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BARRIER FENCING IN WILDLIFE MANAGEMENT

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SUMMARY: Barrier fences have been used to control animal and human depredations since ancient times. They have exerted considerable influence upon the culture of the "protected" areas even though protection was rarely complete. The following materials have been used in construction of fences: earth, vegetative materials, wire, electric shock, and synthetic materials. Fence designs must consider the size, strength, intelligence and/or instinct, and physical agility of the species to be repelled as well as the attraction of the crop or area for potential depredators.

Against deer, the 8-foot upright, vertical overhanging, outrigger and sloping fences are more successful than electric fences. The larger predators are difficult to control with fencing. Net wire fencing of 1/2-inch mesh is needed to keep all small predators out of the poultry yard. An L-shaped poultry netting fence topped with a hot wire has been found generally successful in protecting field crops against both carnivores and rodents. Lagomorphs can be contained with fences 30 to 36 inches high, but must be buried at least 6 inches underground to prevent digging under.

The lyrics of the popular song--D0N'T FENCE ME IN--would have one believe that fences are primarily designed to keep one from wandering. However, with the possible exception of jail birds, dairy cattle and zoo prisoners, the purpose of most fencing is to keep "out" rather than "in." From the 1,500-mile long Great Wall of China down to the backyard chicken coop in prime weasel domain, barriers have played an important role in the development of civilization. South of the Great Wall of China, which reputedly cost a life for each stone laid and was a major factor in the overthrow of the Ch'in dynasty who built it, stable agrarian communities were built as compared to the warlike nomadic tribes of Mongolia on the north. Barbed wire turned free rangeland into farm homesteads in the West during the middle of the previous century. But the most striking example of the influence of fences in wildlife management lies in the dingo fences of Australia.

The Beltana Pastoral Company, one of the oldest livestock corporations in Australia, controls property bisected by a wild dog (dingo) fence (McKnight 1970). On the unprotected side of the fence, the corporation runs 7,500 cattle and no sheep. On the protected side, they run 3,500 sheep and no cattle though both properties are similar environmentally. Furthermore, during one drought period they ran some 16,000 sheep on the unprotected side. Even though the sheep were closeherded and put into dingo-proof yards at night over 3 per cent were lost to wild dog depredations. Thus we see that while fencing is expensive and may not be entirely satisfactory it remains an important consideration in the control of wildlife damage.

Many materials have been used to build barriers to keep depredating wild animals from man's croplands. The most primitive are earth and rocks. Earthen barriers either in the form of breastworks, pits or trenches sometimes filled with water are commonly used by developing nations. This is particularly true in Africa which has more than its share of unruly and overwhelming crop depredators. While built at considerable cost in man power, a sloped ditch that ends abruptly in a 7-8 foot precipice is really the only satisfactory answer to crop-raiding wildlife of the size encountered on that continent (Woodley 1965)-A somewhat less expensive type used against bush pigs in South Africa consists of digging a series of holes, two-feet deep and three-feet in diameter. The excavated dirt is piled up in loose mounds between the holes (Thomas and Kolbe 1942). Tribes in India build low ditches arraying the inner bank with several rows of sharpened bamboo spears to keep depredating antelope, like nilgai, from invading fields (Kumar et al. 1963). The moat that protected feudal lords in medieval times is now commonly used at some of the better zoos to prevent intermingling of the spectators of both primate and non-primate stock without the necessity of unesthetic iron bars. The moat principle has also been used effectively to protect native fields from elephants and antelope (Brown 1968).

Vegetation is used extensively in fences around the world. Probably the oldest use is the piling up of thorny shrubs in more or less temporary barriers as protection of sheep at night from depredations by jackals in India. The growing of thorny shrubs in tight

fences has been used by man for a long time as hawthorne hedges started during the Roman occupation still exist in Great Britain today (Encyclopedia Britannica 1970). In the past when it was not so essential to harvest every square inch of a farm, wildlife biologists encouraged farmers to plant osage orange, black locust or multiflora rose in living hedges to contain domestic stock and humans though these had little effect on the passage of small wild creatures. Mechanized farming practices have eliminated the hedgerow over most of the modern farm scene but these barriers still prevail in some of the developing countries. I have seen tight hedges of thorny succulents in both Haiti and India.

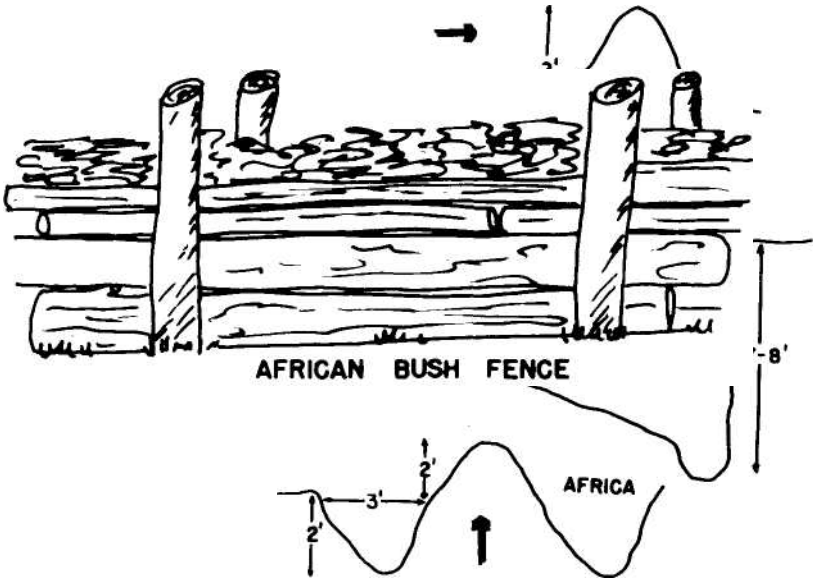
Vegetative barriers in the form of logs and posts are also used. Wooden posts stuck upright in the ground make successful kraals for cattle as they are not as apt to be stampeded by lions they can't see. A 112-mile bush fence built in Tanganyika (Thomas and Reid 1944) prevented the spread of a rinderpest epidemic. This was made of poles set vertically in pairs. Logs and heavy brush were piled between the uprights. Though the fence lasted only 3 years before natural deterioration took over, it apparently accomplished its purpose. Admittedly some of the effectiveness hinged on the fact that in building it the large number of natives cutting brush and making noise probably scared most of the game from the vicinity of the fence for some time. The only thing that got through it were some large carnivores and, of course, elephants. The latter would merely remove the brush and log piles faster than the natives could replace them.

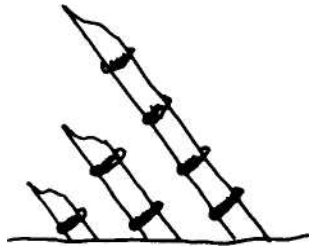
Wire is probably the most common fencing material used world-wide today. It is very flexible, light, easily erected and of reasonable cost. Wire can be used to keep out practically all animals except elephants and rhinos. Probably the widest variety of wire fencing has been designed to control depredations of North American deer. But the longest wire fences in the world undisputedly belong to the Australians. Their earliest barrier fences were for marsupials, but they really started fencing in earnest about i860 in an effort to control the rabbit menace. However, during the construction of long fences, rabbits merely made end runs before they could be completed. Emphasis on fencing has now shifted to controlling dingoes. By 1908, 5,600 miles of wild dog fence had been put up in Southern Australia (McKnight 1969).

The next type is the electric fence. This involves from one to three "hot" wires (Seamans 1957) attached to 110-volt house current--a dangerous and not recommended practice--or more frequently to a battery-operated voltage discharger. When the animal comes in contact with the hot wire, an electric charge traveling the wire jumps the short distance to the "grounded" animal giving it an electric shock. The "fence charger" giving an intermittent shock is considered more effective as the repetition of the shock appears to be a greater deterrent. Furthermore this is less dangerous than a constant flow of current as it tends to keep an animal from being killed by freezing on the wire. Barbed wire should be used on deer fences as the sharp barbs more readily penetrate the insulating hair coat to contact the skin (McAtee 1939). Unlike domestic livestock who can be easily retained by a single fragile electric wire, wild animals are not as easily discouraged. While electric fences have used some in the East (Anonymous 1959A), Bartlett and Boyce (1954) experimenting with twenty different types did not find one that could be considered "deer-proof." In California the deer problem occurs during the summer when the ground is dry. This results in poor grounding with subsequent loss of effect. To counteract this lack of ground, a manufacturer of electric fences recommends driving a 5-6 foot copper rod into the ground and soaking the area every day. (Anonymous 1959B).

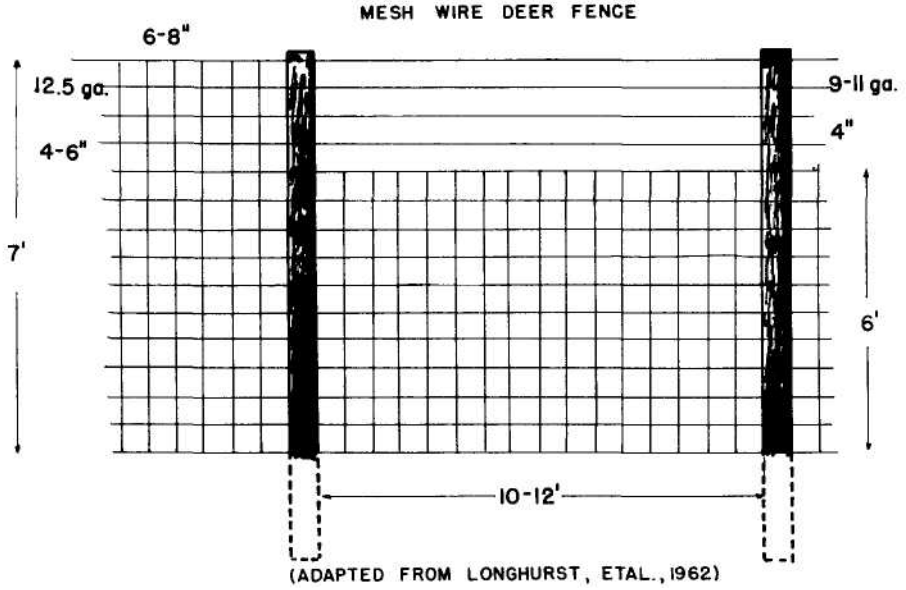
The last group used to build barriers includes a number of man-made materials--metal sheathing, burlap, plastic strips, nets, concrete and panels of plywood, asbestos, etc. Metal is commonly used in rat guards to prevent these agile rodents from climbing trees, ship hawsers, buildings, fences, etc. As it presents a smooth slick surface the animals cannot chew through or scramble over it. Burlap has been draped over a 6-foot wire fence to contain African antelope who even though capable of clearing 8-foot fences would not jump the lower barrier because they could not see the other side (A.D. Thomas, personal letter 1970). Plastic streamers covering the doorways make free flight pens for exotic birds in zoological gardens. These have also been used to keep birds out of open warehouse sheds while permitting easy access by humans. Plastic nets are used extensively over some high value crops to keep depredating birds out. Nylon fish nets, 8-feet high, strung around forest plantations keep deer out during the season of damage (Mealey 1969). The net must be regularly patrolled to release animals caught in it and to repair holes. It is a cheaper fence to build than a permanent 8-foot mesh wire one. Plastic mesh tubes are also proving practical in protecting individual seedlings from deer and rabbit browsing until they are safely established (Campbell 1969). Concrete is generally used in underground

EARTHEN BARRIERS





SHARPENED BAMBOO



curtain walls around buildings to keep Norway rats from burrowing into a building. Asbestos board buried in the face of dams is recommended to discourage muskrat tunneling (Fitzwater and Oderkirk 1961). These then are the materials that can be used in barrier fencing.

Next to consider are the adaptions necessary to contain different species. The first obvious consideration is the size and strength of the animals. An 8-foot chain link fence of 2-inch mesh will keep most animals out. Obviously it can't contain a pushy elephant or an inquisitive mouse. The next consideration might be the intelligence and/or instinct of the animals. A rabbit being confronted with a tight mesh fence will generally try to burrow under it, so the fence must be sunk several inches into the ground to be effective. Pronghorn antelope *are* more inclined to crawl through a fence than jump over it even though they easily could. Next consideration is the physical ability of the species. Deer being chased can clear over 7 feet. Norway rat burrows average about eight inches underground, but they can go down several feet under the right circumstances, thus a 3-foot curtain wall is considered minimum against this species. The last consideration is the attraction to breech a barrier. A vineyard in a desert oasis can expect the onslaught of a number of determined jackrabbits. To be successful such a fence must be closely maintained as well as tightly bui1t.

Fencing is usually directed against one of the following groups of wildlife: (1) hoofed animals, (2) carnivores and (3) rodents and lagomorphs.

HOOFED ANIMALS - Probably the longest fences in this country are to prevent depredations by members of the deer family. As mentioned above electric fences have been used with varying degrees of success. They readily short out when snow drifts or damp vegetation touch them. Under dry conditions their efficiency is lowered due to the lack of good grounding. The best fence against deer seems to be 8-foot high wire mesh. As they usually try to first crawl through a fence rather than jumping it at least the lower half must be made of a tight mesh as shown in the attached sketch (Longhurst et al. 1962).

Rather than going up the required 8 feet, there are a number of fence designs--overhanging, outrigger and sloping fences--that go up only 4-4.5 feet high. These take up more space than the 8-foot fence but are somewhat cheaper to build. A comparison of the estimated costs of these fences several years back is (Blaisdell and Hubbard 1956; Jones and Longhurst 1958):

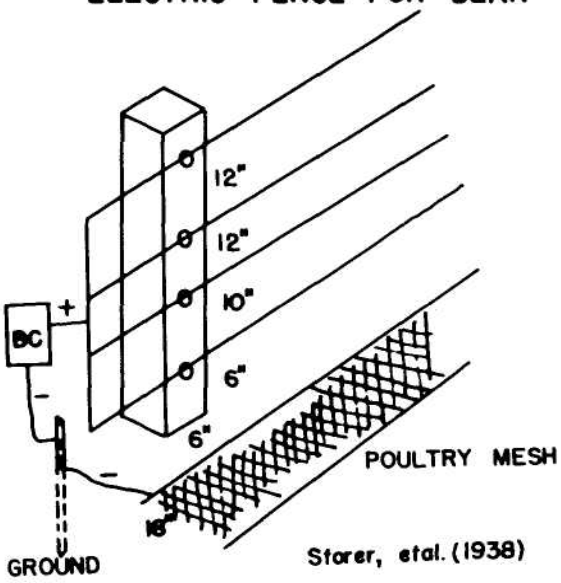
8-foot upright wire mesh fence.....	$2,500 per mile
Vertical overhang fence	1,700 per mile
Outrigger fence.....	1,320 per mile
Sloping fence	1,000 per mile

CARNIVORES - Against the biggest member of this family, bear, a four-wire electric fence mounted on sturdy posts was felt satisfactory in California for protecting mountain apiaries (Storer, Vansell and Moses 1938). Hot wires were spaced 6, 16, 28 and 40 inches above the ground. An 18-inch strip of poultry netting was laid on the ground directly in front of the fence and six inches away from it to provide a good ground. However, Floyd (1960) claims electric fences are useless against bears in Florida in similar situations. Bears in retaliation for the shock often broke the wires. Once they got into an apiary they were difficult to keep out. In Alaska, a 2-wire electric fence reduced by 2/3 the depredation from bear on salmon spawning grounds (Gard 1971). Again failure was blamed on breakage by irritated grizzlies.

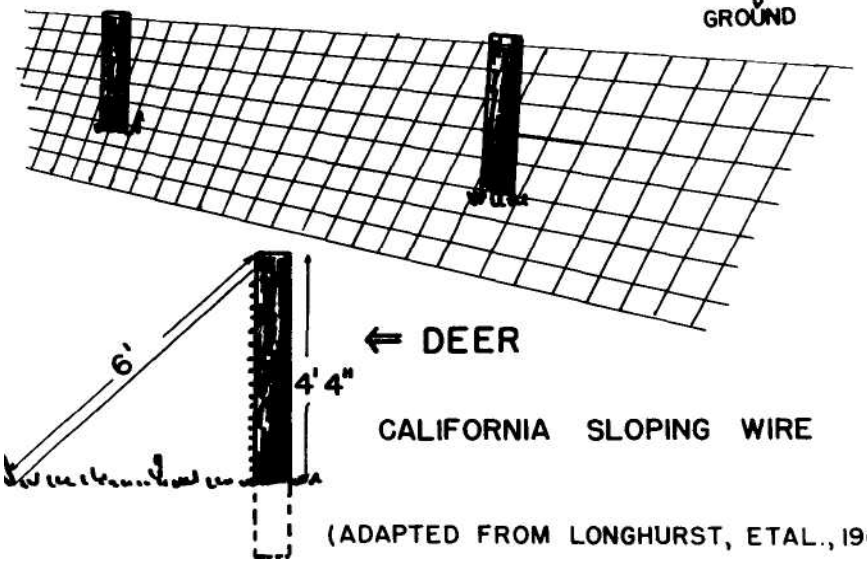
Coyote fencing is not considered as practical in this country as dingo fencing in Australia. The dingo fences are 6 feet high of 4-inch hexagonal mesh. The bottom while not buried is staked to the ground. (McKnight 1969). The recommended coyote fence is 51 inches high. This is topped by 1-2 strands of barbed wire, 3-4 inches apart. Another length of barbed wire is strung tightly along the ground on the opposite side of the fence post from the net wire to discourage coyotes from digging under (Wentworth 1948). This would pose only a minor obstacle to bobcats.

The smaller carnivores--fox, raccoon, skunk and weasels--are both crop and poultry depredators. Studies by Stullken and Kirkpatrick (1953) have shown that 1 × 2-inch welded wire mesh would exclude most of these species from a poultry yard but 1/2-inch hardware cloth would be necessary to exclude the smaller weasels. In the protection of field crops from these smaller animals, electric fences have been reasonably successful. In this case a mesh wire fence 18 to 36 inches high is erected. A hot wire is strung on insulators

ELECTRIC FENCE FOR BEAR

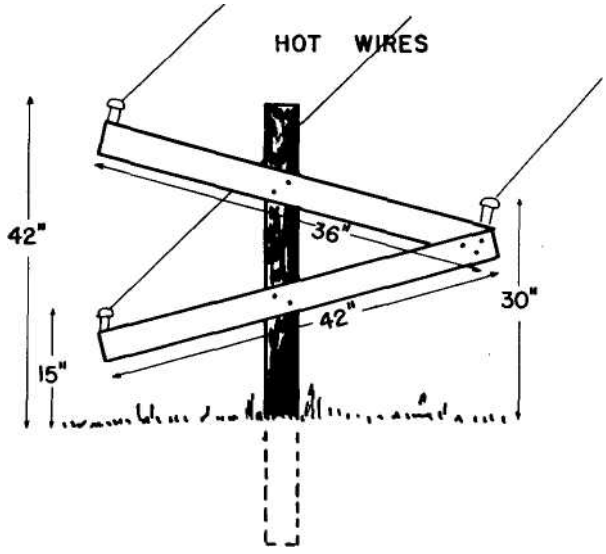


Storer, etal. (1938)



CALIFORNIA SLOPING WIRE

(ADAPTED FROM LONGHURST, ETAL., 1962)



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within 6 inches of the fence top and from 2 to 8 inches from the fence. The climbing animal is shocked as it attempts to climb over the fence. As skunks are poor climbers, the wire must be buried in the ground with a six to twelve inch shelf of wire bent outward to protect against this species.

RODENTS AND LAGOMORPHS - A 1.5-inch poultry wire mesh fence buried six inches in the ground is sufficient for the lagomorphs. The fence should be 36 inches above ground for jackrabbits but need be only 30 inches high for cottontails (Evans, Hegdal and Griffith 1970).

Muskrats and porcupine can be repelled by a combination net wire and electric fence described above under the carnivores. I have seen a very simple fence in Michigan that successfully repelled muskrats from a corn field. Only 18-inch wide poultry mesh was used. The bottom six inches were bent outward but not buried. A hot wire was strung on 3-inch insulators on the top of the very low fence just formed. This same idea was used on an electric fence to keep rats out of cane fields in the Philippines except the charge was designed to kill the rats rather than educate them (Uhler 1967).

Fencing is not only expensive in installation costs but requires constant maintenance to remain effective. However, it offers a nontoxic solution to animal damage problems around high value crops or installations.

LITERATURE CITED

ANONYMOUS. 1959A. Controlling deer, U.S. Bur. of Sport Fish. & Wildl. Reg. 5. 4 p.

ANONYMOUS. 1959B. What is holding them back? Wolseley Engr. Ltd. Brochure.

BARTLETT, I. H. and A. P. BOYCE. 1954. Deer-proof fences. Mich. Dept. Consv. Game Div. Rept. No. 1199. 3 p.

BLAISDELL, JAMES A. and RICHARD L. HUBBARD. 1956. An "outrigger" type deer fence. U.S. Forest Sv., Calif. Forest & Range Exp. Sta., Forest Res. Notes No. 108.

BROWN, D. W. J. 1968. Game control in Kenya. In_ Proc. of the symposium on wildlife management and land use. (Nairobi) p. 209-213.

CAMPBELL, DAN L. 1969. Plastic fabric to protect seedlings from animal damage. In_ Wildlife and reforestation in the Pacific Northwest. Oregon State University. (Corvallis, Ore.), p. 87-88.

EVANS, JAMES, PAUL L. HEGDAL, and RICHARD E. GRIFFITH, JR. 1970. Methods of controlling jackrabbits. 4th Vertebrate Pest Control Conference (Sacramento, Calif.). p. 109-116.

FITZWATER, WILLIAM D. and GALEN C. ODERKIRK. 1961. Controlling muskrats. U.S. Bur. Sport Fish. & Wildl., Reg. 3. 2 p.

FLOYD, JIM. 1960. Crop damage by deer and bear. Suggestions for control. Florida Wildl. Mag., Oct.

GARD, RICHARD. 1971. Brown bear predation on sockeye salmon at Kariuk Lake, Alaska. J. Wildl. Mgt. 35(2)193-204.

JONES, MILTON B. and WILLIAM M. LONGHURST. 1958. Overhanging deer fences. J. Wildl. Mgt. 22(3)325-326.

KUMAR, L. S. S., A. C. AGGARWALDA, H. R. ARAKERI, M. G. KAMATH, EARL N. MOORE and ROY L. DONAHUE. 1963. Agriculture in India. Asia Publ. House (Bombay, India). Vol. II, p.243.

LONGHURST, W. M., M. B. JONES, R. R. PARKS, L. W. NEUBAUER and M. W. CUMMINGS. 1962. Fences for controlling deer damage. Calif. Agr. Exp. Sta. Ext. Serv. Circ. No. 514. 17 p.

MC KNIGHT, TOM L. 1969. Barrier fencing for vermin control in Australia. Geographical Rev. 59(3)330-347.

_____. 1970. Biotic influences on Australian pastoral land use. Yearbook Assoc. Pacific Coast Geographers. 32:7-22.

MEALEY, ROBERT H. 1969. Nylon fencing to protect forest plantations from deer and elk. In Wildlife and reforestation in the Pacific Northwest. Oregon State University Corvallis, Oregon), p. 89-90.

SEAMANS, ROGER A. 1951. Electric fences for the control of deer damage. Vermont Fish & Game Serv., State Bull. No. 16. 77 p.

STORER, TRACY I., GEORGE H. VANSELL and BEN D. MOSES. 1938. Protection of mountain apiaries from bears by use of electric fence. J. Wildl. Mgt. 2(4)172-178.

THOMAS, A. D. and F. F. KOLBE. 1942. The wild pigs of South Africa. J. South Africa Vet. Med. Assoc. 13(1)1-11 .

_____and N. R. REID. 1944. Rinderpest in game. A description of an outbreak and an attempt at limiting its spread by means of bush fence. Onderstepoort J. Vet. Med. and Animal Industry. 20(1)7-21.

UHLER, LOWELL D. 1967. Seasonal abundance of Rattus rattus mindanensis at the International Rice Research Institute College, Laguna, Philippines. The Philippine Agric. 51(7)581-586.
WENTWORTH, EDWARD N. 1948. America's sheep trails. Iowa State Univ. Press (Ames, Iowa).
WOODLEY, F. W. 1965. Game defence barriers. East African Wildl. J. 3:89-94.