The Last Desert Grasslands

The biological case for protecting Otero Mesa

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Southwest Environmental Center
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The Guadalupe Mountains loom to the east of Otero Mesa. Photo by Steve Capra.

Introduction

Standing on Otero Mesa with only the wind and occasional ranch vehicle to break the silence, it is hard to believe that the twin border cities of El Paso-Ciudad Juarez and their millions of inhabitants are only an hour's drive away. This wild landscape seems miles away from anywhere.

Much of Otero Mesa is grassland, a remnant of the sea of grass that once rolled northward out of the Chihuahuan Desert and up through the prairies and plains of the United States and into Canada. Today, those grasslands have mostly disappeared, and with them the wildlife adapted to such environments. Otero Mesa provides a last stronghold for many species that are disappearing elsewhere.

This ecological jewel may soon be lost. The federal Bureau of Land Management (BLM) plans to open up Otero Mesa for natural gas development. If this happens, the resulting fragmentation of the area by a spider web of roads, pipelines, well pads, powerlines and the like, will destroy one of the last intact Chihuahuan Desert grasslands—considered by many to be the most endangered ecosystem in the United States.

This report explains the ecological importance of Otero Mesa, and how it is threatened by energy development that will produce a few weeks worth of natural gas, at best, while permanently altering one of America's last, great places.

Photo courtesy SkyTruth.

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Executive Summary

Otero Mesa is an ecologically unique and threatened landscape. Covering about 1.2 million acres, it contains one of the largest tracts of black grama grassland remaining in the Chihuahuan Desert. The grasslands and wildlife of Otero Mesa are threatened by a proposal by the federal Bureau of Land Management (BLM) to open up the area for oil and gas development.

Once widespread, Chihuahuan Desert Grasslands are among the most endangered ecosystems in North America today, transformed by drought and overgrazing into desert scrub. Where grasslands still exist, they are generally too isolated and small to support the full array of wildlife once found on them. Otero Mesa is the exception, providing vital habitat to a variety of plants and animals uniquely adapted to these rare and fragile desert grasslands.

Like most of the region, Otero Mesa has a long history of use and settlement by humans. Several characteristics enabled Otero Mesa to escape the fate of grasslands elsewhere. One factor is that Otero Mesa's soils are generally shallow and underlain by a relatively uniform layer of cement-like calcium carbonate ("caliche") which makes it difficult for shrubs to get established. Another is the longevity and drought resistance of the dominant grass species, black grama--traits which helped to prevent soil erosion and subsequent shrub encroachment.

Otero Mesa is home to a wide variety of plants and animals, including many species not found elsewhere or declining in other parts of their range. Otero Mesa supports a high diversity of cacti and other plants. It offers hope for restoring desert bighorn sheep to their historic range in New Mexico, and several sites on or adjacent to Otero Mesa have been identified as potential reintroduction sites for desert bighorn sheep. According to the BLM, oil and gas development near these areas would render them unsuitable for bighorn reintroduction.

Otero Mesa provides habitat for 100 to 800 pronghorns, the second fastest land animals in the world, and the only living species of ungulate which originated in North America. Wildlife officials believe Otero Mesa's pronghorn population is one of the few herds (possibly the only one) of native pronghorns remaining in New Mexico, the others having been wiped out by commercial hunting and subsequently reestablished by animals imported from elsewhere.

Otero Mesa is home to approximately 32 colonies of black-tailed prairie dogs--a formerly widespread species now uncommon in the Southwest. Prairie dogs are a keystone species, essential for maintaining the integrity and functionality of grassland ecosystems. Approximately 170 vertebrate species depend upon prairie dogs for their survival to some degree. Compared to surrounding areas, grasslands occupied by prairie dogs support higher numbers of small mammals and arthropods, more terrestrial predators, more types of birds, and higher bird numbers.

Otero Mesa offers one of the best hopes for restoring the endangered Northern Aplomado Falcon to the Southwest. Aplomado Falcons disappeared from the U.S. by the 1950s, in large part due to the loss of desert grassland habitats. Today they are found in some small areas in northern Mexico, and also in parts of Texas where captive-raised birds have been released as part of reintroduction efforts. Otero Mesa provides some of the best potential Aplomado Falcon habitat in the Southwest, and there have been a number of sightings of Aplomado Falcons on Otero Mesa in recent years.

Otero Mesa is especially important as habitat for grassland birds. As a group, grassland species such as Ferruginous Hawks, Burrowing Owls, Loggerhead Shrikes, Grasshopper Sparrows, and Western Meadowlarks have experienced more severe declines in recent decades than any other category of North American birds, mainly due to habitat fragmentation. Otero Mesa provides a home for part or all of the year to many of these.

Otero Mesa's unique ecosystems and wildlife are threatened by proposed oil and gas development. The Bureau of Land Management's plan allows drilling on 95 percent of Otero Mesa. While it only applies to federal lands, it will open the door to oil and gas development over a much larger area.

The amount of natural gas beneath Otero Mesa is unknown, but not likely to be significant. Estimates range from 110 billion to one trillion cubic feet. The latter is equivalent to roughly 16 days of U.S. annual national demand for natural gas. Otero Mesa by itself will contribute little toward national energy independence.

No matter how carefully done, oil and gas development will harm Otero Mesa. There will be significant direct and indirect environmental impacts at every stage of the process. Activities associated with seismic exploration, road and pipeline construction, clearing of well pads, drilling operations, and routine maintenance all cause varying degrees of disturbance and, in some cases, long-term ecological damage. Examples of impacts include soil compaction and erosion, loss of soil biota, stress on wildlife, change in wildlife movement and activity patterns, increased poaching of wildlife, reduced plant growth, spills and leaks of produced water and drilling chemicals, habitat fragmentation, penetration of the underlying caliche layer, and the introduction of noxious weeds. The net result of all these impacts will be the conversion of Otero Mesa's grasslands to a shrub dominated landscape, and the decline or disappearance of grassland associated wildlife species.

The assumption that Otero Mesa can be ecologically restored after significant disturbance is at the heart of BLM's proposed plan for oil and gas development of the area. However, desert grasslands are inherently difficult, if not impossible, to restore. Meaningful restoration in an ecological sense is highly unlikely, as evidenced by numerous unsuccessful attempts by scientists and range managers in the past.

In short, oil and gas development will irrevocably alter the ecological character of Otero Mesa, and the amount of natural gas ultimately produced is likely to be insignificant in comparison to U.S. annual demand.

Last of the grasslands

A unique landscape

Grasslands once blanketed much of the Chihuahuan Desert--a surprising fact given their general absence from the region today. Indeed, the grass was so luxuriant in some places that it was actually harvested commercially for hay. Most of these grasslands have disappeared, converted to desert scrub. Where they still exist, they have generally been reduced to small patches that vary in size from a few acres to a few hundred acres—too small to support the full range of wildlife once associated with these habitats. Otero Mesa is one of the few exceptions.

Located about 40 miles northeast of El Paso, the greater Otero Mesa ecosystem includes about 1.2 million acres in southern New Mexico. Most of it is gently undulating terrain between 4000 and 5600 feet, with a few isolated peaks rising to 7000 feet. The mesa is bounded on the north by the foothills of the Sacramento Mountains, by Crow Flats and the Guadalupe Mountains to the east, and by an escarpment that drops dramatically down to the Tularosa Basin on the west. The mesa gradually descends into the shrubland of west Texas to the south.

Otero Mesa's grasslands are extraordinarily healthy and diverse, with roughly twice as many grass species as rangelands elsewhere in the region.

The western portion of Otero Mesa extends onto the McGregor Range on Fort Bliss Military Reservation. The remainder of the area is a checkerboard of federal, state and private land. The dominant land use is ranching.

Roughly half of Otero Mesa is grassland, dominated by two drought resistant species—black grama (*Bouteloua eriopoda*) and blue grama (*Bouteloua gracilis*).[1] The swales and valley bottoms are characterized by deeper soils and a cover of tobosa grass (*Pleuraphis mutica)* and burro grass (*Scleropogon brevifolia*). Soaptree yucca (*Yucca elata*) are the only tall plants, except for an occasional tree around a stock tank or ranch house. In contrast to much of west Texas and southern New Mexico, mesquite shrubs (*Prosopis glandulosa*) are virtually absent.

Otero Mesa's grasslands are extraordinarily healthy and diverse. The area is home to at least 13 species of grasses, including some that are rare or found nowhere else in the region, such as New Mexico Stipa (*Stipa neomexicana)* and Hairy Grama (*Bouteloua hirsuta)*.[2] In ungrazed areas of Otero Mesa, grass cover as high as 42 percent has been measured. By comparison, rangelands considered to be in "good" condition elsewhere in the region typically have only six or seven species and 10 to 20 percent grass cover.

In addition, the grasslands of Otero Mesa are relatively large and intact. There are no towns on the mesa, nor many roads other than lightly used dirt ranch roads. It is one of the last remaining large tracts of grassland remaining in the Chihuahuan Desert of North America.

The lack of developments, the healthy grassland ecosystem, and the scarcity of shrubs make Otero Mesa a truly unique landscape. It is a window into the recent evolutionary past, still home to essentially the same assemblage of plant and animal species that existed when Coronado rode through the region 500 years ago, looking for the Seven Cities of Gold.

The lack of developments, the healthy grassland ecosystem, and the scarcity of shrubs make Otero Mesa a truly unique landscape.

Disappearing grasslands

Otero Mesa has a long history of use and settlement by humans. However, for most of that history, modification of the landscape was localized and limited to areas adjacent to permanent water.[3]

We can get an idea of what the area looked like from U.S. survey reports following the war with Mexico in 1846-48. The original surveys described large expanses of "excellent" or "good" grassland in the valleys and plateaus between mountain ranges. Mesquite shrubs occurred so rarely that the surveyors took special note of their presence.[4] In most places, soaptree yucca were the only tall plants.

The grasslands of Otero Mesa remain remarkably shrub-free. Photo by Kevin Bixby.

The pattern of land use changed dramatically after the American Civil war as a result of new technologies. The most important advance was the ability to drill deep wells and pump water by windmills. This allowed the livestock industry to expand into the waterless basins and mesas of the region. In addition, the expansion of railroads allowed cattle to be shipped to distant markets, spurring further growth in the industry.

By the early years of the twentieth century, overgrazing in combination with periodic droughts had damaged rangelands throughout the region and set in motion an irreversible process by which grasslands were converted shrublands.[5] By the 1960s, virtually none of the original Chihuahuan Desert grasslands in the U.S. remained shrub free.[6]

A number of factors were responsible for this dramatic transformation. The loss of vegetative cover reduced the ability of soils to absorb and store moisture. Rain falling on denuded watersheds led to increased runoff, erosion, and the lowering of water tables. Many springs and streams dried up. Today, most of the drainages in the region are ephemeral, with deeply incised channels that carry water only for very short periods following intense storms.

In many of the flat areas of the intermountain basins, the barren soil was exposed to wind erosion. Small silt particles were transported out of the region as aerosol dust while the sand particles were blown over the landscape. Where blowing sand encountered mesquite plants it was deposited to form coppice dunes. These dunes now occupy extensive areas of former black-grama grasslands. An example is the area surrounding the El Paso airport on land that is now part of Fort Bliss.

High levels of grazing by domestic livestock reduced the height and abundance of grasses and herbaceous plants, and led to changes in the balance of rodent, rabbit and insect populations. The increase in bare soil and shrubs favored rabbits and certain rodents, putting more grazing pressure and stress on grasses, and further reducing their ability to compete with woody plants.[7] Although considerable research effort has focused on how to control "invasive" woody plants (especially mesquite and creosotebush) and on how to restore grasslands, rangelands continue to be plagued by an increasing abundance of shrubs and loss of grasses as the process of "desertification" continues.

Coppice mesquite dunes. Photo by Walt Whitford.

The deterioration of the Chihuahuan Desert grasslands prompted ranchers to petition the U. S. government for help, leading to the establishment of research centers such as the U. S. Department of Agriculture's Jornada Experimental Range (JER) north of Las Cruces, New Mexico. The focus of research at these centers was on grazing management and restoring the productivity of rangelands.

By the 1960s, few areas remained of undegraded Chihuahuan Desert grassland in the United States. Surviving patches were usually small and isolated.

Records of vegetation changes at the 193,395 acre JER provide a clear picture of what has happened to the desert grasslands in southern New Mexico, southern Arizona and west Texas. In 1858, 60 percent of the JER was covered by grasslands with no or few shrubs, while mesquite shrubland accounted for 20 percent. A century later in 1960, essentially no grasslands remained while mesquite shrubland had increased to 60 percent of the land area.[8] Similar scenarios have been described for other areas of southern New Mexico.[9]

By the 1960s few areas remained of undegraded Chihuahuan Desert grassland in the United States. Surviving patches were usually small--less than 100 acres--and isolated, like grass atolls in a sea of mesquite savanna, mesquite coppice dunes, and other desert scrub formations. Otero Mesa is the rare exception.

How the grasslands of Otero Mesa survived

Several characteristics enabled the grasslands of Otero Mesa to escape the fate of grasslands elsewhere in the region. The first is soil depth. Otero Mesa's soils are generally shallow, less than two feet deep, below

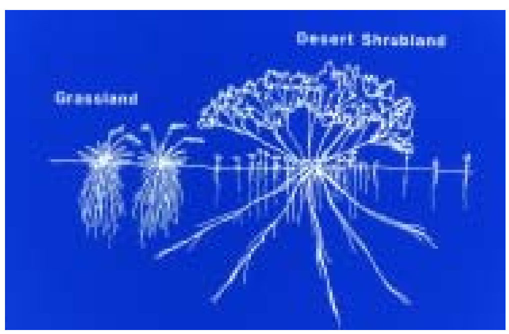
The drought resistance of the dominant grass species, black grama, is one reason why the grasslands of Otero Mesa are still intact, despite continuous grazing by livestock for many years.

which lies a cement-like layer of calcium carbonate called "caliche," or calcrete. The depth to this layer is remarkably uniform over large portions of the mesa, varying by only a few inches from location to location. This caliche layer is not unique to Otero Mesa, but in other parts of the Chihuahuan Desert where grasslands have been invaded by shrubs, its depth below the surface can vary by more than four feet from one spot to another.

Otero Mesa's layer of caliche is also unique in that it is largely unbroken, devoid of the cracks and holes more typical elsewhere. This uniformity helps to prevent mesquites and other shrubs from getting established.[10] The soil is deep enough for grass, but not for shrubs, and there are few openings in the calcrete for shrub roots to penetrate.

The warm-season grasses found on Otero Mesa produce a dense mat of fine roots that are concentrated in the upper 12 inches of soil, which allows them to make efficient use of any amount of rain. Mesquite plants, on the other hand, have tap roots to exploit water found deeper in the soil. To compete with grasses for water, mesquite seedlings must extend their roots below the rooting depth of grasses. The fact that much of Otero Mesa is underlain by a solid floor of natural concrete just two feet below the surface effectively protects the grasslands from invasion by mesquite.

The drought resistance of the dominant grass species, black grama, is another reason why the grasslands of Otero Mesa are still intact, despite continuous grazing by livestock for many years. The ability of plants to resist drought varies considerably from species to species. Black grama grass is particularly well-adapted to endure periods of low rainfall because it is long-lived, and because of the way it grows and reproduces.



The uniform layer of caliche beneath Otero Mesa prevents deeper rooted shrubs from getting established. Diagram provided by Walt Whitford.

Black grama is classified as a warm-season grass because it does not produce new leaves and stems until nighttime temperatures are in the low sixties (farenheit) and there is sufficient soil moisture—an adaptation to the seasonality of rains in the region. The Chihuahuan Desert receives an average of eight inches of rainfall annually, but the amount can vary greatly from one year to the next. Much of the rain falls during the summer, when the prevailing winds bring moisture laden air up from the Gulf of Mexico and the Sea of Cortez. These summer "monsoons" provide the rainfall essential for the growth and survival of warm-season grasses. When summer rainfall is low, the grasses die back.

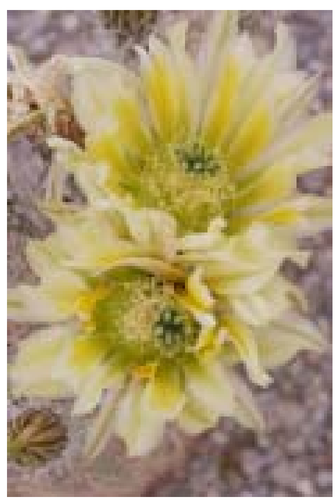
Black-grama grass grows in clumps (tussocks) that expand from the periphery outwards. Most of the growth of black-grama tussocks is by runners that produce new stems (tillers) and add to the diameter of the tussock. Black-grama grass reproduction is primarily via runners. During drought, the outer tillers die first with the result that the black-grama tussock is reduced in diameter. Vigorous tussocks of black-grama can survive several consecutive years of growing season drought. Individual tussocks can survive for several decades.

Other grass species are much less resistant to drought and have relatively short life spans of a decade or less. For example, the central tillers of dropseeds and three awns die first during growing season drought, and the peripheral tillers that survive drought are susceptible to damage by wind blown sand. When stressed by livestock grazing, these species experience high mortality rates even during short drought periods.[11]

When short-lived species die, areas with sandy soils lose the root systems and above-ground grass stems and leaves that provide protection against wind and water erosion. Oil and gas activities that cause surface disturbance are likely to result in the replacement of the resilient grama grasses with short-lived bunch grasses, robbing the system of its resiliency and eventually resulting in severe soil erosion and loss of biological integrity.

Otero Mesa and biodiversity

The importance of Otero Mesa to the preservation of biodiversity--the variety of life forms--found in the Southwest and beyond is enormous. It is home to a wide array of plants and animals, including many species not found elsewhere or declining in other parts of their range.



The Chihuahuan Desert is home to an extraordinary number of cacti species. © Ken Stinnett Photography.

Otero Mesa is home to a wide variety of plants and animals, including many species not found elsewhere or declining in other parts of their range.

One of the hallmarks of the Chihuahuan Desert is its high diversity of cacti, and this is certainly true for Otero Mesa. On the eastern margin of Otero Mesa, the limestone canyons of the Brokeoff Mountains, particularly the Panther Canyon area, support a remarkable diversity of cacti and other plants, including a number of rare species such as Guadalupe mescalbean (*Sophora gypsophila* var. *gaudalupensis*), Guadalupe needlegrass (*Stipa curvifolia*), the gray sibara (*Sibara grisea*), the cliff nama (*Nama xylopodum*) and the five-flower rockdaisy (*Prityle quinqueflora*).

The Cornudas Mountains in the southwest corner of Otero Mesa also support high plant diversity, including the extremely rare coralroot orchid. The combination of limestone outcrops within igneous soils on these mountains provides habitat for ten species of cacti.

Otero Mesa is widely recognized as an important place for wildlife.

As grasslands have disappeared, places like Otero Mesa have become a refuge for animals that are dependent upon these habitats. At least 17 species of lizards are found in the grasslands of Otero Mesa, along with at least 13 species of snakes. Reptiles and amphibians include Texas horned lizards, gray banded kingsnakes, mottled rock rattlesnakes, box turtles, Couch's spadefoot toads, and red-spotted toads. Otero Mesa is also home to mule deer, javelina, kit foxes, coyotes, badgers, bobcats, mountain lions and many kinds of bats and other small mammals.

Otero Mesa offers hope for restoring desert bighorn sheep (*Ovis canadensis mexicana*) to their historic range in New Mexico. This species was once found in most arid mountain ranges in the southern part of the state. Overhunting, and diseases spread from domestic livestock, were the two main causes for the dramatic decline in bighorn sheep numbers throughout the west during the early 1900s.

The New Mexico Department of Game and Fish has an active plan to reestablish desert bighorn sheep to locations within the species' historic range. The Cornudas Mountains on Otero Mesa, and the Brokeoff Mountains and Guadalupe Escarpment on its eastern boundary, have been identified as potential reintroduction sites for desert bighorn sheep. However, extensive oil and gas development could make it impossible to restore bighorn sheep to these areas. As BLM has stated, desert bighorn sheep are sensitive to disturbance, and placement of oil and gas facilities "in or near an area suitable for bighorn would likely eliminate that area from consideration for reintroduction."[16]

Otero Mesa offers hope for restoring desert bighorn sheep to their historic range in New Mexico, but oil and gas development could make the area unsuitable for bighorn reintroductions.

Otero Mesa is home to another native ungulate, the pronghorn antelope (*Antilocapra americana*). Pronghorn are the second fastest land animals in the world, and the only living species of ungulate that originated in North America. Their spectacular speed evolved as a mechanism to escape American cheetahs and other now-extinct Pleistocene predators. The disastrous decline of pronghorn in modern times rivals that of the American bison. From an estimated 30 million pronghorn in 1830, only 1500 remained in 1915, the victim of unregulated hunting for sport and market. There are an estimated 670,000 pronghorn in the wild today.[17]

The pronghorn on Otero Mesa represent a unique desert-adapted lineage.. © Ken Stinnett Photography.

The size of Otero Mesa's pronghorn herd fluctuates between 100 and 800 animals.[18] Wildlife officials believe Otero Mesa's pronghorn population is one of the few herds in New Mexico that was not wiped out by intense commercial hunting in the early 1900s and subsequently reestablished by animals imported from elsewhere.[19] If true, Otero Mesa's pronghorn population represents a unique desert-adapted lineage and an especially important part of New Mexico's natural heritage.

Two keystone rodents

The black tailed prairie dog is another formerly widespread species for which Otero Mesa now provides a refuge. The five species of prairie dogs in North America were once found down the grassy middle of the continent from Canada to Mexico. From an estimated 5 billion prairie dogs in the late 1800s, their numbers have been reduced by 98 percent in the past century as a result of government poisoning campaigns, habitat loss, disease and unregulated shooting.[20] They continue to be killed legally in "varmint" shooting contests and poisoned in some states, even as conservationists have called for greater protections to prevent their extinction.

Prairie dogs were once abundant in the Southwest. Biologist Vernon Bailey wrote about "an almost continuous prairie dog town" along the entire length of the Animas Valley in Hidalgo County (NM) in 1908.[21] Today there are none in the same area, although reintroduction efforts are underway. Few prairie dog colonies remain anywhere in west Texas, southern New Mexico and Arizona. Otero Mesa--home to 32 colonies of black-tailed prairie dogs--is a notable exception.[22]

Prairie dogs are keystone species in grasslands. Black-tailed prairie dogs were wiped out from most of the Chihuahuan Desert, but more than 20 colonies survive on Otero Mesa. © Ken Stinnett Photography.

Prairie dogs are more than cute rodents—they are a keystone species. Keystone species are essential in maintaining the integrity of ecosystems and enabling them to function properly. The loss of a keystone species has an effect on ecosystems disproportionate to its numbers. While there may be some functional redundancy in the species composition of an ecosystem, some keystone species have no functional counterparts and cannot be replaced.[13,14]

Approximately 170 vertebrate species rely to some degree on prairie dogs for their survival.

Prairie dogs earn this title because they modify the environment in a way that benefits many other species of wildlife. Approximately 170 vertebrate species rely to some degree on prairie dogs for their survival, including burrowing owls, pronghorn, and black footed ferrets.[23] Through their burrowing and feeding habits, prairie dogs regulate the way grassland ecosystems operate. They increase primary productivity, species densities, species diversity, soil-structure and soil chemistry.[24] They also serve as food for an astonishing number of predators. Compared to surrounding areas without them, grasslands occupied by prairie dogs support higher numbers of small mammals and arthropods, more terrestrial predators, more types of birds, and higher bird numbers.[25]

Prairie dogs provide unique functions not duplicated by other species. The disappearance of prairie dogs leads to a cascading loss of biodiversity which ultimately threatens to undermine the sustainability of the grasslands in which they occur.[26]

One species that benefits from prairie dogs is the burrowing owl (*Athene cunicularia*)--another grassland species in decline and one that is frequently seen around prairie dog colonies on Otero Mesa. Burrowing owls use prairie dog holes for their nests, and the cropped vegetation around prairie dog colonies probably makes it easier for the owls to find prey. One study documented a 63 percent decline in numbers of nesting pairs of burrowing owls and significant declines in burrow densities following the removal of prairie dogs from an area.[27] When prairie dog colonies were reintroduced into areas from which they had been extirpated some 30 years earlier, several pairs of burrowing owls established residence and produced young within the first year.[28]

Burrowing owl on prairie dog colony on Otero Mesa. © Ken Stinnett Photography.

One study documented a 63 percent decline in numbers of nesting pairs of burrowing owls and significant declines in burrow densities following the removal of prairie dogs from an area.

Prairie dogs also benefit pronghorn antelope by creating "grazing lawns" preferred by pronghorn. Given a choice, pronghorn will select broadleaf herbaceous plants (forbs) over grasses whenever possible. It just so happens that prairie dog colonies are where you find the most forbs. In a study of the short-grass prairie at Wind Cave National Monument in South Dakota, forbs occurred in highest abundance on prairie dog colonies. Not surprisingly, this is where most (55 to 85 percent) of the pronghorn spent most of their time feeding between April and November.[29] Likewise, on Otero Mesa, forbs are most abundant on prairie dog colonies, where pronghorn can often be seen feeding.

Prairie dogs are also important for kit foxes (*Vulpes macrotis*), another species that has declined over much of its range. Kit foxes are primarily found in grasslands, and will abandon areas when shrub densities get too high.[30] They need relatively large areas of contiguous grassland for their home ranges in order to have a sufficient prey base to produce young.

Kit foxes rely on prairie dogs as a source of food, especially during drought periods.[31] They also use prairie dog burrows as den sites. A study in northern Mexico found that 35 percent of kit fox dens were enlarged prairie dog burrows, and an equal percentage were enlarged banner-tailed kangaroo rat (*Dipodomys spectabilis*) burrows, another species also found on Otero Mesa.[32]

The disappearance of prairie dogs in most of the prairie and desert grasslands of North America is probably responsible for the decline of kit foxes. If kit foxes are to survive, it will be in places like Otero Mesa where they can still find the prey animals and den sites they need.

No species is more dependent on prairie dogs than black-footed ferrets (*Mustela nigripes*), which feed almost exclusively on prairie dogs. As grasslands and prairie dogs disappeared, so too did black-footed ferrets, to the point that they are now one of the rarest animals in North America, and protected as a federally listed endangered species. Recovery of Black-footed ferrets within their historic range is limited by the scarcity of large prairie dog colonies that can support reintroduction efforts. The grasslands of Otero Mesa could potentially sustain such an effort, but only if they remain intact.

Kit foxes rely on prairie dogs as a source of food and for den sites. Photo by Walt Whitford.

The disappearance of prairie dogs in most of the prairie and desert grasslands of North America is probably responsible for the decline of kit foxes.

The loss of grasslands in the Chihuahuan Desert has led to the decline of another keystone species, the banner-tailed kangaroo rat (*Dipodomys spectabilis*). Banner-tailed kangaroo rats are considered a keystone species because they build mounds that create nutrient rich, water-enhanced patches of soil, and because they provide food and burrows for other animals.

The concentration of nitrogen in the soil of banner-tailed kangaroo rat mounds is considerably higher than in surrounding areas, even where the mounds have not been occupied by kangaroo rats for more than 50 years.[33] The nest mound soils also have distinctive water storage properties and support a different assemblage of plants, notably those that require high nitrogen soils (such as *Amaranthus* spp.).[34] These plant species are important components of desert grasslands because of their nutrient-rich foliage and seeds.

Abandoned banner-tailed kangaroo rat mounds are utilized for burrows by other mammals such as kit fox, wood rats, and Ord's kangaroo rats. They also provide shelter for several species of invertebrates and snakes. Otero Mesa supports a healthy population of banner-tailed kangaroo rats, with one to ten mounds per hectare (2.4 acres) in areas where the soil is deep enough to excavate a burrow mound.

Banner-tailed kangaroo rats are creatures of open habitats, and will abandon their nest mounds if shrub cover increases to 20 percent or more.[35] It is likely that pipeline corridors on Otero Mesa will eventually become shrub-dominated patches, for reasons explained below. If the pipelines are sufficiently dense, the Otero Mesa grasslands could become unsuitable habitat for banner-tail kangaroo rats, thus creating another of many factors that, in the aggregate, is likely to lead to the unraveling of the ecosystem.

Return of a native falcon?

Otero Mesa offers one of the best hopes for bringing an endangered desert falcon back to the Southwest. The Northern Aplomado Falcon (*Falco femoralis*) is a slate-colored, medium-sized bird of prey that once occurred on grasslands in Arizona, New Mexico, Texas and Mexico. Falcon numbers plummeted in the 1930s and 1940s, and breeding populations of the bird disappeared from the U.S. portion of its range by the 1950s. Biologists believe that the most important factor in the bird's decline was the widespread conversion of desert grasslands to shrublands.[36] At present, Northern Aplomado Falcons are found in some small areas in northern Mexico, and also in parts of Texas where captive-raised birds have been released as part of reintroduction efforts.

Biologists believe that the most important factor in the decline of the Aplomado Falcon may have been the widespread conversion of desert grasslands to shrublands.

Otero Mesa provides some of the best remaining potential Aplomado falcon habitat in the Southwest. © Ken Stinnett Photography.

Reestablishing Aplomados in the Southwest can only happen if the habitat exists to support them. Aplomado Falcons have particular requirements for hunting and nesting. They feed mainly on other grassland birds, such as meadowlarks, horned larks and sparrows, so they need open areas where they can chase and catch their prey. However, they nest in the abandoned stick nests made by other large birds, such as ravens and hawks, and these are usually found in tall shrubs, such as yuccas. They also use shrubs as perches for spotting their prey. The ideal Aplomado Falcon habitat, then--at least in the Southwest--consists of large areas of grasslands dotted with shrubs. This is confirmed by studies of existing populations of Aplomado Falcons, which found that falcons forage and nest in areas with low woody plant densities and high grass cover[37]

Otero Mesa provides some of the best potential Aplomado Falcon habitat in the Southwest. Not only does it have extensive areas with just the right mix of grass and shrubs, but it also has an abundance of the prey species preferred by the falcons.[38] A statistical model developed by the Cooperative Wildlife Unit at New Mexico State University identified much of Otero Mesa as highly suitable falcon habitat.[39]

According to the U.S. Fish and Wildlife Service:

"the Aplomado Falcon depends on the desert grassland ecosystem, and wherever it remains, is essential habitat for the falcon. Therefore, Otero Mesa (including McGregor Range) is a high priority recovery area for the falcon because of the combination of its overall size, relatively unfragmented natural condition, and its proximity to breeding Aplomado populations in nearby Mexico."[40]

Indeed, there have been several sightings in recent years of Aplomado Falcons on Otero Mesa in recent years.[41] The most recent sighting consisted of two birds seen together in August, 2005 in an area of the grasslands slated for oil and gas development.[42]

It may only be a matter of time before Aplomados return to breed on Otero Mesa—if the grasslands remain intact. The proposed development of the area for oil and gas production would fragment it into smaller patches divided by roads, well pads, pipelines, etc. This would have two major negative effects for Aplomado Falcons. First, it would reduce the abundance of prey species such as meadowlarks and horned larks. Studies have shown that these "area-dependent" species produce fewer young in smaller habitat patches.[43] In some cases the number of grassland birds decreased 60 percent within 2000 feet of rural roads.[44] Second, it would eliminate large areas of contiguous grassland needed by falcons to hunt effectively.

Otero Mesa grasslands are the most expansive potential habitats for Aplomado Falcons in New Mexico. Other New Mexico grasslands that are suitable habitat for Aplomado Falcons are smaller (e.g. Nutt grasslands, Armendaris Ranch, Gray Ranch in Hidalgo County) and could only accommodate two or three pairs of breeding birds. Potential habitat in southeastern New Mexico has been divided into very small blocks by oil and gas wells, road, and pipeline corridors. The other suitable desert grassland habitats for Aplomado Falcons in southern New Mexico are small patches of desert grassland in a matrix of desert shrubland with extremely high densities of woody plants. Oil and gas development on Otero Mesa could well ruin it for Aplomado Falcons, and make it very difficult if not impossible to restore Aplomado Falcons anywhere in New Mexico.

The BLM has decided to set aside two blocks totalling 27,000 acres on Otero Mesa as an experimental Aplomado Falcon reserve, where oil and gas will not be allowed for five years. However, this is far too small an area by itself to sustain a population of these wide-ranging birds, and would probably support only three to five pairs, at best.[45] In addition, the BLM may open up even these areas to oil and gas development after five years.

Otero Mesa is especially important to grassland birds, a group that has declined more than any other category of North American bird.

A stronghold for grassland birds

Otero Mesa is especially important to grassland birds. As a group, grassland species have experienced more precipitous and geographically widespread declines in recent decades than any other category of North American birds, mainly due to habitat fragmentation.[46] Otero Mesa provides a home to many of these, either as year-round, breeding or wintering habitat.[47]

Looking at the entire continent, more than half (thirteen of 25) of grassland bird species experienced significant declines from 1966 to 1996.[48]

Six of these have declined to the point that they have formal conservation status (i.e. they are officially recognized as birds in trouble) in the United States and/or Canada.[49] These include the Ferruginous Hawk, Burrowing Owl, Loggerhead Shrike, Grasshopper Sparrow, Baird's Sparrow and Western Meadowlark. All are found on Otero Mesa.[50]

Nearly half of the grassland birds that breed in New Mexico are on a downward trend.[51] These include horned larks, Eastern Meadowlarks, Cassin's Sparrows, Common Nighthawks, Lesser Nighthawks, Lark Sparrows, Ferruginous Hawks, Scaled Quails, and Grasshopper Sparrows.[52] Otero Mesa is used by all of these birds for breeding or as winter habitat.

Most western grassland bird species migrate short distances to spend their winters in the southern and southwestern U. S. and northern Mexico. There are also a number of grassland bird species that breed in the prairie region of North America and move into the Chihuahuan Desert grasslands during the winter. For many of these birds, the desert grasslands are important winter habitat and essential for their survival and return to their breeding habitat.

Otero Mesa provides a home to many grassland birds that are declining elsewhere, like horned larks. © Ken Stinnett Photography.

The major cause for the decline of grassland birds is habitat fragmentation.

Common winter migrants that utilize the Otero Mesa grasslands are Chestnut Collared Longspurs, Brewer's Sparrows, Sprague's Pipits, and Prairie Falcons.[53] All of these species have experienced reduction in numbers during the past 40 years. Two of these--Chestnut Collared Longspurs and Sprague's Pipits--are grassland specialists rarely found elsewhere in the region during winter.[54]

The major cause for the decline of grassland birds is habitat fragmentation, which affects birds in several ways. The size of habitat patches affects the breeding success of birds ("area sensitive" species) which require large areas of uniform habitat to provide food for their young, as well as those ("habitat interior" species) which are only found in relatively uniform habitat that is not adjacent other habitat types.

Habitat fragmentation has been shown to affect the survival of neotropical migratory birds by affecting their ability to replace body mass loss during migration.[55] These are birds that breed in the temperate zone of North America and winter in the tropical areas of Mexico and Central America.

The effects of fragmentation in grassland ecosystems are greatest when the severity of disturbance results in a highly contrasting mosaic of suitable and unsuitable habitat patches derived from what was previously a homogeneous landscape.[56] Fragmentation of winter habitat is just as detrimental to grassland specialists as the fragmentation of breeding/nesting habitat. Some species are more sensitive to fragmentation than others. Grassland bird species that are most adversely affected include Grasshopper Sparrows, Upland Sandpipers and Western Meadowlarks.[57]

Fragmentation and degradation of the Otero Mesa grasslands by oil and gas development will convert much of the area to unsuitable habitat for many grassland bird species. Roads and pipeline corridors constructed for oil and gas development not only divide grasslands into small patches, they produce edges that become habitat for weed species and shrubs.

Discovery of natural gas

Nobody knows how much natural gas lies beneath Otero Mesa. Of the more than 60 oil and gas wells that have been drilled over the past 80 years, only two remain open.[58] Leaving aside obviously self-serving industry projections, credible estimates of Otero Mesa's gas reserves range from 110 billion cubic feet to one trillion cubic feet (Tcf).[59] The "Reasonable Foreseeable Development" (RFD) predicted by the Bureau of Land Management (BLM) assumes a reserve at the low end of this range.[60]

The most optimistic estimate of the amount of natural gas beneath Otero Mesa is equivalent to only 16 days of our annual national demand.

These estimates have to be considered in the context of U.S. consumption. The most optimistic estimate—one Tcf—would satisfy only about 16 days of our annual national demand for natural gas of 22.4 Tcf.[61] Otero Mesa by itself will contribute little toward national energy independence.

In 1997 however, a well drilled by Harvey E. Yates, Co. (Heyco) hit natural gas, and the BLM found itself deluged with applications from oil companies to lease other parts of Otero Mesa. The BLM responded by placing a moratorium on issuing further leases until it could be determined how to proceed.

In 2000, the BLM announced its proposed plan.[62] Most of Otero Mesa (93 percent) would be open to oil and gas development, but 116,000 acres of grasslands would be protected by a "no surface occupancy stipulation;" i.e., industry could drill, but only from pads built on or adjacent to existing roads.[63] To reach unroaded areas, they would have to use directional drilling--a feasible but more expensive option than conventional drilling.

Complaints by industry that the plan was too restrictive found sympathetic ears in the White House, and BLM revised its proposal. On January 22, 2005, BLM issued its final plan. The "no surface occupancy" stipulation for the grasslands was dropped, replaced by a novel requirement that no more than five percent of the grasslands could be disturbed by oil and gas development activities at any given time.[64]

In theory, this sounds like a balanced approach. Oil companies would not be allowed to disturb more than 5 percent of their leased area until they restore areas already disturbed. For example, if a lease is 100,000 acres, the drilling operations could be conducted on 1000 well pads of approximately 5 acres per pad or 500 well pads plus 150 miles of cleared haul roads. The whole area could be explored and developed, but surface disturbance would, in theory, be kept at a minimum.

But there are several problems with this approach. First, a surface disturbance of five percent of the area does not mean that impacts will be limited to only five percent of the area. Impacts such as noise, dust, and runoff, will travel and manifest themselves over a much larger area. The BLM itself assumes that although direct surface disturbance at full field development on Otero Mesa would be less than 100 acres, it would create a zone of continuous occupation and disturbance that would render more than 3000 acres of surrounding land unusable as habitat for Aplomado Falcons and most other wildlife.[65]

Secondly, the plan will set in motion processes that will lead to fragmentation of one of the last remaining remnants of Chihuahuan Desert grasslands.

And lastly, the whole scheme depends upon being able to achieve meaningful restoration of the grasslands on a timescale that makes economic sense—a feat that has yet to be accomplished despite the best efforts of many range scientists, and one that may simply be impossible in the Chihuahuan Desert.

Grassland restoration has yet to be accomplished despite the best efforts of many range scientists, and may simply be impossible in the Chihuahuan Desert.

While this plan only applies to federal lands, it will open the door to oil and gas development over a much larger area. Oil companies have already leased all of the intermingled state lands, and acquired permission to build a pipeline across BLM and private lands to transport oil and gas out of the region. They have been waiting for the green light to drill from the BLM before going ahead with development of the entire area.

How Otero Mesa is threatened by oil and gas development

The finding and extraction of fossil fuels from beneath the earth's surface causes significant environmental impacts at every stage of the process. A look at the devastated landscapes of the Permian Basin near Carlsbad and Hobbs (New Mexico)—an oil field that was first developed in the 1920s—provides ample evidence of this. From the spills of toxic chemicals around well pads, to the poisonous hydrogen sulfide that lurks in low-lying areas, to the contamination of municipal water supplies around Lovington, to the dead birds on natural salt lakes used for the legal and illegal dumping of produced water—nobody could deny that this is an ecological sacrifice zone. The oil and gas industry likes to say it can do it better today, but the process is still inherently destructive from an ecological perspective..

Ecological impacts can be divided into two categories: direct and indirect. Direct impacts are those that cause direct harm to plants and animals. Examples would include the actual clearing of grassland vegetation, or vehicle collisions with wildlife. Indirect impacts do not cause direct physical harm, but result in changes that ultimately prove detrimental, such as noise that renders an area unusuable by wildlife.

The impacts of oil and gas development begin at the exploration stage. Seismic exploration generally requires driving large, dual wheeled vehicles across the terrain, off existing roads. It frequently involves detonating explosive charges to produce shock waves that penetrate the earth, providing geologists with a sense of what lays beneath the earth's surface.[66]

Studies of off-road vehicle impacts in the western U. S. have documented soil damage, soil compaction and reduced plant species diversity in the wheel tracks.[67] Otero Mesa is particularly susceptible to damage from the heavy vehicles used for seismic exploration due to its undulating topography and shallow, fine-textured soil over a layer of caliche, plus the small average tussock size of the perennial grasses that comprise its grasslands.

Oil and gas development has devastated landscapes in the Permian Basin of New Mexico. Photo courtesy of SkyTruth.

Depending upon the route traversed, the wheels may uproot shallow-rooted grasses and loosen the soil, leading to rill erosion of the wheel tracks. If the soil is not loosened or plants uprooted, the wheels of heavy vehicles will compact the soil and reduce infiltration and soil water storage. Either scenario will cause serious damage to the soils and vegetation of Otero Mesa's grassland ecosystems.

Compaction of soil by heavy vehicles will destroy the microtopography that is a key feature of Chihuahuan Desert grasslands. Microtopography is the fine scale differences in elevation between the small mounds that are associated with grass tussocks and the small depressions between tussocks that are devoid of vegetation. This microtopography is important for water infiltration, percolation and storage and is an important structural characteristic of these grasslands.[68] Loss of microtopography reduces water availability to the plants.

Wildlife is affected by seismic exploration activities such as the clearing of corridors, laying cables, transportation of field crews, and detonation of explosives. These can cause wildlife to alter their movement and activity patterns as well as social behaviors. Studies of seismic exploration activities on elk, for example, documented short-term effects on behavior during exploration operations, such as being driven off their feeding grounds.[69]

While similar studies have not been done on pronghorn antelope, pronghorn on Otero Mesa have been observed to cease feeding and flee more than a mile away in response to a sport-utility vehicle stopping within 500 yards of their preferred foraging area--the green "lawn" of a prairie dog colony.[70] Their skittish nature suggests that pronghorn may respond even more dramatically than elk to seismic exploration activities.

If seismic exploration activities displace pronghorn antelope from their preferred feeding areas, and subject them to frequent disturbance causing them to flee, they will sustain higher daily energy requirements than normal. Running simply takes more energy. When fleeing is combined with exclusion from areas with the most nutritious food, the animals' energy loss may exceed energy intake, resulting in poor body condition, lower growth rates and potentially even higher mortality rates of antelope kids.

Seismic "thumper trucks" in Wyoming. Impacts to wildlife occur at every stage of oil and gas development. Photo by Scott Groene.

The BLM estimates that each well on Otero Mesa will generate approximately 6000 vehicle trips per year during production, over a 20-year period or more.

The most serious consequences of oil and gas development are the direct and indirect effects of road construction, pipeline construction, clearing well pads, and constructing sumps for wastewater and waste materials from the drilling process. Let's start with the effect of dust.

Drilling operations require regular and frequent deliveries of material such as drilling mud, drill bits, etc. A new road will have to be built to drill and service every single well. The BLM estimates that each well on Otero Mesa will generate 966 vehicle trips per year during the drilling phase (about three back and forth trips per day), and approximately 6000 trips per year during production (about 20 trips each day), over a 20-year period or more.[71] The heavy delivery vehicles will generate large quantities of dust. It has been estimated that one car traveling over a one-mile dirt road daily generates one ton of dust on average in a year.[72]

Dust can harm vegetation downwind from roads. On Otero Mesa, roads are typically built by clearing vegetation and scraping the soil layer off the underlying calcrete (caliche). The exposed calcrete surfaces will be subjected to erosion by vehicular traffic, which grinds the surface calcrete into a fine powder. The moving traffic discharges the finely powdered calcrete as dust clouds. When dust settles on plant leaves or blades of grass, the dust layer reduces the absorbance of phosynthetically active wavelengths of light and increases leaf surface temperatures by 2 to 3 degrees Celsius.[73] As a result, desert plants exposed to dust during the growing season will experience decreased water use efficiency, reduced rates of photosynthesis, and reduced growth rates overall.

The impacts continue during the non-growing season. If the amount of energy stored in perennial grasses is not sufficient to cover metabolic costs during dormancy and to initiate growth of leaves following the next rain event in the growing season, death of the tussocks will ensue.

It is possible to see today on Otero Mesa how wind blown deposits can harm plants around roads and other cleared areas. Surface materials from existing roads have been transported by wind and deposited around plants in some areas, forming small dune-like accumulations of sand in the wind shadow of grass tussocks.[74] When these sands are moved by winds, the bouncing sand grains are abrasive and can damage the foliage of plants.[75]

Two existing natural gas well pads on Otero Mesa are each approximately five acres in size. The soils have been removed from the well pads and piled up on the sides. The soil piles are showing signs of wind erosion. The well pads are exposed caliche hardpan and are approximately two feet lower than the surrounding terrain. The cleared well pads act as erosion cells, providing extremely long fetches for wind to reach maximum erosive power.[76]

Soils downwind from the bare well pads are exposed to winds that exceed the minimum speed needed to dislodge sand grains from the soil surface and bounce those sand grains along the surface. Once sand particles begin to move, they dislodge other sand grains, producing a cascading effect. The mobile sand buries vegetation at some distance downwind from the well pad. Not only does this affect vegetation, but soil is disappearing from the storage piles, and is no longer available for use in reclaiming the site after drilling and pumping operations are completed. From the extent of erosion observed, it is likely that the entire volume of soil in the piles will be lost by wind erosion over the period of a decade.

The drilling of an oil or gas wells generates large quantities of liquid wastes, including drilling fluids and cuttings, excess groundwater, fraccing fluids, etc. Typically, these are stored in an open pit, lined with plastic and covered by a net to exclude birds. The whole pit is then buried when the well is closed down.[77] The sloping, undulating topography of the Otero Mesa grasslands increases the risk of significant contamination of low areas and playa lake basins from the materials in these pits. The Chihuahuan Desert is subject to episodic rainfalls of greater than one inch of rain in an hour. Although such intense rains occur infrequently, the runoff generated by such a storm will flood the sump pits and transport the wastes stored in the pits to the lowest part of the watershed.

The BLM estimates that 350 miles of new roads could be built on Otero Mesa for oil and gas development over a 20-year period.

More roads

Oil and gas development will require construction of many additional miles of roads. The BLM estimates that 350 miles of new roads could be built on Otero Mesa for oil and gas development over a 20-year period, increasing the existing road density by 17 percent.[78] Road construction alters run-off patterns and microhabitats in ways that may have subtle adverse ecological effects. The significance of these effects is directly related to the density of roads. The more roads there are, the greater the magnitude of the impacts.

Dirt roads in rangelands are designed with crowns that shed rainwater to either side. There are sluices to divert water off the roadway and prevent water and mud from collecting in low spots on the road during storms. However, water has to go somewhere, and eventually it will come to rest in low areas. When runoff volumes are large, such as following the intense summer thunderstorms that are common on Otero Mesa, the deposited sediment can bury and kill plants thereby rendering the run-on areas devoid of vegetation and prone to wind erosion.

Another consequence of increased road traffic on Otero Mesa is the potential for introducing and spreading seeds of alien and invasive plant species. Vehicles and their passengers sometimes act as dispersal agents for these species. Seeds can be carried in mud trapped in the tread of tires or boots, for example. There are several species that are a particular concern because they change ecosystem dynamics and can lead to the disappearance of native animal and plant species over time. Lehmann lovegrass (*Eragrostis lehmanniana*), an African grass that has been widely planted to stabilize road edges has displaced and is displacing native grasses in disturbed and degraded grasslands in New Mexico and Arizona.[79] African rue is another nonnative plant that is already a problem in other parts of Otero County.

The high volume of traffic will have impacts on animals whose home sites or preferred feeding areas are close to roads. Different species of wildlife have varying tolerances for disturbance. Avoidance distances reported for pronghorn range from 0.25 mi to 0.6 miles. Mule deer show evidence of stress in response to disturbances up to 0.29 miles away.[80]

A multi-year study in Wyoming found that mule deer tend to avoid areas near well pads and roads. It also found that they changed their behavior immediately in response to oil and gas activities, and showed no signs of becoming acclimated to such activities over time.[81]

Prairie dogs are also disturbed by vehicle traffic. Because prairie dogs are social animals, when one member sounds an alarm call, the whole group typically dives into burrows. This obviously reduces the amount of time they can spend foraging for food and doing other activities. Frequent disturbances may discourage prairie dogs from venturing as far from their burrows as they might otherwise, thus reducing the amount of food potentially available to them. If disturbances are too frequent, energy and nutrient intake for the entire group may be reduced significantly, reproduction may be affected, and the survival of the colony may be jeopardized.

More roads will bring many of Otero Mesa's prairie dog colonies in close proximity to roads. Prairie dogs make tempting targets for "shooters" who drive rural roads looking for targets. The Heritage Ranch in nearby Luna County (New Mexico) had to abandon efforts to reintroduce prairie dog colonies in suitable habitats near roads because of "live target shooters."

Prairie dogs are not the only targets for shooters in remote rangeland areas. Other species that could be harmed include kit foxes, coyotes, gray foxes, badgers, etc. Increased density of roads will also increase the potential for poaching of antelope and mule deer.

Habitat fragmentation

The most important factor causing the reduction of biodiversity globally is the fragmentation of habitats.[82] Fragmentation occurs when contiguous, large areas of relatively homogeneous habitat are divided into separate smaller patches. As a general rule, smaller patches of habitat support fewer species than larger ones.

The greatest threat posed by oil and gas development on Otero Mesa is that it will lead to fragmentation of the grasslands, causing permanent changes to ecosystem structure, and eventually result in a loss or reduction in abundance of many of the grassland animals.

The greatest threat posed by oil and gas development on Otero Mesa is that it will lead to fragmentation of the grasslands.

Oil and gas development will fragment Otero Mesa in several ways. First, for each well drilled, a well pad of approximately five acres will have to be cleared. Each well pad will need to be served by its own road, pipeline and powerline, all of which will entail clearing more vegetatation. Full development of Otero Mesa will allow for approximately 2500 acres to be cleared.[83] Ostensibly this is a ceiling—the BLM plan requires that additional disturbance cannot take place within the grasslands until an equivalent amount of land is restored. However, true ecological restoration is probably impossible.

To give one example, consider the long-term impacts of buried pipelines. Pipeline corridors are likely to become linear habitats for deep-rooted shrubs, resulting in fragmentation of the contiguous grasslands into smaller patches.

A typical oil well pad in southeastern New Mexico. An average of five acres will be cleared for each well pad constructed on Otero Mesa. Photo courtesy SkyTruth.

Because the soils on Otero Mesa are shallow, excavation of pipeline corridors will of necessity involve breaking into the cemented calcrete layers, which are only two feet below the surface over most of the grasslands. Mesquite shrubs are currently limited to small populations in deep washes and around some livestock watering tanks. Once the pipes are laid and buried, these areas will provide the seed source, and the trenches will provide rooting habitat for their spread. The pipeline corridors will probably become hedgerows of shrubs cutting through the grassland, transforming it into a checker-board separated by shrubs. It is difficult to see how this impact could be avoided.

When shrub hedgerows grow to heights over about five feet, the grassland will no longer be suitable habitat for pronghorn antelope. Pronghorn require open habitats that afford long views to detect predators and utilize their speed to escape.

Any activities associated with oil and gas development that disrupt the cemented calcrete underlying the Otero Mesa grasslands will provide habitat for invasive shrubs, and will reduce or eliminate the grasslands as habitat for animals and birds that are grassland specialists.

The importance of Otero Mesa to grassland birds has already been described. Habitat fragmentation is the number one reason why so many grassland-dependent birds are in trouble today. Oil and gas development could drastically reduce the value Otero Mesa for these species. Studies have shown that the density of grassland birds decreases at distances of up to 1200 meters (3936 feet) from roads.[84] To put it another way, for every mile of road constructed, a nearly 1000-acre zone of disturbance is created. If the BLM is correct that 350 new roads will be built, this could result in a drop in grassland bird numbers over as much as 340,000 acres. Besides the obvious harm to grassland songbirds, such as meadowlarks and sparrows, such a widespread decline in the abundance of bird prey species would reduce the value, perhaps drastically, of Otero Mesa as potential habitat for Aplomado Falcons.

Two examples of habitat fragmentation: clearcutting of the Amazonian rainforest in Brazil (above) and oil and gas development in the Jonah Field in Wyoming (below). Similar development would convert Otero Mesa's grasslands to unsuitable habitat for many bird species and other wildlife that currently find a home there.

Photo by Peter Aegnst, The Wilderness Society and Lighthawk

For every mile of road constructed, a nearly 1000-acre zone of disturbance will be created.

The Restoration Myth

The assumption that Otero Mesa can be ecologically "put back together" after significant disturbance is at the heart of BLM's proposed plan for oil and gas development of the area. The BLM says it will allow a maximum of five percent "combined unreclaimed and unvegetated surface disturbance from exploration, drilling, production and other activities associated with lease operations" on each lease it issues in the grasslands at any one time.[85] For the industry to exceed that amount, it must first reclaim disturbed areas to BLM's satisfaction.

As already noted, there are several problems with this approach. First, the agency has considerable discretion in determining what constitutes successful reclamation, and it is unclear if it will impose requirements that constitute meaningful ecological restoration or settle for something less. Second, even if BLM adheres to strict ecological standards, genuine restoration of Chihuahuan Desert grasslands is exceedingly difficult if not impossible, as evidenced by numerous unsuccessful attempts by scientists and range managers in the past. Third, seeds of native grasses with genetic composition similar to those found on Otero Mesa are not commercially available, at least not yet. And finally, it is highly questionable whether BLM has the resources to monitor and enforce whatever standards it imposes.

Desert grassland ecosystems like Otero Mesa are nearly impossible to restore. Photo by Kevin Bixby.

According to the BLM's final record of decision for Otero Mesa, the agency will require that a reclamation plan be part of a "Surface Use Plan of Operation (SUPO)" developed when an company is issued an permit to drill. The BLM will link "rehabilitation" requirements to the plant species growing adjacent to disturbed sites.[86] "Reclamation will be considered successful when healthy, mature perennials are established with a composition and density that closely approximates the surrounding vegetation as prescribed by the BLM, and the reclamation area is free of noxious weeds."[87]

Although this sounds good, the reality is that this is new ground for the BLM. The agency's historic focus has been on reclamation, not restoration. Reclamation is a term used by many practitioners because "there is no implication of returning to an original state but rather a useful one."[88]

The BLM's reclamation guidelines are contained in its Solid Mineral

Reclamation Handbook H-3042-1 and the Surface Operating Standards for Oil and Gas Exploration and Development (the so-called Gold Book). The guidelines contained in these documents focus on controlling erosion and returning disturbed sites to "productive" uses.[89] Neither objective requires that a site be put back the way it was, with the same species composition and ecosystem functions.

Chihuahuan Desert grasslands are functionally ecosystems and must be examined in an ecosystem context. Once they have been destroyed or severely impacted by human activities, like Humpty Dumpty, it is virtually impossible to put all the pieces together again.

The ecosystems of Otero Mesa are especially fragile because they exist in an environment where seasonal rainfall frequently approaches the minimum necessary to keep important groups of species alive.

Functional biodiversity refers to all of the organisms that are involved in critical ecosystem processes, such as the capture and transformation of the sun's energy and the cycling of nutrients. The ecosystems of Otero Mesa are especially fragile because they exist in an environment where seasonal rainfall frequently approaches the minimum necessary to keep important groups of species alive. Anything that increases stress on these systems, such as the construction and operation of oil and gas infrastructure, poses a threat to the functional biodiversity of Otero Mesa.

Renewal and reorganization of ecosystems is dependent upon the resilience of ecosystems following stress and disturbance. Ecosystem resilience can be thought of as a spring, which is distorted by stress or disturbance. Resilience is a measure of how close it can return to its original shape. Biological diversity plays an important role in ecosystem resilience and sustaining desirable ecosystem states in the face of disturbance and change.[12]

"Reclaimed" oil well pad on Otero Mesa. Note presence of creosotebush shrubs, showing how soil disturbance caused by oil and gas development allows shrubs to invade Otero Mesa's grasslands. Photo by Kevin Bixby.

Why are desert grassland ecosystems so nearly impossible to restore? To answer that question, one must consider the variability of an ecosystem that responds to climate, especially rainfall, as a "pulse-reserve" system. In a pulse-reserve system a trigger (rainfall) stimulates the transfer of energy and nutrients from the reserve (storage in roots and stems of plants, fat and nutrient stores in animal tissues) to the growth tissues of plants or to reproductive organs in animals. This transfer results in a pulse of growth or reproduction and the transfer of some of the growth energy back into reserve.

An important part of that variability accrues to desert grassland ecosystems because of the evolutionary relationships between the plants and the soil biota and the trophic (feeding) relationships among plants, herbivores and predators. The severity of a disturbance can be assessed only by examining the effect of that disturbance on the properties and processes of the ecosystem.

Chihuahuan Desert grassland ecosystems respond to rainfall as predicted by the classical "pulse-reserve" model for arid ecosystems.[90] A trigger--in this case, a rainfall of sufficient magnitude--initiates a pulse of activity by all of the components of the system. That pulse draws upon the energy and resources in the "reserve," resulting in the production and/or addition to the "reserve." The reserve includes seed production, energy storage in root tissues or in stems, reproduction and/or fat storage by animals, and desiccation resistant life stages of soil biota.

The initial pulse of activity includes production of green foliage and photosynthesis by the plants, uptake of water and soil nutrients by plant roots, and activation and growth of the "rhizosheath community"—the assemblage of bacteria, fungi, protozoans, nematodes, and soil mites closely associated with plant roots in the soil a millimeter or so around each root.

In desert grasslands there are several species of nitrogen-fixing bacteria that are part of the rhizosheath community. These bacteria use the mucilaginous (glue/paste like compounds) carbon compounds exuded from the roots as a source of energy for their nitrogen fixing activities.[91]

The growth pulse of desert grasses is dependent upon the presence of this rhizosheath community in the soil. Protozoans, nematodes and soil mites are essential for decomposition and mineral nutrient release.[92] Bacteria and fungi produce the extra-cellular enzymes that breakdown structural components of dead plant and animal material in the soil. The release of mineral nutrients from this decomposing detritus is dependent upon soil animals that graze on bacteria and fungi.

An especially important component of the rhizosheath community are the mycorrhizal fungi (literally fungal roots) that have coevolved as partners in mutually beneficial relationships with many desert grassland plants. The hair-like hyphae of these fungi extend into the soil and penetrate into the root where they form structures within the cells or intercellular spaces of the roots. The fungi help the plants by transporting phosphorus and possibly other nutrients into the roots where they can be transported to the growth points of the plant. The fungi benefit by receiving energy from the host plant in the form of products of photosynthesis that are transported to the roots.

Perennial grassland ecosystems are particularly dependent upon the presence and activity of an intact and specialized soil biota.

There is a large body of research that documents the importance of mycorrhizal fungi for vigorous plant growth and in early stages of the colonization of barren areas by plants.[93] Perennial grassland ecosystems are particularly dependent upon the presence and activity of an intact and specialized soil biota including mycorrhizae. In order for desert grassland plants to respond optimally to a rain event, there must be a viable rhizosheath community in the soil. The presence of a functional rhizosheath community is even more important for the establishment and survival of plants that germinate from seeds following a suitable rain event.[94]

When roads, pipelines and well drilling pads are constructed, BLM policy requires that soil removed from the cleared areas be stored in stockpiles or windrows for future reclamation use. Stockpiled soil does not support a complete soil biotic community. When the soil is placed in piles, soil organisms that are dependent upon living plants are quickly lost.

Soil removed from well pads and haul roads will be stored in stockpiles for up to a decade or longer. However, even short-term storage of soil results in the loss of some species of mycorrhizae and other rhizosheath organisms.[95] When this material is spread back over cleared areas, some fraction of the soil biotic community will have died out during storage. When seeds germinate in the biologically compromised substrate, the seedlings must become established without the assistance of the associative microbial community and possibly without some important fungal symbionts.

Soil excavated to construct this well pad is stockpiled in the distance. Stockpiled soil quickly loses its soil biota. Photo by Kevin Bixby.

The importance of mycorrhizae and microorganisms of rhizosheaths in re-establishment of native plant has been documented in sagebrush steppe ecosystems. In the sagebrush areas of the Great Basin, an annual grass from Eurasia called cheat grass (*Bromus tectorum*) has become so abundant that it now affects all ecosystem properties and processes. In disturbed areas where cheatgrass has taken over, the mycorrhizae associated with native plants has disappeared, making it extremely difficult for native shrubs and grasses to become reestablished.[96]

The difficulty of getting an ecologically appropriate seed mix is another factor that makes restoration problematic. Biologists recommend using seeds with the closest possible genetic makeup to the plants being replaced, to take advantage of the evolutionary adaptation of such stock to the unique conditions of the area being restored.[97] Seeds from distant sources are less desirable because they are poorly adaptated and will contaminate the local genetic material, thereby reducing the vigor and competitive ability of the local plant community.[98] Some experts believe that seed collected from sources more than one kilometer from the restoration site should not be used because it poses an unacceptable risk of genetic pollution.[99]

However, at the moment, there are no commercial sources of black grama grass seed from any location, much less from Otero Mesa. BLM glosses over this problem, saying only that it will develop a source for needed seeds if one is not available.[100]

Commercial seed mixes for use in Chihuahuan Desert rangelands are predominately species of dropseeds, three awns and other species that fall into the short-lived tussock grass category. These species account for less than 10 percent of Otero Mesa grasslands and should not be considered as adequate replacement for the dominant grass species: black grama, *Bouteloua eriopoda* and blue grama, *B. gracilis*. Using them will fragment the native grassland and will not produce a drought and erosion resistant grassland that supports Otero Mesa's current grassland fauna.

The potential genetic problems with planting grasses on Otero Mesa are exacerbated by the life history characteristics of the dominant grasses. Long-lived species, such as black-grama, are genetically more variable than short-lived species such as dropseeds and three awns.[101]

An industry has developed around producing large volumes of generic seeds for use in reclamation. As one of the industry leaders said, "Making seed of local ecotypes available on a similar scale and economy is uncharted territory - it has never been done and no one knows if it can be done."[102]

The problem of soils, commercial sources of seeds, and the potential genetic problems with reseeded rangelands combine to make the risk of failure to restore the Chihuahuan Desert grasslands of Otero Mesa extremely high. On the Jornada Experimental Range and in many degraded areas in the Chihuahuan Desert, efforts to restore grassland communities have had limited success. In most cases, the only grasses that re-establish are the short-lived tussock grasses. Even when seeding with black-grama grass has been attempted, establishment and survival of this species has been so poor that the results could not be considered grassland.

Suitable climatic conditions for germination, establishment and survival of black-grama from seeds occur at low frequency.[103] Since established black-grama plants survive for several decades, this is not a problem in undisturbed grassland. However, because suitable rainfall amounts and seasonal timing for germination may occur on a decadal (10 years or more) time scale, the probability of successful establishment of black-grama grasses from seeding remains very low. Hence even if black-grama seeds were available, it is very unlikely that road cuts, pipeline corridors and well pads could be restored to the type of grasslands they are today on Otero Mesa.

Conclusion

Like Yellowstone and the Everglades, Otero Mesa is a national treasure. It contains one of the largest remaining tracts of grassland left in the Chihuahuan Desert--one of North America's most endangered ecosystems. If it disappears, we will have lost an irreplaceable part of our natural heritage and a critically important place for wildlife.

Photo courtesy SkyTruth.

No matter how carefully it is done, oil and gas development will alter the ecological character of Otero Mesa. The changes will occur slowly, imperceptibly to most people, but they will inevitably transform the area into the same kind of desert shrubland that has come to dominate most of the region. And what will we have gained? In all likelihood, a negligible amount of natural gas, certainly not more than a blip in our national demand for energy.

When all the gas is extracted from beneath Otero Mesa and the oil rigs have moved on, our nation will be no closer to genuine energy independence, but the landscape of Otero Mesa will be irrevocably changed. The expansive grasslands will be criss-crossed with roads, pipelines and powerlines, fragmented into small patches, and isolated by advancing populations of creosote and mesquite. Much of the wildlife that now makes Otero Mesa home will find it an increasingly hostile environment. They will be forced to retreat in ever dwindling numbers to the shrinking pockets of grassland that remain. Eventually many of these animals may disappear from the area entirely.

In an era of vanishing wildlife worldwide, sacrificing the extraordinary grasslands and wildlife of Otero Mesa for a relatively small amount of natural gas would be a tragic and needless mistake.

Endnotes

[1] The total acreage of grasslands on Otero Mesa is derived from two sources. According to the U.S. Army (*McGregor Range Land Withdrawal, Legislative Environmental Impact Statement*. Volume I, p.3-8-6. May 1999.) there are 161,400 acres of grassland on McGregor Range; all of which are located on Otero Mesa. According to the Bureau of Land Management (Mike Howard, pers. Comm.), the remaining grasslands correspond closely to the area designated by BLM as the Otero Mesa Habitat Management Area, which contains 427,275 acres (Bureau of Land Management, *Draft Resource Management Plan Amendment and Environmental Impact Statement for Federal Fluid Minerals Leasing and Development in Sierra and Otero Counties*. P. A-V-10. October, 2000) These two figures add up to 588,675 acres of grassland, or about half of Otero Mesa's 1.2 million acres.

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Alamo Mountain on Otero Mesa. Photo by Jim Steitz

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