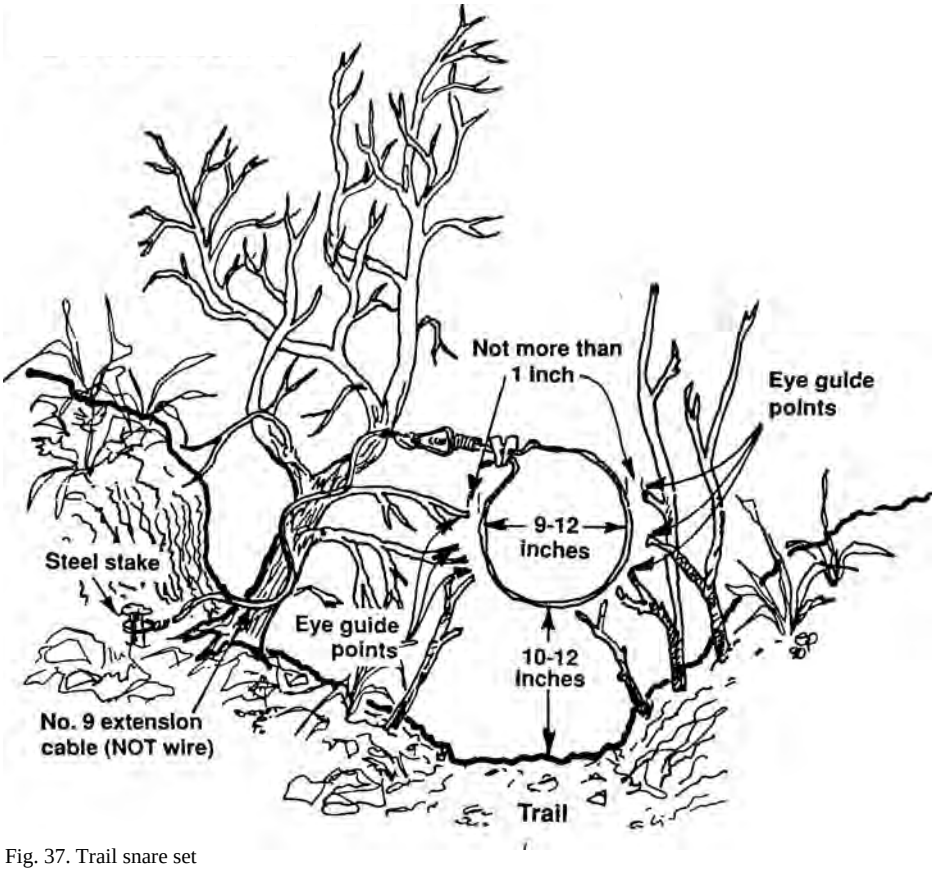


Fig. 37. Trail snare set

Regulations for Snaring. See California laws and regulations regarding the use of snares. Snares should be checked early in the morning to increase the probability of releasing nontarget animals unharmed.

Methods to Avoid Capturing Nontarget Animals. Sites where snares are set should be carefully selected to avoid capturing nontarget animals. Avoid setting snares: (1) in pastures with livestock, (2) within 25 yards (23 m) of animal carcasses (to prevent capturing birds of prey and other scavengers), (3) within major deer, elk, or antelope wintering areas (these big game animals are much less susceptible to foothold traps), (4) on any trails being used by livestock, deer, elk, and other nontarget animals (attract predators away from these trails with specific baits and lures), (5) under fences where livestock, antelope, deer, or nontarget dogs are using the "crawl space," and (6) where people can readily view captured animals.

Use a short snare cable to reduce injuries where accidentally captured dogs might jump over a fence or a tree branch. Also avoid using entangling devices (attachments that increase the chance of killing the snared animal) where dogs might be captured. Use the lightest snare lock (breakaway lock) possible to capture the desired animal. If livestock, deer, elk, or antelope are captured by a leg, they can usually break a light lock but may be held by heavy locks. Record the location and number of snares on a map so they can be found, and remove all snares when damage stops or when they cannot be checked frequently.

Shooting

Shooting coyotes is legal in many situations, and it often ranks high among the choices for removing a predator. Safety, however, is a critical factor that in some circumstances may preclude the use of firearms (for example, local laws may prohibit shooting, or neighbors may be too close).

For shooting coyotes, a medium-powered bolt-action rifle fitted with a scope is recommended. The .223 Remington, .22-250, .220 Swift, or the .243 Winchester are all capable of killing a coyote up to a distance of 250 yards (225 m). Since coyotes are able to detect human scent, the shooter should take a stand downwind from where the coyote will likely approach. An elevated location where the lighting works to the shooter's advantage is a good choice. If predators are killing sheep in the daytime, construct a comfortable blind at a vantage point in the pasture where the killing has occurred. Whenever possible, rest the rifle on a solid support while aiming. A homemade shooting stick will improve accuracy over shooting freehand.

A shotgun, preferably a 12-gauge semi-automatic, can be used for shooting at short range (less than 50 yards [45 m]). Often it is advisable to have both a 12-gauge shotgun and a scoped rifle available. Copper-coated (BB) lead shot, No. 4 buckshot (lead), and in newer shotguns, the larger-sized steel shot works well for killing coyotes.

Calling and Shooting Coyotes. Coyotes may respond to predator calls. Calling, like other methods of predation control, should be used sparingly and only when needed. Coyotes can be called at any time of the day although the first couple of hours after dawn and the last few hours before darkness are usually best. Call in areas where there are signs of coyotes, such as tracks or droppings.

In some situations, coyotes can be located by listening to their howling at sundown and sunrise. Some hunters use sirens to elicit howls from coyotes. Often a voice imitation of a coyote howl works as well. Coyotes often come to a howl without howling back, so the prudent hunter is always ready to shoot.

Hunting at Night. See California Code of Regulations, Title 14, Sections 264 and 264.5. Not many people have witnessed predators killing live stock because it usually occurs at night, away from human activity. As stated previously, calling and shooting predators at night is illegal in many states. Where legal, however, hunting at night with the use of artificial lights may be effective. Red or blue light tends to spook predators less readily than white light does. Calling without the use of artificial lights is effective only with snow cover and the light of a full moon.

Hunting with Dogs. Several breeds are generally known as trailing hounds, including Walkers, Julys, redbones, blueticks, black and tans, Plott hounds, and English fox hounds. Trail hounds follow the scent left by a predator and run it to tree or bay it on the ground. Coyotes are seldom caught and killed by trail hounds. In most instances, trail hounds are used in combination with sight hounds. The trail hounds run coyotes into the open, and then sight hounds are released to capture the fleeing coyote. More commonly, coyotes are shot as they run from the pack of hounds. Sight hounds, generally greyhounds or Russian wolf hounds, are used in open prairie country to run coyotes down and kill them.

Economics of Damage and Control

Sheep numbers in the United States have declined about 80% from 1942 to 1976 (Gee et al. 1977). Former sheep producers reported that the principal reasons for leaving the sheep industry included high predation losses, low lamb and wool prices, a shortage of good hired labor, and the producer's age.

The US Fish and Wildlife Service (1978) estimated the economic impact of coyote predation on producers with predator problems, on producers without predator problems, and on consumers during 1977. They used an average lamb loss rate of 4% (267,000 lambs) and a ewe loss rate of 1.5% (125,000 ewes) to estimate an economic loss of $19 million to producers from coyote predation in the 17 western states. The reduced number of sheep and lambs resulted in a higher market price, which benefited producers by $6 million. The net impact of coyote predation on sheep producers was a loss of $13 million, and the impact on consumers was $4 million in additional costs. The General Accounting Office (GAO 1990) estimated that coyotes in 17 western states killed sheep and lambs valued at $18 million in 1989. The National Agricultural Statistical Service (NASS 1991) reported that sheep and lamb losses to coyotes in the United States were valued at $18.3 million in 1990.

The US Fish and Wildlife Service (1978) reported calf losses between birth and weaning to coyotes across the United States at 0.4%, with predation decreasing to nearly zero by weaning time. Dorrance (1982) reported that coyotes were responsible for 16% of the 1,520 confirmed predation losses of cattle in Alberta from 1974 to 1978. Coyote predation on calves caused producers with coyote problems across the United States to lose an estimated $20 million. However, because of the greater price flexibility of beef compared with sheep, the reduction in the number of beef calves marketed (estimated at 0.4%, or 115,000 fewer calves) resulted in a higher price, which benefited beef producers by $81 million. The net impact of the reduced supply of beef as a result of coyote predation was a gain of $61 million to beef producers, but it cost consumers an additional $98 million in higher prices for beef, resulting in an overall loss of $37 million. NASS (1992) reported that cattle and calf losses to coyotes in the United States were valued at $24.3 million in 1991.

Coyote predation also can cause substantial losses of domestic goats. In three studies in Texas, where an estimated 1.1 million goats (about 90% of the goats in the United States) are raised (Scrivner et al. 1985), predators were reported to take 18.1% of the adults and 33.9% of the kids (Pearson 1986). NASS (1991) reported that goat losses to coyotes in the United States were valued at $5.7 million in 1990.

Pearson (1986) stated that predators, particularly coyotes, accounted for losses of hundreds of chickens and turkeys in the 14 western states. In one study, Andelt and Gipson (1979) reported that between June 4 and August 31, 1976, a mated pair of coyotes apparently killed 268 domestic turkeys in Nebraska valued at $938.

Although the average value of livestock losses to coyotes reflected the overall impact on producers, it did not reflect the severity of losses to some individuals. Balser (1964) and Gee et al. (1977) indicated that coyote predation is much more serious for some producers than others. Most sheep producers suffer no or minor predator losses, whereas 20% to 25% of the producers suffer losses that are significantly higher than the average (US Fish Wildl. Serv. 1978). These losses can drive producers out of business because of low profit margins. Nonfatal injuries and harassment of livestock by coyotes also can result in reduced weight gain and subsequent reductions in profit.

Acknowledgments

Much of the information and several of the figures for this chapter were adapted from the *SID Sheep Production Handbook,* Predator Damage Control chapter, published by the American Sheep Industry Association, Inc. (1990) and various publications authored by F. R. Henderson, J. S. Green, W. F. Andelt, G. E. Connolly, and D. A. Wade.

The section on economics of damage and control was adapted from Andelt (1987).

Figure 1 by Emily Oseas Routman.

Figure 6 adapted from a USDA-APHIS-ADC illustration by Renee Lanik, University of Nebraska-Lincoln.

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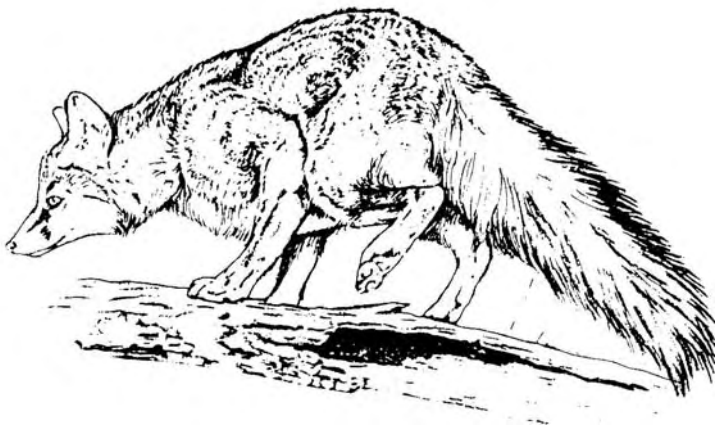
FOXES

Fig. 1. Red fox, *Vulpes vulpes* (left) and gray fox, *Urocyon cinereoargenteus* (right).



Damage Prevention and Control Methods

Exclusion

Net wire fence.

Electric fence.

Cultural Methods

Protect livestock and poultry during most vulnerable periods (for example, shed lambing, farrowing pigs in protective enclosures).

Frightening

Flashing lights and exploders may provide temporary protection.

Well-trained livestock guarding dogs may be effective in some situations.

Repellents

None are registered for livestock protection.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting

Predator calling techniques.

PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994
Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln
United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control
Great Plains Agricultural Council
Wildlife Committee

Identification

California has four species of foxes: Both native and introduced populations of the red fox (*Vulpes vulpes*); the gray fox (*Urocyon cinereoargenteus*); the island gray fox (*Urocyon litoralis*); and the kit fox (*V. macrotis).* The red fox is the most common of the foxes native to North America. Most depredation problems are associated with red foxes, although in some areas gray foxes can cause problems. Few damage complaints have been associated with the kit fox.

The red fox is dog-like in appearance, with an elongated pointed muzzle and large pointed ears that are usually erect and forward. It has moderately long legs and long, thick, soft body fur with a heavily furred, bushy tail (Fig. 1). Typically, red foxes are colored with a light orange-red coat, black legs, lighter-colored underfur and a white- tipped tail. Silver and cross foxes are color phases of the red fox. In North America the red fox weighs about 7.7 to 15.4 pounds (3.5 to 7.0 kg), wit h males on average 2.2 pounds (1 kg) heavier than females.

Gray foxes weigh 7 to 13 pounds (3.2 to 5.9 kg) and measure 32 to 45 inches (81 to 114 cm) from the nose to the tip of the tail (Fig. 1). The color pattern is generally salt-and-pepper gray with buffy underfur. The sides of the neck, back of the ears, legs, and feet are rusty yellow. The tail is long and bushy with a black tip.

The island gray fox has pepper-and-salt upper pelage with a rufous or buffy underfur and a dorsal median black stripe ending in the black tip of the tail.

Kit foxes are not usually associated with livestock and poultry depredation because they typically eat small rodents and lead a secretive life in remote habitats away from people, although they may cause site-specific damage problems.

Please refer to appendices B, C, and D for additional information on gray, kit, and red foxes in California.

Range

Red foxes occur over most of North America, north and east from southern California, Arizona, and central Texas. They are found throughout most of the United States with the exception of a few isolated areas (Fig. 2).

The only native red fox in California is the Sierra Nevada red fox (*V. v. necator*). Because of the Sierra Nevada red fox's high mountain range, it is rarely associated with property damage. The introduced nonnative eastern red fox (V. v. regalis) is the more common red fox seen in lowland California. Eastern red foxes were introduced to California during the early 1900's by the fur farming industry. The red foxes that exist in the lower elevations of California are descendants of red foxes that either escaped from, or were released by the fur farming trade. Eastern red foxes are very competitive for habitat and because of their adaptive nature, are rapidly increasing throughout much of California. The hastening decline of some endangered species is related to the increased presence of and predation by the eastern red fox.

Gray foxes are found throughout the eastern, north central, and southwestern United States They are found throughout Mexico and most of the southwestern United States from California northward through western Oregon (Fig. 3).

The island gray fox is restricted to 6 of the Channel Islands off the coast of southern California. The island gray fox are common on Santa Cruz, Santa Rosa, and San Clemente islands, less common on San Nicolas and San Miguel, and rare on Santa Catalina.

Kit foxes are residents of arid habitats. They are found from extreme southern Oregon and Idaho south along the Baja Peninsula and eastward through southwestern Texas and northern Mexico (Fig. 4).

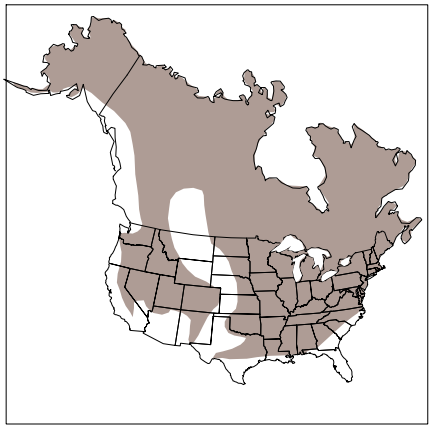


Fig. 2. Range of the red fox in North America.

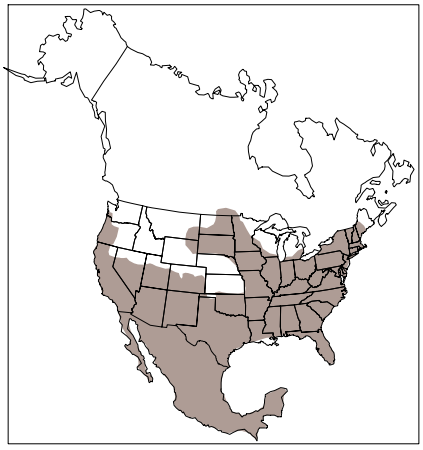


Fig. 3. Range of the gray fox in North America

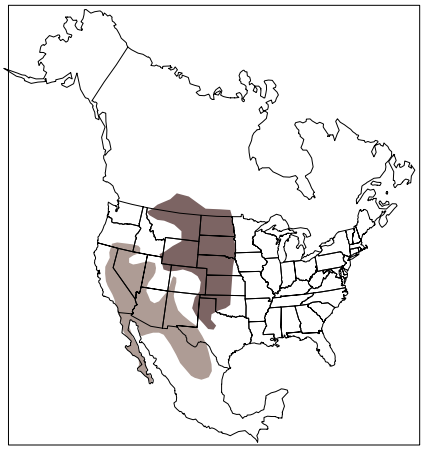


Fig. 4. Range of the swift fox (dark) and the kit fox (light) in North America.

Habitat

The red fox is adaptable to most habitats within its range, but usually prefers open country with moderate cover. Some of the highest fox densities reported are in the north-central United States, where woodlands are interspersed with farmlands. The range of the red fox has expanded in recent years to fill habitats formerly occupied by coyotes (*Canis latrans*). The reduction of coyote numbers in many sagebrush/grassland areas of Montana and Wyoming has resulted in increased fox numbers. Red foxes have also demonstrated their adaptability by establishing breeding populations in many urban areas of the United States, Canada, and Europe. Gray foxes prefer more dense cover such as thickets, riparian areas, swamp land, or rocky pinyon-cedar ridges. In eastern North America, this species is closely associated with edges of deciduous forests. Gray foxes can also be found in urban areas where suitable habitat exists. Optimum habitats for island gray foxes are mixed chaparral, coastal scrub, and shrubby stages of valley foothill

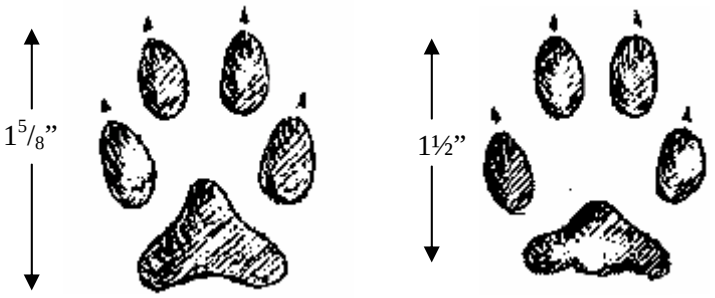
Food Habits

Foxes are opportunists, feeding mostly on rabbits, mice, bird eggs, insects, and native fruits. Foxes usually kill animals smaller than a rabbit, although fawns, pigs, kids, lambs, and poultry are sometimes taken. The fox's keen hearing, vision and sense of smell aid in detecting prey. Foxes stalk even the smallest mice with skill and patience. The stalk usually ends with a sudden pounce onto the prey. Red foxes sometimes kill more than they can eat and bury food in cashes for later use. All foxes feed on carrion (animal carcasses) at times.

General Biology, Reproduction, and Behavior

Foxes are crepuscular animals, being most active during the early hours of darkness and very early morning hours. They do move about during the day, however, especially when it is dark and overcast. Foxes are solitary animals except from the winter breeding season through midsummer, when mates and their young associate closely. Foxes have a wide variety of calls. They may bark, scream, howl, yap, growl, or make sounds similar to a hiccup. During winter a male will often give a yelling bark, "wo-wo-wo," that seems to be important in warning other male foxes not to intrude on its territory. Red foxes may dig their own dens or use abandoned burrows of a woodchuck or badger. The same dens may be used for several generations. Gray foxes commonly use wood piles, rocky out-crops, hollow trees, or brush piles as den sites. Foxes use their urine and feces to mark their territories.

Mating in red foxes normally occurs from mid-January to early February. At higher latitudes (in the Arctic) mating occurs from late February to early March. Estrus in the vixen lasts 1 to 6 days, followed by a 51- to 53-day gestation period. Fox pups can be born from March in southern areas to May in the arctic zones. Red foxes generally produce 4 to 9 pups. Gray foxes usually have 3 to 7 pups per litter. Arctic foxes may have from 1 to 14 pups, but usually have 5 or 6. Foxes disperse from denning areas during the fall months and establish breeding areas in vacant territories, sometimes dispersing considerable distances.



Front Foot Gray fox tracks. Hind Foot

Damage and Damage Identification

Foxes may cause serious problems for poultry producers. Turkeys raised in large range pens are subject to damage by foxes. Losses may be heavy in small farm flocks of chickens, ducks, and geese. Young pigs, lambs, and small pets are also killed by foxes. Damage can be difficult to detect because the prey is usually carried from the kill site to a den site, or uneaten parts are buried. Foxes usually attack the throat of young livestock, but some kill by inflicting multiple bites to the neck and back. Foxes do not have the size or strength to hold adult livestock or to crush the skull and large bones of their prey. They generally prefer the viscera and often begin feeding through an entry behind the ribs. Foxes will also scavenge carcasses, making the actual cause of death difficult to determine. Pheasants, waterfowl, other game birds, and small game mammals are also preyed upon by foxes. At times, fox predation may be a significant mortality factor for upland and wetland birds, including some endangered species.

Rabies outbreaks are most prevalent among red foxes in southeastern Canada and occasionally in the eastern United States. The incidence of rabies in foxes has declined substantially since the mid-1960s for unexplained reasons. In 1990, there were only 197 reported cases of fox rabies in the United States as compared to 1,821 for raccoons and 1,579 for skunks. Rabid foxes are a threat to humans, domestic animals, and wildlife.

Legal Status

In California, gray fox, kit fox, and red fox are designated fur-bearing mammals. The Sierra Nevada red fox is State-listed Threatened and the San Joaquin kit fox (*V. m.mutica*) is also State-listed Threatened and Federally-listed Endangered (Appendix A).

It is illegal to trap Sierra Nevada red foxes and kit foxes, and no red fox may be taken for profit making purposes. See California statutes and regulations regarding the take of furbearing and non game mammals.

Damage Prevention and Control Methods

Exclusion

Construct net wire fences with openings of 3 inches (8 cm) or less to exclude red foxes. Bury the bottom of the fence 1 to 2 feet (0.3 m to 0.9 m) with an apron of net wire extending at least 12 inches (30 cm) outward from the bottom. A top or roof of net wire may also be necessary to exclude all foxes, since some will readily climb a fence.

A 3-wire electric fence with wires spaced 6 inches, 12 inches, and 18 inches (15 cm, 31 cm, and 46 cm) above the ground can repel red foxes. Combination fences that incorporate net and electric wires are also effective.

Cultural Methods

The protection of livestock and poultry from fox depredation is most important during the spring denning period when adults are actively acquiring prey for their young. Watch for signs of depredation during the spring, especially if there is a history of fox depredation. Foxes, like other wild canids, will often return to established denning areas year after year. Foxes frequently den in close proximity to human habitation. Dens may be located close to farm buildings, under haystacks or patches of cover, or even inside hog lots or small pastures used for lambing. Because of the elusive habits of foxes, dens in these locations may not be noticed until excessive depredations have occurred.

The practice of shed lambing and farrowing in protected enclosures can be useful in preventing fox depredation on young livestock. Also, removal of Livestock carcasses from production areas can make these areas less attractive to predators.

Frightening

Foxes readily adapt to noise-making devices such as propane exploders, timed tape recordings, amplifiers, or radios, but such devices may temporarily reduce activity in an area. Flashing lights, such as a rotating beacon or strobe light, may also provide temporary protection in relatively small areas or in livestock or poultry enclosures. Combinations of frightening devices used at irregular intervals should provide better protection than use of a single device because animals may have more difficulty in adapting to these disturbances. When properly trained, some breeds of dog, such as Great Pyrenees and Akbash dogs, have been useful in preventing predation on sheep. The effectiveness of dogs, even the "guard dog" breeds, seems to depend entirely on training and the individual disposition of the dog.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).
There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red Fox (see regulations).

Trapping is a very effective and selective control method. A great deal of expertise is required to effectively trap foxes. Trapping by inexperienced people may serve to educate foxes, making them very difficult to catch, even by experienced trappers.

Proper set location is important when trapping foxes. Sets made along trails, at entrances to fields, and near carcasses are often most productive.

Cage traps are sometimes effective for capturing juvenile red foxes living in urban areas. It is uncommon to trap an adult red fox in a cage or a box trap.

Snares made from 1/16-inch, 5/64-inch, and 3/32-inch (0.15 cm, 0.2 cm, and 0.25 cm) cable can be very effective for capturing both red and gray foxes. Snares are generally set in trails or in crawl holes (under fences) that are frequented by foxes. The standard loop size for foxes is about 6 inches (15 cm) with the bottom of the loop about 10 to 12 inches (25 to 30 cm) above ground level (Fig. 7). Trails leading to and from den sites and to carcasses being fed on by foxes make excellent locations for snares.

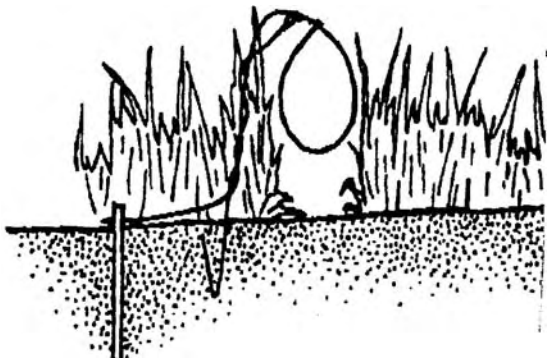


Fig. 7. Properly set neck snare for foxes.

Shooting

Harvest of foxes by sport hunters and fur trappers is another method of reducing fox populations in areas where damage is occurring. Livestock and poultry producers who have predation problems during the late fall and winter can sometimes find private fur trappers willing to hunt or trap foxes around loss sites. Depredations are usually most severe, however, during the spring when furs are not saleable, and it is difficult to interest private trappers at that time.

Artificial rabbit distress calls can be used to decoy foxes to within rifle or shotgun range. Select a spot that faces into the wind, at the edge of a clearing or under a bush on a slight rise where visibility is good. Blow the call at 1/2- to 1-minute intervals, with each call lasting 5 to 10 seconds. If a fox appears, remain motionless and do not move the rifle or shotgun until ready to shoot. If a fox does not appear in about 20 minutes, move to a new spot and call again.

Acknowledgments

We thank Norman C. Johnson, whose chapter "Foxes" in the 1983 edition of this manual provided much of the information used in this section. F. Sherman Blom, Ronald A. Thompson, and Judy Loven (USDA-APHIS-ADC) provided useful comments.

Figure 1 from Schwartz and Schwartz (1981) adapted by Jill Sack Johnson.

Figures 2, 3, and 4 courtesy of Pam Tinnin. Figure 7 courtesy of Tom Krause.

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MINK

Fig. 1. The mink, *Mustela vison,* is a semiaquatic furbearer well known for its high-quality fur.

Damage Prevention and Control Methods

Exclusion

Exclusion usually is the best solution to mink predation on domestic animals. Confine animals in fenced areas. Seal all openings larger than 1 inch (2.5 cm).

Habitat Modification

Generally not feasible.

Frightening

No methods are effective.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

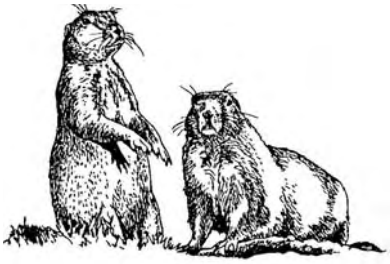
There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting

Normally difficult and impractical.

Identification

The mink (*Mustela vison*, Fig. 1) is a member of the weasel family. It is about 18 to 24 inches (46 to 61 cm) in length, including the somewhat bushy 5- to 7-inch (13- to 18-cm) tail, and weighs 1 1/2 to 3 pounds (0.7 to 1.4 kg). Females are about three-fourths the size of males. Both sexes are a rich chocolate-brown color, usually with a white patch on the chest or chin and scattered white patches on the belly. The fur is relatively short with the coat consisting of a soft, dense underfur concealed by glossy, lustrous guard hairs. Mink also have anal musk glands common to the weasel family and can discharge a disagreeable musk if frightened or disturbed. Unlike skunks, however, they cannot forcibly spray musk.



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Range and Habitat

Mink are found throughout North America,with the exception of the desert southwest and tundra areas (Fig. 2).

Mink are shoreline dwellers and their one basic habitat requirement is a suitable permanent water area. This may be a stream, river, pond, marsh, swamp, or lake. Waters with good populations of fish, frogs, and aquatic invertebrates and with brushy or grassy ungrazed shorelines provide the best mink habitat. Mink use many den sites in the course of their travels and the availability of adequate den sites is a very important habitat consideration. These may be muskrat houses, bank burrows, holes, crevices, log jams, or abandoned beaver lodges.

Food Habits

The mink is strictly carnivorous. Because of its semiaquatic habits, it obtains about as much food on land as in water. Mink are opportunistic feeders with a diet that includes mice and rats, frogs, fish, rabbits, crayfish, muskrats, insects, birds, and eggs.

General Biology, Reproduction, and Behavior

Mink are polygamous and males may fight ferociously for mates during the breeding season, which occurs from late January to late March. Gestation varies from 40 to 75 days with an average of 51 days. Like most other members of the weasel family, mink exhibit delayed implantation; the embryos do not implant and begin completing their development until approximately 30 days before birth. The single annual litter of about 3 to 6 young is born in late April or early May and their eyes open at about 3 weeks of age. The young are born in a den which may be a bank burrow, a muskrat house, a hole under a log, or a rock crevice. The mink family stays together until late summer when the young disperse. Mink become sexually mature at about 10 months of age.

Fig. 2. Distribution of mink in North America.

Mink are active mainly at night and are active year-round, except for brief intervals during periods of low temperature or heavy snow. Then they may hole up in a den for a day or more. Male mink have large home ranges and travel widely, sometimes covering many miles (km) of shoreline. Females have smaller ranges and tend to be relatively sedentary during the breeding season.

Damage and Damage Identification

Mink may occasionally kill domestic poultry around farms. They typically kill their prey by biting them through the skull or neck. Closely spaced pairs of canine tooth marks are sign of a mink kill.

Mink will attack animals up to the size of a chicken, duck, rabbit, or muskrat. While eating muskrats, a mink will often make an opening in the back or side of the neck and skin the animal by pulling the head and body through the hole as it feeds. Like some other members of the weasel family, mink occasionally exhibit "surplus killing" behavior (killing much more than they can possibly eat) when presented with an abundance of food, such as in a poultry house full of chickens. Mink may place many dead chickens neatly in a pile. Mink can eat significant numbers of upland nesting waterfowl or game bird young, particularly in areas where nesting habitat is limited.

Legal Status

In California, mink are designated as furbearing mammals.

See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Mink damage usually is localized. If needed, lethal controls can be directed at the individual mink causing the damage.

Exclusion

Usually the best solution to mink predation on domestic animals is to physically exclude their entry, sealing all openings larger than 1 inch (2.5 cm) with wood or tin and by using 1-inch (2.5-cm) mesh poultry netting around chicken yards and over ventilation openings. Mink do not gnaw like rodents, but they are able to use burrows or gnawed openings made by rats.

Habitat Modification

Habitat modification generally is not a feasible means of reducing mink predation problems on farms. If the objective is to increase natural production of upland nesting wild birds, however, habitat modification may be applicable. The best method of increasing upland nesting success is usually to increase the size and quality of cover areas such as grasslands, legumes, or set-aside areas. Although increasing the density of nesting cover may reduce nest predation by mink, it could lead to an increase in nest predation by species which favor dense cover, such as the Franklin ground squirrel. Because mink frequently use multiple den sites, elimination of potential denning areas may reduce their densities.

Frightening
There are no known frightening devices that are effective for deterring mink predation.

Trapping
Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

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In California, mink can most easily be captured in Conibear®-type body-gripping traps equivalent to No. 120 traps. Mink are suspicious of new objects and are difficult to capture in live traps. Single-door live traps may be effective if baited and placed in dirt banks or rock walls. Double-door live traps can be effective in runways, particularly if the trap doors are wired open and the trap is left in place for some time before activating the trap. Live traps may also be effective around farmyards because mink are more accustomed to encountering human-made objects in those areas.

Use live traps around a farmyard if there is a high likelihood of catching pets. Otherwise, Conibear® traps can be used with or without bait in runs or holes used by mink.

Shooting

Some states may have restrictions on shooting mink, although many will make exceptions in damage situations. If a mink is raiding poultry and can be caught in the act, shooting the animal is a quick way to solve the problem. Normally, though, it is difficult to shoot mink because of their nocturnal habits.

Economics of Damage and Control

Although an individual incident of mink predation can be costly, overall the problem is not very significant to agriculture. Mink damage control on a case-by-case basis generally can be justified from a cost/benefit standpoint, but large-scale control programs are neither necessary nor desirable. Exclusion procedures may or may not be economically justifiable, depending on the severity of the problem and the amount of repairs needed. Normally, such costs can be justified for a recurring problem when amortized over the life of the exclusion structures. Usually damage from other predators and rodents is reduced as well.

Mink are important semiaquatic carnivores in wetland wildlife communities, and are also valuable as a fur resource. About 400,000 to 700,000 wild mink are harvested each year throughout North America, for an annual income exceeding $5 million. Therefore, all lethal control should be limited to specific instances of documented damage.

Acknowledgments

Information for this section came from a variety of published and unpublished sources. Information on damage identification was adapted from Dolbeer et al. (1994).

Figures 1 and 2 from Schwartz and Schwartz (1981).

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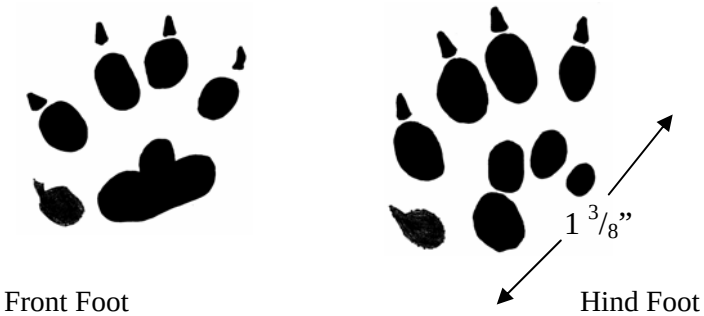

Mink tracks.

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MUSKRATS

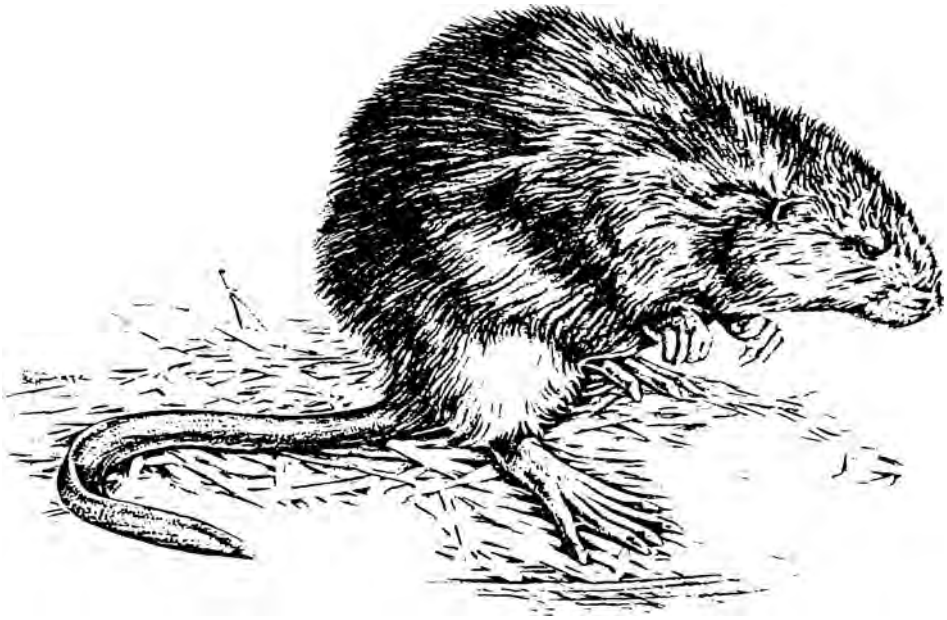

Fig. 1. Muskrat, *Ondatra zibethicus*

Damage Prevention and Control Methods

Exclusion

Riprap the inside of a pond dam face with rock, or slightly overbuild the dam to certain specifications.

Cultural Methods and Habitat Modification

Eliminate aquatic vegetation as a food source.

Draw down farm ponds during the winter months.

Frightening

Seldom effective in controlling serious damage problems.

Repellents

None are registered.

Trapping

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Shooting

Effective in eliminating some individuals.

Other Methods

Integrated pest management.

Identification

The muskrat (*Ondatra zibethicus,* Fig. 1) is the largest microtine rodent in the United States. It spends its life in aquatic habitats and is well adapted for swimming. Its large hind feet are partially webbed, stiff hairs align the toes (Fig. 2), and its laterally flattened tail is almost as long as its body. The muskrat has a stocky appearance, with small eyes and very short, rounded ears. Its front feet, which are much smaller than its hind feet, are adapted primarily for digging and feeding.

The overall length of adult muskrats is usually from 18 to 24 inches (46 to 61 cm). Large males, however, will sometimes be more than 30 inches (76 cm) long, 10 to 12 inches (25 to 31 cm) of which is the laterally flattened tail. The average weight of adult muskrats is

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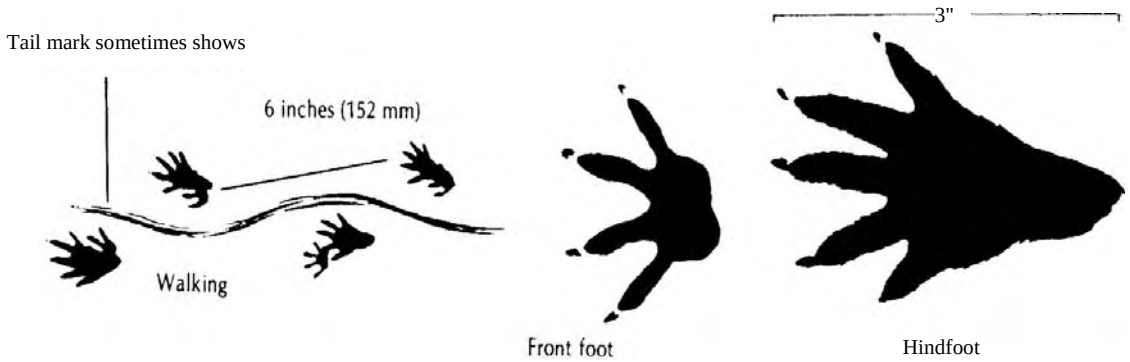

Fig. 2. Muskrat tracks

from 1 1/2 pounds (0.7 kg) to over 4 pounds (1.8 kg), with most at about 2 1/2 pounds (1.1 kg). The color of the belly fur is generally light gray to silver to tan, and the remaining fur varies from dark tan to reddish brown, dark brown, and black.

The name *muskrat,* common throughout the animal's range, derives from the paired perineal musk glands found beneath the skin at the ventral base of the tail in both sexes. These musk glands are used during the breeding season. Musk is secreted on logs or other defecation areas, around houses, bank dens, and trails on the bank to mark the area.

The muskrat has an upper and a lower pair of large, unrooted incisor teeth that are continually sharpened against each other and are well designed for gnawing and cutting vegetation. It has a valvular mouth, which allows the lips to close behind the incisors and enables the muskrat to gnaw while submerged. With its tail used as a rudder and its partially webbed hind feet propelling it in the water, the muskrat can swim up to slightly faster than 3 miles per hour (4.8 kph). When feeding, the muskrat often swims backward to move to a more choice spot and can stay underwater for as long as 20 minutes. Muskrat activity is predominantly nocturnal and crespuscular, but occasional activity may be observed during the day.

Muskrats in the wild have been known to live as long as 4 years, although most do not reach this age. In good habitat and with little competition, muskrats are very prolific. With a gestation period of between 25 and 30 days, females in the southern part of the range commonly produce 5 to 6 litters per year.

Range

The range of the muskrat extends from near the Arctic Circle in the Yukon and the Northwest Territories, down to the Gulf of Mexico, and from the Aleutians east to Labrador and down the Atlantic coast into Georgia (Fig. 3). The muskrat has been introduced practically all over the world, and, like most exotics, has sometimes caused severe damage as well as ecological problems. Muskrats often cause problems with ponds, levees, and crop culture, whether introduced or native. Muskrats are found in most aquatic habitats throughout the United States and Canada in streams, ponds, wetlands, swamps, drainage ditches, and lakes.

Fig. 3. Range of the muskrat in North America.

Habitat

Muskrats can live almost any place where water and food are available year-round. This includes streams, ponds, lakes, marshes, canals, roadside ditches, swamps, beaver ponds, mine pits, and other wetland areas. In shallow water areas with plentiful vegetation, they use plant materials to construct houses, generally conical in shape (Fig. 4). Elsewhere, they prefer bank dens, and in many habitats, they construct both bank dens and houses of vegetation. Both the houses of vegetation and the bank burrows or dens have several underwater entrances via "runs" or trails. Muskrats often have feeding houses, platforms, and chambers that are somewhat smaller than houses used for dens.

Burrowing activity is the source of the greatest damage caused by muskrats in much of the United States. They damage pond dams, floating styrofoam marinas, docks and boathouses, and lake shorelines. In states where rice and aquaculture operations are big business, muskrats can cause extensive economic losses. They damage rice culture by burrowing through or into levees as well as by eating substantial amounts of rice and cutting it down for building houses. In waterfowl marshes, population irruptions can cause "eat-out" where aquatic

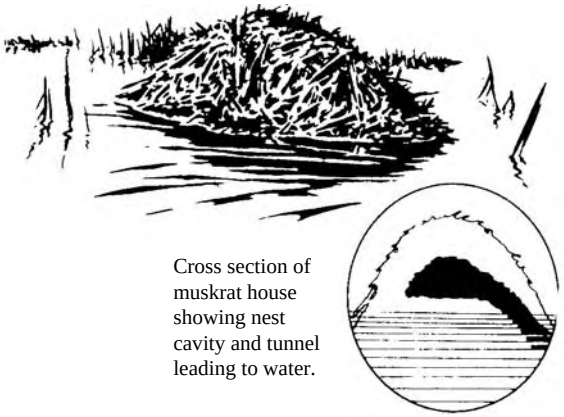

Fig. 4. Muskrat house

vegetation in large areas is virtually eliminated by muskrats. In some locations, such as in the rice-growing areas of Arkansas, muskrats move from overwintering habitat in canals, drainage ditches, reservoirs, and streams to make their summer homes nearby in flooded rice fields. In aquaculture reservoirs, damage is primarily to levees or pond banks, caused by burrowing.

Food Habits

Muskrats are primarily herbivores. They will eat almost any aquatic vegetation as well as some field crops grown adjacent to suitable habitat. Some of the preferred natural foods include cattail, pickerelweed, bulrush, smartweed, duck potato, horsetail, water lily, sedges, young willow regeneration, and other aquatics. Crops that are occasionally damaged include corn, soybeans, wheat, oats, grain sorghum, and sugarcane. Rice grown as a flooded crop is a common muskrat food. It is not uncommon, however, to see muskrats subsisting primarily on upland vegetation such as bermuda grass, clover, johnsongrass, and orchard grass where planted or growing on or around farm pond dams.

Although primarily herbivores, muskrats will also feed on crayfish, mussels, turtles, frogs, and fish in ponds where vegetation is scarce. In some aquaculture industry areas, this feeding habit should be studied, as it may differ significantly from normal feeding activity and can cause economic loss.

General Biology, Reproduction, and Behavior

Muskrats generally have a small home range but are rather territorial, and during breeding seasons some dispersals are common. The apparent intent of those leaving their range is to establish new breeding territories. Dispersal of males, along with young that are just reaching sexual maturity, seems to begin in the spring. Dispersal is also associated with population densities and population cycles. These population cycles vary from 5 years in some parts of North America to 10 years in others. Population levels can be impacted by food availability and accessibility.

Both male and female muskrats become more aggressive during the breeding season to defend their territories. Copulation usually takes place while submerged. The young generally are born between 25 and 30 days later in a house or bank den, where they are cared for chiefly by the female. In the southern states, some females may have as many as 6 litters per year. Litters may contain as many as 15, but generally average between 4 and 8 young. It has been reported that 2 to 3 litters per female per year is average in the Great Plains. This capability affords the potential for a prolific production of young. Young may be produced any month of the year. In Arkansas, the peak breeding periods are during November and March. Most of the young, however, are produced from October until April. Some are produced in the summer and early fall months, but not as many as in winter months. The period of highest productivity reported for the Great Plains is late April through early May. In the northern parts of its range, usually only 2 litters per year are produced between March and September.

Young muskrats are especially vulnerable to predation by owls, hawks, raccoons, mink, foxes, coyotes, and — in the southern states — even largemouth bass and snapping turtles. The young are also occasionally killed by adult muskrats. Adult muskrats may also be subject to predation, but rarely in numbers that would significantly alter populations. Predation cannot be depended upon to solve damage problems caused by muskrats.

Muskrats are hosts to large numbers of endo- and ectoparasites and serve as carriers for a number of diseases, including tularemia, hemorrhagic diseases, leptospirosis, ringworm disease, and pseudotuberculosis. Most common ectoparasites are mites and ticks. Endoparasites are predominantly trematodes, nematodes, and cestodes.

Damage and Damage Identification

Damage caused by muskrats is primarily due to their burrowing activity. Burrowing may not be readily evident until serious damage has occurred. One way to observe early burrowing in farm ponds or reservoirs is to walk along the edge of the dam or shorelines when the water is clear and look for "runs" or trails from just below the normal water surface to as deep as 3 feet (91 cm). If no burrow entrances are observed, look for droppings along the bank or on logs or structures a muskrat can easily climb upon. If the pond can be drawn down from 1 1/2 to 3 feet (46 to 91 cm) each winter, muskrat burrows will be exposed, just as they would during extended drought periods. Any burrows found in the dam should be filled, tamped in, and covered with rock to avoid possible washout or, if livestock are using

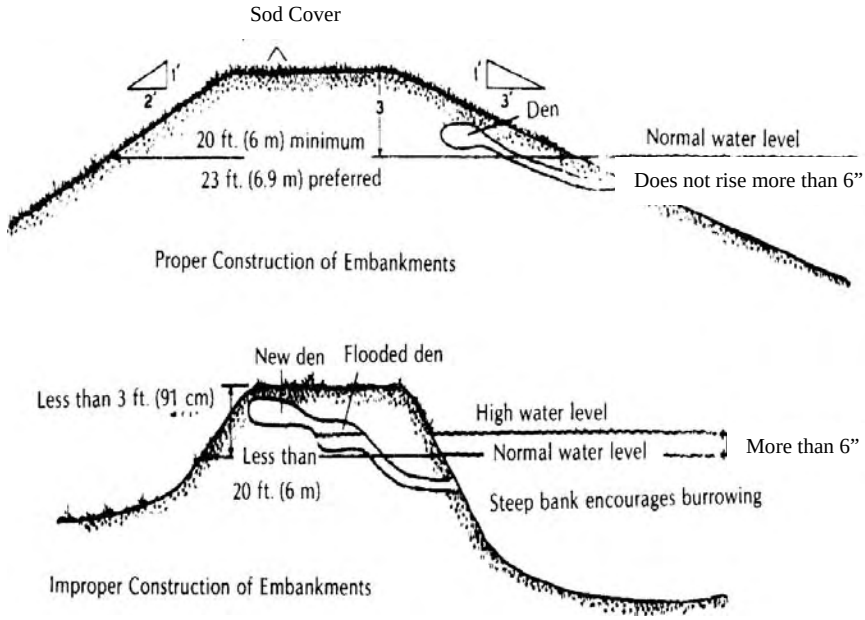

Fig. 5. Proper dam construction can reduce muskrat damage to the structure.

the pond, to prevent injury to a foot or leg.

Where damage is occurring to a crop, plant cutting is generally evident. In aquaculture reservoirs generally maintained without lush aquatic vegetation, muskrat runs and burrows or remains of mussels, crayfish, or fish along with other muskrat signs (tracks or droppings) are generally easy to observe.

Legal Status

Muskrats nationwide for many years were known as the most valuable furbearing mammal — not in price per pelt, but in total numbers taken. In California, muskrats are designated as furbearing mammals.

See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Exclusion

Muskrats in some situations can be excluded or prevented from digging into farm pond dams through stone rip-rapping of the dam. Serious damage often can be prevented, if anticipated, by constructing dams to the following specifications: the inside face of the dam should be built at a 3 to 1 slope; the outer face of the dam at a 2 to 1 slope with a top width of not less than 8 feet (2.4 m), preferably 10 to 12 feet (3 to 3.6 m). The normal water level in the pond should be at least 3 feet (91 cm) below the top of the dam and the spillway should be wide enough that heavy rainfalls will not increase the level of the water for any length of time (Fig. 5). These specifications are often referred to as overbuilding, but they will generally prevent serious damage from burrowing muskrats. Other methods of exclusion can include the use of fencing in certain situations where muskrats may be leaving a pond or lake to cut valuable garden plants or crops.

Cultural Methods and Habitat Modification

The best ways to modify habitat are to eliminate aquatic or other suitable foods eaten by muskrats, and where possible, to construct farm pond dams to previously suggested specifications. If farm pond dams or levees are being damaged, one of the ways that damage can be reduced is to draw the pond down at least 2 feet (61 cm) below normal levels during the winter. Then fill dens, burrows, and runs and rip-rap the dam with stone. Once the water is drawn down, trap or otherwise remove all muskrats.

Frightening Devices

Gunfire will frighten muskrats, especially those that get hit, but it is not effective in scaring the animals away from occupied habitat. No conventional frightening devices are effective.

Repellents

No repellents currently are registered for muskrats, and none are known to be effective, practical, and environmentally safe.

Fig. 7. Conibear®-type body-gripping kill trap

Fumigants
No fumigants are currently registered for muskrat control.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

There have probably been more traps sold for cat catching muskrats than for catching any other furbearing species. A number of innovative traps have been constructed for both live trapping and killing muskrats, such as barrel, and stovetop traps.

The most effective and commonly used type of traps for muskrats in California is the Conibear®-type No. 110 (Fig. 7) The Conibear®-type, No. 110 is a preferred choice because it is as effective in 6 inches (15 cm) of water as at any deeper level. It kills the muskrat almost instantly, thus preventing escapes. All that is needed to make this set is a trap stake and trap.

As a test of trap efficiency, this author once set 36 Conibear®-type No. 110 traps in a 100-acre (40-ha) rice field. The next day 34 muskrats were removed. The remaining traps had not been tripped. Obviously, the area held high populations of muskrats and had not been subjected to recent control efforts. Results were 93.3% effectiveness with the Conibear®-type and 100% catch per traps tripped.

The most effective sets are those placed in "runs" or trails where the muskrat's hind feet scour out a path into the bottom from repeated trips into and out of the den. These runs or trails can be seen in clear water, or can be felt underwater with hands or feet. Which runs are being used and which are alternate entrances can usually be discerned by the compaction of the bottom of the run. Place the trap as close to the den entrance as possible without restricting trap movement.

Trapping muskrats during the winter furbearer season can be an enjoyable past-time and even profitable where prices for pelts range from $2.00 to $8.00 each. Price differences depend on whether pelts are sold "in the round" or skinned and stretched. Many people supplement their income by trapping, and muskrats are one of the prime targets for most beginners learning to trap. Therefore, unless muskrats are causing serious damage, they should be managed like other wildlife species to provide a sustained annual yield. Unfortunately, when fur prices for muskrats are down to less than $2.00 each, interest in trapping for fur seems to decline. However, in damage situations, it may be feasible to supplement fur prices to keep populations in check.

Shooting

Where it can be done safely, shooting may eliminate one or two individuals in a small farm pond. Concentrated efforts must be made at dusk and during the first hours of light in the early morning. Muskrats shot in the water rarely can be saved for the pelt and/or meat.

Other Methods

Although a variety of other methods are often employed in trying to control muskrat damage, a combination of trapping and proper use of toxicants is the most effective means in most situations. In situations where more extensive damage is occurring, it may be useful to employ an integrated pest management approach: (1) modify the habitat by removing available food (vegetation); (2) concentrate efforts to reduce the breeding population during winter months while muskrats are concentrated in overwintering habitat; and (3) use both registered toxicants and trapping in combination with the above methods.

Economics of Damage and Control

Assessment of the amount of damage being caused and the cost of prevention and control measures should be made before undertaking a control program. Sometimes this can be easily done by the landowner or manager through visual inspection and knowledge of crop value or potential loss and reconstruction or replacement costs. Other situations are more difficult to assess. For example, what is the economic value of frustration and loss of a truckload of minnows and/or fish after a truck has fallen through the levee into burrowed-out muskrat dens? Or how do you evaluate the loss of a farm pond dam or levee and water behind it from an aquaculture operation where hundreds of thousands of pounds of fish are being grown? Rice farmers in the mid-South or in California must often pump extra, costly irrigation water and shovel levees every day because of muskrat damage. The expense of trapping or other control measures may prove cost-effective if damage is anticipated.

Obviously, the assessments are different in each case. The estimate of economic loss and repair costs, for example, for rebuilding levees, replacing drain pipes, and other measures, must be compared to the estimated cost of prevention and/or control efforts.

Economic loss to muskrat damage can be very high in some areas, particularly in rice and aquaculture producing areas. In some states damage may be as much as $1 million per year. Totals in four states (Arkansas, California, Louisiana, and Mississippi) exceed losses throughout the rest of the nation.

Elsewhere, economic losses because of muskrat damage may be rather limited and confined primarily to burrowing in farm pond dams. In such limited cases, the value of the muskrat population may outweigh the cost of the damage.

Muskrat meat has been commonly used for human consumption and in some areas called by names, such as "marsh rabbit." A valuable resource, it is delicious when properly taken care of in the field and in the kitchen. Many wild game or outdoor cookbooks have one or more recipes devoted to "marsh rabbit." Care should be taken in cleaning muskrats because of diseases mentioned earlier.

Muskrat pelts processed annually are valued in the millions of dollars, even with low prices; thus the animal is certainly worthy of management consideration. It obviously has other values just by its place in the food chain.

Acknowledgments

Most of the information in this chapter was obtained from experience gained in Alabama, where as a youngster I trapped muskrats and other furbearers to sell, and in Arkansas where muskrat control is a serious economic problem. Colleagues in the Arkansas Cooperative Extension Service, and especially county extension agents, provided the opportunity and background for obtaining this information. The Arkansas Farm Bureau, many rice farmers, fish farmers, and other private landowners/managers, as well as the Arkansas Game and Fish Commission and the Arkansas State Plant Board, were also important to the development of this information.

Figures 1 through 4 from Schwartz and Schwartz (1981).

Figure 5 from Henderson (1980).
Figure 7 from Miller (1976).

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OPOSSUMS

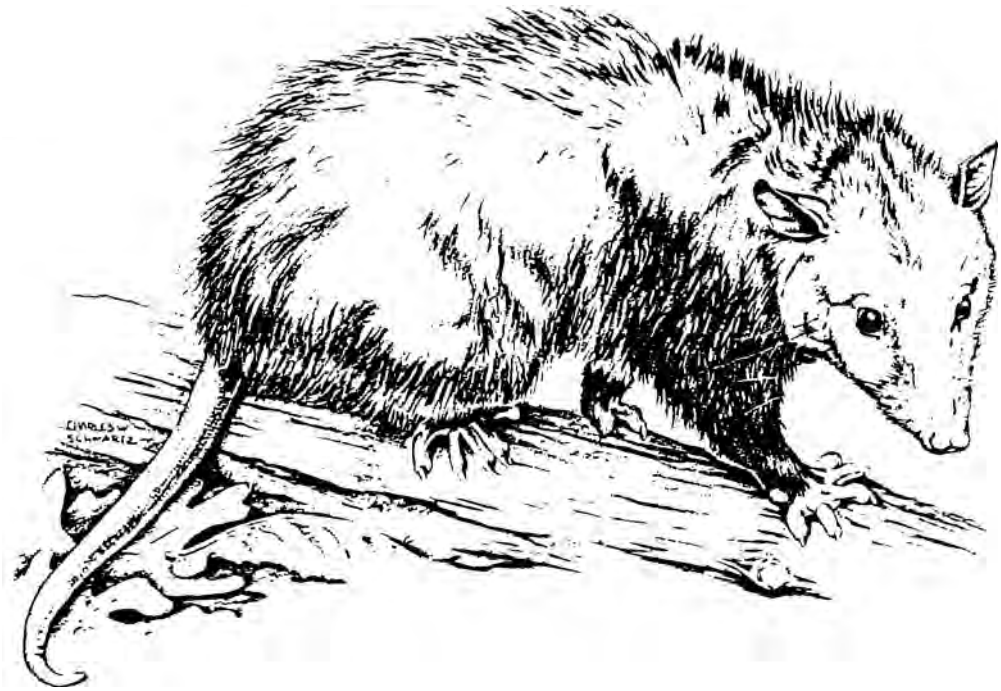

Fig. 1. Opossum, *Didelphis virginiana*

Damage Prevention and Control Methods

Exclusion

Practical where opossums are entering structures.

Habitat Modification

Remove cover and plug burrows to reduce frequency of visits by opossums.

Frightening

Generally not practical.

Repellents

None are registered.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting

Effective where firearms are permitted. Use a shotgun with No. 6 shot or a .22-caliber rifle.

Identification

An opossum *(Didelphis virginiana)* is a whitish or grayish mammal about the size of a house cat (Fig. 1). Underfur is dense with sparse guard hairs. Its face is long and pointed, its ears rounded and hairless. Maximum length is 40 inches (102 cm); the rat like tail is slightly less than half the total length. The tail may be unusually short in northern opossums due to loss by frostbite. Opossums may weigh as much as 14 pounds (6.3 kg); males average 6 to 7 pounds (2.7 to 3.2 kg) and females average 4 pounds (6.3 kg). The skull is usually 3 to 4 inches (8 to 10 cm) long and contains 50 teeth — more

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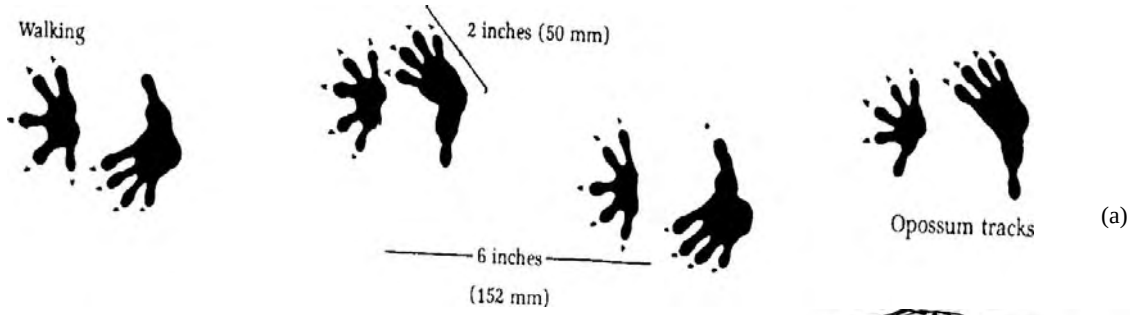
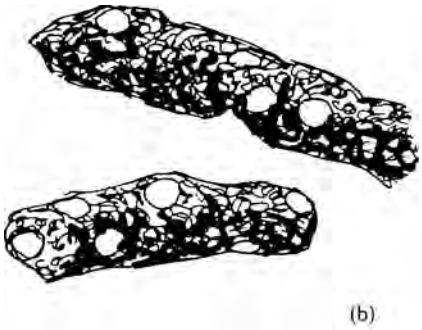




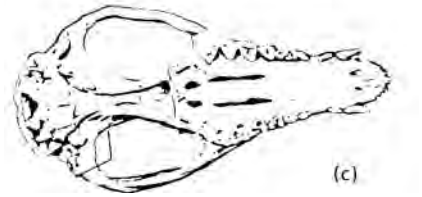


Fig. 2. Opossum sign and characteristics: (a) tracks, (b) droppings, and (c) skull.

than are found in any other North American mammal. Canine teeth (fangs) are prominent. Tracks of both front and hind feet look as if they were made by little hands with widely spread fingers (Fig. 2). They may be distinguished from raccoon tracks, in which hind prints appear to be made by little feet. The hind foot of an opossum looks like a distorted hand.

Range

Opossums are found in eastern, central, and west coast states. Since 1900 they have expanded their range northward in the eastern United States. They are absent from the Rockies, Sierra Nevada axis, most western plains states, and parts of the northern United States (Fig. 3).

Habitat

Habitats are diverse, ranging from arid to moist, wooded to open fields. Opossums prefer environments near streams or swamps. They take shelter in burrows of other animals, tree cavities, brush piles, and other cover. They sometimes den in attics and garages where they may make a messy nest.

Food Habits

Foods preferred by opossums are animal matter, mainly insects or carrion. Opossums also eat considerable amounts of vegetable matter, especially fruits and grains. Opossums living near people may visit compost piles, garbage cans, or food dishes intended for dogs, cats, and other pets.

General Biology, Reproduction, and Behavior

Opossums usually live alone, having a home range of 10 to 50 acres (4 to 20 ha). Young appear to roam randomly until they find a suitable home range. Usually they are active only at night. The mating season is January to July in warmer parts of the range but may start a month later and end a month earlier in northern areas. Opossums may raise 2, rarely 3, litters per year. The opossum is the only marsupial in North America. Like other marsupials, the blind, helpless young develop in a pouch. They are born 13 days after mating. The young, only 1/2 inch (1.3 cm) long, find their way into the female's pouch where they each attach to one of 13 teats. An average of 7 young are born. They remain in the pouch for 7 to 8 weeks. The young remain with the mother another 6 to 7 weeks until weaned.

Most young die during their first year. Those surviving until spring will breed in that first year. The maximum age in the wild is about 7 years.

Although opossums have a top running speed of only 7 miles per hour (11.3 km/hr), they are well equipped to escape enemies. They readily enter burrows and climb trees. When threatened, an opossum may bare its teeth, growl, hiss, bite, screech, and exude a smelly, greenish fluid from its anal glands. If these defenses are not successful, an opossum may play dead.

When captured or surprised during daylight, opossums appear stupid and inhibited. They are surprisingly

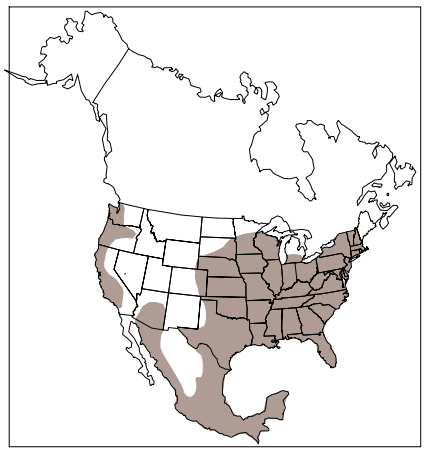


Fig. 3. Range of the opossum in North America.

intelligent, however. They rank above dogs in some learning and discrimination tests.

Damage

Opossums may be a nuisance near homes where they may get into garbage, bird feeders, or pet food. They may also destroy poultry, game birds, and their nests.

Legal Status

The opossum is designated as a nongame mammal in California.

See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Exclusion

Prevent nuisance animals from enter ing structures by closing openings to cages and pens that house poultry. Opossums can be prevented from climbing over wire mesh fences by installing a tightly stretched electric fence wire near the top of the fence 3 inches (8 cm) out from the mesh. Fasten garbage can lids with a rubber strap.

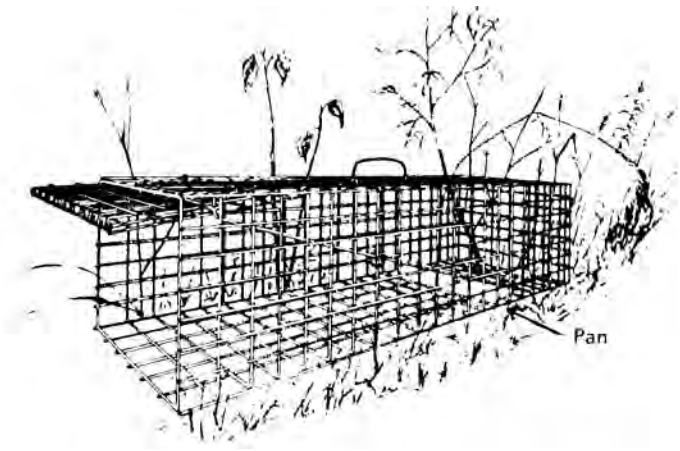


Fig. 4. Cage trap (set position).

Traps

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Opossums are not wary of traps and may be easily caught with suitable- sized box or cage traps (Fig. 4).

A medium-sized body-gripping (kill type) trap will catch and kill opossums. Place bait behind the trap in such a way that the animal must pass through the trap to get it. Body-gripping traps kill the captured animal quickly. To reduce chances of catching pets, set the trap above ground on a running pole (Fig. 6).

In California, it is illegal to use body-gripping traps for recreation or commerce in fur.

Shooting

A rifle of almost any caliber or a shotgun loaded with No. 6 shot or larger will effectively kill opossums. Use a light to look for opossums after dark. If an opossum has not been alarmed, it will usually pause in the light long enough to allow an easy shot. Once alarmed, opossums do not run rapidly. They will usually climb a nearby tree where they can be located with a light. Chase running opossums on foot or with a dog. If you lose track, run to the last place where you saw the animal. Stop and listen for the sound of claws on bark to locate the tree the animal is climbing.

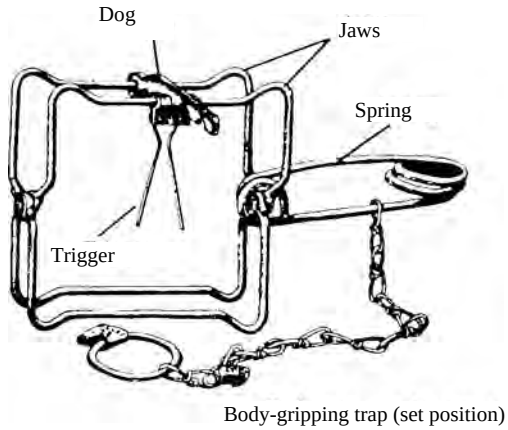
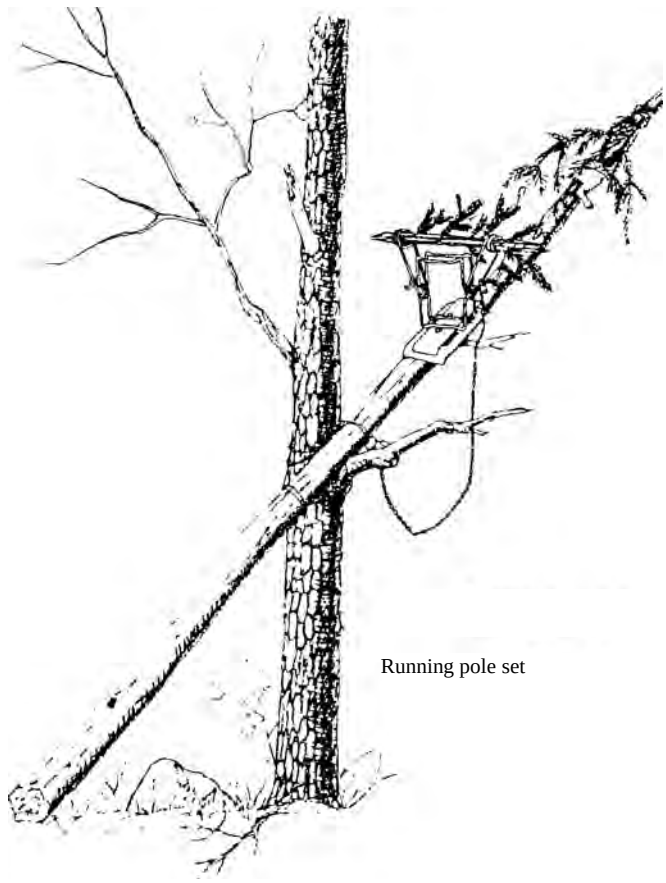


Fig. 6. Body-gripping trap and running pole set.

Economics of Damage and Control

No data are available; however, it is usually worthwhile to remove a particular animal that is causing damage.



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Figures 1, 2a, 2c, and 3 from Schwartz and Schwartz (1981).

Figure 2b by Jill Sack Johnson.

Figures 4 and 6 by Michael D. Stickney, from the New York Department of Environmental Conservation publication "Trapping Furbearers, Student Manual" (1980), by R. Howard, L. Berchielli, C. Parsons, and M. Brown. The figures are copyrighted and are used with permission.

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RACCOONS

Fig. 1. The distinctively marked raccoon (*Procyon lotor*) is usually found in association with water.

Damage Prevention and Control Methods

Exclusion
Usually the best method for coping with almost all types of raccoon damage.

Habitat Modification
Remove obvious sources of food or shelter around the premises; usually not practical as a sole method of controlling damage.

Frightening
Several methods may be effective, but only for a short time.

Repellents, Toxicants, and Fumigants None are registered.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting
Can be very effective, particularly if trained hounds are used to tree the raccoons. Local regulations may apply.

Identification

The raccoon (*Procyon lotor*), also called "coon," is a stocky mammal about 2 to 3 feet (61 to 91 cm) long, weighing 10 to 30 pounds (4.5 to 13.5 kg) (rarely 40 to 50 pounds [18 to 22.5 kg]). It is distinctively marked, with a prominent black "mask" over the eyes and a heavily furred, ringed tail (Fig. 1). The animal is a grizzled salt-and-pepper gray and black above, although some individuals are strongly washed with yellow. Raccoons from the prairie areas of the western Great Plains are paler in color than those from eastern portions of the region.

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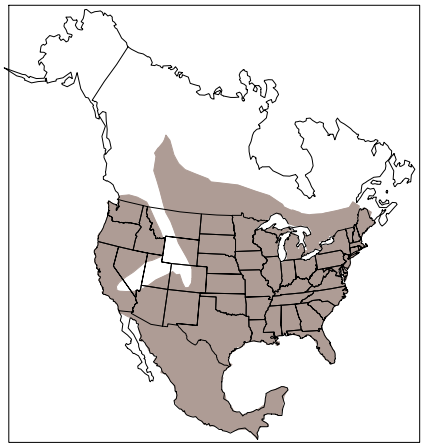


Fig. 2. Distribution of the raccoon in North America.

Range

The raccoon is found throughout the United States, with the exception of the higher elevations of mountainous regions and some areas of the arid Southwest (Fig. 2). Raccoons are more common in the wooded eastern portions of the United States than in the more arid western plains.

Habitat

Raccoons prefer hardwood forest areas near water. Although commonly found in association with water and trees, raccoons occur in many areas of the western United States around farmsteads and livestock watering areas, far from naturally occurring bodies of permanent water. Raccoons den in hollow trees, ground burrows, brush piles, muskrat houses, barns and abandoned buildings, dense clumps of cattail, haystacks, or rock crevices.

General Biology, Reproduction, and Behavior

Raccoons are omnivorous, eating both plant and animal foods. Plant foods include all types of fruits, berries, nuts, acorns, corn, and other types of grain. Animal foods are crayfish, clams, fish, frogs, snails, insects, turtles and their eggs, mice, rabbits, muskrats, and the eggs and young of ground-nesting birds and waterfowl. Contrary to popular myth, raccoons do not always wash their food before eating, although they frequently play with their food in water.

Raccoons breed mainly in February or March, but matings may occur from December through June, depending on latitude. The gestation period is about 63 days. Most litters are born in April or May but some late-breeding females may not give birth until June, July, or August. Only 1 litter of young is raised per year. Average litter size is 3 to 5. The young first open their eyes at about 3 weeks of age. Young raccoons are weaned sometime between 2 and 4 months of age.

Raccoons are nocturnal. Adult males occupy areas of about 3 to 20 square miles (8 to 52 km^2), compared to about 1 to 6 square miles (3 to 16 km^2) for females. Adult males tend to be territorial and their ranges overlap very little. Raccoons do not truly hibernate, but they do "hole up" in dens and become inactive during severe winter weather. In the southern United States they may be inactive for only a day or two at a time, whereas in the north this period of inactivity may extend for weeks or months. In northern areas, raccoons may lose up to half their fall body weight during winter as they utilize stored body fat.

Raccoon populations consist of a high proportion of young animals, with one-half to three-fourths of fall populations normally composed of animals less than 1 year in age. Raccoons may live as long as 12 years in the wild, but such animals are extremely rare. Usually less than half of the females will breed the year after their birth, whereas most adult females normally breed every year.

Family groups of raccoons usually remain together for the first year and the young will often den for the winter with the adult female. The family gradually separates during the following spring and the young become independent.

Damage and Damage Identification

Raccoons may cause damage or nuisance problems in a variety of ways, and their distinctive tracks (Fig. 3) often provide evidence of their involvement in damage situations.

Raccoons occasionally kill poultry and leave distinctive signs. The heads of adult birds are usually bitten off and left some distance from the body. The crop and breast may be torn and chewed, the entrails sometimes eaten, and bits of flesh left near water. Young poultry in pens or cages may be killed or injured by raccoons reaching through the wire and attempting to pull the birds back through the mesh. Legs or feet of the young birds may be missing. Eggs may be removed completely from nests or eaten on the spot with only the heavily cracked shell remaining. The lines of fracture will normally be along the long axis of the egg, and the nest materials are often disturbed. Raccoons can also destroy bird nests in artificial nesting structures such as bluebird and wood duck nest boxes.

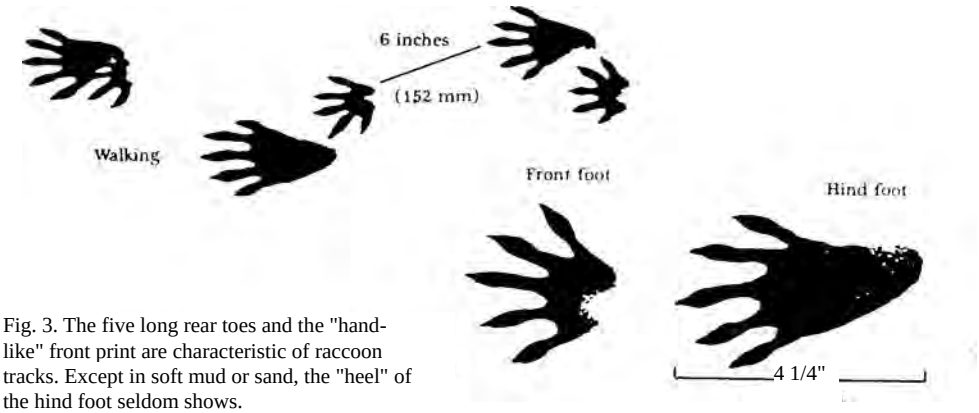


Fig. 3. The five long rear toes and the "hand-like" front print are characteristic of raccoon tracks. Except in soft mud or sand, the "heel" of the hind foot seldom shows.

Raccoons can cause considerable damage to garden or truck crops, particularly sweet corn. Raccoon damage to sweet corn is characterized by many partially eaten ears with the husks pulled back. Stalks may also be broken as raccoons climb to get at the ears. Raccoons damage watermelons by digging a small hole in the melon and then raking out the contents with a front paw.

Raccoons cause damage or nuisance problems around houses and outbuildings when they seek to gain entrance to attics or chimneys or when they raid garbage in search of food. In many urban or suburban areas, raccoons are learning that uncapped chimneys make very adequate substitutes for more traditional hollow trees for use as denning sites, particularly in spring. In extreme cases, raccoons may tear off shingles or facia boards in order to gain access to an attic or wall space.

Raccoons also can be a considerable nuisance when they roll up freshly laid sod in search of earthworms and grubs. They may return repeatedly and roll up extensive areas of sod on successive nights. This behavior is particularly common in mid- to late summer as young raccoons are learning to forage for themselves, and during periods of dry weather when other food sources may be less available.

The incidence of reported rabies in raccoons and other wildlife has increased dramatically over the past 30 years. Raccoons have recently been identified as the major wildlife host of rabies in the United States, primarily due to increased prevalence in the eastern United States.

Legal Status

In California, raccoons are designated as furbearing mammals.

See California statutes and regulations regarding the take of furbearing and nongame mammals.

Fig. 4. Electric fencing can be very effective at excluding raccoons from sweet corn or other crops. Two wires are recommended, but one wire 6 inches above the ground may be sufficient. Electric fence chargers are available at farm supply dealers. The fence can be activated at dusk and turned off after daybreak.

Damage Prevention and Control Methods

Exclusion

Exclusion, if feasible, is usually the best method of coping with raccoon damage.

Poultry damage generally can be prevented by excluding the raccoons with tightly covered doors and windows on buildings or mesh-wire fences with an overhang surrounding poultry yards. Raccoons are excellent climbers and are capable of gaining access by climbing conventional fences or by using overhanging limbs to bypass the fence. A "hot wire" from an electric fence charger at the top of the fence will greatly increase the effectiveness of a fence for excluding raccoons.

Damage to sweet corn or watermelons can most effectively be stopped by excluding raccoons with a single or double hot-wire arrangement (Fig. 4). The fence should be turned on in the evening before dusk, and turned off after daybreak. Electric fences should be used with care and appropriate caution signs installed. Wrapping filament tape around ripening ears of corn (Fig. 5) or placing plastic bags over the ears is an effective method of reducing raccoon damage to sweet corn. In general, tape or fencing is more effective than bagging. When using tape, it is important to apply the type with glass-yarn filaments embedded within so that the

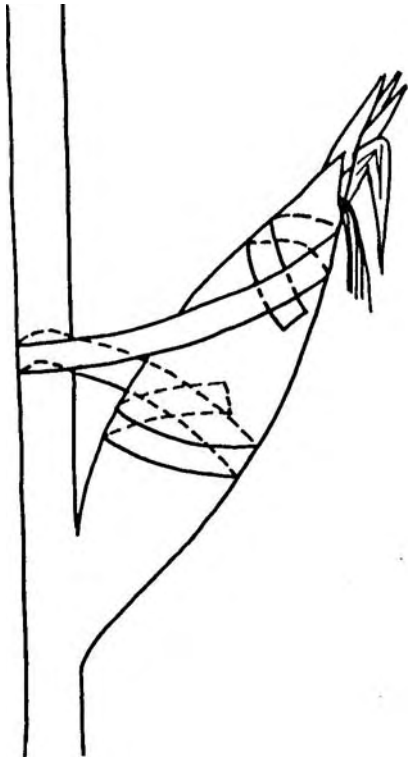


Fig. 5. Wrapping a ripening ear of sweet corn with reinforced filament tape as shown can reduce raccoon damage by 70% to 80%. It is important that each loop of the tape be wrapped over itself so that it forms a closed loop that cannot be ripped open by the raccoon.

raccoons cannot tear through the tape. Taping is more labor-intensive than fencing, but may be more practical and acceptable for small backyard gardens.

Store garbage in metal or tough plastic containers with tight-fitting lids to discourage raccoons from raiding garbage cans. If lids do not fit tightly, it may be necessary to wire, weight, or clamp them down to prevent raccoons from lifting the lid to get at garbage. Secure cans to a rack or tie them to a support to prevent raccoons from tipping them over.

Prevent raccoon access to chimneys by securely fastening a commercial cap of sheet metal and heavy screen over the top of the chimney (Fig. 6). Raccoon access to rooftops can be limited by removing overhanging branches and by wrapping and nailing sheets of slick metal at least 3 feet (90 cm) square around corners of buildings. This prevents raccoons from being able to get a toehold for climbing (Fig. 7). While this method may be practical for outbuildings, it is unsightly and generally unacceptable for homes. It is more practical to cover chimneys or other areas attracting raccoons to the rooftop or to remove the offending individual animals than to completely exclude them from the roof.

Homeowners attempting to exclude or remove raccoons in the spring and summer should be aware of the possibility that young may also be present. Do not complete exclusion procedures until you are certain that all raccoons have been removed from or have left the exclusion area. Raccoons frequently will use uncapped chimneys as natal den sites, raising the young on the smoke shelf or the top of the fireplace box until weaning. Homeowners with the patience to wait out several weeks of scratching, rustling, and chirring sounds will normally be rewarded by the mother raccoon moving the young from the chimney at the time she begins to wean them. Homeowners with less patience can often contact a pest removal or chimney sweep service to physically remove the raccoons. In either case, raccoon exclusion procedures should be completed immediately after the animals have left or been removed.

Habitat Modification

There are no practical means of modifying habitat to reduce raccoon depredations, other than removing any obvious sources of food or shelter which may be attracting the raccoons to the premises. Raccoons forage over wide areas, and anything other than local habitat modification to reduce raccoon numbers is not a desirable technique for reducing damage.

Raccoons sometimes will roll up freshly laid sod in search of worms or grubs. If sodded areas are not extensive, it may be possible to pin the rolls

Fig. 6. A cap or exclusion device will keep raccoons and other animals out of chimneys. These are available commercially and should be made of heavy material. Tightly clamp or fasten them to chimneys to prevent raccoons from pulling or tearing them off.

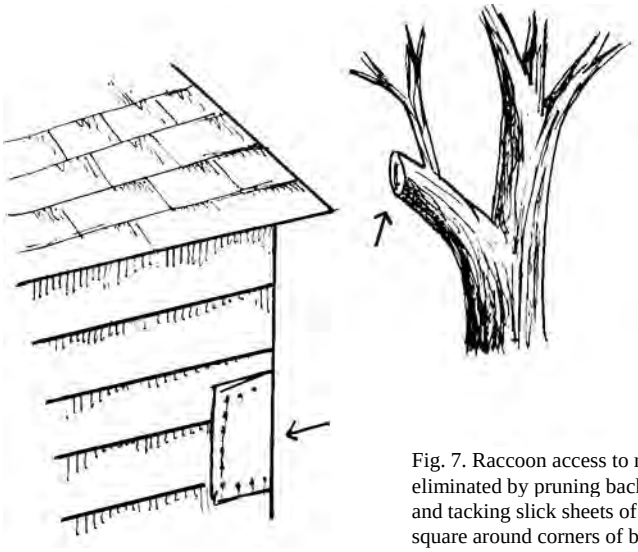


Fig. 7. Raccoon access to rooftops can be eliminated by pruning back overhanging limbs and tacking slick sheets of metal at least 3 feet square around corners of buildings.

down with long wire pins, wooden stakes, or nylon netting until the grass can take root, especially if the damage is restricted to only a portion of the yard, such as a shaded area where the grass is slower to take root. In more rural areas, use of electric fences may be effective (see section on exclusion). Because the sod-turning behavior is most prevalent in mid- to late summer when family groups of raccoons are learning to forage, homeowners may be able to avoid problems by having the sod installed in spring or early summer. In most cases, however, removal of the problem raccoons is usually necessary.

Frightening

Although several techniques have been used to frighten away raccoons, particularly in sweet corn patches, none has been proven to be effective over a long period of time. These techniques have included the use of lights, radios, dogs, scarecrows, plastic or cloth streamers, aluminum pie pans, tin can lids, and plastic windmills. All of these may have some temporary effectiveness in deterring raccoons, but none will provide adequate long-term protection in most situations.

Repellents

There are no repellents, toxicants, or fumigants currently registered for raccoon control.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Raccoons are relatively easy to catch in traps, but it takes a sturdy trap to hold one. For homeowners with pets, a live or cage-type trap (Fig. 8) is usually the preferable alternative to a leghold trap.

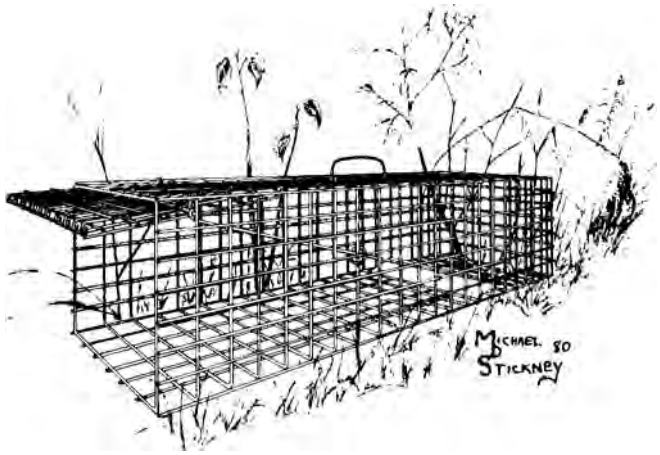
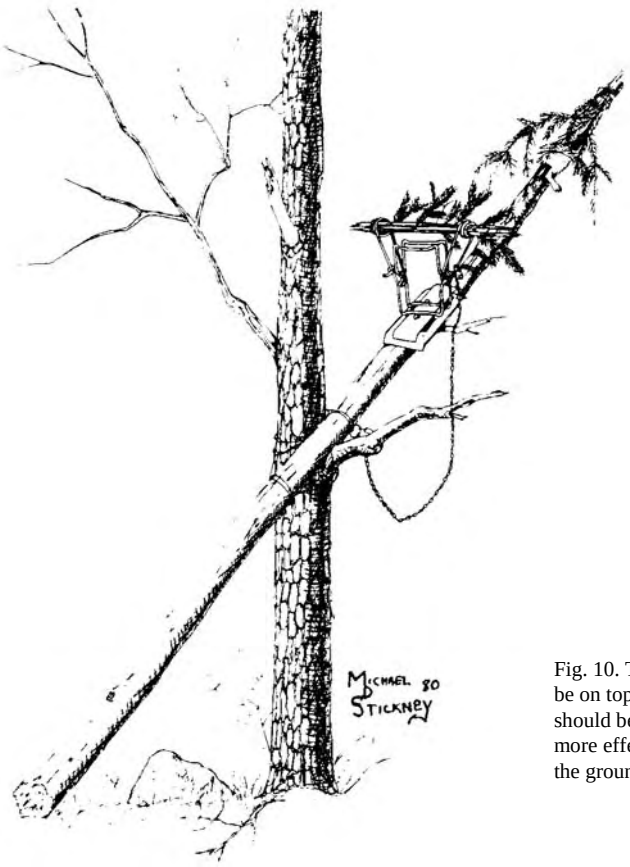


Fig. 8. A cage-type live trap, although bulky and expensive, is often the best choice for removing raccoons near houses or buildings where there is a likelihood of capturing dogs or cats.

Traps should be at least 10 x 12 x 32 inches (25.4 x 30.5 x 81.3 cm) and well-constructed with heavy materials. They can be baited with canned fish-flavored cat food, sardines, fish, or chicken. Place a pile of bait behind the treadle and scatter a few small bits of bait outside the opening of the trap and just inside the entrance. Traps with a single door should be placed with the back against a wall, tree, or other object. The back portion of the trap should be tightly screened with one-half inch (1.3 cm) or smaller mesh wire to prevent raccoons from reaching through the wire to pull out the bait.

Conibear®-type body-gripping traps are effective for raccoons and can be used in natural or artificial cubbies or boxes. Because these traps do not allow for selective release of nontarget catches, they should not be used in areas where risk of nontarget capture is high. Box traps should be used in those situations instead. It is possible, however, to use body-gripping traps in boxes or on leaning poles so that they are inaccessible to dogs (Figs. 9 and 10).

Fig. 9. A "raccoon box" is suspended 6 inches above the ground and is equipped with a Conibear®-type trap. Suspended at this level, this set is dog-proof.



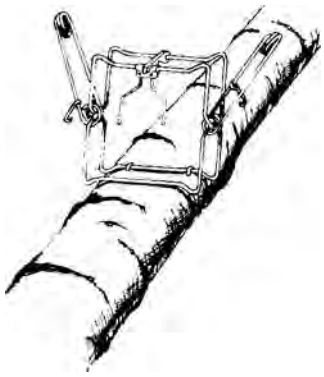


Fig. 10. The leaning-pole set for raccoons is another dog-proof set. The trigger should be on top to prevent the trap from being sprung by squirrels or chipmunks. Bait should be beyond the trap and covered so that it cannot be seen by birds. The set is more effective if a few drops of fish oil or other lure are placed along the pole from the ground level up to the trap.

Shooting

Raccoons are seldom seen during the day because of their nocturnal habits. Shooting raccoons can be effective at night with proper lighting. Trained dogs can be used to tree the raccoons first. A .22-caliber rifle will effectively kill treed raccoons.

Economics of Damage and Control

Statistics are unavailable on the amount of economic damage caused by raccoons, but the damage may be offset by their positive economic and aesthetic values. In 1982 to 1983, raccoons were by far the most valuable furbearer to hunters and trappers in the United States; an estimated 4.8 million raccoons worth $88 million were harvested. Raccoons also provide recreation for hunters, trappers, and people who enjoy watching them. Although raccoon damage and nuisance problems can be locally severe, widespread raccoon control programs are not justifiable, except perhaps to prevent the spread of raccoon rabies. From a cost-benefit and ecological standpoint, prevention practices and specific control of problem individuals or localized populations are the most desirable alternatives.

Acknowledgments

Although information for this section came from a variety of sources, I am particularly indebted to Eric Fritzell of the University of Missouri, who provided a great deal of recently published and unpublished information on raccoons in the central United States. Information on damage identification was adapted from Dolbeer et al. 1994.

Figures 1 through 3 from Schwartz and Schwartz (1981).

Figures 4, 6, and 7 by Jill Sack Johnson.

Figure 5 from Conover (1987).

Figure 8 by Michael D. Stickney, from the New York Department of Environmental Conservation publication *Trapping Furbearers, Student Manual* (1980), by R. Howard, L. Berchielli, G. Parsons, and M. Brown. The figures are copyrighted and are used with permission.

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SKUNKS

Fig. 1. *Left*, the striped skunk, *Mephitis mephitis*; *right*, the spotted skunk, *Spilogale putorius*

Damage Prevention and Control Methods

Exclusion

Buildings: close cellar and outside basement and crawl space doors; seal and cover all openings including window wells and pits.

Poultry yards: install wire mesh fences.

Beehives: elevate and install aluminum guards.

Habitat Modification

Removal of garbage, debris, and lumber piles.

Frightening

Lights and sounds are of limited value.

Repellents

Some home remedies such as moth balls or flakes or ammonia solution may be useful, but no repellents are registered.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Shooting

Practical only when animals are far from residential areas.

Other Methods

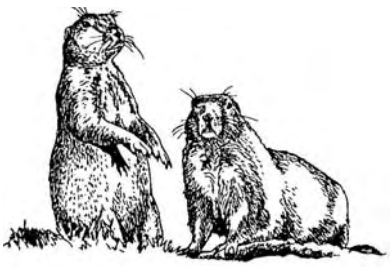
Skunk removal.

Odor removal.

Identification

The skunk, a member of the weasel family, is represented by four species in North America. The skunk has short, stocky legs and proportionately large feet equipped with well-developed claws that enable it to be very adept at digging.

The striped skunk (Fig. 1) is characterized by prominent, lateral white stripes that run down its back. Its fur is otherwise jet black. Striped skunks are the most abundant of the four species. The body of the striped skunk is about the size of an ordinary house cat (up to 29 inches [74 cm] long and weighing about 8 pounds [3.6 kg]). The spotted skunk (Fig. 1) is smaller (up to 21 inches [54 cm] long and weighing about 2.2 pounds [1 kg]), more weasel-like, and is readily distinguishable by white spots and short, broken white stripes in a dense jet-black coat.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994
Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln
United States Department of Agriculture
Animal and Plant Health Insction Service
Animal Damage Control
Great Plains Agricultural Council
Wildlife Committee

The hooded skunk (*Mephitis macroura*) is identified by hair on the neck that is spread out into a ruff. It is 28 inches (71 cm) long and weighs the same as the striped skunk. It has an extremely long tail, as long as the head and body combined. The back and tail may be all white, or nearly all black, with two white side stripes. The hog-nosed skunk (*Conepatus leucontus*) has a long snout that is hairless for about 1 inch (2.5 cm) at the top. It is 26 inches (66 cm) long and weighs 4 pounds (1.8 kg). Its entire back and tail are white and the lower sides and belly are black. Skunks have the ability to discharge nauseating musk from the anal glands and are capable of several discharges, not just one.

Range

The striped skunk is common throughout the United States and Canada (Fig. 2a). Spotted skunks are uncommon in some areas, but distributed throughout most of the United States and northern Mexico (Fig 2b). The hooded skunk and the hog-nosed skunk are much less common than striped and spotted skunks. Hooded skunks are limited to southwestern New Mexico and western Texas. The hog-nosed skunk is found in southern Colorado, central and southern New Mexico, the southern half of Texas, and northern Mexico.

General Biology, Reproduction, and Behavior

Adult skunks begin breeding in late February. Yearling females (born in the preceding year) mate in late March. Gestation usually lasts 7 to 10 weeks. Older females bear young during the first part of May, while yearling females bear young in early June. There is usually only 1 litter annually. Litters commonly consist of 4 to 6 young, but may have from 2 to 16. Younger or smaller females have smaller litters than older or larger

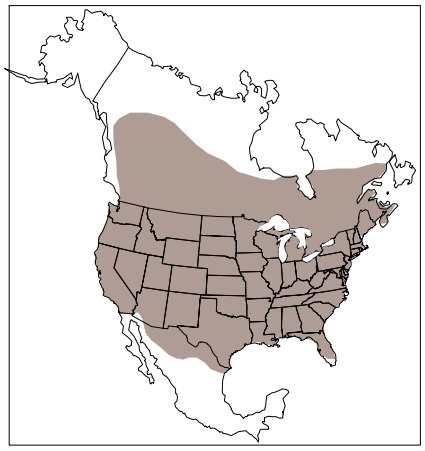


Fig. 2a. Range of the striped skunk in North America.

Fig. 2b. Range of the spotted skunk in North America.

females. The young stay with the female until fall. Both sexes mature by the following spring. The age potential for a skunk is about 10 years, but few live beyond 3 years in the wild.

The normal home range of the skunk is l/2 to 2 miles (2 to 5 km) in diameter. During the breeding season, a male may travel 4 to 5 miles (6.4 to 8 km) each night.

Skunks are dormant for about a month during the coldest part of winter. They may den together in winter for warmth, but generally are not sociable. They are nocturnal in habit, rather slow-moving and deliberate, and have great confidence in defending themselves against other animals.

Habitat

Skunks inhabit clearings, pastures, and open lands bordering forests. On prairies, skunks seek cover in the thickets and timber fringes along streams. They establish dens in hollow logs or may climb trees and use hollow limbs.

Food Habits

Skunks eat plant and animal foods in about equal amounts during fall and winter. They eat considerably more animal matter during spring and summer when insects, their preferred food, are more available. Grasshoppers, beetles, and crickets are the adult insects most often taken. Field and house mice are regular and important items in the skunk diet, particularly in winter. Rats, cottontail rabbits, and other small mammals are taken when other food is scarce.

Damage and Damage Identification

Skunks become a nuisance when their burrowing and feeding habits conflict with humans. They may burrow under porches or buildings by entering foundation openings. Garbage or refuse left outdoors may be disturbed by skunks. Skunks may damage beehives by attempting to feed on bees. Occasionally, they feed on corn, eating only the lower ears. If the cornstalk is knocked over, however, raccoons are more likely the cause of damage. Damage to the upper ears of corn is indicative of birds, deer, or squirrels. Skunks dig holes in lawns, golf courses, and gardens to search for insect grubs found in the soil. Digging normally appears as small, 3- to 4-inch (7- to 10-cm) cone-shaped holes or patches of upturned earth. Several other animals, including domestic dogs, also dig in lawns.

Skunks occasionally kill poultry and eat eggs. They normally do not climb fences to get to poultry. By contrast,

rats, weasels, mink, and raccoons regularly climb fences. If skunks gain access, they will normally feed on the eggs and occasionally kill one or two fowl. Eggs usually are opened on one end with the edges crushed inward. Weasels, mink, dogs and raccoons usually kill several chickens or ducks at a time. Dogs will often severely mutilate poultry. Tracks may be used to identify the animal causing damage. Both the hind and forefeet of skunks have five toes. In some cases, the fifth toe may not be obvious. Claw marks are usually visible, but the heels of the forefeet normally are not. The hindfeet tracks are approximately 2 1/2 inches long (6.3 cm) (Fig. 3). Skunk droppings can often be identified by the undigested insect parts they contain. Droppings are 1/4 to 1/2 inch (6 to 13 mm) in diameter and 1 to 2 inches (2.5 to 5 cm) long.

Odor is not always a reliable indicator of the presence or absence of skunks. Sometimes dogs, cats, or other animals that have been sprayed by skunks move under houses and make owners mistakenly think skunks are present.

Rabies may be carried by skunks on occasion. Skunks are the primary carriers of rabies in the Midwest. When rabies outbreaks occur, the ease with which rabid animals can be contacted increases. Therefore, rabid skunks are prime vectors for the spread of the virus. Avoid overly aggressive skunks that approach without hesitation. Any skunk showing abnormal behavior, such as daytime activity, may be rabid and should be treated with caution. Report suspicious behavior to local animal control authorities.

Legal Status

Skunks are classified as nongame mammals in California.

See California statutes and regulations regarding the take of furbearing and nongame mammals.

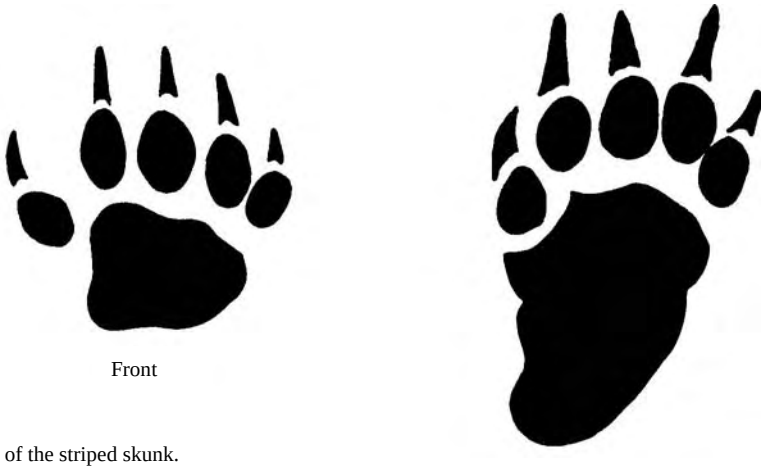


Fig. 3. Tracks of the striped skunk.

Damage Prevention and Control Methods

Exclusion

Keep skunks from denning under buildings by sealing off all foundation openings. Cover all openings with wire mesh, sheet metal, or concrete. Bury fencing 1 1/2 to 2 feet (0.4 to 0.6 m) where skunks can gain access by digging. Seal all ground-level openings into poultry buildings and close doors at night. Poultry yards and coops without subsurface foundations may be fenced with 3-foot (1-m) wire mesh fencing. Bury the lowest foot (0.3 m) of fencing with the bottom 6 inches (15.2 cm) bent outward from the yard or building. Skunks can be excluded from window wells or similar pits with mesh fencing. Place beehives on stands 3 feet (1 m) high. It may be necessary to install aluminum guards around the bases of hives if skunks attempt to climb the supports. Skunks, however, normally do not climb. Use tight-fitting lids to keep skunks out of garbage cans.

Habitat Modification

Properly dispose of garbage or other food sources that will attract skunks. Skunks are often attracted to rodents living in barns, crawl spaces, sheds, and garages. Rodent control programs may be necessary to eliminate this attraction.

Debris such as lumber, fence posts, and junk cars provide shelter for skunks, and may encourage them to use an area. Clean up the area to discourage skunks.

Frightening

Lights and sounds may provide temporary relief from skunk activity.

Repellents

There are no registered repellents for skunks. Most mammals, including skunks, can sometimes be discouraged from entering enclosed areas with moth balls or moth flakes (naphthalene). This material needs to be used in sufficient quantities and replaced often if it is to be effective. Ammonia-soaked cloths may also repel skunks. Repellents are only a temporary measure. Permanent solutions require other methods.

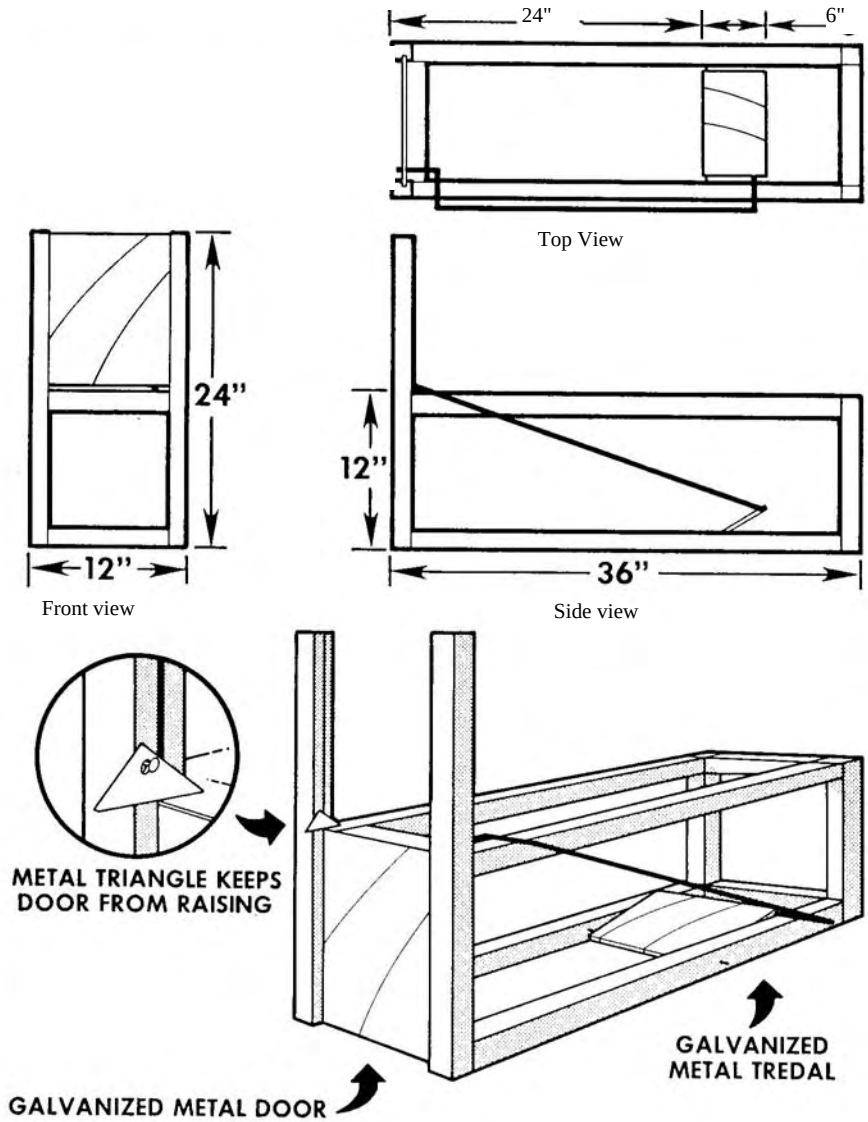


Fig. 4. A box trap can be easily built using scrap lumber and small-mesh, welded-wire fencing.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Box Traps. Skunks can be caught in live traps set near the entrance to their den. When a den is used by more than one animal, set several traps to reduce capture time. Live traps can be purchased or built. Figures 4 and 5 illustrate traps that can be built easily. Consult state wildlife agency personnel before trapping skunks**.**

Use canned fish-flavored cat food to lure skunks into traps. Other food baits such as peanut butter, sardines, and chicken entrails are also effective. Before setting live traps, cover them with canvas to reduce the chances of a trapped skunk discharging its scent. The canvas creates a dark, secure environment for the animal. Always approach a trap slowly and quietly to prevent upsetting a trapped skunk.

Gently remove the trap from the area and immediately release the skunk on the property where trapped or kill the trapped skunk.

If the skunk is to be killed, the US Department of Agriculture recommends shooting or euthanization with CO_2.

Shooting

Skunks caught in traps may be shot. Shooting the skunk in the middle of the back to sever the spinal cord and paralyze the hind quarters may prevent the discharge of scent. Shooting in the back should be followed immediately by shooting in the head. Most people who shoot trapped skunks should expect a scent discharge.

Other Methods

Skunk Removal. The following steps are suggested for removing skunks already established under buildings.

1. Seal all possible entrances along the foundation, but leave the main burrow open.
2. Sprinkle a layer of flour 2 feet (0.6 m) in circumference on the ground in front of the opening.
3. After dark, examine the flour for tracks which indicate that the skunk has left to feed. If tracks are not present, reexamine in an hour.
4. After the den is empty, cover the remaining entrance immediately.
5. Reopen the entrance the next day for 1 hour after dark to allow any remaining skunks to exit before permanently sealing the entrance.

A wooden door suspended from wire can be improvised to allow skunks to leave a burrow but not to reenter. Burrows sealed from early May to

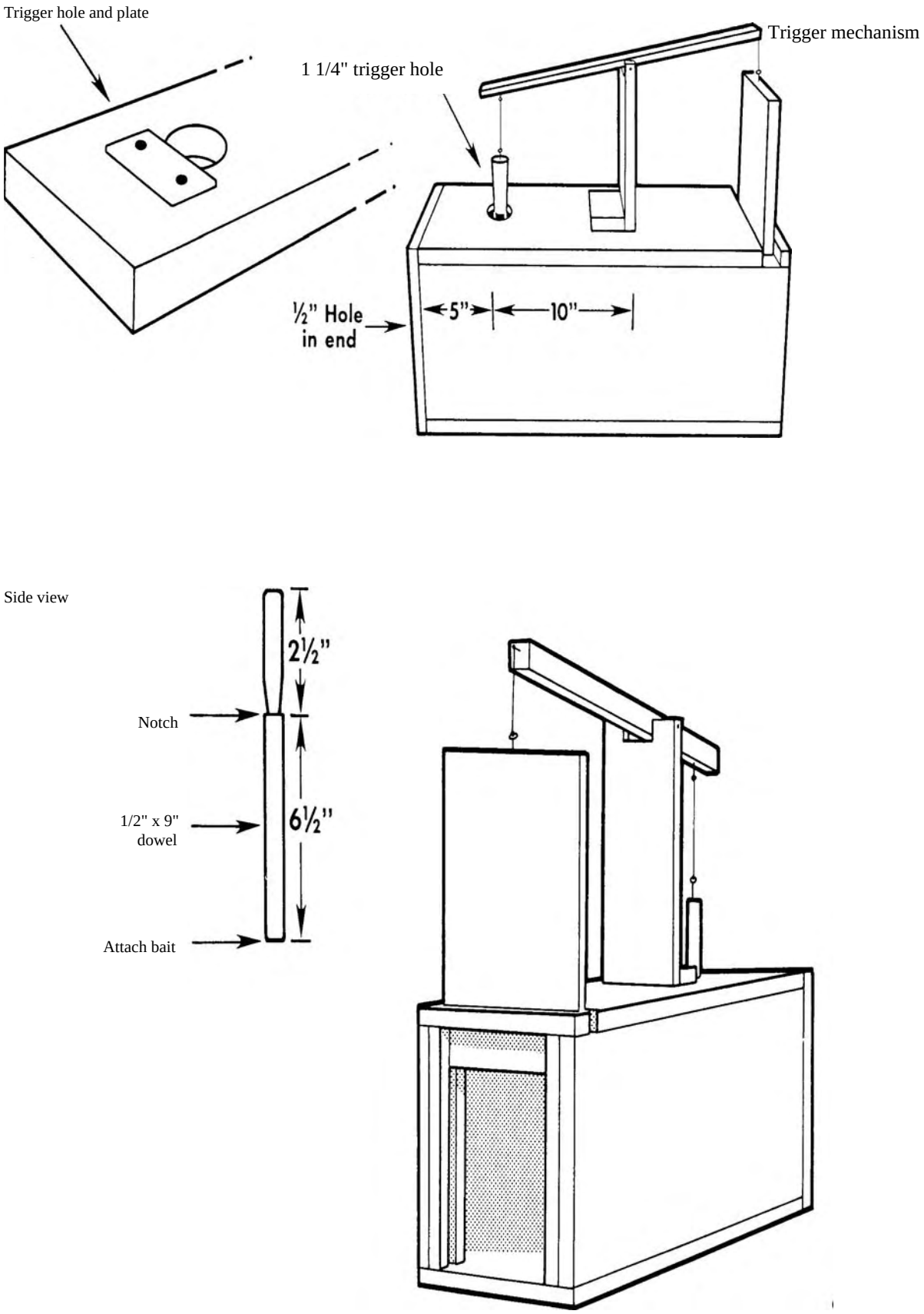


Fig. 5. Alternate design for a box trap.

mid-August may leave young skunks trapped in the den. If these young are mobile they can usually be box-trapped easily using the methods previously described. Where skunks have entered a garage, cellar, or house, open the doors to allow the skunks to exit on their own. Do not prod or disturb them. Skunks trapped in cellar window wells or similar pits may be removed by nailing cleats at 6-inch (15-cm) intervals to a board. Lower the board into the well and allow the skunk to climb out on its own. Skunks are mild-tempered animals that will not defend themselves unless they are cornered or harmed. They usually provide a warning before discharging their scent, stamping their forefeet rapidly and arching their tails over their backs. Anyone experiencing such a threat should retreat quietly and slowly. Loud noises and quick, aggressive actions should be avoided.

Odor Removal. Many individuals find the smell of skunk musk nauseating. The scent is persistent and difficult to remove. Diluted solutions of vinegar or tomato juice may be used to eliminate most of the odor from people, pets, or clothing. Clothing may also be soaked in weak solutions of household chloride bleach or ammonia. On camping trips, clothing can be smoked over a cedar or juniper fire. Neutroleum alpha is a scent-masking solution that can be applied to the sprayed area to reduce the odor. It is available through some commercial cleaning suppliers and the local USDA-APHIS-ADC office. Walls or structural areas that have been sprayed by skunks can be washed down with vinegar or tomato juice solutions or sprayed with neutroleum alpha. Use ventilation fans to speed up the process of odor dissipation. Where musk has entered the eyes, severe burning and an excessive tear flow may occur. Temporary blindness of 10 or 15 minutes may result. Rinse the eyes with water to speed recovery.

Economics of Damage and Control

Skunks should not be needlessly destroyed. They are highly beneficial to farmers, gardeners, and landowners because they feed on large numbers of agricultural and garden pests. They prey on field mice and rats, both of which may girdle trees or cause health problems. Occasionally they eat moles, which cause damage to lawns, or insects such as white grubs, cutworms, potato beetle grubs, and other species that damage lawns, crops, or hay.

Skunks occasionally feed on ground-nesting birds, but their impact is usually minimal due to the large abundance of alternative foods. Skunks also feed on the eggs of upland game birds and waterfowl. In waterfowl production areas, nest destruction by egg-seeking predators such as skunks can significantly reduce reproduction. The occasional problems caused by the presence of skunks are generally outweighed by their beneficial habits. Some people even allow skunks to den under abandoned buildings or woodpiles. Unless skunks become really bothersome, they should be left alone. An economic evaluation of the feeding habits of skunks shows that only 5% of the diet is made up of items that are economically valuable to people.

The hide of the skunk is tough, durable, and able to withstand rough use. Generally there is little market for skunk pelts but when other furbearer prices are high, skunks are worth pelting.

Acknowledgments

Much of the information for this chapter was based on a publication by F. Robert Henderson.

Figures 1 and 2 from Schwartz and Schwartz (1981).

Figures 3 through 5 by Jerry Downs, Graphic Artist, Cooperative Extension Service, New Mexico State University.

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WEASELS

Fig. 1. Least weasel, *Mustela nivalis* (left); Short-tailed weasel, *M. erminea*, in summer coat (middle); Short-tailed weasel in winter coat (right).

Damage Prevention and Control Methods

Exclusion

Block all entrances 1 inch (2.5 cm) or larger with 1/2-inch (1.3-cm) hail screen or similar materials.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Other Methods

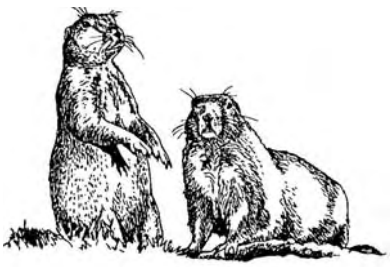
Not applicable or effective.

Identification

Weasels belong to the Mustelidae family, which also includes mink, martens, fishers, wolverines, badgers, river otters, black-footed ferrets, and four species of skunks. Although members of the weasel family vary in size and color (Fig. 1), they usually have long, slender bodies, short legs, rounded ears, and anal scent glands. A weasel's hind legs are barely more than half as long as its body (base of head to base of tail). The weasel's forelegs also are notably short. These short legs on a long, slender body may account for the long-tailed weasel's (*Mustela frenata*) distinctive running gait. At every bound the long body loops upward, reminding one of an inchworm.

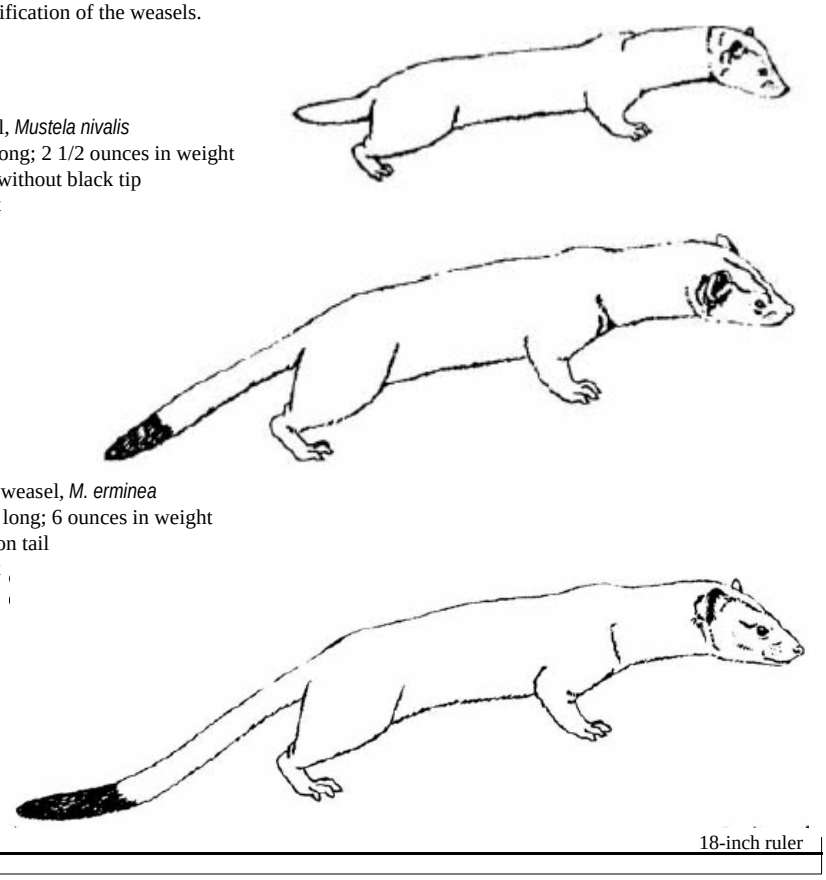
In the typical bounding gait of the weasel, the hind feet register almost, if not exactly, in the front foot impressions, with the right front foot and hind feet lagging slightly behind. The stride distance normally is about 10 inches (25 cm).

Male weasels are distinctly larger than females. The long-tailed and short-tailed (*M. erminea*) weasels have a black tip on their tails, while the least weasel (*M. nivalis*) lacks the black tip



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994
Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln
United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control
Great Plains Agricultural Council
Wildlife Committee

Fig. 2. Identification of the weasels.



Least weasel, *Mustela nivalis*
—8 inches long; 2 1/2 ounces in weight
—short tail without black tip
—white feet

Short-tailed weasel, *M. erminea*
—13 inches long; 6 ounces in weight
—black tip on tail
—white feet

Long-tailed weasel, *M. frenata*
—16 inches long; 12 ounces in weight
—black tip on tail
—brown feet

(Fig. 2). The long-tailed weasel sometimes is as long as 24 inches (61 cm). The short-tailed weasel is considerably smaller, rarely longer than 13 inches (33 cm) and usually weighing between 3 and 6 ounces (87 and 168 g). Just as its common name implies, the least weasel is the smallest, measuring only 7 or 8 inches (18 to 20 cm) long and weighing 1 to 2 1/2 ounces (28 to 70 g). Many people assume the least weasel is a baby weasel since it is so small.

Range

Three species of weasels live in North America. The most abundant and widespread is the long-tailed weasel. Some that occur in parts of Kansas, Oklahoma, Texas, and New Mexico have a dark "mask" and are often called bridled weasels. The short-tailed weasel occurs in Canada, Alaska, and the northeastern, Great Lakes, and northwestern states, while the least weasel occurs in Canada, Alaska, and the northeastern and Great Lakes states (Fig. 3).

Habitat

Some authors report finding weasels only in places with abundant water, although small rodents, suitable as food, were more abundant in surrounding habitat. Weasels are commonly found along roadsides and around farm buildings. The absence of water to drink is thought to be a limiting factor (Henderson and Stardom 1983).

A typical den has two surface openings about 2 feet (61 cm) apart over a burrow that is 3 to 10 feet (0.9 to 3 m) long. Other weasel dens have been found in the trunk of an old uprooted oak, in a bag of feathers, in a threshing machine, in the trunk of a hollow tree, in an old mole run, a gopher burrow, and a prairie dog burrow (Henderson and Stardom 1983).

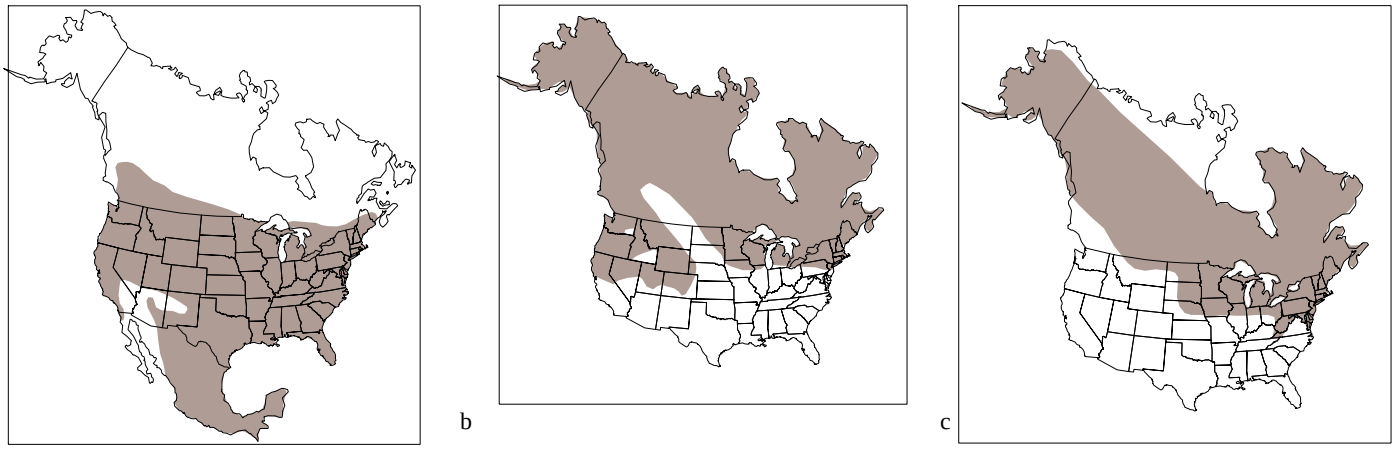


Fig. 3. Range of the (a) long-tailed weasel, (b) short-tailed weasel, and (c) least weasel in North America.

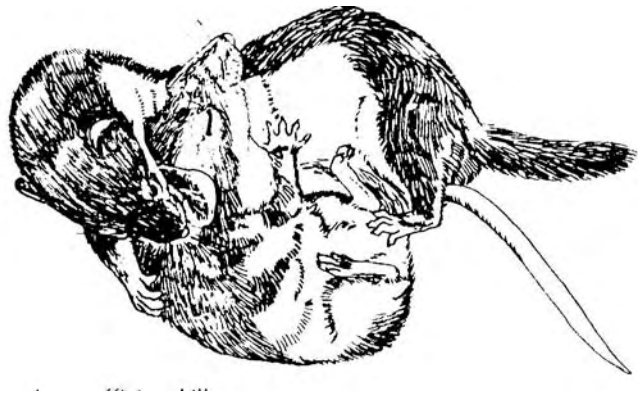


Fig. 4. Weasels are efficient killers, preying on mice as well as on pocket gophers, birds, and other animals.

Food Habits

The weasel family belongs to the order Carnivora. With the exception of the river otter, all members of the weasel family feed primarily on insects and small rodents (Fig. 4). Their diet consists of whatever meat they can obtain and may include birds and bird eggs.

As predators, they play an important role in the ecosystem. Predators tend to hunt the most abundant prey, turning to another species if the numbers of the first prey become scarce. In this way, they seldom endanger the long-term welfare of the animal populations they prey upon.

Long-tailed weasels typically prey on one species that is continually available. The size of the prey population varies from year to year and from season to season. At times, weasels will kill many more individuals of a prey species than they can immediately eat. Ordinarily, they store the surplus for future consumption, much the same as squirrels gather and store nuts.

Pocket gophers are the primary prey of long-tailed weasels. In some regions these gophers are regarded as nuisances because they eat alfalfa plants in irrigated meadows and native plants in mountain meadows where livestock graze. Because of its predation on pocket gophers and other rodents, the long-tailed weasel is sometimes referred to as the farmer's best friend. This statement, however, is an oversimplification of a biological relationship.

Weasels prefer a constant supply of drinking water. The long-tailed weasel drinks up to 0.85 fluid ounces (26 ml) daily.

General Biology, Reproduction, and Behavior

Weasels are active in both winter and summer; they do not hibernate. Weasels are commonly thought to be nocturnal but evidence indicates they are more diurnal in summer than in winter.

Home range sizes vary with habitat, population density, season, sex, food availability, and species (Svendsen 1982). The least weasel has the smallest home range. Males use 17 to 37 acres (7 to 15 ha), females 3 to 10 acres (1 to 4 ha). The short-tailed weasel is larger than the least weasel and has a larger home range. Male short-tailed weasels use an average of 84 acres (34 ha), and females 18 acres (7 ha), according to snow tracking.

The long-tailed weasel has a home range of 30 to 40 acres (12 to 16 ha), and males have larger home ranges in summer than do females. The weasels appear to prefer hunting certain coverts with noticeable regularity but rarely cruise the same area on two consecutive nights.

Weasel population densities vary with season, food availability, and species. In favorable habitat, maximum densities of the least weasel may reach 65 per square mile (169/km^2); the short-tailed weasel, 21 per square mile (54/km^2); and the long-tailed weasel, 16 to 18 per square mile (40 to 47/km^2). Population densities fluctuate considerably with year-to-year changes in small mammal abundance, and densities differ greatly among habitats.

Weasels, like all mustelids, produce a pungent odor. When irritated, they discharge the odor, which can be detected at some distance (Jackson 1961).

Long-tailed weasels mate in late summer, mostly from July through August. Females are induced ovulators and will remain in heat for several weeks if they are not bred. There is a long delay in the implantation of the blastocyst in the uterus, and the young are born the following spring, after a gestation period averaging 280 days. Average litters consist of 6 young, but litters may include up to 9 young. The young are blind at birth and their eyes open in about 5 weeks. They mature rapidly and at 3 months of age the females are fully grown. Young females may become sexually mature in the summer of their birth year.

Damage and Damage Identification

Occasionally weasels raid poultry houses at night and kill or injure domestic fowl. They feed on the warm blood of victims bitten in the head or neck. Rat predation on poultry usually differs in that portions of the body may be eaten and carcasses dragged into holes or concealed locations.

Legal Status

Weasels are designated nongame mammals in California.

See California statutes and regulations regarding the take of furbearing and nongame mammals.

Damage Prevention and Control Methods

Exclusion

Weasels can be excluded from poultry houses and other structures by closing all openings larger than 1 inch (2.5 cm). To block openings, use 1/2-inch (1.3-cm) hardware cloth, similar wire mesh, or other materials.

Trapping

Body-gripping traps are illegal for use in commercial fur or recreational application in California (see regulations).

There are zones throughout California where the use of Conibear-type traps and snares, except those totally submerged, and deadfall traps are prohibited for the protection of the San Joaquin kit fox and Sierra Nevada red fox (see regulations).

Weasels can be captured in live traps with fresh meat as suitable bait.

Economics of Damage and Control

Svendsen (1982) writes:

"Overall, weasels are more of an asset than a liability. They eat quantities of rats and mice that otherwise would eat and damage additional crops and produce. This asset is partially counter-balanced by the beneficial animals and game species. The killing of domestic poultry may come only after the rat population around the farmyard is diminished. In fact, rats may have destroyed more poultry than the weasel. In most cases, a farmer lives with weasels on the farm for years without realizing that they are even there, until they kill a chicken."

Acknowledgments

Figures 1, 2, and 4 adapted by Jill Sack Johnson from"WeaselFamilyofAlberta"(no date),Alberta Fish and Wildlife Division, Alberta Energy and NaturalResources,Edmonton(withpermission).

Figure 3 adapted from Burt and Grossenheider (1976) by Jill Sack Johnson.

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APPENDIX A

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME
Wildlife and Habitat Data Analysis Branch
California Natural Diversity Database
SPECIAL ANIMALS (673 taxa) (Excerpts)
August 2004

CALIFORNIA ENDANGERED SPECIES ACT (CESA) LISTING CODES:

The listing status of each species is current as of the date of this list. The most current changes in listing status will be found in the list of "Endangered and Threatened Animals of California", which the CNDDB updates and issues quarterly (January, April, July, & October).

SE State-listed as Endangered
ST State-listed as Threatened
SCE State candidate for listing as Endangered
SCT State candidate for listing as Threatened

ENDANGERED SPECIES ACT (ESA) LISTING CODES:

The listing status is current as of the date of this list. The most current changes in listing status will be found in the list of "Endangered and Threatened Animals of California", which the CNDDB updates and issues quarterly (January, April, July, & October). Federal listing actions are also available at: http://www.epa.gov/fedrgstr/EPA-SPECIES/index.html.
After careful consideration we have removed the Federal Species of Concern (FSC) designation from this list. The Federal Species of Concern list was not maintained on a statewide basis. The Sacramento field office, with jurisdiction over the central portion of California, maintained a list, but the Ventura, Carlsbad and Arcata offices did not. Therefore, species in the northern and southern parts of the state were not considered. Information on the list maintained by the Sacramento field office is available at: http://sacramento.fws.gov/es/spp_concern.htm

FE Federally listed as Endangered
FT Federally listed as Threatened
FPE Federally proposed for listing as Endangered
FPT Federally proposed for listing as Threatened
FPD Federally proposed for delisting
FC Federal candidate species (former Category 1 candidates)

DFG: CSC: California Special Concern species. It is the goal and responsibility of the Department of Fish and Game to maintain viable populations of all native species. To this end, the Department has designated certain vertebrate species as "Species of Special Concern" because declining population levels, limited ranges, and/or continuing threats have made them vulnerable to extinction. The goal of designating species as "Species of Special Concern" is to halt or reverse their decline by calling attention to their plight and addressing the issues of concern early enough to secure their long term viability. Not all "Species of Special Concern" have declined equally; some species may be just starting to decline, while others may have already reached the point where they meet the criteria for listing as a "Threatened" or "Endangered" species under the State and/or Federal Endangered Species Acts. More information is available on the Department's web site at: http://www.dfg.ca.gov/hcpb/species/ssc/ssc.shtml. All of the Species of Special Concern reports are now available on-line:

Birds: http://www.dfg.ca.gov/hcpb/info/bird_ssc.shtml.
Mammals: http://www.dfg.ca.gov/hcpb/info/mammal_ssc.shtml.
Fish: http://www.dfg.ca.gov/hcpb/info/fish_ssc.pdf.
Amphibians & Reptiles: http://www.dfg.ca.gov/hcpb/info/herp_ssc.pdf.

DFG: Fully Protected: Fully Protected species may not be taken or possessed without a permit from the Fish and Game Commission. Information of Fully Protected species can be found in the Fish and Game Code, (birds at §3511, mammals at §4700, reptiles and amphibians at §5050, and fish at §5515). Additional information on Fully Protected fish can be found in the California Code of Regulations, Title 14, Division 1, Subdivision 1, Chapter 2, Article 4, §5.93. The category of Protected Amphibians and Reptiles in Title 14 has been repealed. The Fish and Game Code is available online at: http://www.leginfo.ca.gov/cgi-bin/calawquery?codesection=fgc. Title 14 of the California Code of Regulations is available at: http://ccr.oal.ca.gov.

	CNDDB RANK	CESA	ESA	IUCN	OTHER
MAMMALS (120 taxa)					
TALPIDAE (moles)					
Scapanus latimanus parvus Alameda Island mole	G5T1S1				DFG: CSC
+*Scapanus latimanus insularis* Angel Island mole	G5T1S1				
SORICIDAE (shrews)					
Sorex lyelli Mount Lyell shrew	G2G3S2S3				DFG: CSC
+*Sorex ornatus relictus* Buena Vista Lake shrew	G5T1S1		FE		DFG: CSC
Sorex ornatus salarius Monterey shrew (AKA Salinas ornate shrew)	G5T1T2S1S2				DFG: CSC
Sorex ornatus salicornicus Southern California saltmarsh shrew	G5T1?S1?				DFG: CSC
+*Sorex ornatus sinuosus* Suisun shrew	G5T1S1				DFG: CSC
+*Sorex ornatus willetti* Santa Catalina shrew	G5T1S1				DFG: CSC
+*Sorex vagrans halicoetes* Salt-marsh wandering shrew	G5T1S1				DFG: CSC
Sorex vagrans paludivagus No common name	G5T1S1				
PHYLLOSTOMIDAE (leaf-nosed bats)					
+*Choeronycteris mexicana* Mexican long-tongued bat	G4S1			LRnt	DFG: CSC WBWG: High priority
+*Macrotus californicus* California leaf-nosed bat	G4S2S3			VU/A2c	DFG: CSC FS: Sensitive WBWG: High priority
VESPERTILIONIDAE (evening bats)					
+*Antrozous pallidus* Pallid bat	G5S3				DFG: CSC FS: Sensitive BLM: Sensitive WBWG: High priority
+*Corynorhinus townsendii pallescens* Pale big-eared bat	G4T4S2S3			VU/A2c (full species)	DFG: CSC (full species) FS: Sensitive (full species) BLM: Sensitive (full species) WBWG: High Priority

Special Animals list – August 2004

	CNDDB RANK	CESA	ESA	IUCN	OTHER
+*Corynorhinus townsendii townsendii* Townsend's western big-eared bat	G4T3T4S2S3			VU/A2c (Full species)	DFG: CSC (full species) FS: Sensitive (full species) BLM: Sensitive (full species) WBWG: High Priority
+*Euderma maculatum* Spotted bat	G4S2S3				DFG: CSC BLM: Sensitive WBWG: High priority
+*Lasiurus blossevillii* Western red bat	G5S?				WBWG: High priority FS: Sensitive
Lassiurus xanthinus Western yellow bat	G5S?				WBWG: High priority
+*Myotis ciliolabrum* Small-footed myotis	G5S?				BLM: Sensitive
+*Myotis evotis* Long-eared myotis	G5S4?				BLM: Sensitive
Myotis occultus (=Myotis lucifugus occultus) Occult little brown bat (AKA Arizona myotis)	G5T3T4S2S3				DFG: CSC
+*Myotis thysanodes* Fringed myotis	G4G5S4				BLM: Sensitive WBWG: High priority
+*Myotis velifer* Cave myotis	G5S1				DFG: CSC BLM: Sensitive
+*Myotis volans* Long-legged myotis	G5S4?				WBWG: High priority
+*Myotis yumanensis* Yuma myotis	G5S4?				BLM: Sensitive
MOLOSSIDAE (free-tailed bats)					
+*Eumops perotis* Western mastiff bat	G5S3?				DFG: CSC BLM: Sensitive WBWG: High priority
+*Nyctinomops femorosaccus* Pocketed free-tailed bat	G4S2S3				DFG: CSC
Nyctinomops macrotis Big free-tailed bat	G5S2				DFG: CSC
OCHOTONIDAE (pikas)					
Ochotona princeps sheltoni White Mountains pika	G5T1T2S1S2				
LEPORIDAE (rabbits and hares)					
+*Brachylagus idahoensis* Pygmy rabbit	G4S3			LRnt	DFG: CSC
Lepus americanus klamathensis Oregon snowshoe hare	G5T3T4S2?				DFG: CSC

	CNDDB RANK	CESA	ESA	IUCN	OTHER
CANIDAE (foxes, wolves, and coyotes)					
+*Urocyon littoralis* Island fox	G1S1	ST[31]		LRcd	
+*Urocyon littoralis littoralis* San Miguel Island fox	G1T1S1		FE		
+*Urocyon littoralis santarosa* Santa Rosa Island fox	G1T1S1		FE		
+*Urocyon littoralis santacruzae* Santa Cruz Island fox	G1T1S1		FE		
+*Urocyon littoralis catalinae* Santa Catalina Island fox	G1T1S1		FE		
+*Vulpes macrotis mutica* San Joaquin kit fox	G4T2T3S2S3	ST	FE		
+*Vulpes vulpes necator* Sierra Nevada red fox	G5T3S1	ST			FS: Sensitive
MUSTELIDAE (weasels and relatives)					
+*Enhydra lutris nereis* Southern sea otter	G4T2S2		FT	EN/A1ace (full species)	DFG: Fully protected
+*Gulo gulo* California wolverine	G4S2	ST		VU/A2c	DFG: Fully protected FS: Sensitive (ssp. *Luteus*)
Lontra canadensis sonorae Southwestern river otter	G5T1S1				DFG: CSC BLM: Sensitive
+*Martes americana* American (=pine) marten	G5S3S4				FS: Sensitive
+*Martes americana humboldtensis* Humboldt marten	G5T2T3S2S3				DFG: CSC FS: Sensitive (full species)
+*Martes pennanti pacifica* Pacific fisher	G5T3T4QS2S3		FC[32]		DFG: CSC (full species) FS: Sensitive BLM: Sensitive
+*Taxidea taxus* American badger	G5S4				DFG: CSC
MEPHITIDAE (skunks)					
Spilogale gracilis amphiala Channel Islands spotted skunk	G5T3S3				DFG: CSC
FELIDAE (cats and relatives)					
Puma concolor browni Yuma mountain lion	G5T1T2QS1				DFG: CSC

[31] State listing includes all subspecies on all islands.
[32] Candidate status refers to the distict population segment in Washington, Oregon and California.

APPENDIX B

Common Gray Fox Urocyon cinereoargenteus
Family: Canidae Order: Carnivora Class: Mammalia
Written by: G. Ahlborn
Reviewed by: M. White
Edited by: M. White

DISTRIBUTION, ABUNDANCE, AND SEASONALITY

Uncommon to common permanent resident of low to middle elevations throughout most of the state. Frequents most shrublands, valley foothill riparian, montane riparian, and brush stages of many deciduous and conifer forest and woodland habitats. Also found in meadows and cropland areas.

SPECIFIC HABITAT REQUIREMENTS

Feeding: Omnivorous. Rabbits, mice, gophers, woodrats, and squirrels are the principal foods (Trapp and Hallberg 1975). Also eats large amounts of fruits, nuts, grains, grasshoppers and crickets, beetles, moths and butterflies, carrion, and small amounts of herbage. Stalks and pounces on rodents and rabbits, or may pursue for short distances. Readily climbs into crooked trees, or those with branches 3 m (10 ft), or less, from the ground (Ingles 1965).

Cover: Brush, natural cavities, and occasionally human-made structures, provide cover.

Reproduction: Dens in natural cavities, in rocky areas, snags, logs, brush, slash and debris piles, abandoned burrows, and under buildings. Nest material usually dry grass, leaves, or shredded bark.

Water: Requires a permanent water source near den; probably drinks daily.

Pattern: Suitable habitat consists of shrublands, brushy and open-canopied forests, interspersed with riparian areas, providing water.

SPECIES LIFE HISTORY

Activity Patterns: Active all year. Primarily crepuscular and nocturnal, occasionally active in daytime.

Seasonal Movements/Migration: Non-migratory.

Home Range: In Wisconsin, home ranges varied from 0.13 to 3.1 km^2 (0.05 to 1.2 mi^2). In Florida, home ranges averaged 7.7 km^2 (8 mi^2), and in Utah, home ranges averaged 1.0 km^2 (0.4 mi^2) (Trapp and Hallberg 1975). Near Davis, California, Fuller (1978) found that 4 females had an average home range of 1.2 km^2 (0.5 mi^2).

Territory: Family groups (parents with juveniles) usually are separated spatially, indicating territoriality (Trapp and Hallberg 1975).

Reproduction: Mates February through March. In California, most births occur in April (Grinnell et al. 1937), following a gestation of approximately 63 days. Average litter size is 4 pups; range 2-7 (Fritzell and Haroldson 1982). One litter/yr. Males and females are sexually mature at 1 yr.

Niche: Adult gray foxes have few predators. Large hawks, golden eagles, great horned owls, domestic dogs, and bobcats may prey on pups. May carry tularemia and rabies (Jennings et al. 1960, Jackson 1961). Population levels may be affected by rabies.

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APPENDIX C

Kit Fox Vulpes macrotis
Family: Canidae Order: Carnivora Class: Mammalia
Written by: G. Ahlborn
Reviewed by: M. White
Edited by: M. White, G. Ahlborn
Updated by: CWHR Program Staff, May 2000

DISTRIBUTION, ABUNDANCE, AND SEASONALITY

Uncommon to rare, permanent resident of arid regions of the southern half of the state (Grinnell et al. 1937, Wilson and Ruff 1999:150). May still occur in eastern Lassen County. Lives in annual grasslands or grassy open stages of vegetation dominated by scattered brush, shrubs, and scrub. The San Joaquin kit fox (V. m. mutica) is Federal Endangered and California Threatened.

SPECIFIC HABITAT REQUIREMENTS

Feeding: Kit foxes primarily are carnivorous. The principal foods are black-tailed jackrabbits and desert cottontails, rodents (especially kangaroo rats and ground squirrels), insects, reptiles, and some birds, bird eggs, and vegetation (Egoscue 1962, Laughrin 1970, Morrell 1971, 1972, Orloff et al. 1986). They hunt by searching, meandering, circling clumps of brush, and wandering back and forth between clumps of vegetation. They stealthily approach larger prey, or prey in the open, then make sudden, swift rushes. They pounce on smaller prey.

Cover: Cover provided by dens they dig in open, level areas with loose-textured, sandy and loamy soils (Laughrin 1970, Morrell 1972).

Reproduction: Pups born in dens excavated in open, level areas with loose-textured soils.

Water: May not require a source of drinking water. Sustains itself on moisture derived from prey (Thacker and Flinders 1999).

Pattern: Open, level areas with loose-textured soils supporting scattered, shrubby vegetation with little human disturbance represent suitable habitats for kit foxes. Some agricultural areas may support these foxes.

SPECIES LIFE HISTORY

Activity Patterns: Active yearlong; mostly nocturnal, but often active in daytime in cool weather (Ingles 1965).

Seasonal Movements/Migration: Non-migratory.

Home Range: Little data available. In California, Morrell (1972) reported home ranges of 2.6-5.2 km² (1.0-2.0 mi²) for the San Joaquin kit fox. Considerable overlap between individual home ranges appears to occur (Morrell 1972). In Utah, Egoscue (1962) reported 0.19 kit foxes/km² (0.5/mi²) before birth of pups, and 0.48 per km² (1.25/mi²) after pups were born.

Territory: No data found.

Reproduction: Kit foxes usually are monogamous, but polygamy apparently also is common (McGrew 1979). Most pups born February through April, following a gestation period of 49 to 55 days (Egoscue 1962). One litter/yr of about 4 pups, range 1-7 (McGrew 1979). Pups weaned at about 4-5 mo. Males and females sexually mature in second yr. In Utah, Egoscue (1975) found a known-age individual of 7 yr at last capture.

Niche: Kit foxes play important roles in their respective ecosystems as "architects of subterranean burrows", which in turn provide cover for many other species (Thacker and Flinders 1999). Kit foxes use dens throughout the year. Nocturnal activity and regular use of dens are important adaptations for thermal regulation and water conservation (Golightly 1981). Potential predators are coyotes, large hawks and owls, eagles, and bobcats. Cultivation has eliminated much habitat. Kit foxes are vulnerable to many human activities, such as hunting, use of rodenticides and other poisons, off-road vehicles, and trapping.

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APPENDIX D

Red Fox Vulpes vulpes
Family: Canidae Order: Carnivora Class: Mammalia
Written by: V. Johnson, J. Harris
Reviewed by: H. Shellhammer
Edited by: R. Duke, S. Granholm
Updated by: CWHR Program Staff, May 2000

DISTRIBUTION, ABUNDANCE, AND SEASONALITY

Rare in Sierra Nevada, but widely distributed in lowlands in central and southern California. The native subspecies V. v. necator is found in the Cascades in Siskiyou Co., and from Lassen Co. south to Tulare Co. Introduced populations inhabit Sacramento and San Joaquin valleys and scattered coastal and inland locations from Sonoma Co. south to Monterey Co., and east to Stanislaus Co. as well as in Ventura, Los Angeles, and Orange cos. Sierra Nevada populations may be found in a variety of habitats, including alpine dwarf-shrub, wet meadow, subalpine conifer, lodgepole pine, red fir, aspen, montane chaparral, montane riparian, mixed conifer, and ponderosa pine. Jeffrey pine, eastside pine, and montane hardwood-conifer also are used. Populations in central and southern California occur in annual and perennial grassland, coastal scrub, wet meadow, emergent wetland, and cropland habitats, and may use mixed chaparral and chamise-redshank chaparral (Grinnell et al. 1937, Ingles 1965, Ewer 1973, Ables 1975, Gray 1975, 1977, Schempf and White 1977, Gould 1980). Most sightings in Sierra Nevada are above 2200 m (7000 ft), ranging from 1200-3700 m (3900-11,900 ft) (Schempf and White 1977). Sightings in central and southern California are below 910 m (3000 ft) (Schempf and White 1977).

SPECIFIC HABITAT REQUIREMENTS

Feeding: Hunts small and medium-sized mammals, ground squirrels, gophers, mice, marmots, woodrats, pikas, and rabbits. Apparently an increasingly important predator of ground-nesting waterfowl, shorebirds, upland game birds, and eggs in lowland California and other areas. Other vertebrates, insects, carrion, fruits, and earthworms used occasionally; carrion important in winter, as are lagomorphs. Hunts in meadows, fell-fields, grasslands, wetlands, and other open habitats. Caches food (Scott 1955, Scott and Klimstra 1955, Sargent 1972, 1978, Ewer 1973, MacDonald 1980, Maccarone and Montevecchi 1981,Samuel and Nelson 1982, Yoneda 1982).

Cover: Uses dense vegetation and rocky areas for cover and den sites.

Reproduction: Den sites include rock outcrops, hollow logs and stumps, and burrows in deep, loose soil (Grinnell et al. 1937, Ables 1975). May move pups to new den several times.

Water: Captive red foxes did not require free water as pups or adults (Sargent 1978).

Pattern: In Sierra Nevada, prefers forests interspersed with meadows or alpine fell-fields. Open areas are used for hunting, forested habitats for cover and reproduction. Edges are utilized extensively (Seidensticker 1999). In lowlands, uses fence lines, hedgerows, woodlots, and other brushy, wooded areas for cover and reproduction, and hunts in cropland, wetland, urban habitats and other open areas (Grinnell et al. 1937. Ables 1975, Samuel and Nelson 1982).

SPECIES LIFE HISTORY

Activity Patterns: Active yearlong; hunts day and night (Grinnell et al. 1937, Ables 1975).

Seasonal Movements/Migration: None in many habitats. Sierra red foxes move downslope in winter into ponderosa pine and mixed conifer, upslope in summer to lodgepole pine, subalpine conifer, alpine dwarf-shrub, and red fir habitats (Grinnell et al. 1937, Schempf and White 1977).

Home Range: Summer home ranges in alpine and subalpine tundra of British Columbia averaged 1611 ha (3979 ac), varying from 277-3420 ha (684-8447 ac) (Jones and Theberge1982). In Minnesota, lllinois, and Wisconsin, home ranges averaged 700 ha (1728 ac) and varied from 155-1554 ha (384-3840 ac) (Sargent 1972, Storm et al. 1976). Red foxes have been known to travel up to 395 km (245 mi). Home range size is influenced by food abundance and habitat.

Territory: The male defends the territory, which is shared by the mated pair and pups. Defense consists of display, scent-marking, chasing, and rare physical conflict (Preston 1975). The entire home range may be defended, or territoriality may break down in times of food abundance (Orr 1971, Zarnoch et al. 1977, Samuel and Nelson 1982, Seidensticker 1999).

Reproduction: Mating takes place in late winter (January-March. After a gestation period of 52 days, young are born in early spring (March-May). Litter sizes in many studies averaged about 5. Most litters are 4-6, though range is 1-12 (Grinnell et al. 1937, Samuel and Nelson 1982). There is 1 litter/yr. Lactation continues 56-70 days (Seidensticker 1999). Pups dependent on parents for 6 mo, and become sexually mature at 10 mo (Orr 1971, Zarnoch et al. 1977).

Niche: Coexists with coyotes in Sierra Nevada, and with gray and kit foxes and coyotes in lowland California. Numbers apparently increase when numbers of coyotes and other predators decrease, through predator control or natural factors (Schmidt 1986). Sierra Nevada populations apparently reduced by grazing in meadows, which reduces prey populations, and by trapping, logging, and recreational disturbance (Grinnell et al. 1937, Schempf and White 1977).

Comments: Sierra Nevada red foxes are rare, and numbers may be continuing to decline (Schempf and White 1977). Lowland populations, presumably introduced, are expanding in range and numbers (Gray 1977, Gould 1980).

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APPENDIX E

BATS IN BUILDINGS

Guidelines for Excluding Bats

Our goal is to promote exclusion methods that ensure the safety of both bats and people. We understand that differing architectural structures and/or climatic conditions may require modification of the guidelines given below. Please feel free to share your ideas about these issues with us when submitting your letter of commitment. We want to encourage you to participate in the "Bats In Buildings" program and look forward to receiving your input.

All BCI recommended exclusion professionals should be licensed by the states in which they work, be insured, and use only approved exclusion methods. They should also provide the property owner with a guarantee and list of references. All written materials should be accurate and scare tactics should be avoided.

One-way devices constructed from light weight polypropylene netting (<1/6" mesh), plastic sheeting, or tube-type excluders are the preferred methods for evicting bats from buildings. Excluders should be placed at all active entry points and should remain in place for at least 5 to 7 days. These devices should be removed after the bats have been excluded, and then exclusion points should be sealed with silicone caulking, caulk backing rod, hardware cloth, or heavy duty polypropylene mesh. In some cases, sealing may require repair or replacement of old, deteriorated wood. BCI strongly recommends that exclusion professionals bat-proof the entire building and avoid spot treatments. Moving bats from one corner of a building to another does not solve the problem and may require that further exclusion work is carried out at some time in the future, further disturbing the bats and the property owner.

Please note that simply waiting until the bats have flown out at night and then permanently sealing entrances shut without the use of exclusion devices, is not approved by BCI. This method often traps some bats inside the building. BCI also discourages the use of 'permanent netting' in most situations. Aerosol dog and cat repellents may discourage bat use of a particular roosting spot for periods of up to several months. They have been used effectively to prevent bats from night-roosting above porches. The spray should be applied by day when bats are not present. Aerosol repellents are not an adequate substitute for exclusion in the case of day roosts and should never be applied when bats are in a roost. For night roosts, we also recommend the use of Mylar balloons or strips of tin foil hung from roosting areas and allowed to move in the breeze.

Maternity season for bats in the US and Canada can range from 1 May through 31 August, although pups have been seen as early as late April in some instances. Eviction of bats, or any activity that directly affects their roosting area, should occur only prior to

or after the maternity season, when young will not be trapped inside, creating additional problems.

Some bats hibernate in buildings during the winter months. Winter exclusions should be performed only if it can be determined that no bats are hibernating in the building. If bats are present during the winter months, exclusions should be postponed until spring temperatures are warm enough for deciduous plants to leaf out and insects to again be abundant.

Ultrasonic devices, chemical repellents, and smoke are not approved by BCI as effective methods to evict bats from buildings. In addition, canned spray foam is not an approved sealant for cracks and holes in most situations. It is not only unattractive, but can result in the death of bats that come into contact with it. This product should never be used when bats are still present.

Traps and relocation are not BCI approved exclusion techniques. Removing large numbers of bats from a building may seem impressive to a customer, but is unlikely to be effective. Traps can be fatal to bats if left unattended or if overcrowding occurs. Bats have excellent homing instincts making relocation attempts unlikely to succeed. They will simply attempt to return to the original capture area upon release. Capturing bats at an exclusion site is not encouraged, although capturing a single bat for species ID or removal of an individual bat from a living space are exceptions to this rule.

Cited from: http://www.batcon.org/binb/guidelines.html

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APPENDIX F

UNWANTED GUESTS: EVICTING BATS FROM HUMAN DWELLINGS

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ABSTRACT: Bats are the second largest order of mammals in the world. Their 925 species are found on all continents except Antarctica. Bats are in serious decline world-wide from shrinking habitat, persecution and pesticides. Historically, bats were recognized for consuming insect pests, but only recently has the critical additional importance of bats in pollination and seed dispersal of semi-tropical and tropical plants been recognized. Bats use artificial structures in place of lost natural habitat, resulting in their destruction out of fear and ignorance. The health risk to humans from bats in buildings is extremely low, but where bat removal is necessary, non-lethal exclusion methods can be very effective.

INTRODUCTION

Bats are the second largest order (Chiroptera) of mammals in the world, and the only mammal capable of true flight (Bat Conservation International 1992). The 925 species of bats represents nearly a quarter of all the species of mammals on earth. The majority live in tropical and semi-tropical regions using a wide variety of roosts in foliage, hollow trees, rock crevices, caves, or burrows of other animals (Fenton, 1983). Of the 44 species in North America, all but four prefer cavities for hibernating and raising their young. Surprisingly, Tuttle (1988) discovered that only 5% of temperate zone caves have the right temperature ranges to be useful to bats. World-wide, bats are in decline from shrinking habitat, persecution, and pesticides. Bats use human dwellings in place of lost habitat, causing further conflicts. The recent discovery of the tremendous importance of bats in ecological systems has set off a much belated effort to reverse their decline.

WHY DO BATS USE HUMAN DWELLINGS?

Thousands of years ago, the cavities bats preferred were abundant as hollow trees, natural rock cracks and caves (Racey, 1992). As humans began to clear the forests, first in Europe, then in North America, the hollow trees disappeared and increasingly bats moved into human dwellings to take advantage of the increase in insects provided by agriculture and domestic animals. Clearing the forests also exposed the cave entrances which people began to explore and utilize, driving more bats to find new homes. Fenton (1983) added that early Europeans lived harsh lives filled with superstition. He pointed out that these small, screeching, flying beasts, who emerged only at night from secret holes and caves, became the myths of bloodthirsty vampires, drafty, dark castles, and evil spirits. Fenton (1983) remarked that we got past the evil spirit part, but continued to consider them dirty, dangerous, common carriers of rabies, and ugly creatures that get tangled in our hair.

The 20th century has seen the most rapid decline in bat numbers in history (Tuttle, 1991). Tuttle listed three reasons for this accelerating decline: 1) increased logging in tropical and semi-tropical forests, 2) increased year-round use of caves for recreational exploring, and 3) deliberate killing from ignorance or as part of vampire bat eradication programs. Fenton (1992b) added a fourth reason: This massive increase in the use of chemical pesticides against insects (70% of bats eat insects), and against bats directly. Bats use human dwellings in summer as well as winter. Female bats seek very warm environments in which to give birth and keep their flightless young. Audet and Fenton (1987) commented that this environment might allow for mother and pup to use all available energy for lactation and growth, and waste none on keeping warm. In cooler northern climates, bat nurseries would have been in the trunks of sun-warmed trees, dry wood being an excellent insulator (Kurta, 1985). The hot summer attics of older homes, in temperate regions of the world, became roomy substitutes for missing trees. Access to dwellings was through any small crevice, plentiful in older homes, where settling opened cracks around chimneys and walls (Fenton, 1992b). Fenton found that the small *Myotis* spp. could squeeze through a crack only 5mm high. In winter, cold-tolerant species such as the big brown bat (*Eptesicus fuscus*) in North America, and *Pipstrelles* spp. in Europe, hibernated in the walls of homes where they tolerate temperatures down to 0^0C (Ransome, 1990).

House Bats and Human Conflict

House-using bats create three common problems that cause people to seek their removal: stains and odor, noise, and fear of disease (Fenton, 1992a). Interestingly, in radio-tracking bats all over Canada, M. Fenton (pers. commun. 1992) discovered that 80% of people who had maternity colonies in their dwellings were unaware of their presence, and that hibernating bats, who are quiet and deposit no guano, are almost never detected. He explained that nursery colonies can deposit large piles of guano under their roosting areas, creating a bad odor and staining the ceiling in the living area below. In addition, nursery colonies are quite noisy with nonstop squeaking and fluttering of moving bats.

Once people detected the bats, Tuttle and Kern (1981) reported that they became fearful of getting diseases from the animals themselves or their guano. They noted that only two diseases can result from contact with bats: rabies and histoplasmosis. Additionally, they pointed out that less than 1% of bats carry rabies, a lower rate than skunks, fox, or domestic dogs. Tuttle and Kern (1981) and Constantine (in Kunz, 1987) reported less than an a dozen human deaths from bat-strain rabies virus in North America since 1955, and that healthy bats do not attack people.

The other infection, histoplasmosis, causes a nonfatal lung infection in humans who breath in the fungal spores in dust contaminated with chicken, pigeon or bat droppings (Tuttle, 1988). It is considered an occupational hazard of chicken farmers, pigeon fanciers, bat biologists, and cave explorers in the eastern United States, but Constantine (in Kunz, 1987) found that histoplasmosis was absent in most of the dryer Western states. Additionally, M. Fenton (pers. commun.) added that histoplasmosis is not known to occur in Canada. Tuttle and Kern (1981) recommended the use of a respirator, with a 2 micronfilter, when handling any dry dung. Fenton (1988) reported that the

various parasites found on bats, and in their roosts, were species-specific and did not bite humans.

THE VALUE OF BATS

How are bats any different than the millions of other commensal animals, like mice and rats, that humans attempt to control world-wide each year? Notably, bats cause little harm to humans and, in fact, are beneficial globally. The biology and ecology of bats is unique among animals. Bats eat the widest variety of foods of any animal on earth. This diet includes insects, arachnids, fish and krill, reptiles and amphibians, rodents and other bats, birds, blood, nectar, and pollen, which has allowed them to colonize all the life zones of the world (Fenton, 1992b).

Seventy percent of the world's bats eat insects, many of which carry disease or are agricultural and timber pests, especially nocturnal moths and beetles (Whitaker, in Kunz 1987). Whitaker (1993) observed that just one bat can consume 600 mosquito-sized insects per hour, and its own body weight in insects daily. In one summer season, he recorded that 150 bats, an average maternity colony in the Midwest, could easily eat 38,000 cucumber beetles, 16,000 June bugs, 19,000 stink bugs, and 50,000 leaf hoppers, among other insects. Tuttle (1990) added that the guano under large bat colonies is a valuable source of fertilizer for rural agricultures in developing countries. Of possibly greater importance is the recent discovery that nectar and fruit-eating bats are the major pollinators and seed dispersers of hundreds of species of tropical and semi-tropical plants, many of which produce crops valued in the hundreds of millions of dollars annually in cash-poor developing countries (Bat Conservation International, 1992; Fenton, 1992b). Thomas (1991) observed that when areas of tropical rain forest are clear-cut, seeds deposited by fruit-eating bats are the first plants to recolonize these disturbed areas.

SOCIAL BEHAVIOR AND MORTALITY

In and of themselves, bats are valuable because they are such a unique and diverse life-form. Ironically, these gentle, shy, and fascinating creatures are very vulnerable to destruction because of their highly social behavior of roosting in very large groups in trees, buildings, caves, and mines easily accessible by humans (Tuttle, 1991). Fenton (pers. commun.) observed that female colonial bat species have only one pup per year, and disturbance of the large summer nursery colonies caused females to abandon the pups. In some countries bats are shot (Rainey, 1990) or netted for food (Tuttle, 1990; Bat Conservation International, 1992). During hibernation, disturbed bats, awakened unnecessarily, waste critical calories needed to endure up to eight months of fasting, and may starve to death before spring arrives (Tuttle, 1991). Bats have been used for target practice, and have been burned and dynamited in the mistaken belief that they were vampire bats (Murphy, 1991). Murphy reported that only three species of bats in Central and South America drink blood, and one of these feeds exclusively on birds.

WAR ON BATS

World War II saw the further acceleration of the decline of bats globally, resulting from the massive development and application of chemical pesticides (Fenton, 1992b). Fenton reported that, at first, bats died from consuming insects sprayed with DDT and

sulfur. Following WW II, many more insecticides were developed and became available to the public for home use. Pest control companies sprang up to take advantage of this quick and easy way to rid homes and farms of all pests, including bats. What followed was 30 years of dosing millions of homes and buildings with a variety of pesticides, some with killing power lasting decades (Fenton, 1983; pers. commun. 1992; Tuttle, 1988; Racey, 1992).

Tuttle (1988) reported what followed. Thousands of bats sickened, left their roosts, and fell dying for miles around the area, frightening people and starting the unfounded belief that most bats were rabid. These roosts were constantly refilled with more bats seeking shelter, providing steady repeat business for exterminators. People and pets sickened and died, because the poisons affected all mammals. Tuttle (1988) went on to add that moth balls, chloroform, bright lights, and fans were tried and all failed. Bomford and O'Brien (1990) reported test results on two high-intensity ultrasonic devices designed to repel rodents and bats, and found that neither worked. Tuttle (1988) reported that ultrasonic devices, in some cases, attracted bats! Millions of dollars were wasted and countless animals and humans suffered because no chemical or electric device has ever been found to repel bats permanently.

HUMANE SOLUTIONS TO BAT PROBLEMS

There are however, two proven options to the problem of bats in human structures. The first is called exclusion or roost sealing, and entails locating and closing all the holes the bats are using to get into buildings. The second involves educating the would-be evictors to coexist peacefully with the bats.

Fenton (1992b) described the first option as two different problems. Residents frequently encountered a bat the first time when it happened to enter a room and fly about. These stray bats were often youngsters from a nursery colony, just learning to fly. Fenton suggested the simple solution of opening a window or a door, removing the screen, turning off the light and letting it fly out. With the more confident homeowner, he suggested waiting for it to land, scooping it up in a thick towel, carrying it outside and gently shaking it out. Fenton cautioned that all bats bite in self-defense when frightened, and should always be handled wearing gloves.

The second problem addressed by both Fenton (1992b) and Tuttle (1988) dealt with the colony itself. They noted that most colonies of bats use either spaces in walls or attics which they have accessed through small openings in the building. They noted that the entry hole or holes often showed some brown staining or guano spatter marks around them, and when bats are in residence, they can be observed by flashlight leaving the hole after dark. In addition, small, crumbly brown bat droppings often accumulate on the ground under an entry hole, giving a clue to the location of hard to spot entrances. Bat researches generally recommend sealing holes in late fall, winter, or early spring, when the roost area is naturally empty. At these times, attic areas are cooler to work in and daylight showing through cracks will help the evictor locate and plug the holes with putty, foam insulation, steel wool, or tape. Bats do not chew entrance holes like rodents, and will not chew their way back in next spring (Fenton, 1992b).

If guano piles are to be removed, Tuttle (1988) recommended wearing a 2 micron mesh filter respirator. Hanks (1991), a professional bat excluder, once removed 2,268kg

of guano from a 19th century building. Guano is a superb fertilizer and gardners carried it all away.

When adult bats are in the roost, Fenton (1992b), Hanks (1991), Tuttle (1988), and E. Pierson (pers. commun. 1994) described a number of simple ways to evict bats without harming them. First, locate all the holes the bats are using and seal all but three or four main exits. Second, hang some barrier material over the holes. This can be heavy plastic netting (1 cm^2 mesh), window screening, or opaque or clear plastic sheeting. Pierson cautioned against using fruit tree bird netting, because small bats can become tangled in its larger hole size and die. Use duct tape or staples to secure the barrier material 4 to 6 cm above the holes, extending at least 30 cm to each side, and 30 to 60 cm below. It should hang loosely so the bats will be able to crawl below the barrier to take flight. When bats return, they try to land directly at the hole which the barrier now prevents them from entering. The exit holes should be checked nightly for several nights, or over several weeks, to make sure all the bats are out of the roost before sealing the last holes and removing the barriers.

Hanks (pers. commun. 1994) has invented a simple excluder of quarter-inch hardware wire cloth, formed into a 20 cm long cylinder, approximately 8 cm in diameter. He cuts one end of the cylinder into 8 to 10 tabs, each 2 to 3 cm long, flared like flowered petals. These cylinders are placed over the exit holes and secured by the tabs. The protruding end of each cylinder is pinched into a narrow, flattened oval just wide enough for a bat to exit through. He has installed thousands of these wire cloth excluders which are left permanently in place. Under no circumstances should a roost be sealed when flightless young are present. Not only is this a cruel, unnecessary death of a valuable animal, but it could cause a serious odor problem.

LIVING WITH BATS

Bat control, however may not be compatible with bat conservation. Brigham and Fenton (1987), radio-tracked pregnant big brown bats (Eptesicus fuscus) as they were excluded from roosts in five buildings in Canada. They discovered the females moved to the nearest other building with a suitable roost, often only 100m away. In rural areas, they reported the females often just moved to the nearest available building. Using bat detectors, they recorded 262 attempts per night to reenter the old roost, and if any new hole was found, the entire colony moved back immediately. Of concern was the fact that these researchers noted a 66% mean infant mortality rate in evicted pregnant bats, as opposed to only a 14% mean infant mortality rate for pregnant females using familiar, undisturbed roosts.

The second option requires educating the public to the enormous value of bats, and the need to protect and coexist with them. As Fenton (pers. commun.) noted previously, 80% of the people are aware of existing bat colonies in their homes, with no detrimental effects on these homeowners. He found this to be especially true if the home was well insulated. The growing interest in composting and pesticide-free gardening might be the incentive for reluctant bat-roost owners to realize quick benefits from such a colony. Removing old guano in fall or winter would stop the odor problem. The attic could then be well insulated, saving the resident heating and cooling dollars, and stopping bat noise. A heavy layer of heat-tolerant plastic, under the colony roosting site, would facilitate the yearly harvest of the rich fertilizer as a renewable resource. If the bats are

evicted from the house walls, the attic or other out-buildings, could be prepared and made available for the colony. This will become a long lasting friendship as bats live up to 32 years (Fenton, 1992b). Where total bat exclusion is necessary, bat houses could be constructed in the area to provide alternate roosts and encourage the bats to stay in the area (Tuttle and Hensley, 1993). In England, as well as Europe, Racey (1992) reported a growing interest in reversing the decline of their once abundant bat populations. He reported that in Britain, a permit, plus approval of the local wildlife authorities, is required to evict bats from a building or cut down a hollow tree.

SUMMARY

For thousands of years bats have been mislabeled as evil, dirty, and dangerous to humans. It was not until 1930 that researchers understood their echolocation. Even though they make up nearly 25% of the world's mammals, they have been so understudied that their tremendous value as insect pest controllers is now being fully appreciated, and their role in the plant seed and pollen dispersion, was virtually unknown before 1950. As a consequence, superstition and ignorance controlled needless persecution and slaughter of these beneficial, flying animals.

Driven from their forest and cave homes, the dwindling number of bats sought refuge in remaining forest tracts and human structures, where they continued to be chemically assaulted and evicted. A massive, 11th hour public education campaign is now under way by such organizations as Bat Conservation International in the U.S., and the Bat Conservation Trust in Britain, to undo the ignorance and promote tolerance of bats. This must include protecting their critical cave and mine roosts, allowing them to share our buildings, and in fact, welcoming them by building bat houses. A better, healthier world for bats will result in a better, healthier world for humans.

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