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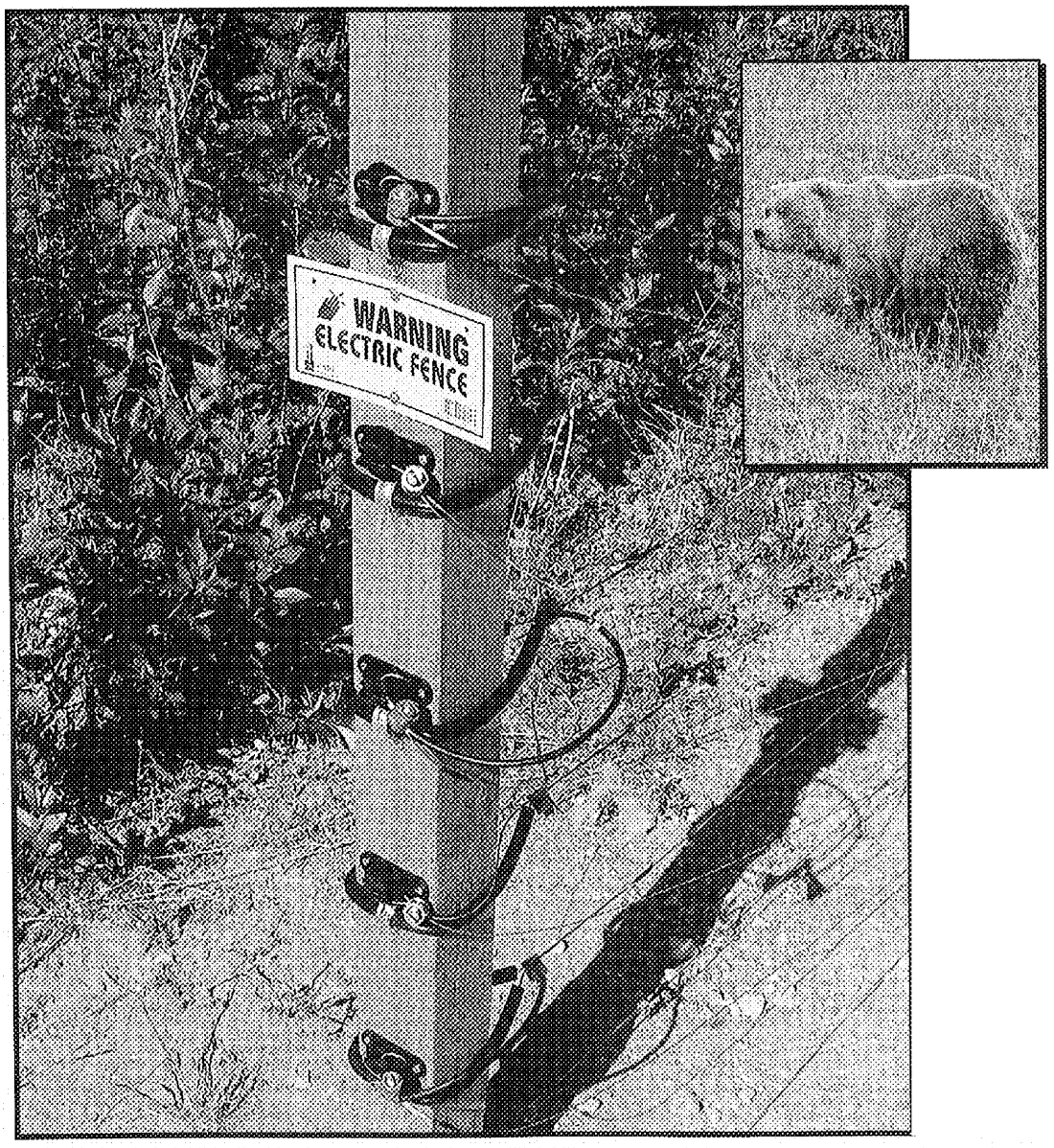
Deterring Bears from Work Areas and Facilities

Tim Craig



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Cover Photo

Close-up of alternating wires on bear safety fence installed at Seven Mile Administrative Site, Dalton Highway, Alaska.

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ABSTRACT

Bears are an important component of Alaska's ecosystems and are greatly valued by the public. Nonetheless, every year people and bears come into conflicts that sometimes result in injury or death. It is incumbent upon public employees to attempt to avoid these incidents. The Bureau of Land Management's Northern Field Office oversees more than 60 million acres of land in 5 administrative units in interior Alaska. Bears inhabit almost this entire area. Because land management activities require BLM personnel to spend time in remote areas of interior Alaska, it is necessary for them to exercise practices that deter bears from permanent and temporary work areas and campsites. This document describes practical techniques to secure such areas to help avoid confrontations between BLM employees and bears.

Author's note: Nonmetric units of measurement have been used throughout this report except where cited references utilized metric (SI) units. In these cases, approximate conversions to nonmetric units appear in brackets.

ACKNOWLEDGMENTS

Most of the information contained in this document was synthesized from material produced by other agencies. In particular we wish to acknowledge the following individuals, who shared information with us during preparation of this publication: Dick Shideler, Wildlife Conservation Division, Alaska Department of Fish and Game; Tom Smith, Biological Resources Division, USGS, Anchorage, Alaska; Eric Follmann, University of Alaska, Fairbanks, Alaska; Tom Hawkins, Region 6, US Forest Service; C. R. Wenger, Region 4, US Forest Service; and Mike Madel, Montana Department of Fish, Wildlife and Parks, Missoula, Montana. Dick Shideler reviewed an earlier version of this manuscript.

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INTRODUCTION

Every year bears and humans clash in Alaska. These clashes, whether they involve competition for hunter-killed big game animals or damage to cabins, often result in financial costs and the injury or deaths of humans and bears. Between 1985 and 1996 over 1000 bears were destroyed in Defense of Life and Property instances in Alaska (Tom Smith, USGS, written comm.). As human presence in bear habitat increases in Alaska, clashes between bears and humans can be expected to increase as well. Bears are still found throughout Alaska, but recent declines in brown bear populations on the Kenai Peninsula (Schwartz et al. 1999) show that even in Alaska, increased human use of bears or their habitat can jeopardize the continued health of the species.

The public is highly interested in conservation of bear populations. Brown bears in particular are valued for wildlife observation (Titus et al. 1999) and for the perception that the species typifies wilderness (Gard 1971). Sighting a bear of any kind is a high point for visitors to Alaska (Albert et al. 2001). Because of the public's interest in bears as a natural part of the Alaska biome, it is important that BLM employees endeavor to avoid confrontations that may result in the destruction of bears.

Several bear–human interactions were reported in 2001 on Bureau of Land Management (BLM) lands administered by the Northern Field Office. During the fire season black bears boldly threatened Alaska Fire Service personnel on 3 separate occasions, causing the relocation of a small fire camp at one site. Later in the summer, construction inspectors shot and killed a black bear as it ransacked their camp trailer. In the fall, a brown bear clawed its way through the wall of a BLM cabin at the Seven Mile Administrative Site on the Dalton Highway. Once inside, the bear did over $4000 of damage.

The following series of options can help BLM personnel to reduce the number of adverse bear–human incidents around facilities and remote work areas. It must be stated at the outset of this discussion that bears are individualistic and possess varying degrees of persistence and ingenuity. Factors that can affect bear–human interactions include: 1) individual experience and success in obtaining human food elsewhere; 2) seasonal availability of natural foods; and 3) local shortage of natural foods, e.g., a berry crop failure. As a result, these recommendations, even if implemented properly, may not eliminate all bear–human interactions. Furthermore, it must be stressed that education and safe storage of food and garbage should always be a primary consideration in preventing bear–human incidents.

PERMANENT FENCES

One way to reduce adverse bear–human interactions around facilities is to construct permanent bear-resistant fences around living, cooking and working quarters. The initial cost of these fences is high and they are not aesthetically pleasing. Nonetheless, the amortized expense is considerably less than other options because the life of the fence is long and maintenance costs are low.

Chain link. One of the best materials to use for a bear-resistant fence is chain link. Follmann and Hechtel (1990) recommend the use of such fences, based on experiences spanning several years during construction and subsequent use of the Trans-Alaska Pipeline.

These authors specify a 2.4 m [~ 8 ft] high fence with an overhanging "barb arm" that is set at an oblique angle to the fence and holds 3 separated

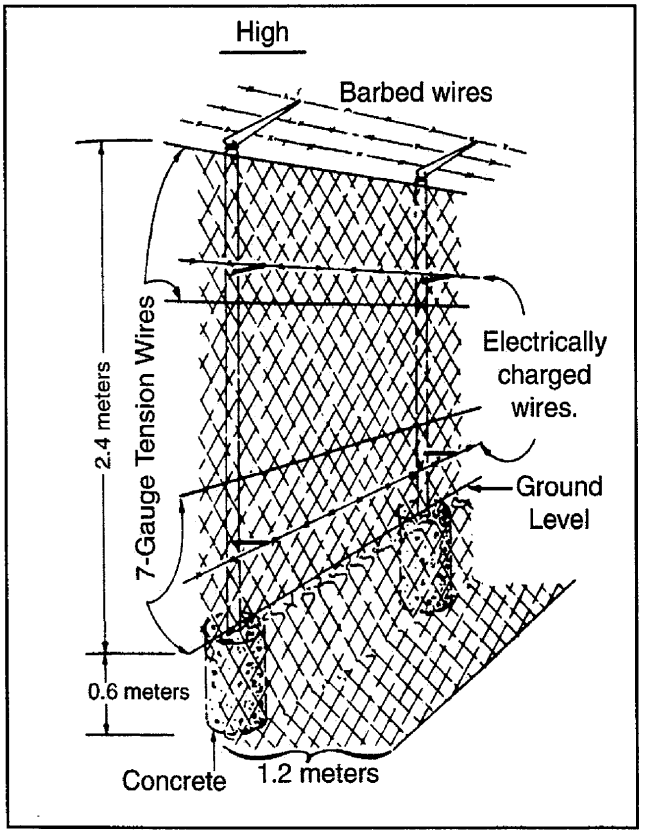

Figure 1. Oblique view of animal deterrent fence. (Follman and Hechtel 1990)

strands of barbed wire (Fig. 1). In addition to the above-ground fence, their design incorporates an apron of buried chain link on the outside of the structure to prevent bears from digging under the fence. This apron should be about 1.2 m [~ 4 ft] wide and be constructed of an "L"-shaped piece of chain link that is 1.8 m [~ 6 ft] wide. One side of the "L" is attached to the bottom of the above-ground portion of the fence at ground level, while the rest descends vertically into the ground 0.6 m [~ 2 ft], then bends 90 degrees outward, forming a buried apron of chain link 1.2 m [~ 4 ft] wide under the ground.

Where a more secure fence is desired, or where a non-electric chain-link barrier fence has not been effective in deterring bears, two strands of electrified high-tensile- strength wire can be added to the outside of the fence by means of outriggers at 0.3 m [~1 ft] and 1.5 m [~ 5 ft 9 inches] above ground. Alternatively, a second, freestanding electric fence may be erected beyond the existing chain-link fence. In this case, the electric fence should be placed near enough the chain-link fence to ensure that the bear touches both the electric and the grounding chain-link fences simultaneously.

It is important to consider soil type when erecting any permanent fence. In some areas the heaving action of frozen soils may expel posts by a process known as "frost-jacking." Where this problem is anticipated, special precautions should be exercised in installing fence posts.

Electric fences. Electric fences have been used for decades to deter bears, including black, brown, and other species, from entering facilities (Davies and Rockwell 1986) and from raiding agricultural crops (Storer et al. 1938; cited in Huygens and Hayashi 1999, original not seen). Electric fences that are placed around facilities have the added benefit of carrying the message, "You are in bear country" — a reminder to people to use caution when working in the area, disposing of garbage, or storing food. Properly constructed electric fences have proven very effective in deterring bears from permanent facilities; failures have usually resulted from improper maintenance. However, bears' thick fur and broad, leathery footpads make them poor conductors of electricity, so it is important to design the fence specifically to deter bears (Dick Shideler, Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.).

Various permanent electric fence configurations have been used with success for both black and brown bears. Huygens and Hayashi (1999) used

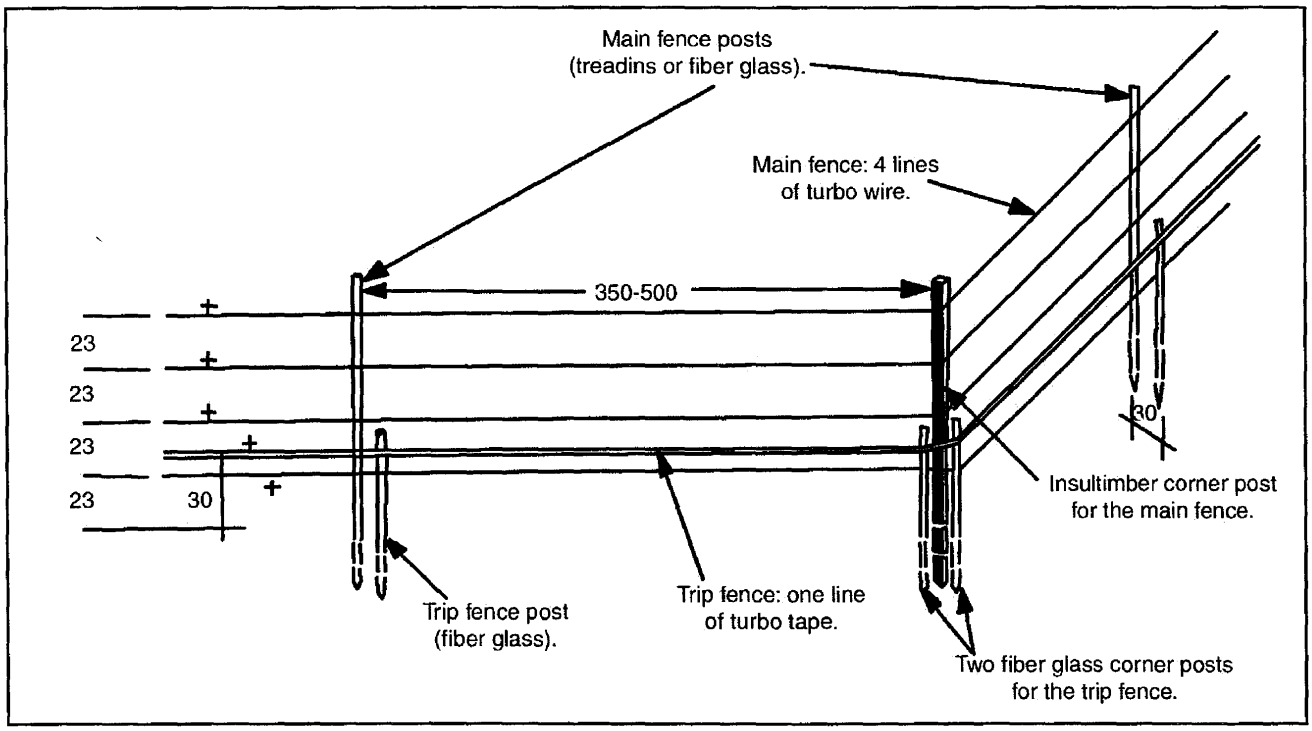

Figure 2. Design of a typical electric fence used to protect crops and apiaries from Asiatic black bear depredation in Nagano Prefecture, central Japan, in 1997 and 1998. All lines were positively charged (+). All units in cm. (Huygens and Hayashi 1999)

electric fences to keep Asiatic black bears *(Ursus thibetanus)* away from sweet corn fields in Japan (Fig. 2). These researchers constructed fences using 4 electro-plastic or "polywires" (woven plastic and stainless steel wire) set about 9 inches apart. The total fence height was about 3 feet from the ground. A fifth line, called a "trip fence," was placed outside of the enclosure about 12 inches in front of the main fence. Wide plastic webbing [~1/2 to 1 1/2 inches wide] with stainless steel wires woven into the fabric was used for this conductor. All of the conductors (wires) were white to increase visibility. The fence was held up by Gallagher™ Insultimber corner posts (Gallagher Power Fence Systems, New Zealand) and fiberglass line posts.

Because the above study took place in an agricultural area where soils were moist, all of the fence wires were positive conductors. However, the dry, gravely, or frozen soils common to Alaska are a poor conducting media and require a different fence configuration. Smith (1995) suggests that in these areas a permanent electric fence should be comprised of 8 wires with alternating ground and hot wires. The bottom wire should be a ground wire, and wire spacing up the fence should be at 2, 8, 14, 20, 28, 36, 44, and 54 inches as measured from the ground. The arrangement of alternating ground and hot wires ensures that when a bear pushes through the fence, the animal will simultaneously touch both a positive and a ground wire. Like-charged conductors should be connected together at each corner of the fence. Light, fiberglass poles can be used for line posts, but larger diameter fiberglass or treated wooden posts should be used for corners. Corner posts must be set at least 3 feet in the ground and adequately braced to withstand the strain of the tension placed on the conducting wires (Fig. 3). Others have suggested the use of high-tensile-strength, smooth stainless steel wires (12.5 gage) that are tensioned to between 200 and 250 lbs (Dick Shideler, Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.). The stainless steel wires are longer-lasting than polywires, and tight wires more effectively push into the bear's fur as the animal strains against the fence.

"Jumpers" and "climbers" should be anticipated. Fences must be constructed so bears do not have "takeoff" points (elevated spots from which to jump). If trees are used as posts, conductors should be placed on the outside of the tree trunk to preclude bears climbing the tree and jumping into the compound (Dick Shideler, Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.). Barbed wire is not recommended on these fences because jumping and climbing bears can get caught up in the wire and pull down the entire fence with their weight. Bears investigate low spots in a fence, so particular attention must be paid to construction and maintenance of fences at these locations.

A perforated, metal can of oozing sardines can be attached to a positive conductor on the fence to ensure that a stubborn bear's first experience with an electric fence is unpleasant (Smith 1995). However, because it is unwise to attract bears to a facility with food, this tactic should only be attempted after bears have become a nuisance in the area and after checking with state and/or federal regulations, which may preclude this aversive training.

TEMPORARY FENCES

The most effective method to deter bears around temporary facilities is the electric fence. Such fences have effectively protected people and property from both black and brown bears at remote camps and work sites.

Temporary electric fences have been used with great success along the Rogue River, a National Wild and Scenic River in Oregon, to prevent black bears from consuming food brought on recreational float trips (Tom Hawkins, US Forest Service, pers. comm.). There, the US Forest Service seasonally erects and maintains several 12 ft by 12 ft, electric-fenced enclosures along the river. These enclosures are about 40 inches high and are comprised of 6 strands of white, electro-plastic wire spaced 6 inches apart. Positive and ground wires alternate up the fence. The substrate along the river is rocky. Nevertheless, because the water table is high, only a single, 2-foot-long grounding stake is required. In locations where ground rods can't be driven into the ground, they are buried horizontally in hand-dug trenches. Freestanding posts made of plastic pipe mounted on round metal bases are used where enclosures are located on solid rock.

Similarly, biologists for the Salmon National Forest in Idaho have successfully used electric fences to deter black bears around campsites. They used a minimum of 4 smooth wires stretched tight and placed no more than 10 inches apart (C. R. Wenger, US Forest Service, pers. comm.). Again,

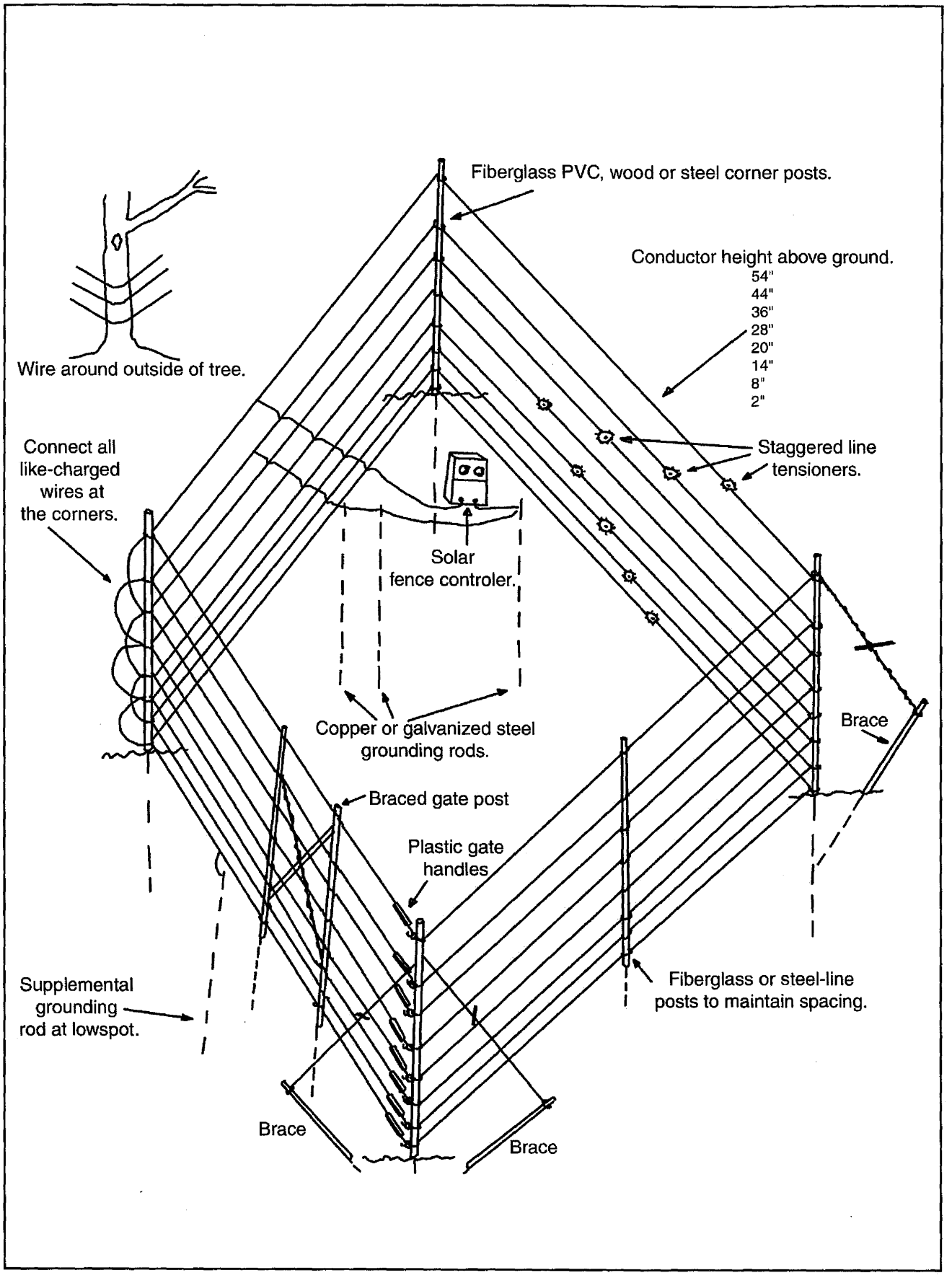

Figure 3. Schematic of electric fence designed to deter bears.

this configuration necessitated good corner bracing and an adequate number of line posts to maintain the wire spacing between spans.

While the above agencies and others (Gard 1971) have found that fewer wires can effectively deter bears, authorities in Alaska recommend using 7 conductors (Dick Shideler, Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.). These fences should have alternating positive–negative conductors of smooth steel or polywire. Alternatively, aircraft cable has also been successfully used as a conductor. The cable is stiffer and heavier than polywire but more durable. Any of these fences can be assembled in town and rolled up for easier transportation and setup at field locations.

Regardless of the material used, the top conductor should be placed at least 48 inches above the ground. It can be made of electro-plastic ribbon to increase visibility. The conductors for this fence are recommended to be at 2, 8, 14, 22, 30, 38, and 48 inches above the ground. The lowest wire should be a ground wire, which can contact the soil if necessary. Again, the wires should be tensioned adequately to avoid shorts and to make a good connection in the fur of any animal pushing its head between the conductors.

The special "Food Storage Order" issued for federal lands in the Northern Continental Divide Grizzly Bear Ecosystem (Special Order No. F10-016L98; USDA, Forest Service, Missoula Montana) describes electric fence systems that meet agency requirements for the storage of bear attractants like horse feed and human food. The specifications for these temporary fences are similar to those recommended by the Alaska Department of Fish and Game as discussed above (48-inch-high fence, 7 conductors, alternating polarity). However, there is one notable difference: the order requires that the top two wires both be positively charged. The order further specifies that the wires (either smooth steel wires or polywires containing at least 6 strands of stainless steel wire) should be 6 to 10 inches apart and that the bottom ground wire should be no more than 2 inches off the ground.

GENERAL CONSIDERATIONS

Conductors. Electro-plastic (polywire) conductors, which are adequate for temporary fences, come in a variety of configurations, including ribbons or tapes of different widths and round "wires" of varying thicknesses and strengths. These conductors also come in different colors, such as high-visibility white and orange. The advantages of polywire conductors over high-tensile-strength steel wire include high visibility, elasticity, and light weight, a consideration where remote, fly-in camps are to be protected. However, most authorities recommend the use of high-tensile-strength 12.5-gage wire because it can be tensioned adequately and is resistant to environmental degradation.

While alternating polarity is the best configuration for most applications, Smith (1995) suggests that where a temporary fence is located in a good grounding area (e.g., a moist soil area) all of the conductors may be positive.

Posts. Temporary fences can be suspended from a variety of post types, including plastic, fiberglass, or steel. However, if steel posts are used, special attention must be paid to maintenance to avoid grounding the system; even songbird droppings can circumvent the insulator and ground the conductors to the steel posts. Regardless of post type, the corners must be braced to withstand the stress of tensioning the wires, and line posts should be placed so as to maintain fence height and spacing (sometimes as close as 8 feet apart). Smith (1995) indicates that on portable systems, "wand"-type fiberglass poles that are just under 1/2 inch in diameter and about 5 ft long may be spaced between 15 to 25 ft apart. He suggests the use of screw-on plastic insulators on these small poles. On bigger diameter fiberglass poles (2" diameter) or wood posts used for corners, he specifies the use of pin lock insulators. In any event, where trees are used as posts, the wires should run around the outside of the trunk so that bears cannot climb the trees and jump down into the compound.

Yukon Flats National Wildlife Refuge uses 4 or 5 strands of polywire to construct bear-proof fences at campsites. Refuge workers suspend the conductors from posts made of light conduit and from trees to which they nail insulators. In some places they have even used duct tape to attach the conductors to willows (Perry Grissom, pers. comm.).

Grounding. Nearly every authority has identified grounding as the single most important part of a properly constructed electric fence. Where soil moisture is adequate, grounding for a temporary fence can be accomplished with as little as 2 ft of galvanized steel rod buried in the ground. However, where the

ground is dry, rocky, or frozen, grounding the fence can be a challenging problem. Precautions must be taken to adequately ground each fence in anticipation of the range of environmental conditions that might be encountered throughout the season. Dick Shideler (Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.) and Smith (1995) both suggest locating ground rods at low spots in the fence, where they are most likely to be nearest the water table in all seasonal conditions.

A minimum of three 1.6 cm [5/8 inch] galvanized steel or copper grounding rods are suggested for most permanent fences. All three rods should be driven into the ground to a depth of 2.4 m [8 ft], placed about 3 m [10 ft] apart, and connected to each other with 12.5-gage wire and ground clamps. If it is not possible to drive the rods in vertically, they can be laid horizontally in trenches dug 2 ft deep. It is important to use special grounding clamps when connecting wires to the grounding rods, so that the metals bite into each other, resulting in a good connection. It is also important to ground the fence and controller separately.

Where it is necessary to build a fence around a large camp or facility, multiple ground rods should be placed along the fence at intervals. Different authorities have suggested different distances at which these rods should be placed, varying from every 150 m [492 ft] (Smith 1995) to every 307 m [1000 ft] (Dick Shideler, Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.). However, it should be remembered that generally "more is better" when it comes to grounding electric fences. In any event, each rod should be connected to every negative conductor. Where soil moisture allows the use of all positively-charged conductors, a separate wire can be run from the negative terminal on the controller along the ground to the ground rod(s).

Gates. Smith (1995) points out that gates are often the weak point in fence designs because they must be secure enough to block bears but still allow people easy entry. He suggests swinging gates with attached outriggers of electric wire for wide openings (e.g., vehicle gates) and spring-handled gates (plastic or no-carbon rubber handles) for temporary or small gates. On the Rogue River, the US Forest Service uses simple wire gates with individual, spring-loaded plastic handles hooked on each conductor (Tom Hawkins, Region 6, US Forest Service, pers. comm.). They also install a switch outside of the fence so the electricity to the gate can be shut off while it is opened.

In 2001 the BLM Alaska Fire Service constructed an electric fence around the Seven Mile Administrative Site facility on the Dalton Highway (Fig. 4). The gate was constructed by stretching the conductors across the gate opening to a single, fiberglass rod. This rod was in turn connected to the gatepost on the opposite side of the gate with two wire "bails," one at the top and one at the bottom of the fence (Fig. 5). To open this gate, the fiberglass rod is tensioned, the top bail lifted off, and the entire gate pulled up out of the bottom bail and opened.

Where continuous access to an area is necessary, for instance at landfills, an electrified cattle guard can be used (Smith 1995). The cattle guard is constructed of Schedule 40 steel pipes, placed side by side 9 inches apart (center to center) and laid on wood cribbing. The wood cribbing in turn rests on dry gravel, which acts as an insulator. The total width of the guard should be 2 m [6.6 ft]. This gate requires a more powerful charger than other bear-

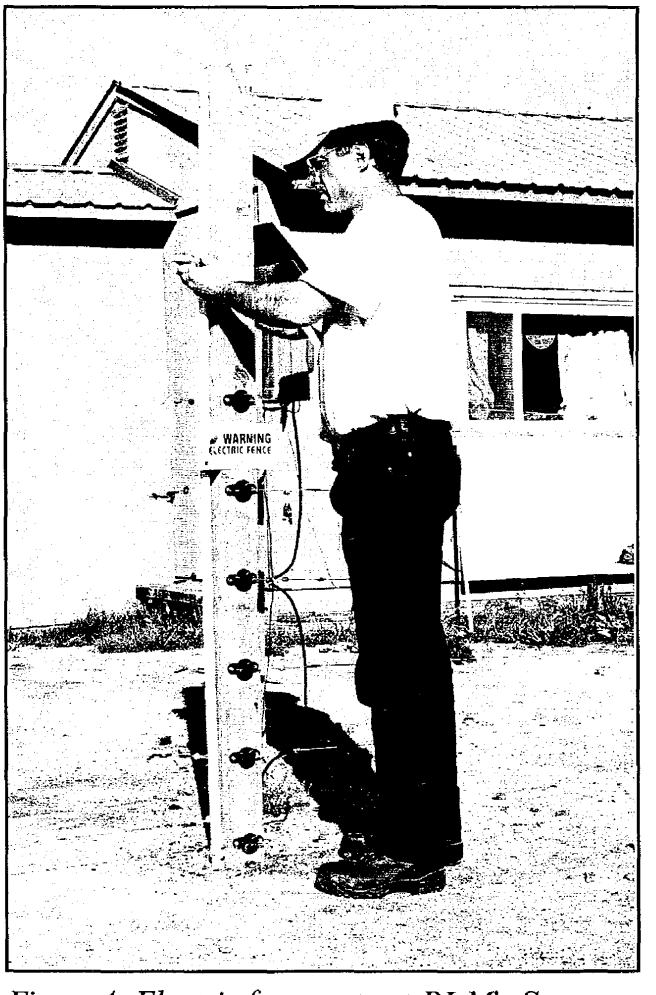

Figure 4. Electric fence gate at BLM's Seven Mile Administration Site.

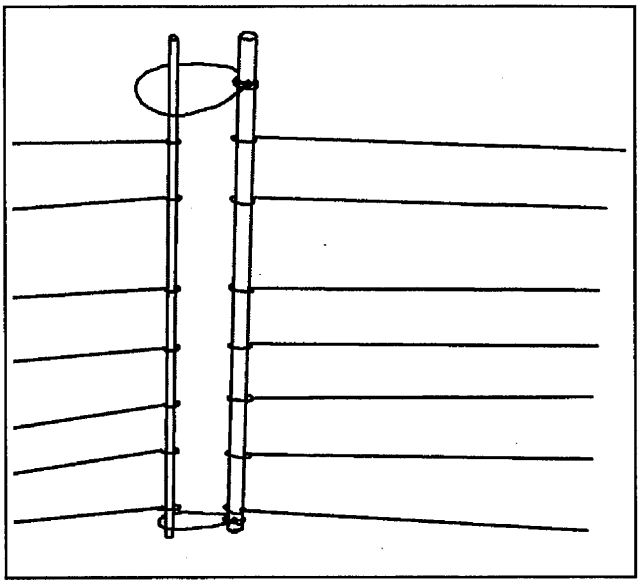

Figure 5. Schematic of suggested electric fence gate.

deterring fences, and "wings" of electric fence should be constructed on each side of the guard to prevent bears from crossing where the side fence and cattle guard meet.

Fence controllers. Solar panels, rechargeable batteries and AC/DC chargers (ones that convert household AC current to DC current) can be used to power controllers to deter bears. Most fence manufacturers recommend using line current where possible. With line current the shape of the charge and consistent voltage provide more effective results when a bear contacts the fence, and there are no concerns about discharging batteries. All authorities stressed the importance of placing chargers, solar panels, and/or batteries inside the fenced area so bears cannot disrupt the power source.

Several different makes of fence controllers (or chargers) can be used to deter bears. Comparison of the relative effectiveness of fence controllers is difficult because manufacturers measure the power their controllers produce in two different ways. Some manufacturers advertise the power of their products by listing the number of volts the units produce. Other manufactures rate the power of their controller's stored energy in joules. A few manufacturers list both values.

It is widely believed that black bears are more easily deterred by a weaker electrical charge. A controller delivering at least 6000 volts was thought to be adequate for black bears in some places in the western US (e.g., Salmon National Forest and elsewhere) or where the fence was temporary. On the Rogue River the US Forest Service uses a 7000-volt charger powered by a 12-volt RV battery (Tom Hawkins, Region 6, US Forest Service, pers. comm.). The battery lasts at least 3 months between recharges in the warm summer temperatures common to that part of Oregon. The agency does not use solar-powered chargers because of concerns that these expensive panels would be stolen. Huygens and Hayashi (1999) energized the fences they used to deter Asiatic black bears with various chargers but preferred one that could deliver 1.6 joules/6500-8000 volts and could be powered by a 12-volt car battery or house current.

A more powerful charger (circa 8000 volts) was usually indicated by authorities where brown bears were to be deterred or the fence was permanent. Dick Shideler (Wildlife Conservation Division, Alaska Department of Fish and Game, written comm.) suggests the use of a charger that delivers at least 8000 DC volts for permanent fences. In addition, he indicates that the charger should deliver low amperage and impedance and have an "on" time of approximately 0.0003 seconds with a rate of 40-50 pulses per minute. For a temporary fence he suggests a charger delivering at least 6000 volts.

Smith (1995) also suggests a charger delivering around 8000 DC volts in a short-duration pulse (i.e., 0.0004 seconds) with 0.75 seconds between pulses where brown bears might be encountered. He further indicates that solar panels work well if there is adequate day length. If not, he suggests the use of a 12-volt deep-cycle battery (80-90 amps) or even a truck battery.

Montana wildlife officials in the Northern Rockies have had good success deterring brown bears with fences charged by controllers producing as low as 0.5 joules of power (Mike Madel, Montana Department of Fish, Wildlife and Parks, pers. comm.). There biologists constructed temporary fences around 2 different horse carcasses in "core" brown bear habitats and powered these fences with a charger that produced 0.7 joules. The researchers then placed motion-sensitive cameras around these baits to record the number and species of bears visiting the sites and their reaction to the fences. The biologists recorded a total of seven visitations by brown bears, including several instances where it appeared that bears were shocked after touching the fences. None of the bears penetrated the enclosures. After 7 days the researchers removed the fences, leaving the

horses carcasses unprotected. Within 7 to 10 days, both carcasses had been entirely consumed by bears and other scavengers.

The Special Food Order for the Northern Continental Divide Grizzly Bear Ecosystem specifies the use of controllers that produce a minimum stored energy of 0.7 joules with a minimum peak output voltage of 5000 volts and a rate of 40 shocks per minute. The Montana Technology and Development Center (MTDC) has published a list of manufacturers who produce controllers that meet these specifications (Table 1).

Manufacturer	Model
Gallagher	B75
Gallagher	B150
Fi-Shock	SS-7000
Parmak	MAG-12SP
Red Snap'r	LIB-15
Speed-Rite	SB 1000
Speed-Rite	SB 1500
Speed-Rite	SB 5000

Table 1. Manufacturers and models of electric fence controllers that meet the requirements of Northern Continental Divide Grizzly Bear Ecosystem Food Storage Special Order (publication #9923-2321 MTDC)

Safety. Modern fence chargers deliver short-duration shocks and generally are not a threat to people. However, two human safety issues should be noted in relation to the use of electric fences. First, there should always b e international warning signs installed along the fence line (Smith 1995). Second, it is imperative that the fence wires should *never* be attached directly to household AC current.

Maintenance. Follman et al. (1980) point out that bears will test fences repeatedly. Therefore, electric fences must be checked often to repair broken wires and remove grounding vegetation. In addition, many people attach a small light to the fence to allow a quick visual inspection of the fence's operation. A good quality tester should be used to test line voltage and pulse frequency periodically. These tests should be conducted as far from the controller as possible.

Problems. In dry soils where grounding is a problem, calcium chloride can be sprinkled on the ground to retain moisture. Alternatively, grounded wire mesh can be placed on or under the ground outside the fence to improve grounding and prevent bears from digging under the fence.

ALTERNATIVES TO FENCES

Propane guns. Propane guns have been used successfully to frighten brown bears away from bee yards and grain piles in the Northern Rockies (Mike Madel, Montana Department of Fish, Wildlife and Parks, pers. comm.). Unfortunately, animals often become habituated to these devices and so their effectiveness declines over time.

Alarms. Alarm systems have two values in bear country: first, they can frighten the animal away, and second, they alert people to an intruder in camp. One alarm system on the market attaches to a single strand of thin wire strung around the perimeter of a camp or work area. If a bear breaks the wire, the alarm sounds. Bear researchers in Alaska sometimes place this "trip wire alarm" system *inside* a temporary electric fence at camp sites so they know if the fence is breached (Tom Smith, USGS, pers. comm.). Another type of alarm system connects directly to the electric fence. When an animal touches a positive conductor, the device is activated, turning on a light and/or a security camera plus an audio alarm.

Lastly, the Critter Gitter™, yet another type of alarm, has been used successfully in the Northern Continental Divide Grizzly Bear Ecosystem. This device detects movement and/or body heat and emits a piercing sound and flashing lights to frighten animals away in response to these stimuli. When the animal is gone, the device resets itself, but to a different sound pattern to prevent habituation. The effective area of detection around the device is about 40 feet, depending on the size of the animal detected. The Critter Gitter can be amplified with an additional siren/strobe light unit.

In Montana, personnel with the Department of Fish, Wildlife and Parks have found that the Critter Gitter can be effective, especially when they added the siren/strobe unit (Mike Madel, Montana Department of Fish, Wildlife and Parks, pers. comm.). Specifically, they use this device where bears have entered an area at a specific spot and are likely to return—e.g., where a bear has dug into a cabin or broken into a bee yard. In these cases, they place the Critter Gitter near the entrance and aim the motion-detector at the "hole." Others have used multiple Critter Gitters, mounted so they face in different

directions, to obtain broader coverage around sleeping areas while backpacking in bear country.

Taste Aversion Conditioning. Ternent and Garshelis (1999) report that a small number of black bears habitually raided food caches and begged food from soldiers at Camp Ripley, Minnesota, causing damage to property and threatening soldiers. The authors used taste aversion therapy to change the behavior of the bears after rubber bullets and high-pressure water had proven ineffective. Specifically, the researchers spiked the human foods most sought by the bears (Meals-Ready-to-Eat, aka MREs) with an emetic. Bears ate these MREs, became ill, and were conditioned to avoid this food source in the future. Unfortunately, the bears continued to enter the camp to look for other foods; their aversion was to MREs, not to the facility itself.

RECOMMENDATIONS

Permanent facility. Chain-link fence enclosures as detailed by Follmann and Hechtel (1990) should be used around permanent facilities. If this is not possible, a high-tensile-strength wire electric fence, as outlined in this document, should be considered. The fence should be 54 inches tall and comprised of 8 conductors, each alternating in polarity. The conductors should be supported by one-inch fiberglass line posts with wooden posts used as corners. The controller should deliver at least 0.7 joules (or 8000 volts if the manufacture does not provide information on joules) and can be powered by line current (AC/DC controller) or a 12-volt battery charged by a solar panel. An alarm system can be attached to the fence for added security if desired.

Long-term seasonal camp. An electric fence should be used to surround long-term seasonal camps. The fence should be constructed of seven strands of polywire or stainless steel conductors suspended from fiberglass posts. Polarity should be alternated if grounding is questionable, and the top two wires should be hot. The fence should be at least 48 inches high. Wires should be about 8 inches apart, except the bottom ground wire, which should be close (<2 inches) to the ground. Again, the controller should put out at least 0.7 joules of stored energy (or 8000 volts if the manufacture does not provide information on joules). The controller can be powered by a 12-volt deep-cycle battery that can be coupled with a solar charger. A trip wire alarm system should be installed inside the fence. In addition, an alarm system can be attached to the fence itself if added security is desired.

Short-term camp. When weight is a consideration, 7 strands of polywire (same configuration as under *Long-term seasonal camp* above) supported by "wand"-type fiberglass rods or by insulators on existing trees may be used. The controller should deliver at least 0.5 joules (or 6000 volts if the manufacturer does not provide information on joules). The unit should be powered by a 12-volt gel-cell battery. A flexible solar panel charger can be added if needed. The total weight for the charging unit and battery will be around 10 lbs. Their use, along with polywire, fiberglass wand posts and a single ground rod (where grounding is good), makes a very portable bear deterrent system for remote work sites.

When transporting the components of an electric fence is not possible, multiple Critter Gitters can be used around the perimeter of camp sites. The units should be mounted so that people entering and exiting tents or structures do not inadvertently trip the devices. In addition, keeping a clean camp is imperative—food odors must be avoided.

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