Ghostly Grazers and Sky Islands

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Abstract—*The evolution of the western range involves millions of years of coexistence of herbaceous plants with a great many kinds of large herbivores, most of the latter suddenly removed around 13,000 years ago. The fossil record indicates more diversity of large herbivores before this time, not less, and with more taxa of large herbivores consuming more forage than livestock eat at present. With extinction of megafauna coinciding with Clovis colonization around 13,000 years ago, large herbivores and their herbivory decreased. Most of our large native herbivores vanished when these prehistoric people invaded. In addition the invaders triggered a considerable surge in fire frequency, declining historically with the introduction of domestic livestock. As archaeologists and geographers have long realized, environmentalists must not overlook or ignore but embrace prehistory.*

Fenceline Mirage

New to Arizona in 1956, I glanced down a fenceline. The fence separated pastures between two ranches in eastern Cochise County. I was near the foot of a Sky Island, the Chiricahua Mountains. The grass on one side of the fence was close-cropped and short; the other was ungrazed with knee-high heads of native grasses, probably including species of *Aristida* (three-awn), *Bouteloua* (grama), and/or *Muhlenbergia* (muhly), all important range grasses with many species in Arizona and New Mexico and many more species across the border in northern Mexico. There was no doubt on which side of the fence the grasses were flourishing and "natural" and therefore more desirable, and which side was eaten down or "overgrazed."

"Viva biomass! Hug the grass! Damn the cows," I thought. That summer was unusually hot and dry. One well-to-do rancher in the Animas Valley in New Mexico loaded his cattle onto trucks to transport them to greener pastures he leased in eastern Colorado. In the fall another couple I had befriended, Alden Hayes and his wife Gretchen, who provided informative answers to all my questions about a region totally new to me, lost their ranch just east of Portal. The spotty summer rains missed the Hayes' pastures; there would be no increase in their herd and the bank foreclosed the mortgage.

Alden had degrees in anthropology from the University of New Mexico and he soon found employment with the National Park Service south of Phoenix at Casa Grande National Monument.

In recent years the "shoot-from-the-hip" environmental judgment of grass huggers who oppose grazing has been gaining traction. Nevertheless, as a starting point for sharpening insight, one could do worse than consider differences through time in the biomass one sees across fencelines. The longest fenceline, to my knowledge, runs along the border separating the grassland and oak woodland of southeastern Arizona from the grassland and oak woodland of northern Sonora. Differences in grazing intensity are clearly visible in the reflectivity seen in satellite images. Pastures on the Mexican side have a distinctly lighter tone than on the Arizona side, where grazing is less intense. Not bothered by the heavier grazing on the Mexican side, those in search of extra diversity in this region must cross the border and head south to find an environment increasingly richer in endemic species.

Census data on grass populations across fencelines are available in southeastern Arizona at the Appleton-Whittell Research Ranch (TRR), 7,800 acres ungrazed since 1969. Carl and Jane Bock compared the biota of moderately grazed pastures adjoining the ungrazed grassland within TRR (Bock and Bock 2000). The results are less alarming than cow cursers might have us believe. Still, in the 1950s, I bought the party line: "cows eat grass and that favors the weeds; cows destroy riparian plants when they trample springs and wet ground; cows are bad and livestock ranching should be eliminated." Is this interpretation invariably sound?

Extinctions in "Near Time"

Through radiocarbon dating, I learned of the dramatic extinctions in "*near time,*" the last 50,000 years. Sweeping extinctions eliminated two-thirds of the large terrestrial mammals native to America around 13,000 years ago. Similar extinctions of large mammals, reptiles, huge flightless birds, and even some trees of the rainforest struck in Australia 50,000 years ago. In the last 3,000 years many species of flightless endemic birds, especially flightless rails, vanished from the islands in the Pacific and Indian Oceans. These and other prehistoric extinctions around the globe march in step to prehistoric human colonizations (Martin and Steadman 1999, Martin 2005).

Before 13,000 years ago America was wonderfully rich in large mammals (Lange 2002). In the Pleistocene, America was far richer in diversity of large mammals than those found by Lewis and Clark. Before the extinctions American diversity of large mammals was much more like that of Africa or tropical Asia. Then around 13,000 years ago people entered the

Americas, very likely from over the Bering Bridge. Coinciding with human arrival of Paleolithic people in the New World, about 100 genera of large mammals disappeared.

What does the prehistoric past have to do with fencelines? When we look down a fenceline on the western range we need to keep in mind the fossil record of the Cenozoic, the last 65 million years and the age of mammals, ending in the ice ages, the last two million years, punctuated, as we have seen, by sweeping extinction of large mammals in America just 13,000 years ago. Some paleontologists have interpreted the megafaunal extinctions in near time as the result of ice age climatic change. But the extinctions strike at the end, not the beginning of the Quaternary ice age, making it unlikely that they were forced by some unique continent-wide climatic change. The human invasion of America is a close chronological fit.

Before the extinctions of 13,000 years ago North America supported at least six species of proboscideans, more than six species of equids and many artiodactyls, such as camelids, stag moose, and brush-oxen, soon to join the ranks of the extinct. There were giant edentates, both ground sloths and glyptodonts; the largest ground sloths equaled an African elephant in size. There were giant tayassuids (javelina) and giant beaver the size of a black bear. In the extinction process all large American mammals mentioned above and even some smaller ones became extinct, as did all the glyptodonts and all American proboscidea.

In the pampas Charles Darwin was among the first to collect the strange bones of what Sir Richard Owen later described as two new orders of South American endemic mammals, the litopterns and the notoungulates. They too vanished late in the Pleistocene when extinctions swept through the Americas. Only in the West Indies did sloths (suborder Phyllophaga) disappear in the mid postglacial rather than around 13,000 years ago, coinciding with the age of the earliest archaeological sites in the Greater Antilles.

Extinction of the largest mammals of the West Indies, the ground sloths, and arrival of prehistoric people lagged similar extinction and human colonization on the mainland by about 7,000 years. Had climatic change been responsible for the extinctions, the West Indian ground sloths would not be expected to postdate extinction of continental ground sloths.

Such a mighty menagerie of giant Pleistocene herbivores was accompanied, not surprisingly, by a retinue of large carnivores, the American lion, a giant short-faced bear, saber-tooth and dirk-tooth cats, cheetah, and a variety of New World avian scavengers to match the largest vultures and storks found now in Africa. In brief, most of the native fauna of America vanished long before ranching of livestock began.

Confined by the trivial timescale of the written word, the history of America available to historians is limited to the last 500 years. Our familiar historic figures, with Columbus, Cortez, and Coronado, also include Alvar Nuñez Cabeza de Vaca who, following shipwreck, found himself and his three surviving shipmates no longer conquerors but captives at the mercy of the natives. They managed to escape, then became venerated as shamans, and traversed an unknown route of over a thousand miles from the Texas coast west through the Chihuahuan Desert and over the Continental Divide to Sinaloa on the Pacific slope of Mexico where they found their countrymen.

Figure 1—Bison on the Armendaris Ranch, June 1996.

Had they traveled in a straight line, which they did not, Cabeza de Vaca and his three companions would have walked at least a thousand miles through the interior of America. They may or may not have journeyed past the Chiricahuas and other Sky Islands. One of them, the slave Estevan, guided Fray Marcos ahead of Coronado north to Zuni where he was killed. He and Coronado may have traveled close to if not through the Sky Islands.

Of interest for our purpose here is the fact that while on his trek from the Texas Coast west to Sinaloa, Álvar Nuñez Cabeza de Vaca often mentioned bison (Adorno and Pautz 1999). Nevertheless, he mentioned no vast herds of tame animals comparable to those seen by Lewis and Clark in Montana.

"Spanish and American explorers in the Southwest failed to find bison in desert grassland west of the Pecos River in eastern New Mexico. … However, the archaeological record indicates their presence in southern Arizona" (Parmenter and Van Devender 1995: 214). According to range scientists Tom Waddell and Joe Truett both bison (figure 1) and prairie dogs are doing very well following introduction on the Armendaris Ranch of Ted Turner, east of the Río Grande in southern New Mexico (personal communication, February 21, 2005).

Vertebrate fossils add insight to what took place. After tens of millions of years, America ceased to be the land of dozens of species of large mammals just 13,000 years ago. If not a full-blown mass extinction like dinosaur extinction at the K/T boundary, the magnitude of loss at least qualifies as the first wave of the planet's sixth mass extinction, the one we find ourselves in now (Leakey and Lewin 1995, Martin 2005). The first wave is not only marked by disappearance of animals but also by virtual disappearance of the dung fungus, *Sporormiella*, which reappears historically in pond sediments accumulating after the arrival of large herds of domestic livestock (Davis 1987, Davis and others 2002). There is no doubt that the first wave of the sixth mass extinction struck a terrible blow, a loss of megafauna whose consequences are all too often ignored and whose significance remains underestimated.

Trauma in Near Time

Those with an eye for prehistory appreciate the many changes initiated by early people. In the beginning some 13,000 years ago Clovis hunters with Clovis Points killed mammoth and bison. In southern Arizona both Clovis hunters and mammoths soon vanished, to be replaced by a different economy, the Cochise Culture, foragers of flood plains and adjacent bajadas. Beyond harvesting wild plants and small mammals, the desert dwellers learned to cultivate corn and stored surplus crops in the ground in pits while living in pit houses. Occasionally bison bones turn up in remains of the Cochise Culture and of the Sobaipuri, farmers of the San Pedro River into the time of Father Kino.

Occasional sub-fossil records (Mead and Johnson 2004) not withstanding, Spanish explorers and military parties did not report bison in Arizona or New Mexico. Some view the scarcity of bison as an indication of an unfavorable environment. Nevertheless, with native societies thriving on both cultivated and wild plants, and hunting whatever they could obtain, absence of bison and scarcity of mountain sheep in archaeofaunal samples might not mean the absence of a climate and environment favorable to both. Instead, it might reflect the presence of too many humans, including many would-be big game hunters, reduced to foraging for small game, gathering wild plants, and cultivating corn (maize), beans, and squash. Arizona's first cornfields are thousands of years old. Very likely corn cultivation and wild, free ranging bison did not mix well in the view of prehistoric agriculturalists. It is no surprise that when introduced historically in three parts of Arizona, bison thrived.

War Zones in Wild America

Early explorers such as Lewis and Clark, to name one famous example, did not see bison throughout the west. They found none on the Columbia River or the Clearwater. Zoogeographers had yet to map, much less to speculate on, what the range of bison might mean. Early travelers and explorers discovered that despite local abundance in one region, bison might be absent elsewhere. Understandably, bison were absent from places that they were not well adapted to occupy, such as tropical rain forest along with the rest of the tropics south of Nicaragua, their southernmost locality (McDonald 1981).

That does not explain absence of bison in certain North American grasslands. Had bison ranged where livestock can thrive, at least in small numbers, they would have inhabited all prairies, the High Plains, the Palouse loess, California's coastal grasslands, the desert grasslands of Arizona and New Mexico, and the rich grasslands of northern Mexico on the high, summer-wet plateau above the Chihuahuan Desert and between the Sierra Madre Oriental, the Sierra Madre Occidental, and the Valley of Mexico (map in McClaran and Van Devender 1995, page 2). Yet we know that only some of these grasslands held bison historically. Why was that?

In a long neglected entry in his trip log 200 years ago William Clark provided a possible answer: "*I have observed that in the country between the nations which are at war with each other the greatest numbers of wild animals are to be found*" (William Clark, Friday, 29th August 1806). Lewis and Clark were a month out of St. Louis and near to the end of their expedition. It took many months of experience over parts of two years on the Upper Missouri, the Clearwater, and the Columbia, with Clark rafting down the Yellowstone River and thereby seeing significantly more country rich in buffalo than his co-captain, Meriwether Lewis, before William Clark entered that one sentence in his journal.

What Lewis and Clark reported was a West in flux as far as bison hunters and bison hunting were concerned. Introduced diseases and the uneven distribution of trade goods, among many other traumas of contact, drastically altered the numbers and even the presence of native people. More than climate and the environment, Indians played a crucial role in determining where bison would be found along the route followed by Lewis and Clark and other early travelers (Martin and Szuter 1999, Martin and Szuter 2004).

Until recently, few historians have mentioned that in Montana between the upper Missouri River and the Yellowstone, regions where Native Americans were largely absent, Lewis and Clark were in a war zone. The abundant bison, elk, deer, beaver, and, locally, grizzly bear that we venerate as part of our national heritage thrived when Native Americans were largely absent, as Lewis and Clark noted when they traveled through Montana.

In the Upper Missouri River in Montana Lewis and Clark and other early observers found all wild species to be surprisingly tame and fearless, or truculent in the case of the grizzlies. It is an old story. But are we ready to accept the evidence that the game rich "wild America" of our dreams was in fact an intertribal war zone, a faunal refuge developing between cultures in conflict? In this "top-down" interpretation, carrying capacity alone did not enable bison to swarm over the state of Montana in the first decade of the 19th Century. It was the absence of any resident bison hunters.

West of the Continental Divide most and at times all of the Columbia River drainage lacked bison, as it did in the days of Lewis and Clark. Is this because the natural vegetation is unsuitable for any large ruminant, cattle included? Those who advocate suppressing both cattle and ranching seem to think so (Wuerthner and Matteson 2002). Should such a policy be accepted without question throughout the West, including southern Arizona? Fifty years ago I thought along those lines, until I learned more about the fossil record of large mammals.

Some vertebrate paleontologists regard the loss of large mammals as climatically driven, but nothing in the proxy data of ice age climatic change, whether fossil pollen, fossil content of pack rat middens (Martin 1999), or chemical and geochemical signatures in ice core or marine core records reveals a unique pulse that might explain a unique extinction event (Martin 2005). More than that, if there was a severe climatic shock, why did mostly large animals succumb, those most mobile and best buffered against climatic insult by virtue of their large size, enabling them to emigrate to more suitable climates while weathering extremes?

Given the intensity of prehistoric cultural activity in Arizona and adjacent states, with hunting unregulated, we need not be surprised that recently with hunting focused on deer and other big game, smaller mammals like opossum and coati have spread north from Mexico into Arizona, New Mexico, and Texas while javelina (*Peccari tajacu*), raccoons, and elk, despite hunting pressure, are increasing in numbers. Increase in javelina may possibly be involved in the increase in prickly pear in southern Arizona, as the increase in mesquite is partly attributed to distribution of mesquite seeds in sweet pods attractive to livestock and javelina (for matched photos showing mesquite and prickly pear increase see Turner and others 2003). Javelina, whose bones do not appear in zoo-archaeological collections, now range north to and beyond Interstate 40 in both north-central Arizona and New Mexico. Javelina are popular prey and if zoo-archaeologist Christine Szuter and I read the fossil record right (Martin and Szuter 1999, Martin and Szuter 2004) the spread of javelina in the 19th and 20th Century reflects relaxation of a hunting pressure that was heavier in prehistoric times for some of our larger mammals than it is now.

As hunting pressure is reduced on large carnivores and management favors them, it is no surprise to learn that more than the accidental jaguar ranges into Arizona from Mexico. If tapir were not dependant on heavy tropical forest to escape hunters, they too might be returning to Arizona along with the javelina. Fossil tapir bones were excavated in the Clovis archaeological site at Lehner Ranch on the San Pedro, at Ventana Cave on the O'Odham Reservation, and on the Colorado Plateau in northern Arizona. Certainly Arizona is not any colder now than it was over 13,000 years ago and if temperature rather than predation limits tapir range, the animals should have returned to Arizona from the tropics.

Fencelines and Fossils

The late Pleistocene fossil record of the Southwest, unknown to me when I made my fenceline judgment call almost 50 years ago, is attracting the interest of ecologists and naturalists. Judging by radiocarbon dates, until 13,000 years ago the Americas were rich in proboscidea, both mammoths and mastodons, with a third family, the gomphotheres, in Mexico and Florida south to Argentina and Chile. Native equids, horses of many species, evolved in America along with the camelids.

In addition, there were extinct tayassuid pigs, *Platygonus* and *Mylohyus,* much larger than our native javelina. There were ground sloths, especially the Shasta ground sloth and occasionally Jefferson's ground sloth. The pronghorn included not only the living species but also a dwarf genus, *Stockoceros*.

Carnivores included dire wolves, lions twice the mass of African lions, and especially at Rancho la Brea the famous saber-tooth cat. Fossils of the dirk-tooth cat are found in Texas in Friesenhan Cave, associated with bones of probable prey, juvenile mastodonts (Martin 2005). A giant short-faced bear (*Arctodus simus*), larger than a grizzly, fell victim to the Hot Springs, South Dakota, Mammoth Site, very likely attracted to rotting carcasses of sub-adult young male mammoths caught in the slippery sink. Young males, no longer under the guardianship of the matriarch in the matriarchal mammoth herd, were especially at risk when first out on their own. At Huntington Canyon at 9,000 feet in the Wasatch Mountains above Salt Lake City a giant bear died close to the remains of an aged and moribund mammoth (Madsen 2000), perhaps its actual or intended prey.

Dry caves in the Grand Canyon harbor extinct animals including a surface made by the trampling of the Shasta ground sloth (figure 2). In a Grand Canyon cave rich in the remains of late Pleistocene condors I found a bone of a much larger avian scavenger, *Titanis* (Martin 2005). In addition, in various parts of Arizona there were extinct bloodsuckers, vampire bats, *Desmodus.* There was an extinct skunk, *Brachyprotoma*, along with extinct species of pack rats, *Neotoma.* The best dietary record of an extinct mammal comes from the analysis of a meter deep dung deposit of the extinct Shasta ground sloth (Hansen 1978).

On the Mexican border in Cochise County at Naco archaeologist and Arizona State Museum Director Emil Haury reported a Columbian elephant (Haury 1953) that had been speared before death. Local residents, the Navarettes, father and son, found the carcass; it was an adult female that was not butchered and, some suspect, may have escaped the Clovis hunters whose sites would be excavated downstream on the San Pedro at Lehner Ranch and Murray Springs (figure 3). The Naco mammoth yielded a total of eight unbroken Clovis points, an extraordinary number (Haury 1953). The Naco discovery remains one of the most unusual finds in the fossil record of American mammoths. The artifacts found at Murray Springs were more likely to be broken (figure 4), presumably because any unbroken points or shaft-straightening tools would be used again and were removed from the kill sites.

One obvious result of near time extinctions is impoverishment of the megafauna of America, including the mountains and valleys of the Sky Island archipelago—the land in southern Arizona and southern New Mexico between the Colorado Plateau and the Mexican Plateau. To repeat the litany, based on near time records, the missing (and all too rarely missed} animals that are known or might be expected in this region include mammoths, mastodonts, camelids, equids, tapir, Shasta ground sloths, dwarf antelope, dire wolves, saber-tooth cats, an extinct skunk, marmots, California condors, and vampire bats. They appear in the fossil record until the end of the last ice age, 13,000 years ago; perhaps a few may have lasted longer (Martin 2005).

Camelids, equids, and dwarf pronghorn evolved in North America during the tens of millions of years of the Cenozoic; others invaded from other continents or regions, the proboscideans beginning over 10 million years ago. All are undeniably native and only missed inclusion in our national songs such as "Home on the Range" by virtue of their end-Pleistocene extinction. Otherwise we might well sing: "*Give me a home, where mastodonts roam, where ground sloths and glyptodonts play…*"

Can we rule out climatic change as part of the story? Ice core records of the Pleistocene reveal details of climatic changes that occurred repeatedly over hundreds of thousands of years (Alley 2000). Those of the various glacial stages were

Figure 2—Ground sloth dung on trampled surface, Rampart Cave. Photo by Charles Kepner.

remarkably similar in magnitude, involving major change in mean temperature. The paleoclimatic record indicates a great many pulses; most of them appear to be comparable in amplitude. Beyond the fact of megafaunal extinction, nothing unique occurred around the end of the Pleistocene, around 13,000 radiocarbon years ago. The cold climate of the time was about to warm rapidly, just as it had many times before, as can be read in the ice core and marine core records. Suddenly, with no warning, something eliminated America's elephants, horses, camelids, ground sloths, and many other large mammals mentioned previously.

In the spirit of *The Eyes of Discovery* (Bakeless 1961) zoologists turn to historians for written records when they evaluate competing strategies of management. To these they now need to add the record of fossils provided by paleontologists. The previously mentioned mammoths, mastodonts, ground sloths, tapir, native species of horses, camels, bison, dire wolves, and vampire bats once lived in or around the Chiricahuas, Huachucas, and other Sky Islands. They vanished without triggering any extinction among the native plants of the region. In fact riparian plants may have increased considerably in biomass, after the extinctions, judging by the number of riparian species found in the dung of extinct mammoth (Davis 1987, Davis and others 2002). In the presence of proboscideans riparian growth may have suffered serious attrition, far more than we see in the case of livestock.

In the past conservationists and field ecologists have paid scant attention to monumental changes in near time. That no longer works. The late Quaternary arrival of humans in America, revealed in stratigraphic detail from excavations of the mammoth kill sites on the San Pedro River in Cochise County and at the Clovis type site near the town of Clovis in eastern New Mexico, allows us to speculate on events 13,000 years ago when anthropogenic fires became a new force on the landscape. For whatever reason, that is when the native large mammals of Arizona, New Mexico, Sonora, and Chihuahua vanished. Conservationists, wildlife managers, and ecologists can no longer ignore that loss and the profound meaning it conveys for those who would design with nature.

Figure 3—Tracks at Murray Springs.

What about bison? The animal is often considered to favor tall grassland in the mid-continent, where Coronado finally found the bison he had heard about, far to the east of Santa Fe, supposedly in Kansas. Pleistocene fossils of bison occur in parts of Arizona and New Mexico, in floodplains of the

Figure 4—Clovis artifacts from Murray Springs.

desert grassland, and occasionally in the Holocene. Neither Alvar Nuñez Cabeza de Vaca, nor Fray Marcos, nor Coronado reported bison in Arizona and New Mexico. Some managers or advocates for a return to "wildness" have argued that the absence of historic or Holocene fossil records indicates the unsuitability of a region for livestock. Do those who think this way have their history right? The success of bison on Ted Turner's Armendaris Ranch near Truth or Consequences in southern New Mexico suggests that bison are better adapted to droughty pastures of desert grassland than are cattle.

The postglacial fossil range of bison, mapped by Graham and Lundelius (1994: 460-461), does not extend east of the midcontinent, ending 100 miles west of the Mississippi River. The entire southeast of the United States harbors few if any Holocene fossil records of bison. Then, historically, there is a remarkable expansion. In the last few hundred years, after the time of Hernando De Soto and before European settlement west of the Atlantic coast, bison made their move. They swept east across the Mississippi into the abandoned fields of the American Indians from New York State south to Florida (Rostlund 1960). Diseases, including small pox, unwittingly introduced by De Soto and other conquistadors may account for the collapse of large Indian settlements. For whatever reason bison suddenly found lebensraum to the *east* of the Mississippi.

To understand the last thousand years we need come to grips with the Cenozoic, the last 60 million years, including the evolution of American horses, camelids, and ground sloths. Beginning over 10 million years ago proboscideans (gomphotheres, mastodonts, and mammoths) invaded from Eurasia and speciated. As a consequence American vegetation coevolved with large herbivores to match those found now in African Parks such as Kruger in South Africa or the Serengeti in Tanzania.

With extinction of megafauna coinciding with Clovis colonization around 13,000 years ago large herbivores and their herbivory decreased. Perhaps some of the native plant species lost some of their resistance to grazing. The increase in fire frequency by anthropogenic ignitions of the human newcomers may have reduced plant biomass in season as effectively as pre-extinction grazing and browsing. I am thinking of ground sloths, extinct equids, extinct camelids, extinct bovids, and extinct proboscideans. The historic arrival of livestock in a land largely lacking large herbivores since prehistoric extinction over 10,000 years earlier, restarted a trophic function (energy exchange) that had evolved in North and South America over tens of millions of years.

Wildfires

In the 10,000 years between the end of grass consumption by native megaherbivores and before the arrival of their domestic proxies (cattle, horses, sheep, goats) another catastrophic consumer of vegetation deserves consideration: wildfire. In the 10,000 years of the Holocene and with the possible exception of occasional transient bison, the grasslands of the borderlands were consumed by nothing larger than insects, especially orthoptera (grasshoppers, crickets, roaches). After the Ryan Fire of April 30, 2002, the Research Ranch might have looked like what one would have seen in Cochise County during the millennia after megafaunal extinction and before ranching began, when the prehistoric Cochise Culture and its Hohokam successors controlled fire frequency. Warfare and fire are reflected in the four corners archaeological record to a greater degree than some pre-historians have indicated (LeBlanc 2003).

Soon after the Ryan Fire, Manager Bill Brannon of the Research Ranch noted something he had not seen before: a large number of both raptorial birds and ravens coursing over the burned ground, attracted by the windfall. They were preying on the native mice and packrats searching for suitable cover in their newly exposed runways.

Northeast of the Research Ranch is the Babocomari Ranch. On heavy flood plain soils the Babocomari supports a tall dense stand of sacaton grass that can attain two meters in height, a rich habitat for Botteri sparrows, pack rats, and javelina. In spring the dry sacaton is burned to provide new green grass for cattle. I suspect that the practice was familiar to the Sobaipuri, the Apache, and their predecessors hunting small game. What are the dynamic biotic changes that can be expected following wildfire treatments compared with grazed and ungrazed control sites?

Perhaps it is time to establish a third experimental site, a "fire ranch" in which the summer-rain grass crop will be allowed to mature, dry out, and then be burned off at the end of winter. Would this favor a different suite of grass species from what occupies Research Ranch now? Might such an assemblage be more representative of the grassland communities found prehistorically? At the very least an increased fire frequency would appear to favor avian predators.

Over the years my fenceline interpretation of 1956 has changed. Now when I look down a fenceline separating heavily grazed from ungrazed pastures I find challenging questions to ponder. For example, aside from overgrazing, what about under-browsing? Or under-burning? Or seed dispersal by livestock (figure 5) suggesting cattle substituting for what bison might have done?

Figure 5—Cow patty with seedling cholla, suggesting what bison might have done.

Those that denigrate livestock on public and private ranges—both cattle and horses, along with sheep in northern Arizona, and, increasingly, camelids (vicuna, alpaca or dromedary) plus the best-adapted large herbivore escaped into American arid lands and thriving in southern New Mexico, the gemsbok (*Oryx gazella*)—might be surprised to learn of the *Oostvaardersplassen*. This nature reserve of 6,000 hectares in the Netherlands, almost twice the size of the Research Ranch, tests the impact of wild-living Heck cattle, wild-living konik horses (*Equus przewalski*), and roe deer. Will the cattle, horses, and deer living in what Vera calls "the wild" facilitate the establishment of various species of wild flora and fauna, including thorny bushes and trees (F. W. M. Vera 2000: 383)? Reflecting a wet climate and favorable soil to facilitate biomass in the Netherlands, in 1999 there were about 500 Heck cattle, 450 konik horses and 400 red deer in the *Oostvaardersplassen*.

Finally, if plant lovers want to see many more species of vascular plants than occur in southern Arizona and New Mexico, I recommend the land where Sky Islands coalesce into the Sierra Madre in northern Mexico (Martin and others 1998). There, new records and occasionally new species of vascular plants continue to turn up, never mind heavy grazing, lumbering, and frequent fires in mountains attaining 2,700 meters, and roughly as far south of the border as the White Mountains are to the north (figure 6). Richest of all are the gigantic incisions in the Sierra Madre known as barrancas (figure 7) where 10 square kilometers will harbor at least 823 species of vascular plants and at least 17 species of oaks (*Quercus*) plus two hybrids (Spellenberg and others 1996). This species richness greatly exceeds anything found north of the border where the entire range of the Pinalenos, Mt. Graham included, has 786 species of vascular plants and the Rincons with Saguaro National Park has 986. These ranges have 1,800 meters or more of relative relief. No hot spot north of the border can match the Cascada de Candameña.

Yes, there are major downsides to the spread of livestock in Mexico and magnificent thorn forest and tropical deciduous forest is being sacrificed to the cattle industry. Surely some other species, adapted to aridity, capable of good meat production, and leaving a lighter footprint on the land is worth considering as an alternative. New Mexico may already have a solution in its gemsbok, the Kalahari oryx. Are experiments with aliens still totally taboo? Will we fiddle while dry tropical forest is torn down for cattle?

Figure 6—*Tigridia pavonia,* Iridaceae, Sierra de Obscura, Chihuahua.

As archaeologists and geographers have long realized, environmentalists must not overlook or ignore but embrace prehistory, including the fire stick foragers and the extinct animals that vanished at the start of our watch in America. If not a place for domestic grazers such as cattle, horses, sheep, and goats, wild America known to Lewis and Clark harbored deer, elk, and buffalo, along with wolves and grizzly bear, all of which did or might have lived around the Chiricahuas, just like they lived in Montana, if Native Americans foraging

Figure 7—Basaseachic Falls, a waterfall of over 245 meters.

on wild plants and cultivating corn in the Southwest had not suppressed javelina, elk, and buffalo.

Introduced buffalo appear to do very well on Ted Turner's Armendaris Ranch in southern New Mexico. If my suggestion that the lack of large herds of native bison throughout the southwest, in the Chihuahuan Desert and in the desert grassland of northern Mexico, prehistorically reflects predation by native people, and not the unsuitability of desert grassland for bison, the success of Turner's Armendaris Ranch is no surprise.

For both ranchers and preservationists the take home message is that the evolution of the western range involves tens of millions of years of coexistence of herbaceous plants with a great many kinds of large herbivores, most of the latter suddenly removed around 13,000 years ago for reasons that remain controversial. Most of our large native herbivores vanished when prehistoric people invaded. In addition the invaders triggered a considerable surge in fire frequency, declining historically with the introduction of domestic livestock (Davis and others 2002).

In this thumbnail sketch for fenceline philosophers, grazing differences can certainly change the dynamics of what species of grasses thrive on one side of the fence compared with another, as the Bocks' book, *The View from Bald Hill* (2000), reveals. There are more comparisons to consider and few ecologists, least of all the Bocks, will claim that all ranching is ecologically "wrong" and that blanket protection of the range from all large domestic herbivores is invariably "right." In the evolution of the desert grasslands, the fossil record indicates more diversity of large herbivores in the past, not less, and with more taxa of large herbivores presumably consuming more forage than is eaten by livestock at present. It is not only the fossil record that needs to be considered, it is also the experiments in the Netherlands to recreate wild lands in the *Oostvaardersplassen* with free ranging cattle, Przewalski's horses, and roe deer. It is time to experiment with more fire and more taxa of large mammals in American ranges and browse-lands. In monitoring the experiment we may find that fencelines have a great deal to teach, far more than fenceline photographers may realize . . .

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