Recreation Tech Tips

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Specifications for Portable Electric Fence Systems as Potential Alternative Methods for Food Storage

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Since 1995, persons using any portion of the national forests in the Northern Continental Divide Grizzly Bear Ecosystem (NCDE) have been required to store food, garbage, and other attractants (such as horse feed) in a bear-resistant manner. A portable electric mesh fence system was evaluated to determine whether it was effective in keeping bears away from stored food (figure 1). The NCDE includes some wilderness and nonwilderness portions of the Flathead, Lewis and Clark, Lolo, and Helena National Forests south and west of Glacier National Park.

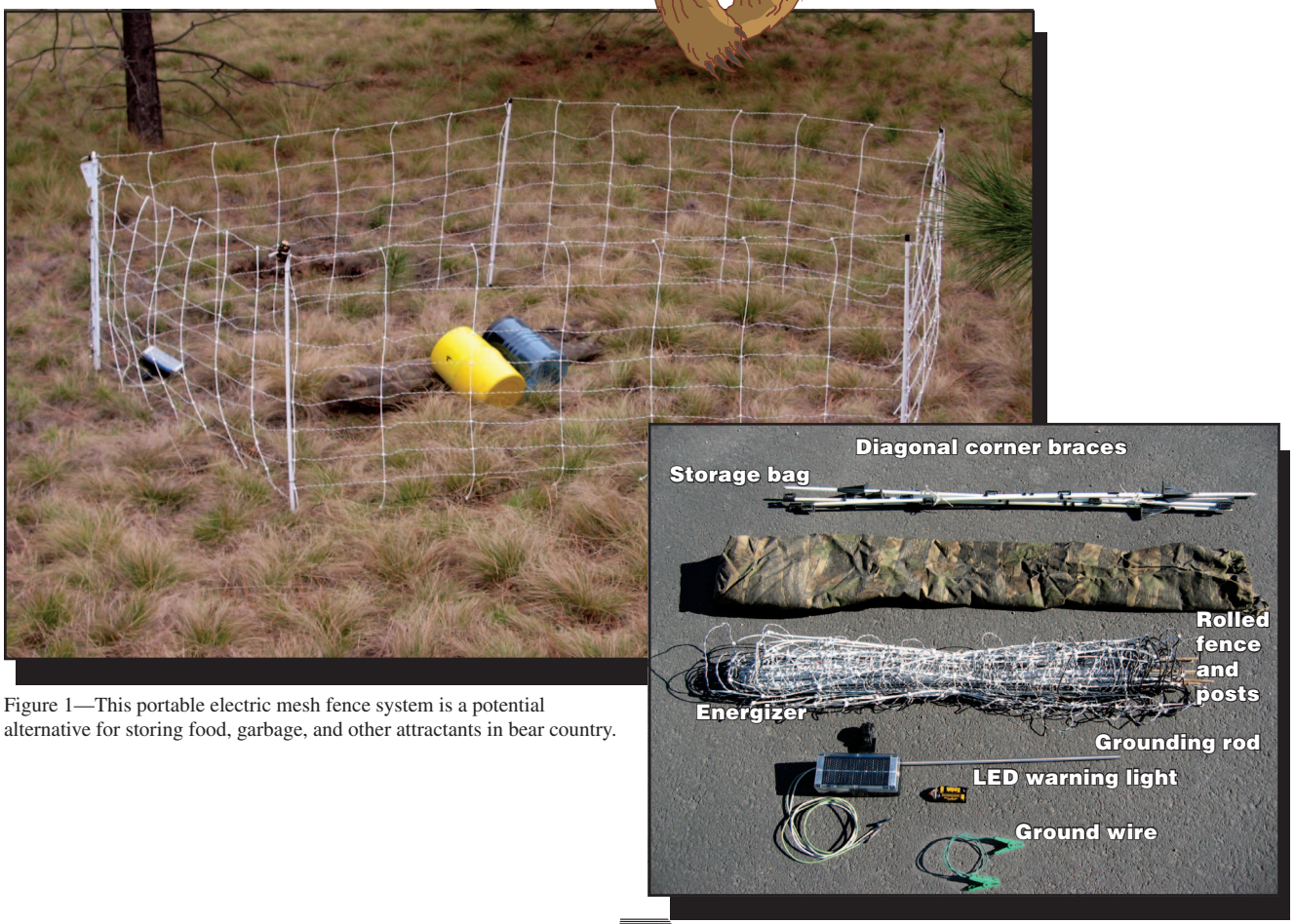

Figure 1—This portable electric mesh fence system is a potential alternative for storing food, garbage, and other attractants in bear country.

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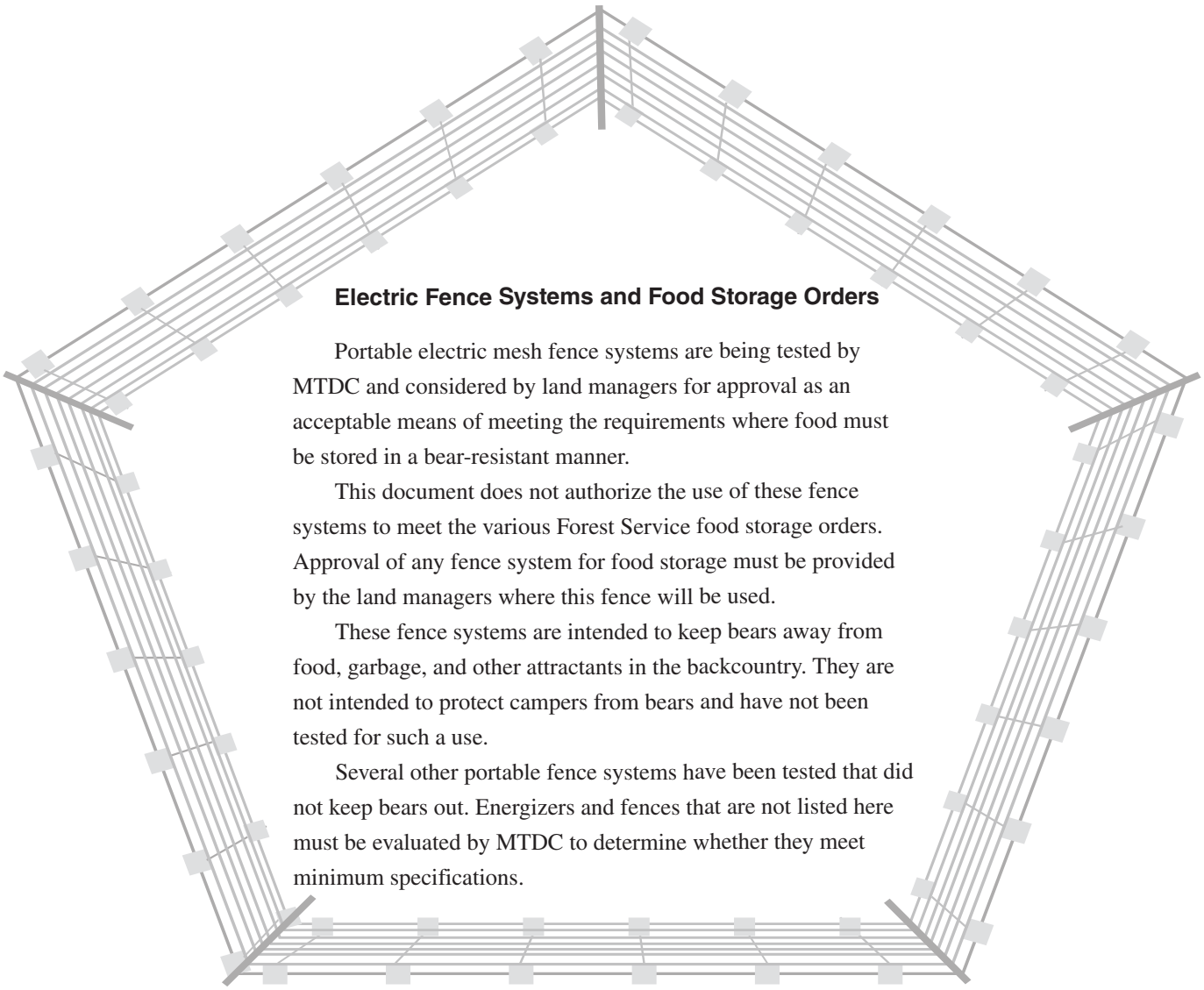

Electric Fence Systems and Food Storage Orders

Portable electric mesh fence systems are being tested by MTDC and considered by land managers for approval as an acceptable means of meeting the requirements where food must be stored in a bear-resistant manner.

This document does not authorize the use of these fence systems to meet the various Forest Service food storage orders. Approval of any fence system for food storage must be provided by the land managers where this fence will be used.

These fence systems are intended to keep bears away from food, garbage, and other attractants in the backcountry. They are not intended to protect campers from bears and have not been tested for such a use.

Several other portable fence systems have been tested that did not keep bears out. Energizers and fences that are not listed here must be evaluated by MTDC to determine whether they meet minimum specifications.

Similar storage requirements have been in place since 1990 in the Greater Yellowstone Grizzly Bear Ecosystem (GYE). The GYE includes some wilderness and nonwilderness portions of the Beaverhead-Deerlodge, Bridger-Teton, Custer, Gallatin, Targhee, and Shoshone National Forests. The area where these special orders apply is being expanded.

The National Outdoor Leadership School (NOLS) in Lander, WY, developed a portable electric mesh fence system as an alternative method of storing food in bear country. They have tested different configurations of the fence system over the past few years. The system has failed only a few times, usually because of human error or because animals accidentally ran into the fence at night and knocked it down. Flashing LED (light-emitting diode) lights were added to make the fence more visible.

The energizer weighs 1.8 pounds and the fence weighs 4 pounds. Without the braces, the kit weighs 7 pounds. With the five diagonal braces, the fence kit weighs 9 pounds, about as much as a heavy backpacking tent.

The Missoula Technology and Development Center (MTDC) and the Northern Region tested fence systems in 2003, 2004, and 2005 during the spring when bears were coming out of hibernation. A carcass was placed inside the fence as an attractant. Remote cameras monitored black bears and grizzly bears that visited the sites during the day and night.

Summary of Test Results

MTDC tested a number of battery-operated energizers in the lab to evaluate the voltage waveform and output energy of the different units (figure 2). Field testing determined which energizers kept bears out. As future energizers are evaluated, their voltage waveforms and output voltages can be compared to those of energizers that were successful in field testing.

MTDC tested the portable electric mesh fence system on the east slopes of the Rocky Mountains after the grizzlies had come out of hibernation in 2003 and 2004 near Choteau, MT, and in 2005 near East Glacier, MT. The fences were installed in areas heavily used by bears. Cow, horse, and deer carcasses were placed inside the fences to entice bears. Video cameras were installed to record bears actually making contact with the fence. Two test sites, each with a different fence configuration and/or energizer, were used each year.

In 2003, the portable electric mesh fence system was tested at two sites for 2 weeks. No failures were recorded during that time. Within 2 days after the fence system was removed, bears or other wildlife had eaten the carcasses or carried them off.

In 2004, the portable electric mesh fence system was again tested at two sites for 2 weeks. For these tests, an automatic alarm system was installed that sent an e-mail message by satellite modem to MTDC offices in Missoula, MT, whenever a bear was detected in the area. One site had about 20 bear visits, some by the same bear, based on video imagery. The other site had 12 to 15 visits.

Bears got into the fence three times while we were evaluating different energizers. Two of the break-ins occurred when we were testing an energizer that proved to be too weak. Break-ins were no longer a problem after a 0.11-joule energizer was installed. The third break-in occurred when an early spring snowstorm buried the lower half of a fence, shorting it out.

In 2005, tests were conducted at East Glacier for 3 weeks. Bears visited nine times at one site and five times at the other. At one site, a bear that was digging contacted an energized wire. The bear raised up, pulling part of the fence out when it ran away. That bear was the only one that got inside an electric fence during 2005.

NOLS tested its portable electric mesh fence system for more than 3,000 user nights in 1995 in Wyoming, Utah, Idaho, and Alaska without any incidents. NOLS staff members think that the blinking LED lights are a big deterrent to bears.

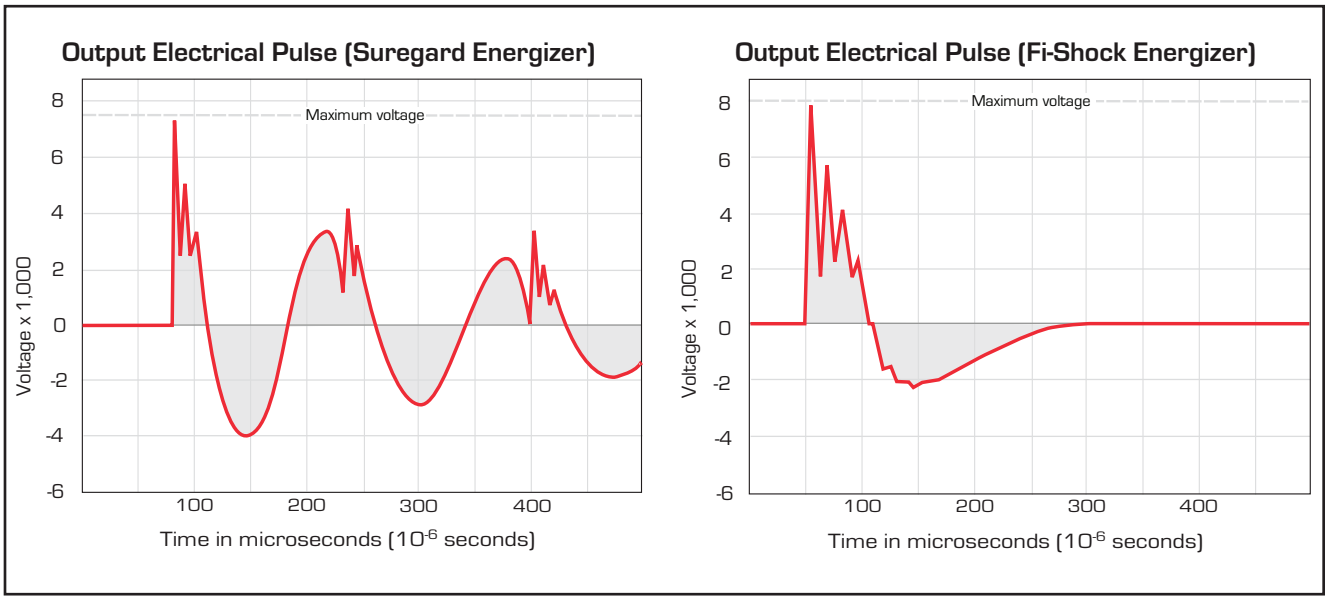

Figure 2—Different energizers have different pulse shapes. Effectiveness appears to be a factor of the total area (shaded) under the waveform curve. The "ringing" or oscillating pulse on the left appears to be more effective than the pulse on the right. Also, a pulse with higher voltage and amperage but a short duration is more effective and safer than a lower voltage with a longer duration.

Electric Fence System Requirements

Table 1 summarizes the specifications of the fence system that has proven effective for food storage. As new components for electric fence systems are developed, they will require testing and approval.

Table 1—Summary of MTDC specifications for energizers and portable electric mesh fence systems.

Fence height
Required: 33 inches
Recommended: 42 inches
Post length
Required: 42 inches
Recommended: 48 inches
Post construction
Required: Polyethylene with metal spike on bottom
Recommended: Fiberglass posts with metal spike
Strands of stainless steel wire per horizontal wire
Required: 3
Recommended: 9
A metal tab fastened to one of the horizontal strands of both the hot and ground wires is highly recommended as an attachment point for the energizer leads.
Number of horizontal wires
Required: 7
Recommended: 12 or more
Horizontal opening in mesh
Recommended: 6 inches or less
Maximum allowed: 12 inches
Length of ground rod (earth ground is mandatory)
Required: 1 foot
Recommended: $1\frac{1}{2}$ feet
Energizer output
Required: 0.11 joules
Recommended: 0.2 joules
Tested peak output voltage (on every hot conductor, with no load other than the fence)
Required: 5,000 volts
Recommended: 7,000 volts
Minimum pulse duration (with a 10,000-ohm load applied)
Required: 0.05 milliseconds
Minimum shocks per minute
Required: 35
Recommended: 45
Distance between fence and items inside
Required: $1\frac{1}{2}$ feet
Readable placard indicating fence is electrified
Required: 1
Maximum fence length
60 feet
LED lights
Required: 2
Recommended: 3

A ground wire return fence (with alternating hot—energized—and ground wires) must be used. Mesh with semirigid stays (figure 3a) is recommended to keep the mesh from drooping, which could allow the hot wires to short out against the ground wires below them (figure 3b).

Figure 3a—Semirigid vertical stays (above) are preferred to flexible vertical strands (figure 3b, below) because they prevent hot wires from sagging and shorting out the fence.

Figure 3b—Unless this fence is kept tight, the flexible vertical strands may allow hot wires to sag, shorting out the fence.

The recommended size for fence enclosures is 6 feet per side with five sides for the backpacker version (figure 4) and a maximum of 12 feet per side with five sides for the outfitter's version. The outfitter version must have diagonal braces on the corner posts. It can be created using two backpacker fences.

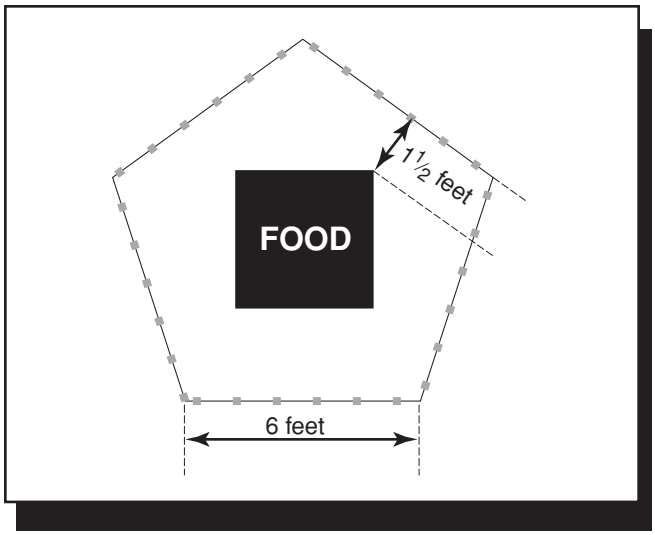

Figure 4—A recommended fence enclosure for backpacker's food would have five 6-foot-long sides. Food must be stored at least 1½ feet away from the fence. Outfitters needing to protect more food can combine two of these fences to enclose an area with 12-foot-long sides.

Flashing LED lights (figure 5) are required on two sides of the fence to prevent persons, stock, and wild animals from running into the fence and knocking it over.

Make sure that the fence's bottom wire is near the ground, so that bears cannot crawl or reach under the fence without getting shocked.

If the fence is installed on wet snow, pack the snow down so it cannot short out the fence's bottom wire. A ground wire return fence with alternating ground and hot wires is effective even when the earth is too dry to be a good conductor. The grounded wires in the fence provide a direct electrical return path to the fence controller's ground terminal.

Figure 5—LEDs (light-emitting diodes) attached to two sides of a portable electric mesh fence can warn campers or animals before they touch or run into the fence.

Because a bear must make good contact with two wires to get a shock, it may apply some force to the fence before the conductors work through the fur and contact its skin. This is why inside diagonal braces are recommended for the corner posts on the larger outfitter version (figure 6).

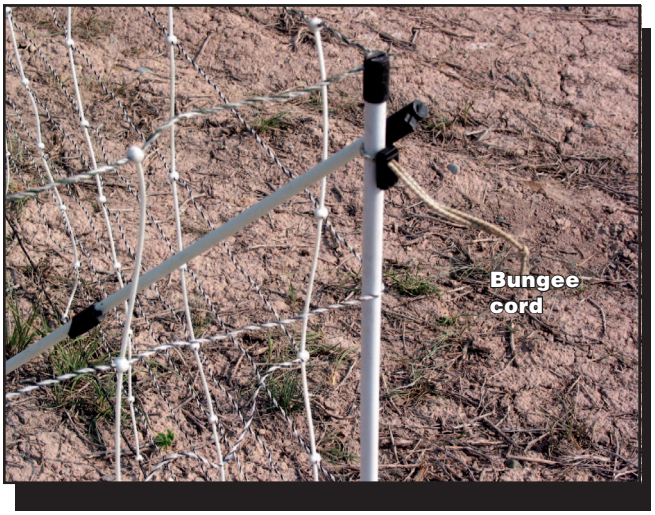

Figure 6—Bungee cords can be used to hold diagonal braces against corner posts.

The ground rod provides an electrical circuit with the earth as the return path when the soil is moist. A bear will get shocked when it contacts any hot wire while standing on moist soil or when it touches a hot wire and a ground wire simultaneously.

Grass and weeds should be clipped or removed around the fence's perimeter so moist vegetation does not contact energized wires, even in windy conditions. Wet vegetation conducts some of the electric current to the ground and will decrease the shock delivered to a bear. Fences that contact wet vegetation are unlikely to produce the required 5,000 volts.

Check the fence with a fence tester that indicates voltage (Gallagher Model G50104 or equal). Place one lead on one of the energized wires and the other lead on a ground-wire. If the voltage reading is higher than 5,000 volts, the fence is working properly. If the voltage reading is lower than 5,000 volts, vegetation probably is shorting out the fence. Clear the obstructions and retest. Another possible cause of low fence voltage is a discharged battery.

Installing the Fence System

Choose a spot to install the fence system where the ground is flat, no trees or brush hang over the fence, and where the fence does not block an established game trail. Unroll the fence and grab the posts, allowing the loops of mesh to droop between them (figure 7). To install the fence:

Figure 7—If the fence mesh has been gathered accordion style, the fence will be easy to install.

1. Hold the posts and allow the fence mesh to drop.
2. Insert one of the end posts into the ground at your starting point.
3. Insert each of the remaining posts into the ground to delineate the five sides of the fence (see figure 4).
4. At the end, push the last post into the ground next to the first post.
5. Reposition individual posts until you are satisfied with the fence's tension and shape.
6. Attach the diagonal braces to the fence posts, if the braces are being used.
7. Make sure that the energized hot wires are on the outside of the posts (figure 8).
8. Place the energizer next to the posts just inside the fence where animals cannot damage it. Drive the ground rod near the energizer (figure 9).

Figure 8—Make sure that the hot wires (arrows) are on the outside of the fence posts. Otherwise, a bear could knock the post over without getting shocked.

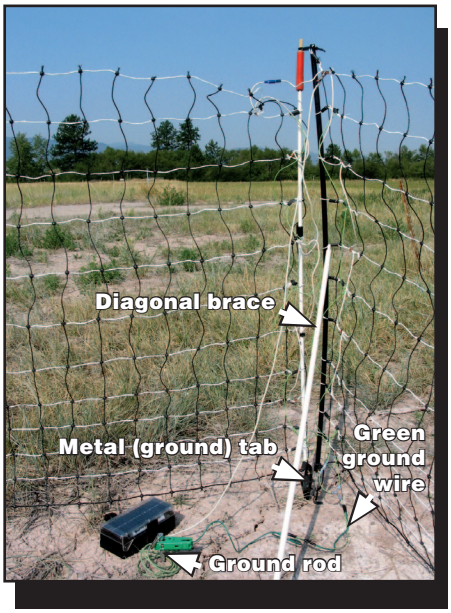

Figure 9—Connect the ends of the fence and attach the energizer to the fence and the ground rod. The ground rod should be at least 1 foot long. If the soil is dry, pour water near the rod to ensure a good electrical ground.

9. Clip electrical wires onto metal tabs crimped on the fence mesh near the end post (figure 10).
10. Attach the energizer's green wire (ground, see figure 9) to the fence ground wire. Connect a separate green (ground) wire from the ground rod to the fence.

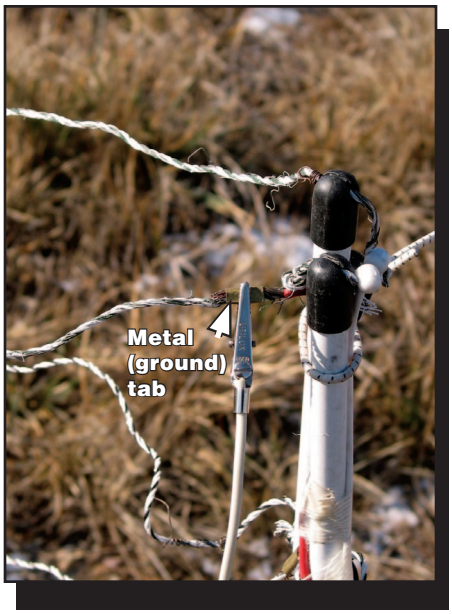

Figure 10—Clip the leads from the energizer to the hot wire (shown) and ground wires of the fence.

11. **Connect the white or red (hot) wire from the energizer to the proper metal (hot) tab on the fence mesh.**

    CAUTION: If you do not connect the hot lead from the energizer to the proper metal (hot) tab on the fence and the ground lead to the proper metal (ground) tab on the fence, the energizer will not operate properly.
12. Use adjustable bungee cords to attach the LED lights on two of the posts.
13. If the soil is very dry, pour water over the ground rod to provide a good earth ground.

Using the Fence System

1. After food has been placed in the middle of the enclosure, close the fence. With the energizer outside the fence, turn it on. After you are sure the energizer is operating properly, carefully slide the unit under the fence into the fenced area. The fence's bottom one or two wires are ground wires, so you should be able to do so without getting shocked. The energizer must be inside the fence to keep it out of the reach of animals.
2. Use a fence tester (Gallagher Model G50104 or equal) to check the fence voltage. Place one lead on one of the energized wires and the other lead on a ground wire. If the voltage reading is higher than 5,000 volts, the fence is working properly. If the voltage reading is lower than 5,000 volts, food must be stored by another approved means, such as hanging it properly from a tree.

Removing the Fence System

1. Turn the energizer off.
2. Disconnect the energizer and electrical fence connections.
3. Remove the LED lights.
4. Remove the diagonal braces, if they were used.
5. Pull each post from the ground as you walk down the line.
6. Gather up the fence by collecting the posts with the loops of mesh drooped between them (see figure 6). Allow the mesh to fold into loops, accordion style, as you proceed.
7. Lay the fence flat on the ground and *roll* the mesh around the *posts*.

Suppliers of Energizers and Electric Mesh Fences That Meet Specifications

Power Innovations (Models: Sureguard S4-Plus, S4, S10, and M-4)
110 Barton Rd. • Lismore, NSW2480, Australia
Phone: 61–2–6628–2000 • Fax: 61–2–6628–2022
Web site: *http://www.sureguard.com.au*
Email: *help@sureguard.com.au*

Gallagher Power Fence (Models: B11, B75, and B80)
18940 Redland Rd. • San Antonio, TX 78270–8900
Phone: 800–531–5908
Web site: *http://www.gallagher.com.au*

Stafix (Models: B0.5 and AN90)
Web site: *http://www.stafix.co.nz/stafix_new/*

PEL (Models: 901B and 110B)
Web site: *http://www.pel.co.nz/pel_new2/*

Electric Mesh Fences That Meet Specifications

J.L. Williams Co. (Models: Electro-Web P-75 and P-89)
P.O. Box 209 • Meridian, ID 83680
Phone: 800–843–3702 • Email: *freeinfo@safefence.com*
Web site: *http://www.safefence.com*

Kencove Farm Fence, Inc. (Models: NSG, and NSG12X)
344 Kendall Rd. • Blairsville, PA 15717-8707
Phone: 800–536–2683 • Email: *fence@kencove.com*
Web site: *http://www.kencove.com*

Premier 1 Supplies (Model: Electronet)
2031 300th St. • Washington, IA 52353
Phone: 800–346–7992 • Email: *info@premier1supplies.com*
Web site: *http://www.premier1supplies.com*

Recommended Fence Improvements

The fence's current configuration uses alligator clips attached to metal tabs that allow improper electrical connections. A better alternative would use polarized connectors (figure 11), that would always connect hot to hot, and ground-to-ground.

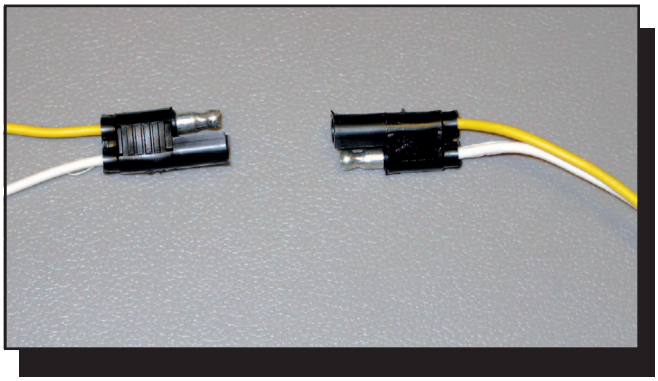

Figure 11—Polarized connectors could prevent improper electrical connections.

Maintenance Tips

VOLTAGE

- Clip grass, weeds, and branches around the fence's perimeter so moist vegetation will not contact hot wires, even in windy conditions. Retest the fence's voltage.
- Clip the hot lead to the solid metal connector rather than a piece of plastic twine and ensure that the ground lead is connected to the ground clip on the fence. A separate wire should connect the ground clip to the ground rod.
- Find a good ground by using the ground rod to probe for damp soil.
- Clean the energizer's battery contacts with a pencil eraser.
- Use dry silicone spray on the charger in humid areas. Silicone will reduce the possibility that moisture will allow the high voltage current to arc to the energizer's case.
- During cold conditions, use new batteries and replace them more frequently than when it's warm. Solar energizers, such as the Sureguard S4–Plus, may not keep the batteries fully charged from November through February, when days are short and temperatures are low.
- **Make sure that the ground and hot leads are connected correctly or the fence will not operate properly.**

CARE

- Care for the energizer the way you would care for a cell phone, radio, GPS receiver, or other electronic device.
- Place the energizer in a dry, foam-padded case before transporting it.
- Clean the battery contacts with a pencil eraser as needed.
- Keep your energizer dry. If it falls in water, open the energizer's case and dry it in the sun or expose it to a breeze before turning it on.

TROUBLESHOOTING

- Are the batteries holding a charge? Use new batteries to see whether they fix the problem.
- Is anything corroded? If so, try cleaning the battery contacts with a pencil eraser.
- Are the hot and ground lead wires connected properly?
- Are the wires intact?
- Is the energizer dry? If it looks wet, try opening the energizer's case and drying the energizer in the sun or exposing it to a breeze before turning it on.
- Does the green (ground) wire go from the ground clip to the ground stake?
- Does the red (hot) wire go from the energizer to the white (hot) wire tab on the fence?
- Is anything inside the energizer obviously broken or disconnected?
- Have you tried tinkering? If you do, remember that the first rule of intelligent tinkering is not to lose any parts.

Acknowledgments

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- Mike Madel and Mike Maples of the Montana Department of Fish, Wildlife and Parks in Choteau, MT, for allowing us to test the prototype fence system on the east slopes of the Rocky Mountains and helping us monitor the test sites.
- Brian Castaldi, MTDC, for helping install the camera monitoring system.

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Kim Barber has been the grizzly bear and wolf biologist for the Rocky Mountain Region of the Forest Service since 1992. Barber, who is based in Cody, WY, represents the six National Forests in the Greater Yellowstone Area (GYA) on the Interagency Grizzly Bear Study Team, leads the Grizzly Bear Cumulative Effects Modeling Team for the GYA, and serves on various technical teams for the Interagency Grizzly Bear Committee. He has also worked for the Forest Service in Utah, Nevada, and Alaska. He received a bachelor's degree in zoology from Weber State College and a master's degree in wildlife management from Utah State University.

John Gookin is the curriculum and research manager and a senior instructor at NOLS in Lander, WY. He received a bachelor's degree in biology and environmental studies from Lake Forest College in Chicago, IL. He taught high school science and was a U.S. Marine before joining NOLS in 1981.

Gary Kees is a project leader specializing in reforestation and nurseries, facilities, recreation, and GPS projects at MTDC. He received his bachelor's degree in mechanical engineering from the University of Idaho. Before coming to MTDC in 2002, Kees worked for the Monsanto Co. in Soda Springs, ID, as a mechanical/structural engineer and project manager.

Jim Claar joined the Forest Service in 1989 and has helped establish standards for food storage and other techniques for living and recreating in bear country. He has been the leader for the Northern Region carnivore program since 1999. Jim also serves as the team leader for the national lynx biology team, team leader for the interagency wolverine biology team, and regional lead for interagency gray wolf coordination. He has a bachelor's degree in wildlife biology from the University of Montana and a master's degree in wildlife management from the University of Idaho.

Library Card

Karsky, Dick; Barber, Kim; Gookin, John; Kees, Gary; Claar, Jim. 2007. Specifications for portable electric fence systems as alternative methods for food storage. Tech Tip 0723–2305P–MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 10 p.

If a portable electric fence system is to be used as an alternative method for storing food, garbage, and other bear attractants (such as horse feed), it must be approved by the land manager where it is used. Special orders have been issued in the Northern Continental Divide and Greater Yellowstone Grizzly Bear Ecosystems that require food, garbage, and other attractants to be stored in a bear-resistant manner. Those ecosystems include portions of national forests near Glacier and Yellowstone National Parks in Idaho, Montana, and Wyoming. This tech tip provides specifications for portable electric mesh fences and energizers for this use and how they must be installed.

Keywords: backcountry, black bears, camping, energizers, food, garbage, grizzly bears, refuse, regulations, special orders, storage, Ursidae

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