

Some call Dean M. Anderson Sky Rider, but he's really a Cyber Cow Whisperer.

His colleagues call him Sky Rider because he rounds up cattle with the help of Global Positioning System (GPS) signals coming from satellites.

But his prototype locator/controller cow collar also whispers electronic versions of the cowboy's "gee" (go right) and "haw" (go left) into the cow's ears. By controlling movement, the whispered commands act as a virtual fence.

"Cows can seem ornery if they don't do what we want them to do," says Anderson, an ARS animal scientist in Las Cruces, New Mexico. "After all, they still have some wildness in them from their prehistoric ancestors, aurochs." These wild oxen once roamed Earth freely. They stood 6 feet tall and were the subject of many a cave painting, along with woolly mammoths and bison.

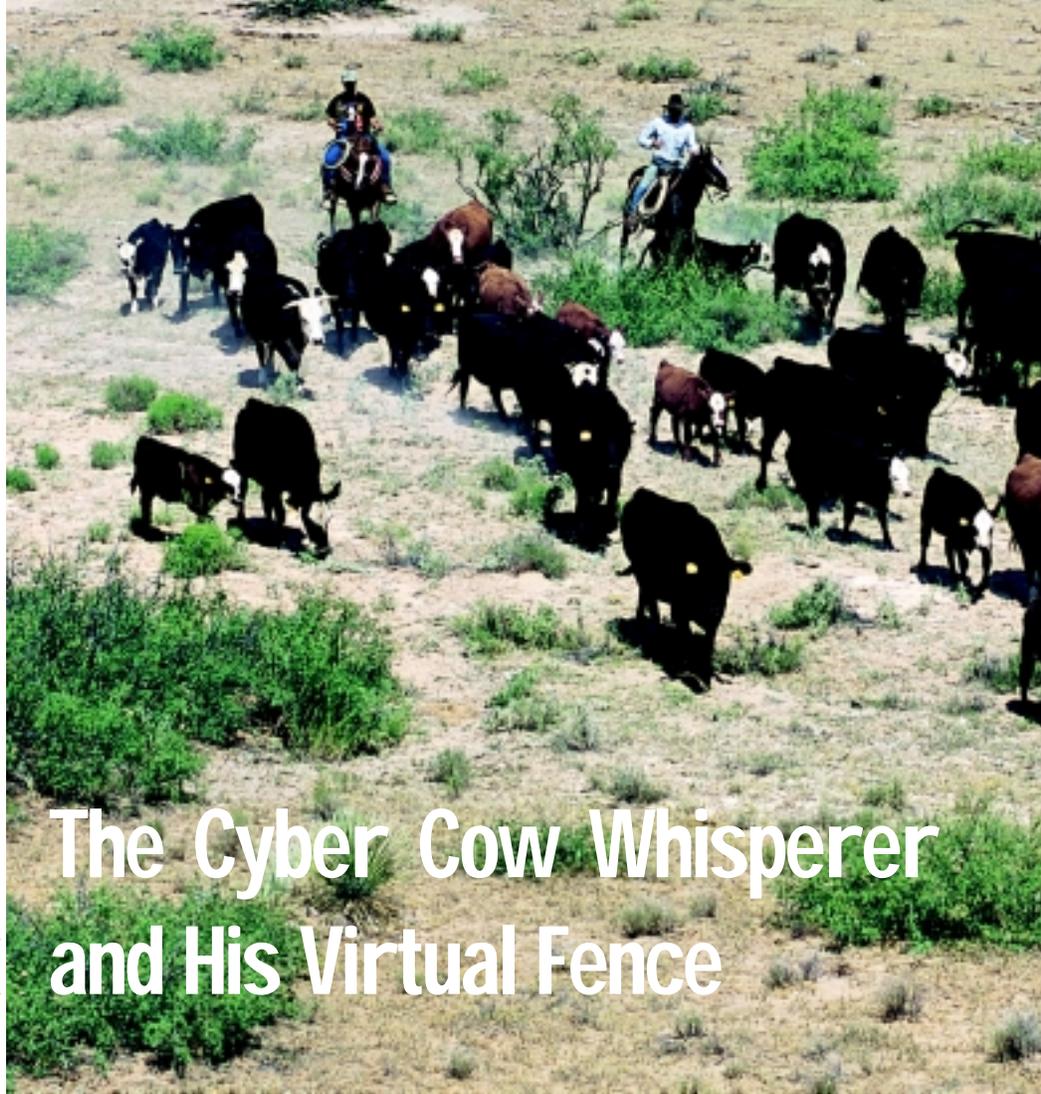
Anderson is a longtime student of using cattle's innate behaviors to manage them in a kinder, more effective, and gentler way. He has automated the husbandry principles of better-known practitioners of low-stress animal management, such as Bud Williams, Burt Smith, Temple Grandin, and Buck Brannaman, the real Horse Whisperer, played by Robert Redford in a movie of the same name.

Anderson also teaches low-stress animal-handling concepts, such as how to control cows by invading and retreating from their personal space.

"You can make a cow move in different directions depending on where you stand, or by the direction, angle, and speed of your approach," he says. "The virtual fence uses electronically generated cues instead of a person to achieve the same effect."

Hands-Off Cattle Drivers

Anderson oversees his "sky-riding" research from a pickup truck. He gives the cows their marching orders with a



SCOTT BAUER (K9102-6)

The Cyber Cow Whisperer and His Virtual Fence

On the 300-square-mile Jornada Experimental Range near Las Cruces, New Mexico, technicians Rob Dunlap (left) and John Smith round up cattle the time-honored way. High-tech equipment may make roundups easier in the future.

manually operated signal transmitter, which looks like a remote control for toy airplanes and cars. Anderson says manual control is necessary in the research-and-development phase, but eventually his virtual fence will be completely automatic, with all signals coming from satellites. Ranchers will be free to have their morning coffee while they check their computers to see their cows' movements over the past few days and then program future meanderings.

Anderson says that the patented invention won't replace resource managers or the cowboys who ride the range, but it will help them accomplish their goals by working on "animal time."

"Animal time is preferable to human clocks when managing cows and their behaviors. This reduces stress for both the cowboys and the cows."

Traditionally, cowboys and ranchers

rise before the cows and then wake the cows up to move them to another pasture. Balking cows often stand stubbornly between the ranchers and a second cup of coffee, not to mention the rest of their busy schedules. If the electronic whisper is used correctly, it can lower the stress of these cattle roundups.

Anderson explains: "It is desirable to administer the sound cues when the animal is moving. As a foraging animal approaches a virtual fence line and passes a programmed point, it activates sound cues to the animal's right or left side. Software in the device mathematically determines to which side the cues should be applied, based on the animal's angle of approach to the virtual fence line. Since animals tend to move away from startling sounds, if we want the animal to move left, we'd give the cues to the right side, and vice versa."



A prototype cow collar whispers electronic versions of the cowboy's "gee" (go right) and "haw" (go left) into the cow's ears. By controlling the cow's movement, the whispered commands act as a virtual fence.

sound and shock treatments, we leave it alone so we don't put unwarranted stress on it," Anderson says. "Remember, we're manipulating animal behavior, and a one-size-fits-all approach is simply not realistic."

He plans to attach heart monitors to some cows before proceeding much further, to quantitatively document the physiological impact the cues have on the animals.

"I don't think it stresses the animals unduly because many times I've seen them resume grazing shortly after being startled by a signal. The only difference is that afterward they're facing the desired direction," Anderson says.

Livestock Can Shape Landscapes

So why move a cow at all? One reason is to provide animals with enough high-quality forage to meet their nutritional needs.

"Improved testing technologies allow us to determine—in minutes rather than days—exactly what the animal has been eating. This information allows us to respond immediately in managing their needs, and the virtual fence can rapidly guide the animals to new areas of forage," Anderson says.

Furthermore, few land managers would dispute the pivotal role animal distribution plays in shaping landscapes. Past overgrazing certainly played a part in desert landscapes around the world.

Anderson and his cows operate on a range station established 88 years ago in the vast Chihuahuan Desert. In 1912, about 190,000 acres of semidesert rangeland in southern New Mexico were withdrawn from public use to form the Jornada Experimental Range. Sprawling between the San Andreas Mountains to the east and the Rio Grande Valley to the west, this research ranch is one-fourth the size of Rhode Island and is ARS' largest field station.

Since the Jornada's beginning, animal scientists have worked to establish principles for proper grazing manage-

ment by trying various tools to distribute cattle evenly over large pastures. Separating water troughs from salt blocks helped lure them to different areas but has never been fully successful.

"There are few, if any, simple answers when it comes to managing animals," Anderson says. "Fences are the only sure way to rotate cattle grazing areas, but they're not always practical here in the arid Southwest, where a cow may have to graze more than 640 acres to get enough grass in a year."

Early in his research career, Anderson experimentally evaluated rotational stocking, in which large numbers of cattle were moved through a series of relatively small paddocks at short intervals to prevent overgrazing. This procedure had merit; but conventional fencing costs, even electric fences or suspension fences with widely spaced posts, made it an economically questionable practice outside the research arena.

For the first time, virtual fencing offers a tool to improve foraging through manipulating animal distribution and stocking density in a flexible and rapid manner without the need for continuous human presence or ground-based wire and posts.

"It is obvious how excluding animals from areas with poisonous plants or sensitive landscapes—such as stream areas—could be accomplished using this device; however, it may be less obvious how animal density can be managed," Anderson says. Virtual fence lines do not have to enclose just acreage; they can be programmed to surround individual animals. Group dispersion can be managed by deciding how close together individual animals should be during foraging or other activities.

Origin of the Concept

The idea of a virtual fence for cows came to Anderson when he was a graduate student in the mid-1970s—long before current technology was available.

"On Highway 6, just north of Waco,

First, Get Their Attention

The initial sound cues are soft, although they can get louder if the animal continues to move without changing direction. At another predetermined point, a mild electrical shock—also capable of increasing in intensity, if needed—is applied from a battery on the collar to reinforce the sound. The shock is the same as that given off by electronic collars used to train dogs or keep them within safe boundaries. It's designed to get the animal's attention without inflicting physical harm. Preliminary research indicates it's seldom necessary to use the electric shock, or even raise the decibels, once cows learn the consequences of not responding appropriately. It takes only a few times for them to learn the correct response.

"If a cow's too stubborn to go the way we want it to go, even after a full set of

1 Craig Hale (left), of Future Segue, and animal scientist Dean Anderson examine the prototype virtual fence device they invented. Audio cues generated from the device tell the cattle which way to move. (K9102-1)



2 Technician Roy Libeau (left) and Anderson place a neck saddle containing the prototype virtual fence system on a cow. (K9102-7)



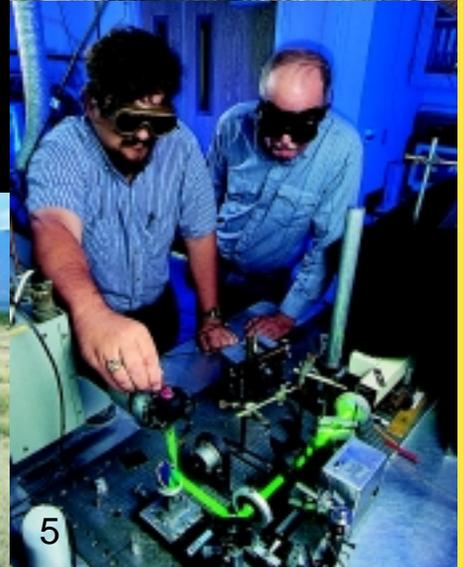
3 The prototype virtual fence device is shown here as a neck saddle. Future versions may be reduced to the size of an ear tag or smaller. (K9102-9)



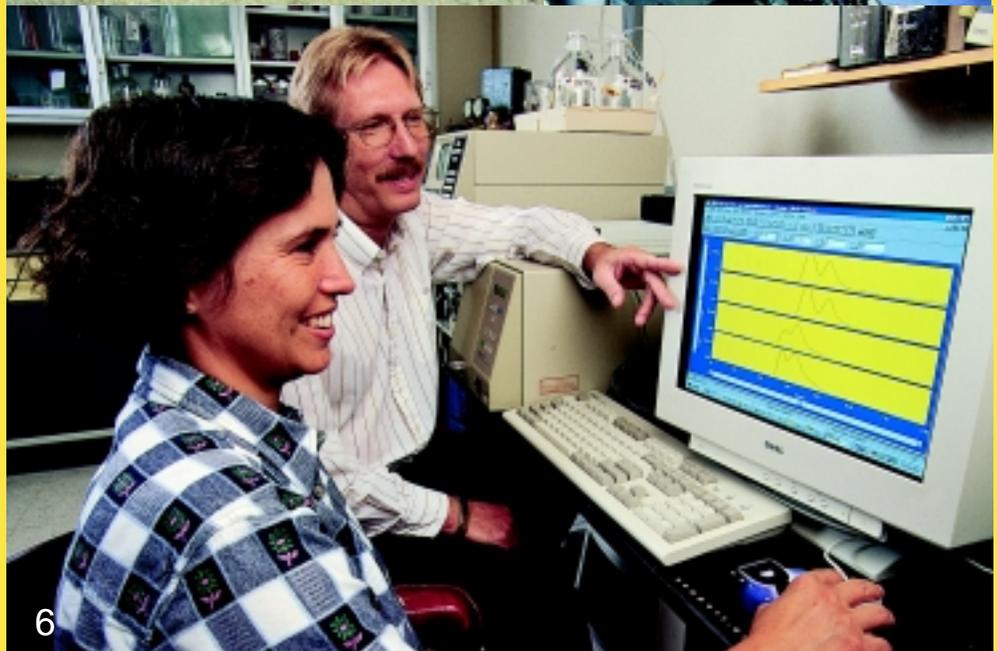
4 Cattle and sheep grazing together in a "flerd." The animals are bonded socially, so they remain together. (K9101-17)



5 Gary Rayson (left), an associate professor at New Mexico State University, and Anderson use fluorometry to rapidly determine diet composition of free-ranging herbivores. (K9101-19)



6 Postdoctoral research associate Mary Lucero and animal scientist Rick Estell evaluate plant-extract data from diets of cattle. (K9101-20)



Photos by Scott Bauer

Texas, my graduate adviser and I were driving and talking when a small paddock came into view. There, with outstretched necks, leaning against a fence that no longer stood upright, was a menagerie of livestock, all attempting to secure that last blade of green grass just out of reach. My professor commented: 'That is what fences were not designed to do,'" Anderson recalls.

"I thought, That's right. If you manage cattle correctly so they have enough nutritious plants to eat all the time, you should be able to manage them with a fence that's as invisible as radio waves."

Intermingled Species Graze Safely

Anderson and colleagues have used electric fences on the Jornada to protect sheep from predators. To help eliminate the use of the costly fences, Anderson again turned to innate animal behaviors as management tools. Cattle and sheep won't always stay together if stocked on the same pasture. But if a bond between the two species is formed, the sheep will consistently stay close to the cattle in a configuration termed a "flerd."

Anderson and Clarence V. Hulet, a retired ARS animal scientist, raised lambs with young heifers for 30 to 60 days to get them to bond to cattle. The cattle drive off coyotes and stray dogs.

There is another benefit to intermingling cattle, sheep, and even goats: Bonded livestock species spread themselves more evenly over the pasture during foraging, compared to animals that have not bonded. Furthermore, sheep tend to eat plants passed over by cattle, so more animals could potentially be raised per acre. Anderson and colleagues found that adding two sheep per cow did not damage the range during years with average to above average precipitation. With virtual fencing, sheep and goats could experience the same freedom as the instrumented cows they follow.

Who's the Boss?

"With virtual fencing," says Anderson, "I'm again trying to capitalize on innate animal behavior. I will accomplish my management goals, but on their schedule. It's like doing a job the way you know it should be done, but letting your bosses feel like it was all their idea.

"For example, after a cow has been in a corral for a drink of water, with a few subtle cues as she leaves the corral it should be possible to move her to a new area to graze. A fundamental law of physics is that it's easier to move a body that's already in motion than to start one moving from a dead stop," Anderson says.

"If you let the animals think they're winning and still accomplish your goals, you have a win-win situation—and you don't need a 'Berlin Wall' to hold them in. My career has focused on the efficient and humane treatment of animals—from rotational grazing, to weighing animals as they pass through gates to a water trough in a pasture without having to gather them in a barn for manual weighing, to the virtual fence, which allows the animal to move freely but under guidance based on sound ecological practices." Anderson credits USDA's Natural Resources Conservation Service, Grazing Lands Technology Institute, for providing financial support for his research.

It's Economical, Too

For large areas of the world, conventional fencing is just not economical, yet animal control is desperately needed to prevent improper resource use.

"Half of the cost of fencing is in the labor, which would go sky-high if you fence high mountain pastures," says Anderson. But with virtual fencing, "you no longer have to fence for human convenience. Virtual fences can go wherever the ecology dictates the cow needs to go. In the past, we've always placed fences based on accessibility—whether by vehicle, horse, donkey, or on foot. Human convenience has always won out, not any theory of range management.

But that's not always best for the range or the cow."

Anderson believes that technological advances will eventually make the virtual fence more affordable. "In the future it may be possible to instrument individual animals for only a few dollars apiece," he says. "Data I collected in 1998 suggested that conventional fencing costs from \$1,200 to \$14,000 per mile for materials and installation."

But Anderson thinks cost won't be as big a barrier to adopting virtual fencing as the ability to think differently about cattle management. Since cows follow leaders, and bonded sheep and goats follow cows, Anderson envisions needing the virtual fence device only on the leaders. He plans research to find out how and if he can identify the characteristics of leaders among range animals.

"The leaders on the range may not have the same motivation to lead as the animals that are always first to enter the milking parlor," he says.

Anderson makes it clear he isn't advocating an end to conventional fences. "Fences that mark property boundaries or protect the health and safety of people or livestock should not be replaced with virtual fences," he says. "But for management of vast acreages, eliminating internal fences may be ecologically and environmentally judicious."

"The cow won't do the job like a 9-to-5 employee, or even a 4 a.m. to-10 p.m. rancher," Anderson says, "but the cow will do the job—with a little help from 21st century technology."—By **Don Comis**, ARS.

This research is part of Rangeland, Pasture, and Forages, an ARS National Program (#205) described on the World Wide Web at <http://www.nps.ars.usda.gov>.

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