



Managing Human-Wildlife Interactions: Moles

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Three species of moles are native to Virginia — the Eastern mole (*Scalopus aquaticus*), the hairy-tailed mole (*Parascalops breweri*), and the star-nosed mole (*Condylura cristata*) (figures 1-3). Of these three species, the Eastern mole is the most widely distributed within Virginia and occurs statewide; however, it becomes less common where elevation exceeds 2,000 feet above sea level. Although the star-nosed mole is reported to exist statewide, it is more commonly found in the northern Piedmont, Coastal Plain, and Tidewater regions; pockets of abundance also are reported in several southwestern counties (e.g., Russell, Smyth, Wythe, Grayson, Floyd, Patrick, and Henry). The hairy-tailed mole is found along and west of the Blue Ridge Mountains and often at higher elevations (more than 2,500 feet above sea level).

Because these animals spend much of their lives underground and do not directly interact with humans, most people are not familiar with them. Still, it's relatively easy to recognize the telltale signs left behind from a mole's presence. Despite the annoyance of having to make potentially costly and repeated repairs to damaged lawns and gardens, homeowners should realize that moles provide important services in several ways. Contrary to public folklore, moles are not herbivores; they actually are insectivores that feed on the larvae and adult forms of insects that live underground. These animals therefore provide a beneficial ecological service by helping to manage populations of some of the worst lawn and garden insect pests. Although they may consume small amounts of plant material, they do so only incidentally while foraging for nonplant food items. Further, their digging activity improves soil aeration, increases water percolation, and speeds incorporation of organic matter into the soil — all are beneficial to good soil health. Nevertheless, many people confronted with repeated damage to lawns have little tolerance for these small mammals and resort to costly (and sometimes illegal) actions in their effort to rid their property of moles. This publication provides an overview of the biology and behaviors of these three species and examines the options available to those affected by moles on how to reduce damage.



Figure 1. Eastern mole (*Scalopus aquaticus*). Note the short, hairless tail and the large, heavily clawed front feet used for digging. ("Eastern mole" by Brian Gratwicke, licensed under CC BY 2.0.) <https://creativecommons.org/licenses/by/2.0/>



Figure 2. Hairy-tailed mole (*Parascalops breweri*). Note the distinctive short but fully haired tail. ("Brewer's mole, hairy-tailed mole, taupe à queue velue" by Dan Nydick is licensed under CC BY-NC 4.0. <https://creativecommons.org/licenses/by-nc/4.0/?ref=openverse>)



Figure 3. A nest containing 3 young-of-the-year star-nosed moles. Note the unique sensory appendage on the snout of each individual from which the animal gets its name. ("Baby star-nosed moles" by Hillbraith is marked with Public Domain Mark 1.)

Biology and Behavior

Moles live in underground burrow systems beneath the lawns of residential properties, golf courses, cemeteries, and recreational fields, but they also can be found under fallow fields, forest edges, croplands, and pastures. It is rare to encounter a mole above ground — if this were to occur, it likely would be in the spring or fall in the hours before dawn or after dusk, or at night when moles attempt an overland dispersal to a new foraging area.

The type of soil, its moisture content, and the availability of reliable food all influence mole activity. In general, moles avoid heavy clay or stony, coarse gravel soils, but instead prefer moist, sandy loam soils where digging is easier. Soils that are too porous and dry or too wet usually fail to maintain the integrity of the underground tunnel system that moles create, so they usually avoid these conditions. The star-nosed mole frequently occupies low-lying habitats where damp (not saturated) soils commonly exist, such as areas adjacent to streams, lakeshores, and wetlands. In contrast, both the Eastern and hairy-tailed moles prefer the drier soils of upland habitats. Individuals of all three species can swim, but the star-nosed mole notably is the most adept and occasionally can be seen swimming away from or toward an underwater opening to its tunnel system.

Adults of all three species will reach between 4 and 8 inches in length from the nose to the tip of the tail. Of the three species, the star-nosed mole, on average, is slightly larger than the other two species. Males of both the Eastern and hairy-tailed moles typically are larger in size than respective females, whereas male and female star-nosed moles are approximately equal in size. All three species display brownish-gray fur, though the slate-colored underfur makes hairy-tailed and star-nosed moles appear somewhat darker. Their very short, velvety fur bends easily in any direction and thus reduces resistance the animal encounters as it moves within the tight confines of the tunnel, especially when backing up or rolling over. All moles have short, powerful forearms that terminate in broad, outward-turned palms equipped with prominent digging claws on the toes. They have small eyes, nondescript ears (typically hidden under the fur), an elongated head, and, for Eastern and hairy-tailed moles, a furless pointed snout. However, small tactile hairs on the snout (also found on the forepaws, top of the head, and tail) enhance the mole's sensing of its environment.

Unlike the other two species, the star-nosed mole exhibits a highly modified snout, characterized by a large fleshy projection with 22 short “tentacles” radiating from it — the feature from which this animal's name originates. These tentacles, found in no other mammal, contain a large number of sensory receptors, so the appendage seems to be a tactile device rather than an olfactory aid, one that helps the animal better distinguish items it encounters within its environment.

Moles can detect light vs. dark but are virtually blind. However, they have a well-developed sense of smell. In fact, recent research suggests that moles smell in “stereo” (i.e., they use their two nostrils independently to enhance the sensory signals received).

Although quite similar in overall appearance, Eastern and hairy-tailed moles can best be distinguished by differences in their tails. The tail of an Eastern mole is short (0.6-1.2 inches) and hairless, whereas that of the hairy-tailed mole is slightly longer (0.9-1.4 inches) and densely covered with short, stiff hairs.

Moles construct two types of tunnels (figure 4). One is a network of shallow, interconnecting feeding tunnels located just under the ground surface, often observed from above ground as raised, snake-like ridges or conspicuous mounds of soil pushed up from below (figures 5 and 6). Moles create new shallow feeding tunnels daily; some may be used only once before being abandoned, whereas others may be maintained as a conduit to extend the mole's search for food into new areas. The other type of tunnel is the deep (6-20 inches below the surface), permanent tunnels within which the mole actually resides. These deeper tunnels provide the pathways moles use to move from the living chambers to the feeding tunnels. This deeper network also provides protection against most predators. Hairy-tailed moles may use the same burrow system continuously for up to eight years, but this rarely occurs unless a site possesses a tremendously rich and abundant food base to support the population over time. All species of moles make feeding tunnels, yet Eastern moles are more likely to leave behind the readily detectable evidence of their presence across the ground surface. Although they sometimes also create the large (1- to 2-foot-diameter, 4- to 9-inch high) “molehills” often directly above where an underground chamber was being excavated, molehills are more often attributed to star-nosed moles.

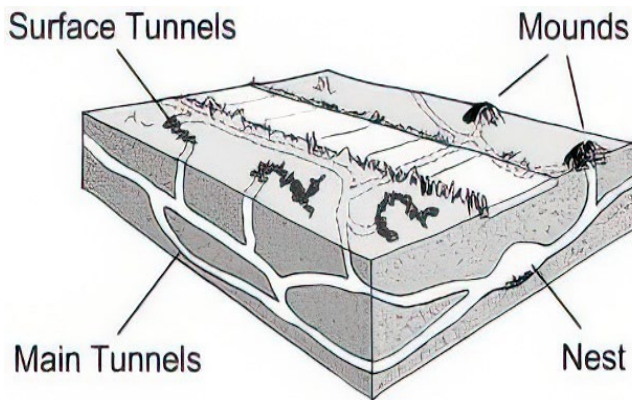


Figure 4. Schematic drawing of a typical mole tunnel system, including temporary surface feeding tunnels, deep permanent tunnels, and nest chamber. (Image courtesy of University of Arkansas Cooperative Extension.)



Figure 5. Above-ground raised ridges characteristic of the type of shallow feeding tunnels created by moles.



Figure 6. Photograph of raised mounds of soil in a residential lawn that are created by moles as they dig underground tunnels. (Photo by author Jim Parkhurst.)

Many people believe that moles are rodents, like mice or rats, but they actually are members of the scientific order *Eulipotyphla*, which includes animals like shrews and hedgehogs that are predominantly insectivorous. Moles typically consume earthworms, slugs, ant larvae,

and the adult and larval stages of numerous other insects, but they may ingest small amounts of vegetation and seeds taken inadvertently during the pursuit of their prey. Moles rarely damage or destroy plants or bulbs by direct feeding, but they frequently can dislodge plants or uproot bulbs while tunneling in their search for food. Moles remain active year-round and their search for food often extends over several lengthy stretches of time during both night and day. It is typical for them to actively feed or tunnel for three to four continuous hours, interspersed with shorter periods of rest. Although moles can be active at any time of day or night, research shows they display several peak periods of activity, most often in early to mid-morning and again in late evening. Because they have a high rate of metabolism and expend tremendous amounts of energy when constructing new tunnels or expanding existing tunnels, they need to eat frequently. To satisfy this high demand for food, one mole can dig up to 150 feet of new tunnel each day and likely will consume an amount of food equal to 60%-70% of its body weight daily.

Moles typically are solitary creatures, although the star-nosed mole is somewhat more social than either the Eastern or hairy-tailed mole. The only times individuals consistently are seen together are during the spring breeding season (typically anytime from February to April) or when a female is rearing her brood. After a 4- to 6-week gestation period, the female will produce a single litter of two to five young (up to seven with star-nosed moles) each year. Birthing occurs in an underground nest chamber within the permanent tunnel system; this birthing chamber usually is located about 12-18 inches underground and often lies beneath a hardened surface such as a large stone, tree, paved sidewalk, or roadway. Young moles leave the nest at about 5-6 weeks of age and disperse somewhere outside the mother's currently occupied territory. Moles become sexually mature by the end of their first year and can live up to five or more years in the wild. Mortality typically is greatest among young inexperienced individuals who fall prey to predators during dispersal from the birthing area or as a result of interaction with humans. Primary predators of moles include large snakes, skunks, foxes, weasels, and domestic cats and dogs. Several species of snakes will enter the tunnel system (when access is available) to search for prey, whereas most mammalian predators will dig into a feeding tunnel when they detect underground movement. Hawks, and especially owls hunting at night, will prey on unsuspecting moles if caught unprotected above ground.

Economic Status and Importance

Moles are extremely beneficial because they consume the larvae and adult stages of numerous pest insects, such as Japanese beetles (*Popillia japonica*), that affect garden and landscape plants and turf. Additionally, their tunneling activity loosens the soil, thereby improving aeration and percolation, and mixes deeper soils with surface organic material, all of which helps to improve soil quality. However, facilities that rely on providing intact, undisturbed grassed surfaces, such as golf courses, baseball/soccer/football fields, or turf farms, incur significant costs from having to repair turf damaged by moles (figure 7). Although often deemed more cosmetic than seriously damaging, the tunneling activity of moles may force homeowners to make repeated repairs to sections of lawn where moles have been feeding actively.

Moles frequently receive blame for eating the roots of vegetation or feeding on garden plants and bulbs, but this rarely is the case. Instead, voles (herbivorous small rodents that also live in underground tunnels) are responsible for causing most of that type of foraging damage. In reality, though, moles are not free of blame. They inadvertently uproot, dislodge, or heave garden plants out of the soil as they create new surface feeding tunnels. Commercial bulb growers and producers of row crops sometimes sustain economic losses caused by moles when they push bulbs or plants out of the soil or when dislodged plants die as their exposed root systems dry out. Equipment used to harvest crops or mow grass can be damaged or dulled when it hits a raised mound of soil or the ridges created by moles; this adds additional costs when machines are taken out of service to perform needed repairs.



Figure 7. Numerous molehills in a residential lawn, displaying the type of extensive physical and potentially significant economic damage possible to turf from the feeding activity of moles. (Photo by author Jim Parkhurst.)

Management Options

For commercial agricultural producers, attempts to eliminate moles over large acreages is difficult, if not impossible, given the amount of time and effort needed to perform such work. However, options do exist for others affected by moles, especially homeowners living on small-acreage residential properties. Those who seek benefit from the services provided by moles (i.e., getting rid of troublesome insect pests and improving soil quality) can simply leave the mole alone and let it forage until it reaches a point where little food resource remains. Once the animal finds itself spending more time and energy in the pursuit of prey than it gets back in reward for that effort, it often will vacate the area, hoping to find better conditions elsewhere. After the mole departs, owners can repair damaged areas of lawn.

Where a more aggressive response is necessary, deterrents, physical barriers, or traps may help manage mole problems. Because of the mole's solitary habit and relatively low productivity, only one or two animals likely are causing the damage observed in the typical residential yard. With a bit of effort and persistence, keeping a residential yard free of serious mole damage for a number of years is possible.

Deterrent Realities

Many "home remedies" passed down through the years are completely ineffective, can be hazardous to residents, pets or companion animals, and nontarget wildlife, and, in most cases, are illegal. Examples of such "remedies" include gassing tunnels with auto exhaust or carbon dioxide from a fire extinguisher, placing broken glass shards, pins, or other sharp objects in the tunnels, putting a wad of chewing gum (folklore often emphasizes use of Juicy Fruit) into a burrow, or pouring caustic household cleaning chemicals such as ammonia or bleach or even gasoline into a molehill. Only chemicals registered through the U.S. Environmental Protection Agency and certified for use on moles can be applied legally. Regarding nonchemical deterrents, the suite of devices referred to as sonic or vibration-producing devices generally display little deterrence on moles. Because moles live underground and see poorly, visual deterrents have no value in mole management.

Physical Barriers

To obtain relief from persistent mole damage inflicted upon small seedbeds or garden plots, gardeners may consider installing a perimeter barrier of sheet metal or hardware cloth set deep into the soil. To install such a barrier, dig a trench about 20 inches deep and 10 inches wide around the entire outer edge of the bed. The material used to make the barrier should be bent to create an "L"

shape, with the “foot” of the L being about 8-10 inches wide and the vertical portion sufficiently tall enough (approximately 25 inches) to protrude above the soil when installation is finished. Place the entire device into the trench, with the L at the bottom of the trench facing out away from the garden. Then backfill the trench and tamp down to hold the barrier upright and firmly in place. All connections in the barrier, especially the corners, must be intact if this barrier is to be effective.

A simpler, but perhaps more expensive, approach is to prepare a perimeter trench much like that described above, but, instead of installing a metal barrier, fill the trench entirely with coarse gravel. This wide, deep barrier of stones often is sufficient to dissuade moles from attempting to tunnel through it. Commercially available aggregate products now are being sold (examples include Vole Bloc, PermaTill, and Espoma Soil Perfector) that replicate the effect of natural stone but are likely to be considerably more expensive than common gravel purchased in bulk. Please note: Neither the metal nor the stone perimeter method is likely to be feasible or cost-effective for very large gardens.

To deter moles from entering a raised bed, attach panels of galvanized hardware cloth or other similar small-mesh (less than 1 inch) wire fence material to the base of the bed frame at the time of initial installation and prior to filling the bed with soil. This obstruction will prevent moles that tunnel toward a bed from entering the frame from below ground. Even though hardware panels typically are galvanized to prevent rust and deterioration, over time that protection will wear down and the metal will begin to decay. Replacement of the protective barrier may be necessary periodically, especially in sites with high soil moisture.

Repellents, Fumigants, and Toxicants

Any pesticide products applied in an effort to manage moles must bear an EPA registration for moles *and* have approval for use in Virginia. Although a product may possess a national EPA registration, any product not certified for use in Virginia is illegal despite its national registration. Applicators assume full responsibility for assuring that a chemical meets both of these criteria before using it and then applying the material according to label directions. Many pesticide products currently registered for use on moles are labeled “Restricted Use Products;” applicators must possess certification in Vertebrate Pesticide Application (Category 7D) to acquire and use restricted materials.

Currently, the only repellent formulations registered for use on moles contain capsaicin or coyote or fox urine

as active ingredients. Several products based on formulations containing castor oil (primarily ricinoleic acid) previously were registered, but all such registrations have now expired or been canceled.

White milky spore (*Paenibacillus popilliae*) is a naturally occurring bacterium that specifically attacks the larvae of the Japanese beetle but is not harmful to the larvae of most other insects. The Japanese beetle is a common pest of home gardens and especially in turf, so the seasonal abundance of their larvae represents a prominent food item in the diet of moles. Milky spore, now available in commercial formulations, has been promoted as a means to reduce mole conflicts by limiting the availability of these grubs. However, because it is ineffective in eliminating larvae of other insects, white milky spore doesn't affect the abundance of other potential food items that moles may consume. As a result, this option, when used alone, is unlikely to provide a desired level of control because moles simply will shift attention to other available foods rather than leave the site.

In the past, applications of broad-spectrum insecticides often were recommended for managing moles in turf by attempting to reduce populations of various beetles and grubs, which, as noted above, represent major food items for moles. The assumption used to justify this chemical approach was that, when faced with a reduced food supply, moles simply would leave the area. However, in practice, applications of these insecticides rarely are effective in removing all potential food sources. Because moles feed on a wide variety of invertebrates, not just beetles and grubs, they simply switch to other readily available prey species unaffected by these pesticides (usually earthworms or night crawlers). Furthermore, some particularly strong broad-spectrum insecticides can significantly disrupt the ecological balance of organisms inhabiting turf, wiping out both beneficial and pest organisms in the soil. Certain formulations, particularly granular formulations, have proven to be highly toxic to wildlife when granules are scattered on the ground's surface. Songbirds can die when they mistakenly ingest these granules, thinking they are grit, the coarse material birds ingest and store in the upper digestive tract (the crop) to help grind up the hard covering of seeds or tough shells of insects to aid digestion. Today, broadcast application of broad-spectrum insecticides as a mole deterrent is not recommended; insecticides should be used only to resolve specific insect problems, not mole problems.

Several fumigant products are registered for use in Virginia, some of which are classified as Restricted Use Products. A nonrestricted product intended for underground applications within the deep tunnel system of moles is the sodium nitrate gas cartridge. However, because gas cartridges are incendiary (flammable) devices,

they should never be used where a threat of fire exists, like under a building or in a field of dry vegetation. Several formulations of aluminum phosphide are registered for use on moles, but all are classified as Restricted Use Products and, due to the extreme toxicity of this active ingredient, application of aluminum phosphide should be left to certified professional applicators only.

The successful application of mole toxicants can be challenging given that these animals live in underground tunnels and the fact that moles generally are not attracted to chemical-treated baits commonly used to manage populations of tunneling rodents. In accordance with labeling directions, all mole toxicants must be applied *below ground*, within the tunnel system being used by the mole; distribution of toxicant materials labeled for moles above ground is prohibited, primarily to prevent harming other animals. To enhance the chance of success of in-burrow toxicant applications, first identify areas where fresh tunneling activity currently is occurring; there is little value (monetarily or in terms of ultimate success) in treating tunnels moles no longer use. To detect active foraging sites, make a small opening (no larger than 1 inch in diameter) in several existing mounds or ridged tunnels using a screwdriver or other pointed implement. Place a marker at the location of each hole to make it easy to find those exact spots later. After 12-18 hours, return to those spots and see if any of the holes have been sealed closed. Because moles do not want openings to the burrow system that might provide access to potential predators, they periodically perform surveillance of their entire tunnel system and will seal up any openings they detect near their primary activity centers. Spots where an opening was not resealed likely indicate areas that have been abandoned and would not be successful areas to apply controls.

An alternative approach would be to gently tamp down sections of ridged runways or soil mounds that have been pushed up, marking each section that has been pressed down. The same monitoring approach would be followed here: If any marked sections have not been raised since they were tamped down, that area has been abandoned. But, if the ridges or mounds reappear, those are active feeding sites and areas for possible treatment. For baiting purposes, focus treatment only on sites actively being used by moles.

Toxicant products containing bromethalin (0.025% active ingredient) are now available commercially for treating mole problems, including Talpirid, Tomcat Mole Killer, Victor Poison Mole Worms, and others. The majority of these products deliver the active ingredient using either a “gummy worm” or “poison peanut” formulation (figure 8). These flexible, treated baits are

designed to replicate the appearance and texture of the worms, grubs, or larvae that moles search for and thus are believed to be attractive baits. The baits must be inserted into the tunnel where moles are actively feeding. Several registered formulations of zinc phosphide-, warfarin-, or diphacinone-treated baits also are available (as Restricted Use Products) for specific application situations and with special precautions; as such, certified professional applicators should perform this work.



Figure 8. A mole takes a “gummy worm” toxic bait used to manage populations of moles. (Image courtesy of Bell Laboratories, used by permission.)

Trapping

Trapping represents a tool that provides only temporary relief from moles; trapping rarely provides a permanent solution to the root cause of a mole problem. If the existing conditions that initially attracted the animal (i.e., an abundant food supply) are not changed, removing an offending individual from that environment serves only to alleviate problems associated with that individual — other individuals can be expected to occupy high-quality habitats and soon will fill the void left behind after the previous individual was removed. Thus, in most cases, reliance on just trapping will become a persistent maintenance operation.

To consider the feasibility of implementing a trapping effort, it is important to understand existing regulations regarding the capture, transport, and release of wildlife. Sections of the Code of Virginia allow landowners the right to capture certain animals that are causing damage to their property. However, it is illegal in Virginia to transport any wild animal captured on one’s own property and release that animal on property that someone else owns (this includes federal, state, or municipal lands), unless specific authorization to do so has been obtained from the Virginia Department of Wildlife Resources. A property owner can release a captured animal in other areas of their own property where, presumably, its activity will not be objectionable. If a captured animal is

injured or needs rehabilitative care, it can be transported to a [licensed wildlife rehabilitation facility](https://dwr.virginia.gov/wildlife/injured/rehabilitators/) (https://dwr.virginia.gov/wildlife/injured/rehabilitators/) once that facility confirms, in advance, its willingness to accept the animal. Please note: These facilities cannot accept healthy, uninjured animals, except for orphaned young-of-the-year. If neither of these options is feasible, the captured animal must be killed. If a property owner does not feel comfortable performing this action, trained professionals experienced in trap-and-remove operations can be located using the Department of Wildlife Resources' ["Find a Trapper"](https://dwr.virginia.gov/wildlife/nuisance/trappers/) tool (https://dwr.virginia.gov/wildlife/nuisance/trappers/). In most cases, they will charge a fee for their service.

Trapping moles can be done using either live capture or lethal trapping. A simple live-capture approach uses a container into which the animal will fall and is unable to escape, commonly referred to as a "pit trap." The best time to trap moles is in the spring, as soon as the first signs of activity (raised ridges) are noted, or again in the fall when seasonal rains help re-saturate the soil and insect larvae produced during the summer growing season begin to dig deeper into the soil to overwinter. To be successful, first determine where the mole is currently active. To identify which runways are active, follow a similar process to that outlined above regarding toxicant treatment. Short sections of visible runways can be gently tamped down and marked. Each marked section should be observed for several days; tamp down any freshly raised sections during each inspection. If a tunnel is raised each day, it is an active runway and that is where a trap should be placed.

To create a "do it yourself" functional pit trap, dig a hole in the center of the most active runway; the hole should be approximately 8-9 inches in diameter and 10-12 inches deep — large enough to place a lidless, restaurant-sized can (typically referred to as a #10 tin can) vertically in the hole, open end up. When fully inserted into the hole, the top rim of the can must be at or slightly below the level of the bottom of the mole's runway. Backfill and pack dirt tightly around the sides of the can to secure it in place. Then place a small handful of soil loosely into each of the two exposed runway openings on either side of the can. Also, lightly tamp down the top of the runway extending about 1 foot on both sides of the can to solidify everything. Finally, place a weighted section of lumber, plywood, or other solid material large enough to cover the entire area over the open pit of the trap. This cover blocks out light and prevents anything from falling into the hole, yet still provides a means of

easy access for monitoring. As the mole travels through its passageways and encounters the soil plug placed in its way, it will attempt to reopen the runway by digging and pushing forward, but in so doing, it will fall into the can where it will be unable to escape. If the runway tunnel is not reopened or if a mole is not captured within one or two days, the mole likely has moved on. In that case, move the device to another active runway. If any nontarget organisms are caught, can simply remove them and set them free somewhere else on the property. Always wear stout gloves and long sleeves to help protect hands and arms from scratches or bites when handling captured animals.

A variety of lethal "kill traps" for moles (e.g., harpoon, scissor, or body-gripping types) is available commercially, many of which can be purchased at farm supply and hardware outlets. However, these devices can be difficult to set and people who have little prior experience in setting these devices may face a risk of serious personal injury. Additionally, because several of these designs will be accessible above ground when properly set, they may not be suitable for use where inquisitive children or pets are present; dislodging a set trap could result in serious injury if the device activates when handled by an untrained individual. For these reasons, lethal trapping probably should be left to those trained in the operation of such devices and the handling of wild animals.

Resources

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- National Wildlife Control Training Program. 2013. "Moles." Pages 159 to 166 in *National Wildlife Control Training Program, Volume 2: Supplemental Species Information*, edited by S. M. Vantassel, P. D. Curtis, S. E. Hygnstrom, and R. Smith. Ithaca, New York: Department of Natural Resources, Cornell University.

Websites of Interest

Eastern mole: <https://dwr.virginia.gov/wildlife/information/eastern-mole/>.

Star-nosed mole: <https://dwr.virginia.gov/wildlife/information/star-nosed-mole-2/>.

Hairy-tailed mole: <https://dwr.virginia.gov/wildlife/information/hairy-tailed-mole/>.

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Produced by Virginia Cooperative Extension, Virginia Tech, 2023

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VT/0623/420-201 (CNRE-169P)