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Excluding Mammals from Airports

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To ensure aircraft safety, it is critical to exclude large mammal species such as deer (*Odocoileus* spp.), feral swine (*Sus scrofa*), and coyotes (*Canis latrans*) from airport environments, as well as to consider thoroughly and carefully all available management methods. Airports are often located on or adjacent to undeveloped land that provides habitat for various species large enough to pose a direct hazard to aircraft. Unoccupied expanses of forage near runways provide deer with sufficient incentive to leave cover and occupy airport lands. Associated risk and tragic collisions have ranked deer as the most hazardous wildlife group to aviation (Dolbeer et al. 2000, DeVault et al. 2011), necessitating the evaluation of appropriate means for excluding them and other medium to large mammals (Dolbeer et al. 2000). Exclusionary fences are the most effective, long-lasting, and straightforward tool for eliminating risks posed by deer and other large mammals at airports; however, these fences can be costly to purchase, erect, and maintain. Fences provide a visual sense of security for airport managers but also can accomplish a measurable and statistically significant level of protection to aircraft at airports (DeVault et al. 2008). A variety of evaluations and experiments have been conducted on fence options. Determining the most appropriate fence for a specific setting to accomplish a desired outcome can be challenging. When reviewing this body of literature, airport managers must consider the level of motivation among deer or other species in the experiment and relate it to their situation. In this chapter we review a variety of fence applications for excluding medium to large mammals and provide recommendations.

Federal Aviation Administration Recommendations

The Federal Aviation Administration (FAA) prepares and circulates advisories on recommended practices to airport operators and safety inspectors. Since 2000, the FAA has disseminated three particular advisories, called CertAlerts, related to fencing strategies for deer (see http://www.faa.gov/airports/airport_safety/certalerts/). The first (No. 01-01; Castellano 2001) established minimum fence standards for excluding deer from airports. Standards specified chain-link fence at least 2.4 m (8 feet) high with 0.6-m (2-foot) outriggers with an unspecified number of strands of barbed wire. Recommendations specify that the fence must also be buried a minimum of 0.6 m (2 feet) and monitored daily. In 2004, recommendations were revised to specify a 3.0-m (10-foot) chain-link fence topped with three strands of barbed wire and a 1.2-m (4-foot) skirt buried in the ground at a 45° angle on the outside of the fence (Castellano 2004).

Research results compiled by the National Wildlife Research Center, which is part of the U.S. Department of Agriculture, Wildlife Services program, prompted the release of CertAlert No. 02-09, stating that alternative electric-fence designs (1.2–1.8 m [4–6 feet] high, 5–9 strands) proved 99% effective in stopping deer

Fig. 5.1. Breaches in airport fencing can allow easy access to the air operations area. From DeVault et al. (2008)

and could be suitable in limited, though unspecified, situations at airports (Castellano 2002). In 2004, an additional CertAlert was released that included all of the above information but specified that gates in fence lines must provide no more than a 15.2-cm (6-inch) gap that could potentially allow access by deer (Castellano 2004). Minimum recommendations provided in the CertAlerts for chain-link fences are appropriate when land managers must virtually eliminate access by medium to large mammals, realizing there is always potential for a break in a fence to occur by uncontrollable causes.

Deer-Strike Statistics

From 1990 through 2009, the FAA received 964 reports of deer–aircraft collisions (i.e., deer strikes)—including white-tailed deer (*O. virginianus;* 879), mule deer (*O. hemionus;* 55), and generic "deer" of undetermined species (30)—with 84% of the strikes resulting in damage (Dolbeer et al. 2011). Reported cost of the strikes was $31.7 million (http://wildlife-mitigation.tc.faa.gov/wildlife/database.aspx). Coyotes are an additional wildlife hazard, resulting in 321 strikes, 22% of which having an adverse effect on aircraft and 9% causing damage (Dolbeer et al. 2011). As populations of deer and feral swine continue to increase (Côté et al. 2004, Ditchkoff and West 2007, respectively) the threat of strikes increases, mandating the exclusion of these mammals from airports.

Physical Abilities

When attempting to exclude or contain an animal, its size, intelligence, and physical ability must be considered (Fitzwater 1972). There are a variety of published studies that evaluate fence designs capable of excluding various-sized wildlife, including small rodents (e.g., Connolly et al. 2009, Honda et al. 2009). Mammals may get past a fence by going over, under, or through it (Fig. 5.1).

When we focus on jumping ability, for example, we find that literature and observations suggest deer are capable of jumping 2.3- to 2.4-m (7.5- to 8-foot) fences (Falk et al. 1978, Sauer 1984) and that fences <3 m (10 feet) high might not be entirely deer proof (Curtis et al. 1994, Kaneene et al. 2002, VerCauteren et al. 2006*a*). Yet documented cases of deer penetrating such fences are scarce in published literature, so researchers sought to verify the true abilities of white-tailed deer by conducting a series of experiments in which they motivated deer to jump progressively higher fences until they would jump no higher (VerCauteren et al. 2010). Deer in their study would not jump a 2.4-m fence, and very few (<10%) would jump 2.1 m (7 feet), suggesting that a 2.4-m fence will contain or exclude most white-tailed deer (VerCauteren et al. 2010). However, incidental observations of deer jumping 2.4-m fences (see Arnold and Verme 1963, Sauer 1984) indicate that a well-constructed and maintained fence of >2.4 m in height is justified where 100% deterrence is required, such as at airports.

Deer are not only adept at jumping barriers but are more likely to maneuver through or under poorly constructed fences (Feldhamer et al. 1986). Black bears (*Ursus americanus*) are proficient climbers and have been documented climbing 1.8-m (6-foot) fences, presenting yet another challenging species to exclude (deCalesta and Cropsey 1978). Coyotes are capable of jumping 1.5-m (5-foot) fences from a standstill and can climb 1.8-m wire-mesh fences (Thompson 1978; Fig. 5.2). Burying fences or installing aprons of wire mesh on fences, as suggested in FAA CertAlerts (Castellano 2001, 2002, 2004), not only reduces potential for burrowing animals digging under a fence, but also minimizes risk of other larger mammalian species entering beneath a fence (Fig. 5.3).

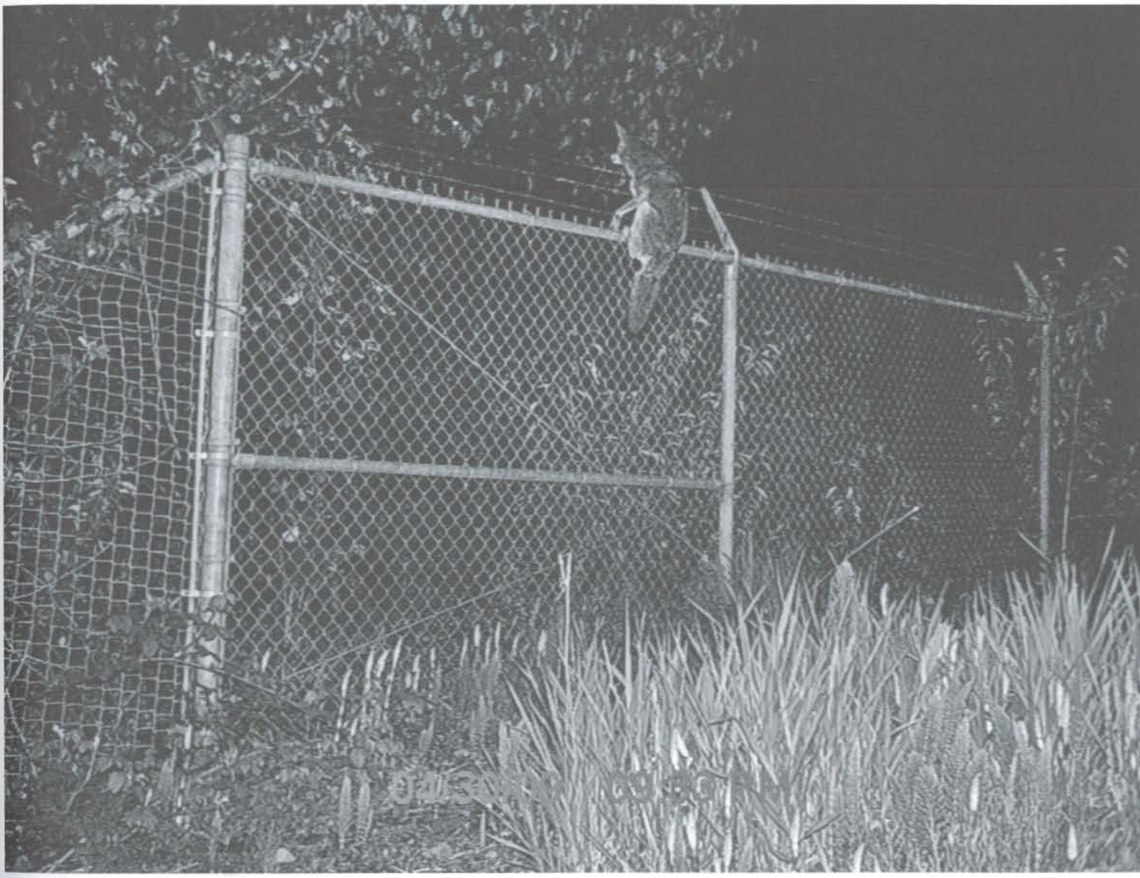

Fig. 5.2. Coyote scaling a fence at a major western U.S. airport. Photo credit: Port of Portland

Openings in fences that appear small enough to impede deer may actually be large enough for motivated deer or other mammals to squeeze through. Adult white-tailed deer were able to pass through a 25.0-cm (10-inch) gap at the bottom of a fence (Falk et al. 1978, Palmer et al. 1985, Feldhamer et al. 1986). Caribou (*Rangifer tarandus*) will also pass through a fence rather than jump, even though they are capable of jumping 2.2 m (7.5 feet; Miller et al. 1972). Coyotes are capable of crawling through 15.2 × 10.2 cm (6 × 4 inch) openings and can walk through 30.5-cm (12-inch) mesh (Thompson 1978). Ward (1982) reported that a 15.0-cm (6-inch) gap under a fence was enough to allow passage by mule deer, and Feldhamer et al. (1986) documented deer in Pennsylvania, USA, passing through 19.0-cm (7.5-inch) openings. Ultimately, a fence must be of sufficient height, tight to the ground or preferably buried, and lack gaps >15.0 cm^2 (2.3 $inches^2$) to ensure exclusion of deer.

Fig. 5.3. Some mammals, including coyotes, can penetrate fencing without a belowground apron by burrowing. From DeVault et al. (2008)

Motivational Factors

Overall efficacy of fences for impeding passage is usually related directly to the associated level of motivation. As such, the more motivated an animal is to penetrate a fence, the more substantial the fence needs to be (Goddard et al. 2001). Deer and other animals stressed by immediate life-or-death situations (e.g., being pursued by a predator) frequently exhibit atypical behaviors and, under certain circumstances, may penetrate a fence that would otherwise deter them (Bryant et al. 1993, Conover 2002, Lavelle et al. 2011). The motivation to vacate lands adjacent to an airport may be unpredictable, supporting the need for robust fence construction in such areas. Complete enclosure of airports is justified, though not all areas (i.e., adjacent to areas with minimal human activity) require the same level of security.

Motivational factors such as seasonal and daily movements, food, and predators (including humans) are important considerations in assessing the efficacy of a fence design. For example, deer collisions with aircraft peak in October and November (Biondi et al. 2011), as do collisions with automobiles, a direct correlation to increased movements associated with the breeding season (Bellis and Graves 1971, Hawkins et al. 1971). Most collisions occur during crepuscular periods when deer activity peaks or at night, when lowered visibility makes deer detection more difficult (Carbaugh et al. 1975, Biondi et al. 2011).

If food is abundant and competition minimal, deer will be less motivated to access resources on the other side of a barrier, suggesting that a less substantial fence design may be adequate and effective (DeNicola et al. 2000), depending on the need and consequences of a breach. For example, under minimal motivation, simple fencing such as a 25-cm single-strand electric fence can be effective in excluding deer (Steger 1988). Deer with slightly more motivation were excluded from a 4-ha melon planting with the use of a four-strand electric fence that was 97.0 cm (3.2 feet) tall, resulting in the producer's first harvestable crop in years (McAninch 1986). Complicating the issue further, individuals competing for food will try harder to penetrate a fence to access food on the other side.

Factors Contributing to Breaches

Habitat adjacent to a fence also influences the level of motivation to breach that fence. Feldhamer et al. (1986) examined the efficacy of two fence designs for excluding deer, including a 2.7-m (9-foot) woven-wire fence and a 2.2-m (7.2-foot) woven-wire fence topped with two additional strands of high-tensile wire along an interstate highway. When adjacent to forested areas, the 2.7-m fence was more effective than the 2.2-m fence, but on nonforested or level ground, efficacy between fences was similar. Deer rarely, if ever, attempted to jump the 2.7-m fence, choosing instead to go under wherever possible.

One difficultly encountered in fence installation is inflexible fence material that cannot follow ground contours, resulting in gaps between the fence and the ground. A single strand of barbed or high-tensile wire strung below a fence can be a simple solution to the problem of gaps (Bryant et al. 1993). Gaps can also be avoided by investing time and money to create a straight and level course for fence installation, improving overall efficacy and visibility of the fence to approaching animals and minimizing damage from falling trees and limbs (Smith 1983, Palmer et al. 1985).

Current recommendations for airport fence construction include the addition of a 1.2-m apron extending underground at a 45° angle on the outside of the fence (Castellano 2004). Ideally, this addition would be made as the fence is being constructed, though it could be added to an existing fence. The addition of an apron will all but eliminate potential for deer, coyotes, and most other medium to large mammals to enter an airport by passing under a fence (Fig. 5.3).

Economics of Fencing

Aircraft strikes with medium to large mammals are costly in terms of damage to equipment and potential for injuries or death to humans (Biondi et al. 2011, DeVault et al. 2011). As a result, it seems sensible to provide maximum protection for all airports. If the presence of medium to large mammals is not acceptable, airports should accept the cost and erect the most substantial fence available. We realize, however, that smaller, noncommercial airports may be financially limited and that erecting a less extensive fence than

recommended by the FAA may be the only option. Consequently, smaller airports often have varying levels of perimeter fencing that reveal vulnerabilities to threats posed by deer and other mammals (DeVault et al. 2008). Although cost ultimately determines which means for exclusion is chosen, construction details are also important. DeVault et al. (2008) documented a situation in which deer followed a fence of suitable height and configuration but of insufficient length. Deer traveled to its end, where they gained access to an airfield and corn that was available on the other side of the runway.

Airports frequently cover large expanses of land, oftentimes requiring the installation of kilometers of fence. The relationships between size and shape of the area being fenced, and how they affect total costs, should also be considered (VerCauteren et al. 2006*a*). Larger areas are more cost-effective (lower cost per unit area) to fence than smaller areas, because as the perimeter length increases, the area enclosed increases to a greater degree (Brenneman 1983, McAninch 1986). Further, square areas are more cost-effective to enclose than elongated or oddly shaped areas of the same size.

When weighing the merits of installing a fence to control deer damage to crops, the cost relative to the fence's potential savings should be considered. Until recently, efforts to manage wildlife damage have rarely been evaluated economically (Caughley 1977, Dyer and Ward 1977, Caslick and Decker 1979, Dolbeer 1988, Blackwell et al. 2003). Researchers have placed more emphasis on determining statistical significance of experiments than on evaluating economic significance (Dillon 1977). Yet economic modeling of systems related to risks posed by wildlife is worthwhile and important in considering management strategies (VerCauteren et al. 2002). In situations where economic benefit can be quantified, economic models can facilitate selection of fence type to be used (VerCauteren et al. 2006*b*). Net present values can be used to determine which type of fence, if any, would be cost-effective. Net present values compare the value of a dollar today to its value in the future and is an efficient way to measure benefits and costs that accrue over the lifetime of a particular fence design. A model on fence selection related to deer damage provides users with tools to make informed decisions regarding fencing options (VerCauteren et al. 2006*b*). This best fence selection model provides economic analyses and predicts the economic outcomes relative to the area and perimeter of the protected area, value of the resource being protected, cost, life span, and efficacy of the fence. The model can increase user awareness regarding how parameters such as efficacy or life span fluctuate with varying level of financial investment, and it may provide insight for airport managers tasked with selecting the best fence for the situation.

Although all fences require regular maintenance to remain effective, inexpensive fences like the baited electric version require additional maintenance in application of attractants or repellents. A less expensive fence may require more maintenance and may not last as long as a fence that requires a higher initial investment (Byrne 1989). Current FAA recommendations specify the need for daily fence checks to eliminate the possibility of allowing access to airports, and appropriate labor estimates should be incorporated into predicted budgets for fencing applications.

Fence Options

Fences exclude or contain animals by providing a physical barrier, a psychological barrier (via behavioral conditioning), or a combination of both. Fences such as woven wire present a physical barrier that prevents animals from passing over, through, or under. Conversely, a two-strand electric polytape fence provides a minimal physical barrier but acts as a psychological barrier by delivering negative stimuli (shock) upon contact (McKillop and Sibly 1988, Curtis et al. 1994). Other fences, like electric 15-strand high-tensile wire, function by combining both effects. Traditionally, fences of wire-mesh construction were used for excluding or containing deer and other mammals. More recently, electric fences consisting of multiple strands of high-tensile steel wire or polyrope have gained popularity, as associated costs and labor are lower than traditional wire-mesh fences (VerCauteren et al. 2006*a*; Fig. 5.4). They require additional vigilance and maintenance, however.

Temporary Fences

Although many fences are erected as long-term installations—providing protection for >30 years with reg-

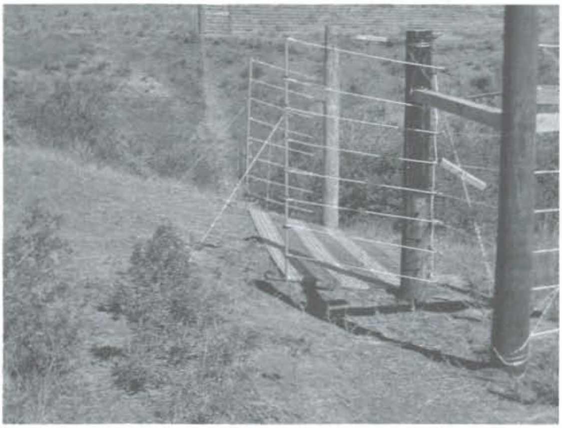

Fig. 5.4. **Novel fencing designs include electrified polyrope and electrified mats that allow the passage of vehicles through gates but deter mammals.** Photo credit: Kurt C. VerCauteren

ular maintenance—risk of damage is often seasonal, related to periodic factors such as migration, accessing preferred foods (Flyger and Thoerig 1962), and breeding season (Marsh et al. 1990). In situations when year-round protection may not be deemed necessary, a variety of temporary fence designs, such as polytape and polypropylene snow fence, may be sufficient. When protecting particular agricultural resources (e.g., ripening crops, orchards, etc.), the need for protection may be only temporary. Though surely limited, there may be airports where only seasonal protection is needed (e.g., migrating caribou herds), and temporary fences might fulfill that need.

Temporary fences may be less expensive, but they are also less durable and less effective than permanent fences and may be prone to damage and degradation. Temporary fences are typically lightweight (i.e., polypropylene, nylon) and often erected using posts that do not involve digging and can be installed with handheld post pounders. Steel T-posts or fiberglass posts are sufficient for most temporary fence installations.

Electric Fences

Although other types of fences physically keep wildlife out of airports, electric fences typically rely on behavioral conditioning by delivering a shock to animals attempting to breach them (Porter 1983, McKillop and Sibly 1988, Curtis et al. 1994, Leblond et al. 2007). At airports where deer densities and motivation to enter are minimal and smaller mammals are not a concern, electric fences may be entirely adequate, though they have limitations. Electric multistrand, high-tensile wire or electric polyrope fences are comparably priced at $4 to $13/m ($1 to $4/foot) installed (Seamans and VerCauteren 2006) but are typically less effective than wire-mesh fences because their deterrence relies solely upon delivery of negative stimuli (McKillop and Sibley 1988).

For electric fences, two general rules apply: first, erect them before animals are in the habit of entering the area (Wilson 1993, Craven and Hygnstrom 1994, Curtis et al. 1994) and second, keep the fence electrified. If a fence loses power, animals like deer will be quick to penetrate it (Ward 1982, Clevenger et al. 2001, Conover 2002, Poole et al. 2004). Additionally, failure-detection devices should be incorporated into electric fence systems to minimize potential for breaches and to allow for prompt repairs (Leblond et al. 2007). Other factors should be taken into account when considering the use of electric fences, including voltage requirements, charge configuration, fence configuration, seasonal fences, and attractants. For successful deer control, high-tensile wire and polytype materials should carry a minimum charge of 3,000 V (Matschke et al. 1984, Duffy et al. 1988, Curtis et al. 1994). Fence design should reflect the size of target species to ensure wire spacing is sufficient to deliver adequate charge to offending animals, such as strand spacing no greater than 15.2 cm for deer. Also, electric fences are most effective when target individuals approach calmly and slowly, receiving a significant shock that prompts retreat. Fences that allow wildlife to approach with the momentum to carry them through the barrier are not as effective (McKillop and Sibley 1988).

Various materials are available for constructing electric fences. The most durable and longest-lasting option is high-tensile strength, smooth steel wire and is commonly available in 12.5-gauge natural galvanized and green colorations. Such fences have been used to contain and exclude large mammals in New Zealand for nearly 40 years (Byrne 1989). Numerous field trials have shown that they have nearly eliminated passage by deer (Tierson 1969, Brenneman 1982, Palmer et al. 1985). Craven and Hygnstrom (1994) reported slanted and upright high-tensile fences to be suitable for pro-

tection of orchards, large vegetable gardens, and other fields under moderate to high deer pressure, whereas the offset electric may only be suitable for smaller fields (<1.6 ha) under moderate deer pressure. Average costs of materials to construct a high-tensile electric fence range from \$2 to \$5/m (\$0.6 to \$1.5/foot). Proper maintenance requires frequent inspection, seasonal tensioning of wire, and suppression of vegetation. Electric high-tensile fences may not offer the same security as wire-mesh fences of comparable height, but they can be less expensive. Fallen trees, for example, will occasionally compromise a fence, but the elasticity of high-tensile wires often keeps them from breaking, and they often spring back into place once trees are removed (Brenneman 1983). Although cost and characteristics may be appealing, when 100% exclusion is necessary, these fences should not be considered.

The integration of petroleum-derived woven materials (primarily polypropylene) and strands of conductive metal wires has revolutionized the fencing industry. Polyrope, polywire, polytape, and polynet fences are widely available and appropriate for a variety of applications. Polyrope, such as that developed by ElectroBraid Fence Ltd. (Yarmouth, Nova Scotia, Canada; see also Seamans and VerCauteren 2006), is now an acceptable option in some airport environments and can be installed closer to areas of aircraft movement than traditional wire-mesh fences (Castellano 2002). These polyfence options are particularly appealing over wire options because of their easier construction, teardown, and storage if only used seasonally, as well as their high visibility and potentially increased efficacy against approaching wildlife, which may minimize animal–fence collisions (Hygnstrom and Craven 1988). Additionally, electric fences of polyrope construction can significantly reduce movements by moose (*Alces alces*; Leblond et al. 2007) and feral swine (Reidy et al. 2010), though they are by no means impenetrable. Managers can minimize problems with vegetation shorting-out these fences by using low-impedance energizers or by running positive and negative charges on alternating strands.

Wire-Mesh Fences

In general, fences of wire-mesh construction are installed with the expectation of a long and effective life span (Isleib 1995). This is often exactly what is needed in an airport setting, and so woven-wire mesh fence designs are well suited. Areas requiring high security (i.e., airports and correctional facilities) necessitate substantial fence heights in excess of 2.4 m, which are available in various wire-mesh construction, including woven wire, chain link, and V-mesh, but these options are not created equal. Wire-mesh materials vary in weight, durability, expected life span, ease of construction, and cost. Woven-wire fence was favored by survey respondents in Michigan and Wisconsin and considered very effective for excluding deer from crops (Isleib 1995). Quality wire-mesh fence materials cost \$10 to >\$20/m (\$3 to >\$6/foot) and can last >30 years (Curtis et al. 1994).

Chain link is frequently the material of choice for airport installations. As such, recommendations for airports mainly emphasize use of chain-link fence of 2.4 m topped by additional fence materials or 3.05 m in height. Chain link is typically perceived as providing the highest-level security with minimally spaced mesh, enabling it to be effective in excluding all but smaller mammals.

Other wire-mesh fence designs similar to chain link include high-tensile woven wire, welded-wire mesh, and V-mesh. Each material has advantages and disadvantages, but for airports that need to exclude animals from the size of fox to moose, chain-link fencing is the most desirable fencing material. Woven-wire mesh is typically less expensive and easier to install than chain link, but its larger mesh spacing also makes it less effective for excluding young animals (Lavelle et al. 2011). Likewise, wire-mesh fence is commonly used to minimize wildlife–vehicle collisions along busy highways within migration corridors. A 2.4-m wire-mesh fence along highways can be effective in reducing wildlife collisions, especially when used in conjunction with alternate routes of passage that allowed for continued movement while minimizing motivation to breach a fence (Ward 1982, Lehnert and Bissonette 1997, Clevenger et al. 2001).

Gates

Traditional hinged gates constructed of materials at least as stout and tall as adjoining fence lines provide comparable levels of protection; however, in high-

traffic areas they may not be practical. In low-traffic areas, gates may be considered a nuisance and are potentially left open, creating risk by allowing entry by wildlife (Seamans 2001). Open gates are often the cause for animals ending up where they should not be (Van Noord 2000). Alternatives to traditional gates are being developed and tested, both with scientific rigor and in ongoing management practices (Bashore and Bellis 1982, Seamans and Helon 2008, VerCauteren et al. 2009). Means to allow easy access by vehicles and machinery while effectively preventing passage of medium to large mammals are needed. VerCauteren et al. (2009) compared commercially available Bump-gates, novel deer guards (multiple conveyors placed over a pit 0.4 m [1.3 feet] deep), and unprotected plots, and demonstrated that alternatives to traditional gates exist; however, these alternatives may not be suitable for high-security applications where any entries are unacceptable. Reed et al. (2007) tested modified cattle guards that were 3.7 m (12 feet), 5.5 m (18 feet), and 7.3 m (24 feet) long for controlling movements of deer, with little success (16 of 18 deer monitored successfully crossed the guard). Peterson et al. (2003) also evaluated three designs of deer guards and found bridge grating to be 99% effective at excluding Key deer (*O. v. clavium*). Belant et al. (1998) developed a design with round tubing and successfully excluded >88% of deer, compared to pretreatment crossings. Seamans and Helon (2008) evaluated the use of experimental electric mats (Fig. 5.4) as an alternative to gates and found them to be 95% effective. At airports, bridge grates or electric mats in conjunction with hinged gates that are closed during times of low traffic volume may be excellent options.

Gates are not only necessary to eliminate passage by medium to large mammals into or out of an area, they may play an important role in allowing them to exit an area from which they were intended to be excluded. Managers should proactively prepare for unforeseen occurrences where animals inadvertently access airports. One way is to construct devices (i.e., one-way gates, earthen escape ramps) that allow animals that entered to exit on their own without human intervention. For example, one-way gates, constructed of a funnel-like assemblage of metal tines, were developed and evaluated for allowing deer to exit highway rights-of-way (D'Angelo et al. 2007, Reed et al. 2007). Although they may be only occasionally effective, they are routinely used in large fence installations. In comparing one-way gates to earthen escape ramps, ramps were roughly ten times more effective in enabling deer to exit highway rights-of-way (Bissonette and Hammer 2000). Stull et al. (2011) found woven-wire fence topped with outriggers angled away from the protected area acted as one-way barriers allowing animals to exit easier than entering.

Summary

Of all available methods for alleviating potential risk of aircraft–mammal collisions at airports, exclusionary fencing is the most straightforward, effective, recommended, and most used. Even so, costs for supplies, construction, and maintenance can seem prohibitive. When considering the level of security needed to exclude deer and other mammals from airports, managers must ask, is anything short of 100% exclusion acceptable? When human lives are at stake, erecting one of the many effective varieties of exclusionary fencing is imperative. Selection of appropriate fence materials should involve consideration of multiple factors, including level of acceptable risk, maximum potential levels of motivation of deer and other mammals to breach, surrounding habitat types, seasonality of hazards, and costs (both in supplies and labor for the life span of the fence). Although erecting and maintaining an exclusionary fence may seem like the complete solution to medium and large mammal–related hazards at airports, management of these hazards should allow for additional strategies to be implemented as needed. Population management strategies (Chapter 7) may be necessary on adjacent lands to minimize pressure for animals to enter airport properties. Additionally, plans for use of frightening devices and lethal management tools should be established in the event of a fence breach. Any technique can fail, so mitigation measures must be immediately available to minimize potential for disaster.

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