March 1990

FRIGHTENING METHODS AND DEVICES/STIMULI TO PREVENT MAMMAL DAMAGE-- A REVIEW

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ABSTRACT: Various frightening stimuli, primarily visual and acoustic, have been used to prevent or alleviate damage by depredating mammals (e.g., deer (Odocoileus spp.), raccoons (Procyon lotor), tree squirrels (Sciurus spp.), coyotes (Canis latrans). Frightening methods are most appropriate for use where a crop or situation needs protection from pest mammals for only a period of a few days or weeks. The ability of animals to habituate to such stimuli limits their long-term usefulness. Against nocturnal species, various types of lights and noisemakers are the most useful. Combining acoustic and visual stimuli can enhance effectiveness, while varying the techniques used, the placement of frightening devices, and/or the timing sequence can delay habituation. Other types of physical frightening stimuli are also reviewed.

Proc. 14th Vertebr. Pest Conf. (L.R. Davis and R.E. Marsh, Eds.)
Published at Univ. of Calif., Davis. 1990.

INTRODUCTION

With increasing public concerns about possible health and/or environmental hazards associated with pesticide use in agricultural settings, there has been growing interest in techniques that can be used to reduce or replace the use of pesticides for controlling vertebrate pests. This paper reviews the current status and potential uses of physical frightening stimuli as a nonpesticide method for alleviating mammalian pest problems, principally in home yards and agriculture.

The basic goal of using frightening devices/stimuli is to prevent or alleviate damage by depredating mammals by reducing their desire to enter or stay in the area where the crop or garden is located or where livestock are kept. Various stimuli, primarily visual and acoustic, are used for this purpose. One significant advantage is that these methods can give immediate results. The ability of animals to become accustomed to such stimuli relatively soon and thus no longer frightened by them is the major limitation to their usefulness. Also, practical restrictions on the size of area that can be protected with some of these devices can make these methods quite expensive. Because of their relatively short-term effectiveness, the greatest use of frightening stimuli is to protect crops that are most vulnerable to wildlife damage for short periods of time, such as a few days or weeks prior to harvest. They may also be used to frighten problem mammals from an area to provide a few days' lead time for initiating or applying other control methods such as trapping or fencing, or as a supplement to other control methods such as odor or taste repellents. Table 1 gives information on the methods and/or devices most likely to provide some short-term animal damage relief.

Table 1. Passive methods or devices most effectively used to frighten some select species. They are most effective where a crop or an area needs immediate protection for a relatively short period of a few days or a couple of weeks and are particularly useful for small acreages.

Pest	Frightening techniques[a]	Duration of results	Comments
Deer (Odocoileus spp.)	Gas exploders, rope firecrackers, revolving lights	Few days to a week	May help move migrating herds on to other areas.
Raccoons (Procyon lotor)	Lighting the area, playing a radio	Few days at best	Raccoons accustomed to people are very difficult to frighten
Foxes (Vulpes spp.) (Urocyon spp.)	Gas exploders, ripe firecrackers, revolving lights	Few days at best	Flooding a backyard garden with light may discourage foxes from damaging melons, etc.
Coyotes (Canis latrans)	Gas exploders, revolving lights, rope firecrackers	Few days at best	Highly unpredictable in their response to frightening devices.
Rabbits (Sylvilagus spp.) (Lepus spp.)	Gas exploders, rope firecrackers	Few days to a week	For very temporary relief. Provides time to install fence.
Rodents Order Rodentia	-	-	Frightening techniques rarely have any appreciable effects on small rodents.

[a]The passive frightening techniques suggested are those most often used and have given some relief; however, other very similar methods may be worth trying. Individuals patrolling an area and shooting live ammunition to harass (when and where legal), or shooting cracker or other noise-producing shells can be effective but time consuming and much more expensive in labor and materials.

Because physical frightening stimuli have not generally been widely used on pest mammals, lack of long-term effectiveness and the fact that, at least in the past, more alternatives for mammal damage control were available, there has been limited research evaluating the use and efficacy of frightening devices/stimuli to repel mammalian species. Published reports on the efficacy of frightening methods and devices for mammal control are thus scarce. Most information about the effectiveness of such techniques is from trial and error and is in the form of anecdotal accounts. Unfortunately, it is also seldom possible to identify with certainty factors influencing the apparent success or failure of these control efforts under field conditions, and laboratory studies in this area provide limited information that can be translated to field situations.

Some factors that appear to influence the effectiveness of using frightening stimuli include the strength of the animals' reaction to the stimuli, the availability and suitability of alternate sites where they can disperse to rest or feed, the species' site tenacity, the effect of nonreacting individuals acting as decoys, and the time of year (are the animals breeding, rearing young, wintering, etc.). In addition, many pest animals (e.g., deer, raccoons, opossums (Didelphis virginiana). beaver (Castor canadensis), coyotes, etc.) are essentially nocturnal feeders, thus much of their damage occurs in the dark. While the night vision of some of these species is good, passive visual stimuli such as scarecrows, flagging, streamers, sun-reflecting surfaces and devices offer reduced repellency to these night feeders. For this reason, artificial light and sound-producing (acoustic) devices generally hold more promise for nocturnal species.

For best results, control programs should be started at the first sign of damage (before feeding patterns are established) and continued persistently. Using several kinds of frightening stimuli alternately or simultaneously may also enhance effectiveness. Diversifying frightening stimuli by changing the placement and type of frightening devices used, altering the firing or lighting sequence, etc., often delays habituation, thus lengthening the period of effectiveness.

VISUAL STIMULI

A variety of visual stimuli is used to scare pest animals from crops and gardens. These include stimuli which generally involve lights, movements, and/or various types of reflective objects. In the past, carcasses of the pest species were sometimes hung around areas to be protected in an effort to frighten away others of the same species. Threatening images such as scarecrows and predator models or silhouettes (either stationary or moving) have also been used.

Lights

Many of the most serious mammalian pests are nocturnal; therefore, various types of continuous, flashing and/or revolving spot- or floodlights, lanterns, strobe lights, and flares have been used to disrupt their use of an area. Such techniques have been used to move or deter pest mammals such as deer (True 1932), bison (Bison bison) (Meagher 1989), elephants (Elephas maximum) (Monroe and England 1978, Wood 1982), raccoons (Harley 1977, Fitzwater 1990), rabbits (Sylvilagus spp.) (Carlton 1977), rats (Rattus spp.) and mice (Mus musculus), and predators such as coyotes (Fall 1988), foxes (Vulpes spp.) (Carlton 1977), and bears (Ursus spp.) (Boddicker 1976).

Few in-depth studies have been conducted to evaluate the precise effectiveness of lighting as a deterrent. Most of those using such techniques consider lighting alone to be ineffective or only temporarily effective (a couple of days to a couple of weeks), with a few reporting moderate success. Lights used in conjunction with gas exploders, shooting, explosive (cracker) shells, or some type of pyrotechnics (rockets, firecrackers, etc.) are more effective than if used alone. Olfactory repellents, in some instances, may add to the effectiveness of lights and vice versa. While lighting techniques may be readily applied to small gardens or crops of a few acres, lighting large agricultural fields would be prohibitively expensive.

Moving and/or Reflective Stimuli

Novel objects that move and/or are reflective have a long history of use to frighten animal pests. In most cases these objects are hung around the perimeter of the field or garden to be protected (i.e., tied to fences) or in or over the crop itself (i.e., tied to tree branches).

Moving and/or reflective stimuli have particularly been used in efforts to prevent depredation by deer. Nonreflective stimuli that have been used include cloth strips or rags (True 1932, Mills 1938) flags, plastic jugs, and wind propellers (Scott and Townsend 1985). Reflectors (Scott and Townsend 1985), tinsel (Garthwaite 1968), aluminum plates or pans (Hale 1973, Scott and Townsend 1985), flashing, whirling strips or disks (Carlton 1977), and pieces of tin (True 1932) have also been used to protect small acreages of crops and gardens.

Reflective objects, stationary and moving, have been used to prevent damage by other species as well. Suspended pieces of tin (Spalding 1885) and whirling, twisting, or fluttering strips or disks (Carlton 1977) have been used to repel rabbits. Similarly, aluminum pie pans, tin can lids, plastic windmills, etc., have been explored to repel raccoons, opossums, and skunks (Spilogale spp. and Mephitis spp.). Some have suggested surrounding the perimeter of the garden with water-filled clear glass bottles/jars or empty wine bottles planted upside down (Harley 1977) to repel small mammals such as rabbits and groundhogs (marmots) (Marmota spp.) based on the questionable theory that these animals will be frightened by reflections of light or of themselves.

The use of moving reflective objects at best provides limited (low-to-moderate) short-term relief in protecting crops and gardens from the most troublesome mammalian pests. In a recent survey of Ohio Christmas tree, nursery, and fruit growers, only 20 of 1,487 respondents reported hanging objects in (12) or around (8) trees to repel deer (Scott and Townsend 1985). Of these, only 2 reported complete protection, 9 felt that the objects provided some degree of protection, and 5 considered the technique ineffective.

Threatening Images

Use of purportedly threatening images is another approach to frightening mammal pests from crops and gardens. Scarecrows by themselves may temporarily repel such mammals, but because no real threat exists, they are unlikely to provide adequate long-term protection in most situations. When used in conjunction with shooting or some other threatening technique, their effectiveness is increased. Scarecrows have been used against deer (Hale 1973), and predators including bears, coyotes, mountain lions (Felis concolor), and raccoons.

Of the Ohio Christmas tree, nursery, and fruit growers surveyed that reported using scarecrows to repel deer (9 of 1,487 respondents), most (8 of 9) indicated that they provided little or no protection from deer (Scott and Townsend 1985).

A variety of predator models has been recommended or suggested for use against rabbits, mice, squirrels, and other rodents. Many are available commercially. These include cat silhouettes, papier mache, plastic or inflatable owl models, hawk models, helium-filled balloons with suspended hawk-shaped kites, and plastic, rubber, or inflatable models of snakes. Most of these are designed to be staked to the ground, mounted on posts or fences, or attached to trees. Some of these can be modified to enhance movement and some have sources of lighting available for use at night. Noncommercial (homemade) predator models have also been constructed and used. Some have tried placing a toy snake or old piece of garden hose in the garden to repel rabbits (Harley 1977).

Predator models are used in an effort to take advantage of naturally occurring predator-prey relationships. However, unless reinforced in a meaningful fashion, inanimate predator models are unlikely to be perceived as a real threat for very long. Lifelike models incorporating both imagery and motion (e.g., avian predator models that simulate flight with mechanical wind-driven movements) appear more natural and thus more effective than stationary models. Motion is also thought to delay habituation to the models because it makes the models appear more threatening.

Some mammals do have a fear of new objects placed in their environment (neophobia) and may shy away from these for a few days. This phenomenon can be used to temporarily repel deer, rabbits, and certain other pests by placing any strange-appearing or unusual object in a visible location. For example, a number of 4-foot stakes driven into the ground about a foot with empty cardboard boxes inverted over the top of the stake often provides a few days' protection.

ACOUSTIC STIMULI

Gardeners and agriculturists have used all kinds of sound-producing techniques to repel mammalian pests from their fields or gardens. Everything from shouting, hand clapping, assorted noisemaking devices (both homemade and commercially produced), and recorded animal sounds and communication signals (all in ranges that are audible to humans) to ultrasonics (above the hearing range of man) have been tried in efforts to prevent or alleviate damage.

Noisemakers

Noisemakers, especially those that make loud and sudden noises, are used to repel a variety of mammal pests. Animals tend to initially avoid areas with loud and/or unfamiliar sounds.

Noisemakers, including tin-can rattles and other rattling devices, vehicle horns or sirens, and/or whistles, have been used with variable success to repel or move such mammals as rabbits, deer (Carlton 1977), bison (Meagher 1989), and coyotes. One technique often mentioned in gardening literature as a way to repel rabbits (Harley 1977) and moles (Harley 1977, Seymour 1979, Fitzwater 1990) involves partially burying empty soft drink bottles so that their necks extend above ground (some suggest 4 inches). Supposedly the sound and/or vibrations from the wind whistling across the bottle tops frightens them; however, this technique is without merit.

Other noisemaking efforts such as shouting, tape recordings of human voices, and radios try to take advantage of the tendency of wild animals to fear/avoid humans and their activities. Tape recordings of human voices have been explored for use against deer, raccoons, coyotes, foxes, bears, and rabbits (Carlton 1977). Portable radios and blaring music have been used against deer, coyotes, foxes, bears, mountain lions, bobcats (Lynx rufus), and raccoons. While these may give some immediate short-term relief, animals tend to become accustomed to these in a few days or weeks, depending on the species and situation.

Another category of acoustic repellers includes devices that produce loud explosive sounds such as discharging firearms (and recordings of gunshots), the use of cracker shells or other explosive or sound-producing shells, automatic gas-operated exploders that run on propane, acetylene gas, or calcium carbide (CaC_2), and various types of pyrotechnics (firecrackers, rope firecrackers, pressure-triggered firecrackers, etc.). Gas exploders are the most commonly used and effective of all frightening devices. Once set up, they operate automatically, thus requiring little labor. The more labor-intensive roving patrols of individuals intermittently firing cracker shells is the second-most useful technique.

Discharging firearms, cracker shells, and/or other explosive shells are effectively used to repel deer (True 1932, Carlton 1977, Scott and Townsend 1985) and to direct bison movements (Meagher 1989). Gas exploders and various pyrotechnics are used to repel foxes, coyotes (Wade 1983), bears (Lord 1979), tree squirrels, and rabbits as well as troublesome big game species such as deer, elk (Cervus elaphus), and pronghorn antelope (Antilocapra americana). Most sources indicate that such sound-producing devices are effective to various degrees and generally more effective than visual or other acoustical stimuli. Effectiveness may be enhanced and habituation delayed by diversifying the control program, for example, by changing the location and types of noisemaking devices every few days, staggering the firing sequence of the devices, and/or using multiple frightening techniques simultaneously. Such control efforts are more practical for small acreages and generally impractical and too expensive for protecting large areas.

Numerous other sound-generating repellers are available commercially. One of the more commonly promoted and used commercial devices is AV-ALARM®. While originally developed to repel birds, the manufacturer reports that it has been used effectively (either alone or in combination with strobe lights, etc.) against deer, elk, coyotes, wild boar (Sus scrofa), porcupines (Erethizon dorsatum), and raccoons. However, many who have used such devices in mammalian pest control programs or research have generally found AV-ALARM to be only temporarily effective, if at all (Roper and Hill 1986).

Bioacoustics

Use of animal-produced sound or communication signals, often referred to as biosonics or bioacoustics, is another approach to using acoustic stimuli to repel animals from an area. Work to date has primarily focused on the use of conspecific distress or alarm calls to repel birds (Frings 1964, Fitzwater 1970, Boudreau 1972). However, research examining the potential use of mammalian communication signals to alleviate pest problems has been limited. While initial experimentation with recorded rat distress calls showed

some promise (Sprock et al. 1967), the use of biosonics for rodent control in buildings was abandoned because the alarm and distress calls were too stressful to people (Lund 1975). Wade (1983) reported that recorded distress calls have been only temporarily effective against coyotes.

Speculated advantages of using communication signals are that they are meaningful to the animals at relatively low intensities and are often species-specific so other animals need not be disturbed by efforts to control one species (Frings 1964). Furthermore, while animals rapidly habituate to novel visual and acoustic stimuli, they do not as readily habituate to alarm signals unless they are constantly exposed to the signals, whereby they soon learn there is no danger or physical harm associated with the sounds (Frings and Frings 1963, Boudreau 1972). Associating distress calls with other danger stimuli such as gun fire reduces the likelihood of habituation occurring. Fitzwater (1970) notes that some recommend combining the calls with pyrotechnics or cracker shells.

While the previous discussion has focused on the use of conspecific communication signals, there have also been efforts to utilize communication signals from one species (a predator) to repel another species (generally a prey species and the target of the control effort). Tape recordings of barking dogs have been suggested for repelling deer, foxes, bears, mountain lions, bobcats, raccoons, and rabbits. However, there is little indication as to whether this technique is effective.

Ultrasonics

Ultrasonic devices have been extensively promoted for the control of rodent problems, primarily within buildings. While generally developed for use against rats and mice, some types of ultrasonic devices are promoted as repelling squirrels, chipmunks (Eutamias spp.), bats (Order Chiroptera), skunks, deer and/or coyotes. The high-frequency sounds produced by such devices are inaudible to most adult humans, although it is well established that most rodent species can hear and communicate with such sounds. However, while rodents may temporarily avoid areas "covered" with high-frequency sounds, rodents habituate to them and will feed or nest alongside the operating devices. Ultrasonics, as demonstrated by many tests (Greaves and Rowe 1969, Meehan 1976), will not drive established rodents out of buildings or areas. Wilson and McKillop (1986) found high-frequency sound ineffective on the European rabbit (Oryctolagus cuniculus). Similarly, vehicle-mounted devices to alert deer crossing highways (Fitzwater 1990) and collar-mounted devices to protect domestic sheep from coyote attacks lack good data supporting their effectiveness. Furthermore, even if such sound were effective for frightening, the characteristics of high-frequency sound (i.e., their directional nature and rapid attenuation) impose practical limitations on most potential uses of ultrasonics for alleviating mammalian pest problems. There have been so many failures reported with high-frequency sound that little can be said in favor of such devices. Many of these devices are very costly.

Special Considerations for the Use of Visual and Acoustic Stimuli

Diversification and variation are key elements in prolonging the time to habituation. Different methods can be used singly or in combination. Changes in methods may have to be made every couple of days (or nights). Diversification can also be furthered by moving frightening devices such as gas exploders, firecracker ropes, or revolving lights to different locations or occasionally elevating or lowering them. The timing of the firing sequence of automatic gas exploders can be varied. For the best and most lasting results, a whole sequence of variations can be planned in advance.

Acoustic and visual stimuli are often used in combination, with greater success at times than when either is used alone. For example, devices that combine periodic explosions with moving or flashing lights have been used to repel deer (True 1932, Mills 1938) and bears (Floyd 1960), and devices combining sirens and strobe lights have been used to reduce coyote predation on sheep (Linhart et al. 1984, Fall 1988). While initially more effective, some have reported that habituation eventually occurs with these combinations of devices as well.

Some points deserve special consideration before using audible techniques to alleviate damage by mammals. Such techniques, if played at night, may irritate neighbors when used in populous areas. Local noise ordinances may also exclude the use of many sound-producing methods. Before using pyrotechnics for animal damage control, check with your local fire marshall regarding any restrictions on their use and avoid using them in situations where there are potential fire hazards.

PHYSICAL DISCOMFORT AS A REPELLING METHOD

Harassment Shooting

Physical harassment is used to move problem animals from an area. When and where legal, shotgun shooting to harass is conducted with a shot-sized and/or explosive charge which inflicts some discomfort but does not kill or maim. This is important where the species is protected or cannot be legally killed in a particular situation. Shooting to harass is sometimes used to frighten wild or stray dog packs, feral pigs, raccoons, bear or deer. Firing birdshot at deer will cause them to leave a field or area for a time; however, they may soon return, and True (1932) concluded that this technique was not worth the time and expense.

Vibrating Devices

Nonpesticide methods of preventing or controlling damage by burrowing mammals such as pocket gophers (Thomomys spp., Geomys spp.) and moles (Family Talpidae) generally involve trapping, which can be difficult and time consuming. Various soil vibrating devices including toy pinwheels, small commercially produced windmills, and battery-powered vibrators (the latter two types of devices producing both sound and vibrations) have been suggested as relatively passive methods of controlling pocket gophers (Seymour 1979) and moles (Carlton 1977, Harley 1977). In addition, advertisements for some devices claim they are also effective against shrews (Family Soricidae), voles (Microtus spp.), kangaroo rats (Dipodomys spp.), ground squirrels (Spermophilus spp.), and pocket mice (Perognathus spp). The base of the device is pushed into the ground in or near burrows or runways and these wind- or battery-powered devices reportedly produce vibrations in the soil that the animals supposedly cannot tolerate, causing them to move from the area. While gardening literature often suggests the use of such devices, there are no acceptable scientific studies to support their efficacy.

Electromagnetic Devices

Electromagnetic pest control devices are another type of

mammal repeller. Manufacturers claim that these devices disorient pest animals, causing them to stop eating, drinking, and reproducing. As a result, animals supposedly either move out of the electromagnetic field or starve to death. Vertebrate species claimed by the manufacturers or distributors to be "susceptible" to these various devices include chipmunks, coyotes, foxes, ground squirrels, mice, mountain beavers (Aplodontia rufa), opossums, pocket gophers, prairie dogs (Cynomys spp.), rabbits, rats, snakes (Suborder Serpentes), and voles. However, these claims have never been supported with scientific data. Various studies have found these devices to be ineffective against rats, mice, ground squirrels, voles, and pocket gophers (Case et al. 1978, Fitzwater 1978, Byers 1979, Conroy 1980).

As a result of such research findings, EPA took action against manufacturers and distributors of these devices to stop most of their sales in the U.S. on the basis that the devices were ineffective and therefore misbranded (Conroy 1980), although a few of these or similar devices continue to be marketed and new advertisements crop up now and then.

SUMMARY

Frightening methods and devices/stimuli to prevent animal damage are useful for some pest mammal species and are most effectively used where crops need to be protected for a relatively short period such as just prior to harvest. Frightening methods are generally more suitable for protecting small acreages. For nocturnal animals lights as visual stimuli and acoustic stimuli in the form of noisemakers, such as automatic gas exploders or firecracker ropes, offer temporary relief. Combinations of acoustic and visual stimuli work better than either alone. Shooting to harass has merit with some species, particularly deer. Rotating or changing methods every couple of days along with a shifting of positions of the frightening devices will prolong time to habituation.

Ultrasonic, vibrating, and electromagnetic devices as currently available generally lack effectiveness and are of little practical value.

Frightening methods and devices serve best where there are nearby alternative places for the animals to feed and when the methods are employed before the animal becomes conditioned to feeding on the crop, garden, or in the area needing protection. Frightening methods or devices may provide enough immediate relief so that other more permanent or lasting control methods such as trapping or fencing can be initiated. The speed with which most pest mammals habituate to frightening stimuli is the major limitation of this approach, plus the fact that some species (e.g., pocket gophers and moles) are not effectively frightened at all by any of these methods. Although the effectiveness of frightening methods is generally relatively short term, the same can be said of certain other methods of animal damage control, including chemical repellents, and even population reduction, where the voids created are quickly filled with new animals from adjacent areas.

Of the devices and methods available, gas exploders are most often used by growers, followed by lighting of some type, and pyrotechnics (rope firecrackers, rockets, etc.), depending on the pest and the situation. Gunfire, with or without the use of cracker shells, can be very effective and gives immediate results but requires a lot of time and effort, which makes it expensive and often impractical for use beyond a day or two.

ACKNOWLEDGMENTS

Funding was provided by the University of California Sustainable Agriculture Research and Education Program. This paper represents part of a larger project entitled "The evaluation of nonpesticide methods for vertebrate pest control relevant to sustainable agriculture." We wish to express our thanks to Dorothy E. Beadle for editorial assistance, and to Dr. Walter E. Howard for the use of his extensive reference collection.

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