Fences

Pronghorn Biological Requirements and History: Within a decade of erecting barbed wire fences on western rangelands, Caton (1877:48) was reporting that 4-foot (1.2 m) high fences were restricting pronghorn movements: " *This inability to leap over high objects may no doubt be attributable to the fact that they live upon the plains, where they rarely meet with such obstructions, and so they and their ancestors for untold generations have had no occasion to overleap high obstructions, and thus from disuse they do not know how to do so, and never attempt it when they do meet them.*"

Caton was essentially correct. Pronghorn had adapted over the millennia to open landscapes without vertical barriers. In the relatively short time since the fencing of the West began, restricting the movement of nearly all pronghorn populations, these animals have shown themselves unable to go through fences as do bison, or to vault them as do deer and elk. Instead, pronghorn have learned to negotiate certain fences by crawling underneath them. But if the bottom wires are too low, by virtue of design or the buildup of sand, soil, vegetation or snow, pronghorn movement is seriously impeded.

Pronghorn welfare has suffered in proportion to the sale of barbed wire. In 1879, 5 tons (4.5 metric tons) of barbed wire was manufactured in the United States. Six years later, 40,000 tons (36,000 metric tons) were being strung across western rangelands. By 1945 this figure had reached 234,000 tons (210,600 mt) per annum (Leftwich and Simpson 1978). Initially most of the fences were "drift fences," which resulted in large numbers of pronghorn being trapped to freeze to death in blizzards (Hailey 1979). Later, the fencing of pastures became more and more commonplace, further restricting the movement of pronghorn populations until the species was excluded from much of its former range (Russell 1964, Martinka 1967, Spillett et al. 1967, Hailey 1979).

Today, fences are built on western rangelands to control access along roads, highways, and railroads; to protect agricultural crops; to limit access to mining operations, military installations, and private property; and for other purposes. However, the majority of fences are installed to control domestic livestock. How these fences are designed and constructed determines their effect on pronghorn welfare. Fences can be built to: (1) fully restrict and control pronghorn movement; (2) control cattle and horses, but allow pronghorn passage; or (3) control all ungulates including domestic sheep and goats, as well as pronghorn movements.

These fences present complete or partial barriers to movements of pronghorn and have obstructed seasonal movements and travel to water or feeding areas. As a result, pronghorn populations have continued to decline on some rangelands. Extensive mortality has also occurred when animals became entangled or trapped as they attempted to negotiate these barriers (Oakley 1973).

Pronghorn should be given high priority when considering fencing and a greater effort should be made to harmonize rangeland use by livestock and pronghorn. U. S.

Bureau of Land Management (1985) manual H-1741-1 states that all means of livestock control (herding, use of natural land forms, exclusion of certain kinds and types of livestock, distribution of salt and water sources, etc.) should be considered before deciding to use a specific fencing configuration. The manual also directs that the potential effects of fencing, including costs, on other resources be considered carefully before deciding what fencing to use. Provincial and state wildlife managers should ensure that federal land managers comply with these important directives. Wyoming Game and Fish Department fencing guidelines maintain that no fencing should occur perpendicular to major migration routes or on transitional and winter rangelands used by pronghorn (Lee et al. 1998).

Often, past efforts were concerned primarily with ways to modify pronghorn behavior to minimize the effect of fences. It cannot be assumed that pronghorn will adapt to changes resulting from livestock use, or that they will learn behavior patterns allowing these animals to adjust to habitats altered by fences. Observations in Wyoming indicate no marked increase in the number of pronghorn learning to jump fences; however, older individuals have a greater tendency to jump fences than fawns, which have never been observed jumping fences (H. Harju, pers. com.).

Net-wire fences to control domestic sheep are particularly disastrous for pronghorn seeking preferred forage in the arid southwest (Buechner 1950, Hailey 1979). In northern habitats, fences often severely impede pronghorn movements during winter (Spillet et al. 1967, Oakley and Riddle 1974, Mitchell 1980, Barrett 1982, Pyrah 1987). Woven wire and sheep-tight fences prevent pronghorn from drifting ahead of severe storms to rangelands with preferred forage or less snow. By restricting free movements, fences cause pronghorn to remain in areas offering little protection or food during storms, resulting in malnutrition and death from “winter-kill.” Popowski (1959) aptly summarized the seriousness of this issue by stating "When pronghorn are denied freedom in seeking seasonal food requirements, they sicken and die of malnutrition; and when they can't drift to avoid severe winter storms they often collect in fence-corners and freeze to death." Deep snow fills depressions where pronghorn normally crawl under fences can make fences pronghorn-proof. Crusted or wind-packed snow covering the fence’s lower wires prohibited pronghorn from crawling underneath, and snow does not provide a solid enough surface for launching an effort to jump the fence. In such situations, fences on pronghorn movement corridors and wintering areas need to be "laid down."

After more than 100 years experience with fences, pronghorn primarily still go under rather than through or over fences. Büechner (1950) observed that most pronghorn seem unaware of their ability to jump, and often die of starvation rather than jump sheep-tight fences. Yet, during pronghorn trapping operations in Wyoming, adult pronghorn jumped over an 8-foot (2.4 m) fence (Spillet et al. 1967), and have jumped 7-foot (2.1 m) horizontal structures (Mapston 1968). Spillett et al. (1967) reported that a pronghorn's ability to see over a fence was an important factor in their willingness to jump fences; they also observed pronghorn using snowdrifts to cross fences.

Research and Litigation: One of the first extensive evaluations into pronghorn/fence interrelationships was accomplished in Montana and Wyoming by Rouse (1954). He noted fences were obstacles unless the bottom wire was at least 15 inches (38 cm) above the ground, and that fences with lower bottom wires were totally impassable.

The first intensive field study of the effects of fencing on pronghorn was conducted in Wyoming by Spillett et al. (1967). These investigators tested 22 types of fences to evaluate pronghorn movements under controlled conditions. Results indicated a fence 32 inches (81 cm) high was the maximum most pronghorn would readily jump. When pronghorn could not pass under a sheep-tight fence, a cattle guard-like structure called an "antelope pass" was developed, which proved only partially satisfactory due to fawns sometimes breaking their legs when negotiating the “pass.”

More recently, another intensive pronghorn/fence study was completed near Roswell, New Mexico (Howard et al. 1990). Rangeland pastures were stocked with pronghorn to evaluate the influences of cattle and domestic sheep, especially the effects of stocking rates and competition for forage. Pronghorn viability was greater in cattle pastures than in sheep pastures due in part to fewer restrictions posed by cattle fencing. Cattle fences allowed more movement even though sheep-tight fences were modified with short sections that allowed pronghorn to move between pastures as forage conditions changed.

Figure 33. The Vizcaino pronghorn facility, located in Baja California Sur, Mexico, contains all interior fences with 6 strands of smooth wire for 7 separate small pens. The smooth wire fences have been effective for more than a decade (Cancino et al. 2002). Photo by Ramon Castellanos.

Two major lawsuits have involved livestock fences and pronghorn welfare on public lands. On the Roswell Grazing District in New Mexico, fences were modified "wolf type" by the federal government to permit the passage of pronghorn. The decision to modify fencing on public land was contested by livestock permittees. But the appeal was dismissed in administrative hearings, resulting in a major victory for pronghorn and multiple-use. Hence, modifying fences for pronghorn on public lands dedicated to multiple use are on solid grounds and should continue (Yoakum 1980).

The second legal case also established an important precedent. A rancher near Rawlins, Wyoming constructed a fence around approximately 9,600 acres (3,885 ha) of private and public lands, thereby excluding pronghorn from critical winter rangelands. Many pronghorn died due to being denied access to favored winter foraging areas. The case went to the U. S. District Court for the District of Wyoming and the judge decreed that the rancher's woven-and-barbed wire fence was in violation of the federal Unlawful Enclosures Act of 1885. The rancher immediately appealed the federal judge's ruling and the case went to the Tenth Circuit Court of Appeals, where three judges unanimously upheld the lower court's decision. The case then went to the U. S. Supreme Court, which upheld the decisions of the District and Circuit courts.

Figure 34. Woven-wire fences topped with 2 to 3 strands of barbed wire, often present complete barriers to the movement of pronghorn. This is especially true for fawns that are less capable of jumping over wire fences. Photo taken on the Sybille Wyoming Wildlife Research Unit by J. Ward.

Highway Fences: Büechner (1950) recognized early on that fenced highways impacted pronghorn movements. Fenced highways and railroad rights-of-way effectively fragment habitat and isolate pronghorn herds (Ockenfels et al. 1994, Ockenfels et al. 1997). The combination of multiple fences and nearly constant traffic seriously restricts, but does not necessarily prevent, movement across highways. The ability of pronghorn to negotiate highways is often critical to their survival. Devastating winter-kills have occurred when snow cover prevented pronghorn from going under highway fences

(White 1969). Ockenfels et al. (1994) present a list of possible mitigation features to use at highway rights-of-way. Removing or taking down fences during severe winter weather should also be considered, even though such action may require much coordination and planning.

Fences for Pronghorn: Fences constructed with objectives to allow or completely restrict pronghorn movement generally fall into 2 categories. The first consideration is to allow pronghorn unobstructed passage and is covered elsewhere. The second category is to control pronghorn movement to keep the animals out of agricultural fields, landing strips, highways, etc. Such exclusions can be permanent or temporary. Past research and field testing of the many different fencing configurations has determined the fence designs most appropriate for various control needs. Spillett et al. (1967) emphasized that pronghorn in captivity react differently to fences under different motivational levels, with the level of motivation being the key factor in determining the extent of the barrier required. If not stressed by harassment or lack of forage or water, pronghorn can be controlled with a low fence with the bottom wires close to the ground. Some situations, however, are inadequate to control highly motivated animals, which require a higher barrier to restrict movement.

The following discussion pertains to a fence design that has been proven to contain "highly motivated" pronghorn. Of two successful applications of this fence design, one involved keeping pronghorn from an irrigated alfalfa field surrounded by sagebrush steppe during the late summer and fall when native vegetation became mature and dry. Another "highly motivated" situation was the enclosure of pronghorn that had been trapped and transported 60 mi (100 km) from their native range (Pojar et al. 2002). In both cases, there was direct visual and track evidence that the animals "paced" the fence indicating a desire to cross. This fence design precluded any breech of the fence by pronghorn while allowing "jumpers" such as mule deer and elk passage over the fence.

The fence (Fig. 35) is 61 in. (155 cm) high and was a combination of smooth wire and net wire with 6 in. (15.25 cm) squares (Pojar et al, 2002). The first smooth wire was 1 in (2.54 cm) above the ground and 1 in (2.54 cm) below the bottom of the net wire. The net wire was 32 in (81.3 cm) high. Above the net wire there were an additional 4 strands of smooth wire. The first was spaced 3 in (7.6 cm) above the net wire with 3 more strands spaced equally at 8 in (20.3 cm) above the preceding wire. For additional strength, it would be desirable to have the top wire replaced with 1 in (2.54 cm) wide metal impregnated nylon tape (as is used for electric fences). This should be some color other than white so the jumpers can see it against a snow background. Of course it is important to make sure the bottom of the fence adequately seals all geographic depressions and drainages to prevent pronghorn crawling under the fence.

With increased speed and volume of motor vehicle traffic on Interstate and alternate highways, crossing structures are needed in pronghorn habitat to protect the animals and vehicle passengers. The above fence design would assist guiding pronghorn to less hazardous areas.

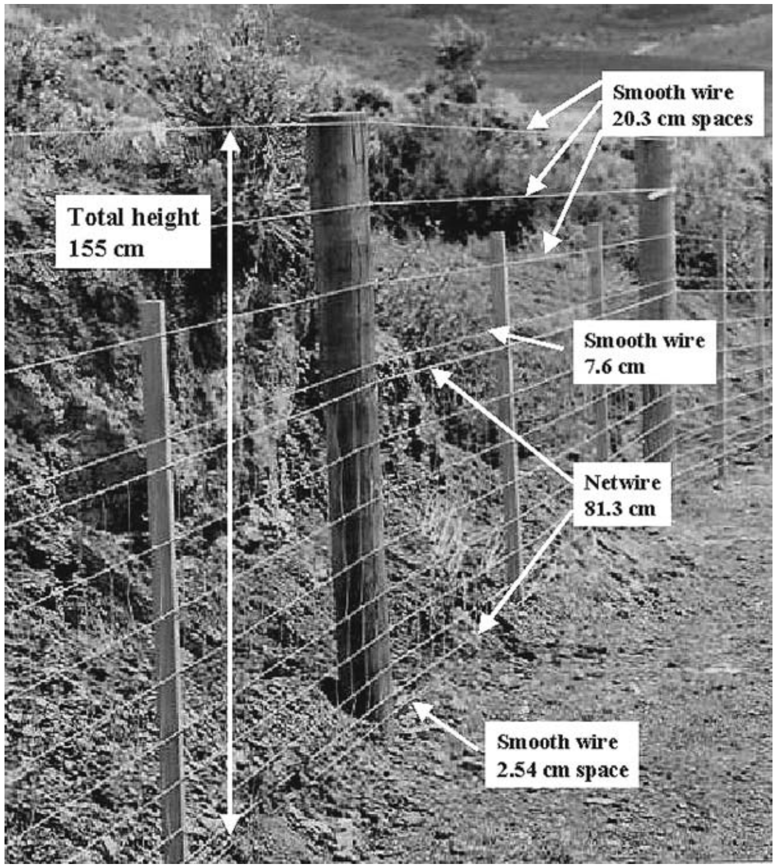


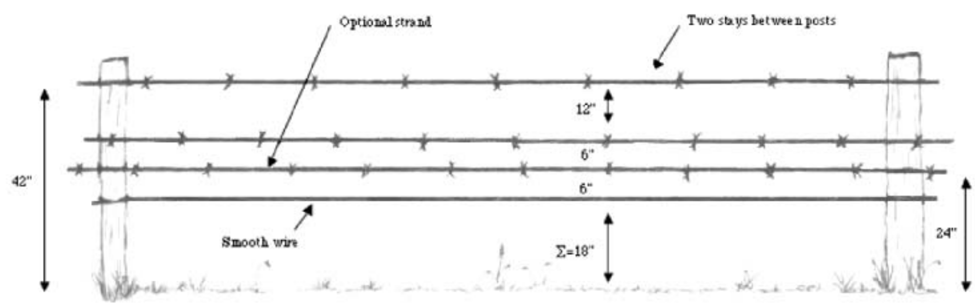
Figure 35. Effective fence design for controlling pronghorn movement under moderate to strong motivation. This type of fence has been successfully used as both an enclosure for newly translocated pronghorn and as an exclosure to prevent pronghorn from using an irrigated alfalfa field. Photo by Tom Pojar.

To hold pronghorn in a large rangeland enclosure containing adequate food, water, and space throughout the year, the fence specifications in Fig. 23 can also be used. Gates should be constructed of wire rather than wood, thereby allowing the pronghorn to see through the fence. Many miles of these "sheep-tight" fences (including the "wolf-type" variation to control coyote movements) are virtual barriers to pronghorn. Should the fenced area be small, and the possibility for harassment from domestic dogs and other sources exist, the fence should be at least 8 feet (2.4 m) high to keep pronghorn from jumping over.

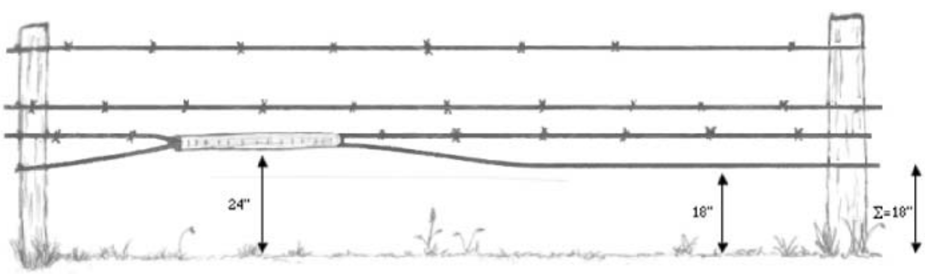
Smaller fences, designed to hold captive animals, present certain unique problems and are often best constructed of wood to prevent panicky or adventurous animals from getting caught between wires or in net-wire openings (Tim Hill, pers. com.). For larger enclosures, an electric fence outside of a net or woven wire fence is used (Fig. 33). To reduce cost, one of the fences can consist of 7 smooth wires provided that a visual barrier is also present to reduce the chances of pronghorn colliding with the wire (R. Castellanos, pers. com). This barrier may consist of cloth, plastic, or be a “snow fence.” In these larger enclosures, such as the pens built on the Cabeza Prieta National Wildlife Refuge and near

Guerrero Negro in Baja California Sur, it may also be advantageous to have 10 m shunts of woven wire fence to facilitate the segregation and movement of animals.

Fences to Control Livestock: Fig. 36a and 36b illustrate suggestions for barbed-wire fence specifications that allow pronghorn of all ages to go under the bottom wire, yet control movements of cattle and horses (Kindschy et al. 1982). Fences constructed according to these specifications have been built for hundreds of miles on pronghorn habitat, and have proven effective for rangelands experiencing dual use (livestock and wildlife) since the fence design was originally published during the 1950s (Griffith 1962). Although arguable by some livestock personnel that the fences allow calves to go under the fence, the return reply has been that such calves can likewise return back to the cows. More than a half century of hundreds of miles of rangeland fences built—appear to confirm that this is a reality. This case record stands as one of the most successful fence designs on western rangelands used by pronghorn and cattle.



Proposed "Pronghorn friendly" fence design for livestock (Fig 36a).



Same fence with "Goat-Bar" in strategic location (Fig 36b).

Figure 36a and 36b. Suggested wire fence specifications using barbed and smooth wires for rangelands used by cattle and pronghorn. Such fences have been most effective on extensive rangelands. They are less effective surrounding agriculture fields and drinking water facilities (Kindschy et al. 1982).

Ranchers in the Southwest often encircle water sources with fences to trap or redistribute livestock. These enclosures often are built of woven-wire, and contain 10 or more strands of barbed wire, or snow fencing. Such structures are highly detrimental to pronghorn, especially young animals inexperienced in negotiating such obstacles. The fencing of water holes in such a manner appears to violate the same basic mandate prohibiting sheep-tight fences on public lands dedicated to multiple use (Yoakum 1980, Yoakum and O'Gara 1990).

Special facilities allowing pronghorn movement through livestock fences were developed in Wyoming by Spillett et al. (1967) and later modified by Maptson (1972) and Howard et al. (1990). These so-called "antelope passes" allowed adult animals to jump through sheep-tight fences, but some fawns broke their legs in passing. “Antelope passes,” therefore, have limited application and are not recommended for mitigating pronghorn movements through woven-wire fences (Yoakum et al.1996).

Wildlife biologists working in Idaho adjusted barbed-wire fences to allow seasonal access by pronghorn when rangelands were not in use by livestock (Anderson and Denton 1980). The height of the lower wire was increased from 18 to 38 inches (46 to 97 cm). Raising fences has special merit for areas experiencing snow depths of 12 inches (31 cm) or more. However, such a system requires that habitat managers have adequate personnel available to manipulate the wires lest the fence be a detriment rather than a benefit to pronghorn and other wildlife.

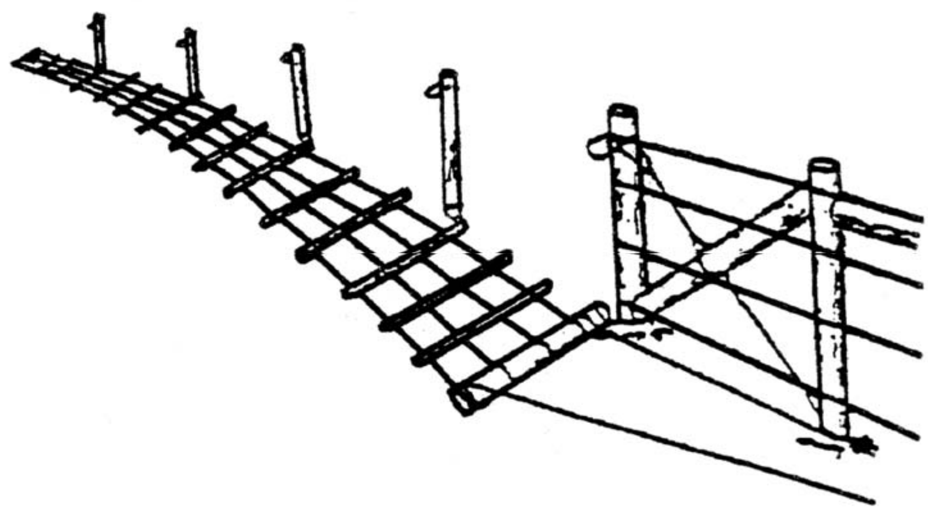


Figure 37. Let-down fence to permit pronghorn and other wild ungulates to cross (Karsky 1988). Letting down the wires from at least four posts should suffice, and distances between gaps would depend on the local conditions. (from Yoakum 2004e)

Let-down panels may serve well under some conditions but are rarely used (Fig. 37). Inherent problems concerning who puts them up and takes them down are common, however. When a bad storm hits, ranchers take care of their livestock first, and wildlife agencies generally do not have enough personnel to let down the panels when needed. Pronghorn tend to become conditioned to fence lines, and in some instances when let-down panels have been installed, migrating pronghorn have walked past the downed area, seemingly unaware of the opening. Leaving gates open in such areas when livestock are not present might help alleviate this problem.

A better solution, although one still not as ideal as no fence at all, is the provision of “goat bars” in strategic passageways. These “goat bars” consist of pieces of a longitudinally slit PCB pipe from 6 to 12 feet in length, into which the bottom two strands of fence are inserted into the slit, thus lifting the "bar" and facilitating the passage of pronghorn under the fence (Figure 36b).

Disassembling Fences: Designing, installing, and maintaining fences includes the responsibility to modify or dismantle these structures when they are detrimental to other resources or no longer serve the objective for which they were originally intended

An area in central Colorado in which a barbed-wire fence had been constructed many years previously to control livestock had been unoccupied by pronghorn until relatively recently (Pojar and Gill 1990). The fence was known to contribute to physical injuries and restrict pronghorn movements. Unfortunately, funds were not available to modify the fence for the benefit of pronghorn. Through the cooperation of conservation and education organizations that volunteered their labor, the bottom wire of the fence was raised to 16 in (40.6 cm) above the ground, thus benefiting pronghorn. There are hundreds of miles of similar fences on private and public rangelands that can be improved as pronghorn habitat. In Arizona, the Arizona Antelope Foundation and other wildlife conservation organizations volunteer their labor to modify many miles of fence each year to make them more passable to pronghorn.

The need to disassemble barbed and woven-wire fences on pronghorn habitats was first recognized as a responsibility of habitat managers during compilation of the Environmental Impact Statement and Comprehensive management Plan for the Hart Mountain National Antelope Refuge in Oregon (U.S. Fish and Wildlife Services 1994). Case histories identified that fences built to manage livestock had maligned and killed pronghorn, deer, bighorn sheep, and other wildlife. More than 212 miles (341 km) of refuge interior fences were constructed on the refuge during the last 100 years. Since these fences no longer served a management purpose, annual removal projects have been conducted. As of 2005, around 198 miles (318 km) of fences have been disassembled—primarily through volunteer labor of conservation organizations (Chappel 2005). Similar fence removal and/or modification projects have been accomplished on the Charles Russell National Refuge in Oregon, Buenos Aires and Cabeza Prieta National Wildlife Refuges in Arizona, and the National Monuments of Aqua Fria in Arizona and Carrizo Plain in California.

A review of range improvement guides and manuals discloses detailed specifications on how to construct and maintain fences. Recognizing that fences can contribute to physical injury and at times restrict mobility of pronghorn and other wildlife, it is recommended that guides, handbooks, manuals and management plans to construct fences contain specifications to modify or remove fences that adversely effect wildlife and no longer serve their original objective. Few were found that provided recommended techniques for modifying fences to meet wildlife needs and none could be located that identified the responsibility for disassembling fences that no longer served a purpose (U.S. Bureau of Land Management 1980, 1985, Karsky 1988, Brunner 2000).

Specifications for three and 4-strand barbed wire fences designed to control cattle but facilitate pronghorn movement are shown in Figures 38a and 38b. These heights and measurements allow pronghorn to negotiate such fences under most circumstances (Spillett 1965, Kie et al. 1994, Lee et al. 1998, Yoakum 2004d).

The fence illustrated in Figure 38 is intended to control domestic sheep, yet allow the passage of pronghorn (U. S. Bureau of Land Management 1985, Salwasser 1980, Yoakum 1980, Karsky 1988, Kindschy 1996, Payne and Bryant 1998). However, the bottom wire is 10 inches (25 cm) above the ground—a height restrictive to pronghorn. This design is not recommended for pronghorn habitats. According to Rouse (1954:11): "any fence that effectively controls domestic sheep will likewise control pronghorns."

"Wolf" and 'Anti-Coyote' Fences: A "wolf-type" fence was designed in Texas and New Mexico during the 1940s to exclude coyotes from rangelands containing domestic sheep. Their design was essentially a 36-inch (91 cm) roll of net wire fence with the bottom 12 inches (30 cm) buried below the ground. Three to four strands of barbed wire were then strung above the woven wire to a height of 50 to 60 inches (127 to152 cm). Other "anti-coyote" fences have been designed using combinations of barbed, et, and electric wires (Karsky 1988, Kie et al. 1994)—all having the objective of preventing coyotes from digging under, passing through, or jumping over the fence. Although successful in their intended purpose, these fences also prohibit pronghorn movement and are illegal on public lands where "multiple-use" is a land –use objective (Yoakum 1980).

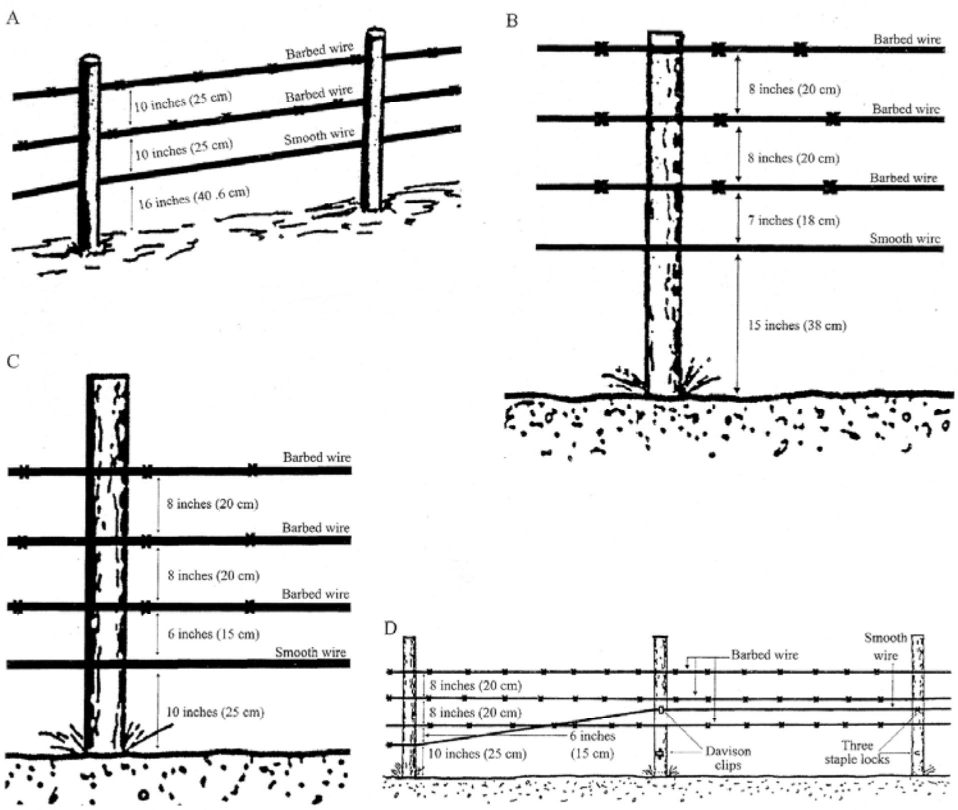


Figure 38. Specifications for (A) three-strand (Karsky 1998) and (B) suggested four-strand wire fences on rangelands used by cattle and pronghorn and (C) barbed and smooth wire fencing

recommended for fences on rangelands grazed by domestic sheep, cattle and pronghorn (Karsky 1998). The latter fence will restrict pronghorn movements because the lower wire is too close to the ground, so it will not allow pronghorn to crawl underneath. However, it can be modified to allow pronghorn access through the fence when the bottom wire is raised as illustrated in (D). (from Yoakum 2004e)

Let-down Fences: A "let-down" fence is designed to allow sections of wire to be laid on the ground, thus allowing pronghorn the opportunity of passing over the barrier during times of seasonal movement or after deep snows (Karsky 1988). One design uses a wire loop at the top of the fence post and a pivot bolt at the bottom to hold a "stay" in place (Figure 37). Such a design allows sections of the fence to be easily let down and be re-erected. Another design allows the "let-down" section to be pulled back against a section of standing fence. Such fences must be designed to provide for an adjustment of the wire's tension as the wire cannot be so taut as to not allow the fence to lay flat nor so loose that loops of wire create a hazard to pronghorn. Experience over the last 3 decades indicates that labor is often unavailable to "let-down" these fences prior to severe snow storms, however.

Adjustable Fences: The "adjustable fence illustrated in Figure 39 was designed in Idaho (Anderson and Denton 1980) to allow the lower strand of wire to be raised from 16 inches (41 cm) to 38 inches (97 cm) to 38 inches (97 cm) above the ground. This design is especially beneficial to pronghorn in areas where the snow depth can exceed 12 inches (30 cm). One person can adjust a mile (1.6 km) of wire in approximately 30 minutes.(L. Anderson , pers. comm.) reported that pronghorn repeatedly selected the sites having the bottom wire higher than those sections of fence where these wires had not been raised.

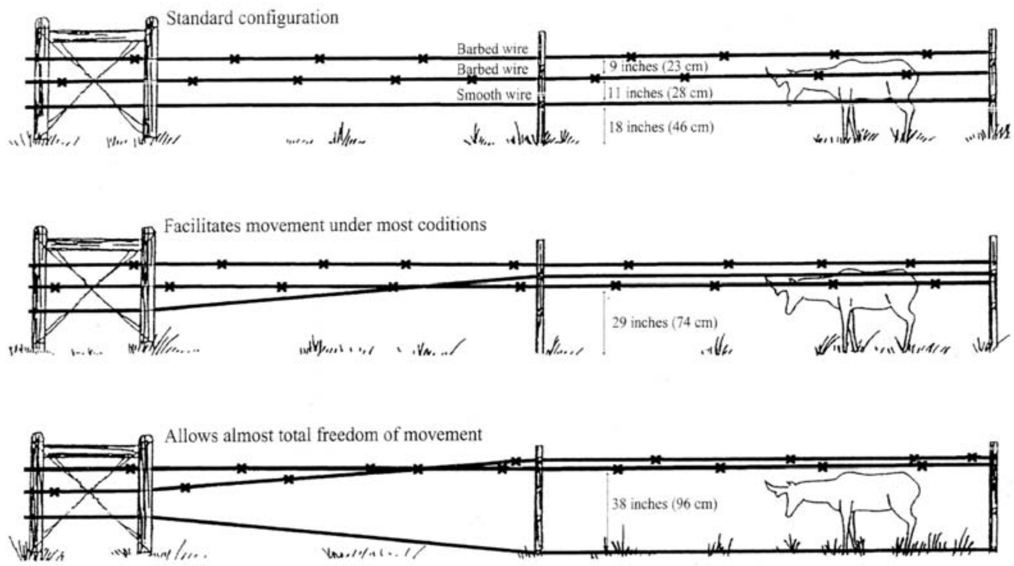


Figure 39. Three-strand barbed wire fence with modifications for pronghorn access (Anderson and Denton 1980). This design especially is beneficial when snow makes it difficult for pronghorn to crawl under the fence. The configuration depicted in the center would suffice during most winters. The 38-inch (97cm) clearance would be needed where snow depth exceeded 20 inches (51cm). If the fence blocked a movement corridor from summer to winter rangelands, long areas of modification might be required to accommodate pronghorn moving with a snowstorm. (from Yoakum 2004e).

Buck and Pole Fences: Wood fences constructed of aspen or pine logs are no longer widely used on rangelands due to their labor–intensive construction, the local scarcity of materials, and difficulty of transportation. Nonetheless, such fences, are still found due to heir aesthetic values and durability in areas of heavy snow.

Scott (1992) reported on the ability of pronghorn and other wild ungulates to negotiate through a buck and pole fence on the northern boundary of Yellowstone National Park in which the bottom rail was 18 inches (46 cm) above the ground. Of the pronghorn that attempted to reach the other side, 72 % either passed around the fence or crawled under the fence even though they sometimes experienced some difficulty in the process. Pronghorn encountered more problems on the park side of the fence, which had four wood rails as opposed to only one brace rail on the other side. Pronghorn too inhibited to pass through the fence walked along the barrier until finding an open gate or other opening. A suggested design that allows pronghorn to pass through a buck and pole fence is provided by Karsky (1988) in Figure 40.

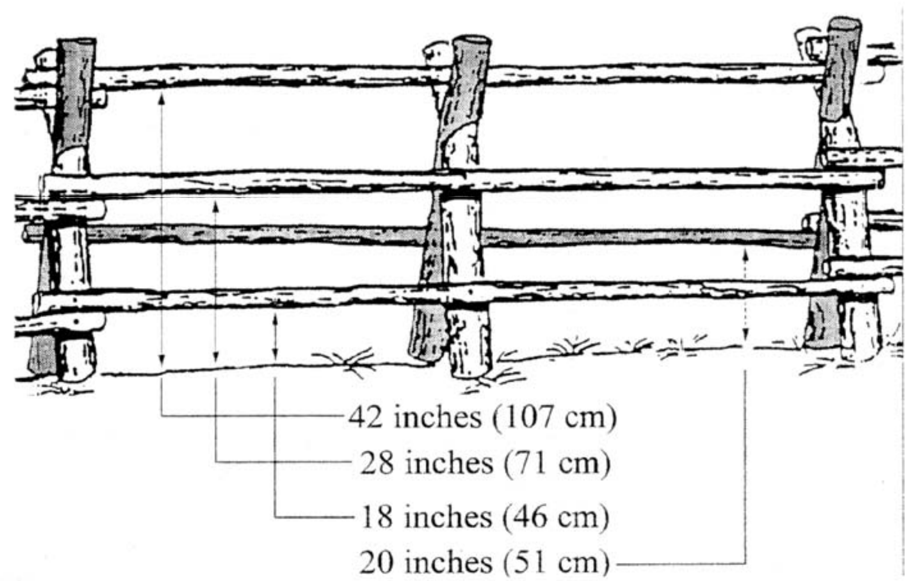


Figure 40. Typical section of a three-rail buck and pole fence that will allow pronghorn to pass through (Karsky 1988). An attribute of this type of fence is that it enables snow to be scoured out by turbulent winds, making the fence negotiable during times of deep snow without the requirement of seasonal removal. However, wooden fences generally are not used on western rangelands because materials are costly, and the fences are labor intensive to build and maintain. (from Yoakum 2004e)

Electric and Other Anti-pronghorn Fences: Management objectives may at times seek to prevent pronghorn from entering a certain area or to restrict their movements to within an area (Yoakum 1980, Yoakum et al. 1996). Such restrictions can be accomplished with an electric fence that carries intermittent electrical charges that shock animals coming into contact with the fence. Once pronghorn are exposed and conditioned to an electric fence, such fences can pose a psychological barrier as well as being a physical obstacle. Such fences are relatively easy to install, have a reasonable service life, and may result in a 25 to 30% savings in the cost of labor and materials (Karsky 1988).

Standard, two wire electric fences, have effectively managed livestock on Western rangelands, and kept pronghorn our of newly planted rangeland seedlings in Malheur County, Oregon (R. Kindschy, pers. com.).

With recent innovations, electric fences, formerly considered temporary structures, can now be virtually permanent. Standard energizers can electrify up to 6 miles (9.7 km) of wire with a useful life of up to 4 years. Recently developed New Zealand energizers can effectively electrify more than 75 miles (121 km) for a period of 10 to 15 years (Karsky 1988).

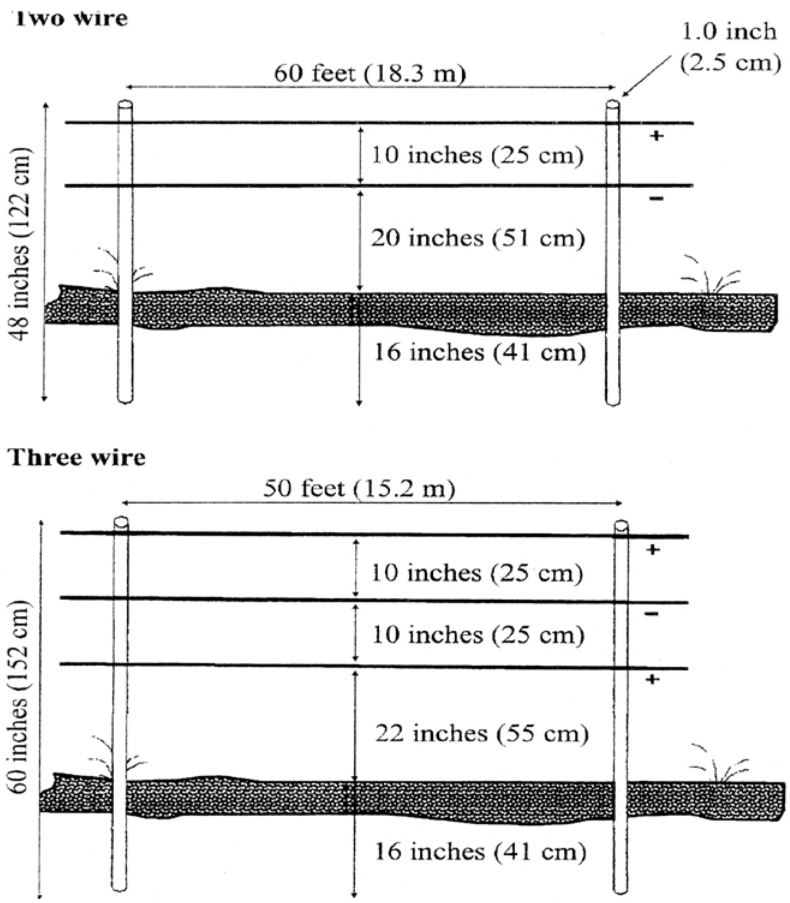


Figure 41. Two-(top) and three-wire (bottom) electric fence designs featuring 0.75 1.0 inch (1.9-2.54cm) diameter, solid, fiberglass line posts. The wire is 21.5 gauge, class III galvanized, with a maximum tensile strength of 170,000 pounds per square inch (11,953 kg/cm2) and a maximum breaking strength of 1,308 pounds (626 kg). The wires are connected to the line posts and stays by metal clips. (from Patritch 2005).

In central Colorado, a three-strand electroplastic-twine fence was installed around an alfalfa field visited by pronghorn (Pojar et al. 2002). In addition, the field was fenced with sections of four-strand barbed and net wire to control livestock. Before the electric fence was installed, the daily mean daily number of pronghorn on the field over a 6 day period was 38.7. After the electric fence was erected, the mean daily number was 2.16 (n=70). This study indicated that electric fences can be a substantial barrier to pronghorn movement, especially where the animals come into contact with "live wire." Hence, to facilitate pronghorn passage, electric wires should not be strung so that the bottom wire is "live" (Fig. 41). Even so, future research on the use and non-use of pastures bordered by electric fences is much needed.

When erecting a permanent electric fence to exclude pronghorn, Pojar et al. (1994), suggested building a 60-inch (150 cm) tall five-strand (or more) high-tensile wirer fence, as described by Palmer et al.(1985). Such a fence (Fig. 42) would result in a fence with a long life, low maintenance costs, less expensive than conventional net-wire fencing, and be an effective barrier for both pronghorn and deer.

Recently, preliminary results of a long-term study relative to the effects of electric fences on bison, elk, deer, pronghorn and cattle for fences constructed on rangelands were reported by Patrich (2005). Specifics of the fence designs tested are in Figure 29. When a pronghorn or other ungulates came in range, a camera recorded the animal's reaction to the electric fence resulting in 191 recordings for pronghorn. Findings indicated pronghorn were not often severely shocked. Apparently electric shock appears not to be an important factor influencing reactions. The insulating quality of pronghorn guard hairs, combined with generally dry soils, allow animals to contact the hot wires and feel little or no pain. They may be more susceptible to shock when the soils are wet. The authors contended that a 3-wire fence is as effective structure to meet the goals of controlling bison and livestock, and allowing pronghorn, deer, and elk access on western rangelands.

*Antelope Passe*s The 1963-64 Wamsutter, Wyoming, pronghorn-fence research project, saw the development of several devices purported to facilitate the movement of pronghorn through fences (Spillet 1965, Spillet and Zobell 1967). One of these, the "the antelope pass" (Mapston 1968, Mapston and Zobell 1972) was essentially a miniature cattle guard that capitalized on the tendency for pronghorn to "broad jump" rather than "high jump." These "antelope passes" were placed in strategic locales, usually near a fence corner, and monitored for use by pronghorn (Figure 42).

Unfortunately, later field tests showed that although some adult animals jumped over the guards, others refused to negotiate them. Fawns could not easily leap over the structures and some suffered leg injuries in the attempt. Investigators therefore concluded that, even with a doubling of the "passes' width, the "antelope pass" was of limited value and should only be used if no other means of passage could be provided (Newman 1966, Kerr 1968, Mapston 1968, Bear 1969).

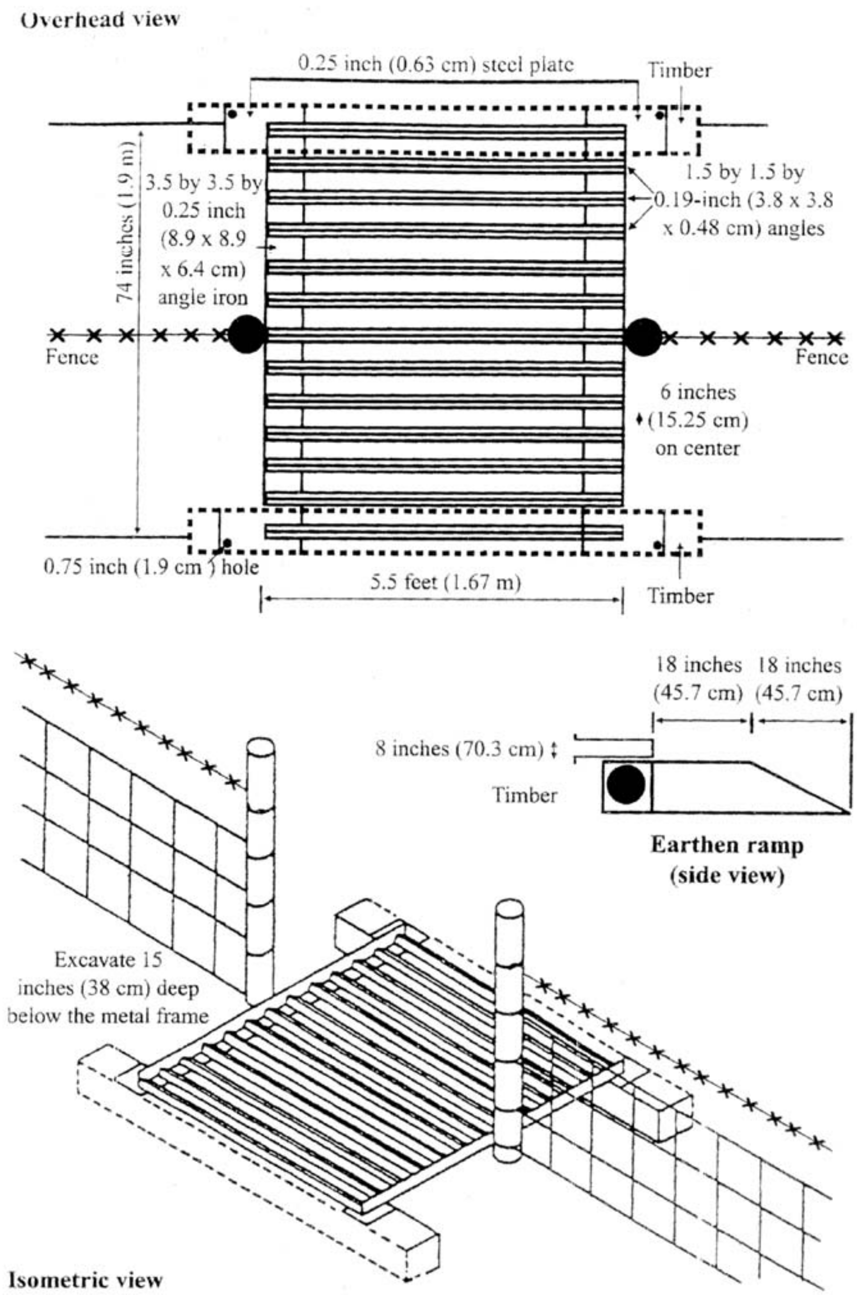


Figure 42. Antelope passes were designed and tested to allow pronghorn passage through woven-wire fences on public lands in Wyoming (Mapston 1968). These structures were about half the size of standard cattle guards and designed to prevent vehicle access. Because they are narrow, the cost of materials to build an antelope pass is about half that of cattle guards (Mapston and Zobell 1972)

Recommendations for Fencing Pronghorn Habitats: The issue of pronghorn/fence interrelationships involves biological, managerial, and legal decisions; therefore, the following checklist should be reviewed prior to installing fences on pronghorn habitats (Yoakum 2004).

1. No fencing should be constructed until a comprehensive evaluation has been made for each proposed project site. The probable effect the proposed fencing would have on pronghorn and the benefit to livestock management should be evaluated and determined to the extent possible.

2. Where fencing is deemed necessary, only the minimum amount for livestock management should be permitted. Where fencing is required, provisions should be made for unrestricted passage for all pronghorn age classes, during all seasons, and under all climatic conditions.

3. Fencing a waterhole may be as detrimental as fencing a seasonal movement route. Critical pronghorn habitats (winter concentration areas, seasonal movement corridors, fawning areas, water sources, etc.) should be designated as "special" biological areas requiring specific justification to be fenced.

4. Barbed-wire fences for cattle that allow pronghorn movements should consist of three strands of wire with the bottom wire smooth and 16-18 inches (41-46 cm) or more above the ground, with maximum heights of 36 inches (91 cm).

5. For rangelands having domestic sheep the problem is more complex. Any fence that effectively controls sheep will most likely restrict pronghorn movements. Net wire fences should not be built in pronghorn habitats. Where net wire must be used, mitigating provisions such as let-down panels or adjustable fences should be incorporated into the fence line at strategic pronghorn movement sites.

6. Specially designed fences (buck and pole, rail, suspension, etc.) should be no higher than 34 inches (86 cm) from ground level, with a bottom gap at least 16 inches (41 cm) above the ground.

7. All new fences should have white rag flagging tied to the top wire between each post to improve visibility of the new hazard. Pronghorn may become accustomed to the new fence by the time the flagging deteriorates. Grey "camouflage" steel posts should be avoided.

8. "Wolf-type" fences to exclude coyotes from pastures completely restrict pronghorn movements. The construction of this fence design should not be allowed on public rangelands occupied by pronghorn.
9. "Antelope passes" have been shown to be of limited value because fawns have been observed to break legs trying to jump over the guards. This is particularly true where such devices are only infrequently used, as in areas with low pronghorn densities, or seasonal movement corridors.

10. *No more than two "stays" should be permitted between fence posts to allow sufficient slack in the bottom wire. If three or more stays are used, no more than*

two stays should be attached to the bottom wire. Many highway and pasture fences are too "tight" for easy pronghorn egress and ingress.

11. Let-down fences serve well under some circumstances. A major concern is the managerial guarantee that the fence will be let-down prior to severe snowstorms.

12. Where rangeland operations switch from domestic sheep to cattle, net wire fences should be removed or extensively modified to allow pronghorn movement.

13. Emphasis should be placed on reduced fencing, and other livestock control methods such as herding should be considered as alternative management practices. Livestock operations, especially for domestic sheep, should be implemented with minimum fencing.

Existing fences that restrict pronghorn movements should be modified to allow free passage for these animals. Modifications should include the total removal of unnecessary fences, removal of excess wire strands, restringing bottom wires to >16-18 inches (41-46 cm) above ground level, replacing barbed bottom wires with smooth wire, and installation of passage devices (goat bars, let-down panels, adjustable fences, etc.).

Dysfunctional fences in pronghorn habitat that no longer serve their intended purpose should be removed. Abandoned fences, together with cattle guards, corrals, and other structures, have the potential to cause injury and impede the movement of wildlife, especially pronghorn.

Although funds are often requested to construct new fences, funding to remove dysfunctional fences are often difficult to come by due to the lack of an immediate objective. And, because the disassembly of fences, is rarely part of a government agency's budget, it is important that periodic evaluations and management plans address this need. Similar procedures should also be employed on private and other lands as a responsibility of land stewardship.

Fortunately, problems associated with abandoned or unnecessary livestock fences are increasingly being recognized. This is especially so on wildlife refuges, and to a lesser extent on lands administrated by the U. S. Forest Service and Bureau of Land Management. As a result, such agencies are encouraging public organizations to remove and salvage unwanted fences—especially those in pronghorn habitat. Sportsmen's groups and conservation volunteers are increasingly taking up this challenge and are themselves requesting land management agencies to conduct fence inventories and participate in cooperative fence removal projects. Since the 1990s, the Oregon Natural Desert Association, the Order of the Antelope, and numerous other conservation organizations, have assisted in dismantling hundreds of miles of fence in pronghorn habitat throughout the West, not only on federal land, but also on state and private lands. Indeed, such cooperative projects, along with similar efforts at fence modification, have been a *cause celeb* providing both a purpose and field experience for such disparate organizations as the Arizona Antelope Foundation, the Sierra Club, various chapters of the Audubon Society, and a variety of land trusts—all working in cooperation with state and federal agency personnel.