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Kathleen H. Keeler
*University of Nebraska-Lincoln*, kkeeler1@unl.edu

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# GRASSLANDS
## AN INTRODUCTION

"Grasslands" was the subject of the seventeenth annual symposium of the Center for Great Plains Studies, held at the University of Nebraska-Lincoln, in April 1994. Grasslands are so basic to the Great Plains experience as to be invisible. If you stand here in eastern Nebraska, it is so far in any direction across grasslands to any other landscape (a cornfield is a planted grassland, after all) that the role of grasslands in our lives does not seem worth considering. Local variation is much more visible. You can't see the prairie for the grasses, to adapt the idiom.

And yet, grasslands played and continue to play a guiding role in the development of this region. They shape economics, architecture, and social interactions, as well as weather, agriculture, and native species.

A symposium on grasslands grew out of the need to talk about grassland ecology with nonecologists. Ecology and environment are cliches in the media today. They are also organizing principles of everyone's daily life. Ecology is the academic discipline focused on the way organisms, humans included, interact with their surroundings (environment). Ecological principles include the rules by which water and nutrients flow through the environment (i.e., ecological systems), energy transfer among organisms, and the factors controlling increases or decreases in animal and plant numbers. Whether we notice them or not, these rules apply in native prairies, wheat fields, suburban yards, and urban landscapes. Like the laws of chemistry and physics, ecological principles are always there.

Environment, whether natural or human-made, is critically shaped by regional climate and history and, conversely, shapes the lives of people and organisms. For example, grasslands are windy places: on the average the prairie wind is blowing 16 kph (10 mph).[1] Consequences of this include: native birds and insects are strong fliers; many plants are wind-pollinated; many plants have wind-dispersed seeds; local people never leave papers or even empty garbage cans lying around. High evaporation rates are also characteristic, especially in late summer. These conditions have selected for water-efficient plants like buffalo grass (*Buchloe dactyloides*) but also lead to casual treatment of wet laundry (in this region mildew within a week is rare). These are immediate and obvious effects of climate

as environment. But climate and grassland soils have made this area productive for agriculture and ranching, both of which employ a small and scattered human population. This creates its own set of consequences: outmigration of young people, infrequent and small population centers, high transportation costs due to long distances and low volume, low diversity of human occupations and of goods and services available, and so on. These characteristics result from the region's ecological characteristics. The role of the natural environment in shaping the regional patterns deserves notice. Grassland regions will continue to have distinctive differences from coastal or mountainous regions, despite telecommunications and mobile populations, because the local environments differ. A definite goal of the symposium was to raise consciousness of the ways in which our environment has affected our human ecology and behavior.

The symposium was also intended to enhance exchange about grasslands among disciplines. All fields are in motion, so outsiders need constant updating. In particular I wanted to communicate current ecological views of prairies to nonecologists. The problem has several aspects: first, new discoveries in prairie ecology are reshaping the way we understand grasslands. Second, ecologists speak more to each other than to those outside the field, so their ideas do not always get out. Add to this that ecology, like every field, has both obvious and cryptic jargon, and we have a continuing need to communicate about prairies. I will lay out a couple of examples to show how ecological thinking has changed and then introduce the two papers from the symposium, which demonstrate other changing views.

Ecological breakthroughs do not appear on the front page of the daily paper like medical advances, but ecological thinking has changed as much since 1970 as medicine. One difference is that in medicine new technologies produce changes in theory; for ecology radically revised theories result from better field experiments and more rigorous analysis.

Let me illustrate the changed viewpoints with an example. One of the most important questions for ecology concerns the stability of ecological systems: how easily will a disturbed community recover its original structure and composition? The historical perspective, as Europeans discovered vast American grasslands and watched plants grow back into torn-up wagon paths, was that ecosystems recovered on their own. Disturbances revegetated without human intervention and, eventually, vanished. At the same time, the undisturbed prairie reproduced year after year, despite fire and flood and grasshopper plague. Thus, ecosystems were seen as both resilient (recovering well after disturbance) and stable (unchanging in the face of natural variation).[2]

Our current synthesis certainly recognizes that disturbed areas will be revegetated by "nature." But the modern view is much revised. There *is* no Mother Nature, an all-knowing, calculating entity, but rather the simple, elegant drive of organisms to reproduce themselves and spread their offspring across the land. The process is not organized, therefore, but rather the outcome of the individual success or failure of each nearby plant and animal. These collectively can be seen as forming a pattern of colonization, but it is propelled by individual responses. From this view, it is but a small step to observe that nearby plants and animals and the environmental variables determining their success or failure determine the outcome: there is no inevitable result.

Consequently, we have no certainty that ecological succession, as the recovery of communities after disturbance is called, will lead inexorably to an ecological community indistinguishable from the original one. This difference in theory is accommodated through qualifications added to the original model. The basic story of ecological succession as told by F. E. Clements and others remains sound, but whether the same community appears at the end of the process requires a number of specific conditions. For example, the original prairie wagon trail will revert to prairie, *if*

surrounded by prairie. But if the area is now in the middle of a small city, a community of weeds and then trees is more likely to move "naturally" onto the site, partly because of changed conditions in the local environment (for example, no prairie fires) but especially because seeds of weeds and trees are available and seeds of prairie plants are not. Other variables affecting the recovery of natural systems include the scale of the disturbance and the environmental conditions. Strip mining, which removes soil and deposits heavy metals on the surface, is a dramatic example of a disturbance that may not spontaneously return to prairie: normal plants cannot endure the metals. And there are many kinds of environmental alteration. Global climate change applies here, but so does local warming as a result of heat leaking from buildings or increased humidity because of evaporation from reservoirs and irrigation canals.

The lack of availability of seeds to establish prairie species is easily recognized as preventing ecological succession, and there are many places in the contemporary Great Plains where it is a mile to a native grass, a long way for a 2 mm. ($^1/_{16}$") long seed to disperse. Less obvious in changing the successional outcome is the impact of animals, or the absence of animals: species in the prairie that depended on disturbances produced by bison or prairie dogs may simply not return, or be unable to maintain themselves, in the absence of bison or prairie dogs, so that ecological succession in prairie reserves without these animals ends differently than it did in presettlement times. Moreover, we may not know which of the missing smaller organisms, such as insect pollinators, is responsible for reducing the success of some species. Conversely, species repeatedly introduced (e.g., red cedar—*Juniperus virginianus*—in bird droppings) have an enhanced chance of success. Also important but subtle are edge effects: an array of exotic species inhabits human-disturbed habitats and generally can live on the edges but not invade healthy native ecosystems. Thus, small areas and edges will be at higher risk of change owing to pressure from exotic species than the interior of large areas. If any of these factors is different, succession can go to a different end point because different plants and animals do well in the changed conditions.

One result of the changing view of succession is that terms like sere or subclimax are no longer widely used since they imply a dependable series of stages, and in the complex mixing going on today such recognizable stages frequently do not occur, despite revegetation of disturbed sites.

Different interpretations of the idea of trusting Mother Nature also become critical to the management of natural areas. Jared Diamond makes the case lucidly in a *Natural History* article on the dilemma of Fontenelle Forest in Omaha.[3] Because there are no predators and the forest is a small "island" of trees in a city, deer in Fontenelle Forest have increased in number to the point at which they are eating plants faster than the plants can grow. Tree regeneration has stopped and deer eating habits are determining what plants in the forest are common (unpalatable to deer) and rare (tasty to deer). Modern ecological knowledge, as Diamond argues, suggests we must intervene to remove or reduce deer. Following older ideas of "letting nature take its course" will result in deer transforming the forest. The fact is all actions (including no action) have consequences. Nonintervention may allow outcomes we do not want, such as greatly reduced plant diversity in Fontenelle Forest. This is a problem for earlier theory but makes sense in light of our present knowledge.

A second example of changing ecological theory is seen in how we would explain what factors determine the abundance and distribution of plants and animals on the prairie. You can see the change very clearly by comparing D. C. Costello's *The Prairie World* (1970) with O. J. Reichman's *Konza Prairie, A Tallgrass Natural History* (1989).[4] Both give a sound description of prairie environment and ecology. The engaging prose of Costello, however,

provides the impression that you are looking into a museum diorama and seeing there "how it was," while the prairie of Reichman is presented more like a video, with moving animals, plants in competition, and the grassland a mosaic of constantly changing patches. Our early understanding of prairie ecology focused on the role of climate: wind, water availability, temperature extremes. And no one doubts that lack of water dominates everything in a drought or that midwinter temperatures shape animal and plant behaviors. Current views, however, add two other major influences. Animals (and the role of organisms generally) also determine the abundance and distribution of prairie species. The most dramatic prairie example of a keystone species may be the prairie dog (*Cyonomys ludovicianus*).[5] A keystone species operates like the keystone in an arch: it determines the abundance of many other species.[6] Not just blackfooted ferrets, but rattlesnakes, burrowing owls, and a host of ground-dwelling vertebrates and invertebrates depend on the burrow systems of prairie dogs. Bison, moreover, aggregate on prairie dog towns for the higher nutritional value of the new growth there, and prairie dog grazing shifts plant availability so that many species are much more abundant on prairie dog towns than anywhere else. Thus, abundance and distribution of organisms on the prairie is a function of this one animal. Keystone species are dramatic examples, but a species need not be a keystone species to have a significant effect on the abundance of the animals and plants that feed on it, or that it feeds on, or that compete with it for food or space. In sum, we currently recognize that interactions of organisms can decisively affect the abundances we see. Working out how such connections actually function is a central challenge to contemporary ecological inquiry.

Another dimension of our altered theoretical view takes into account the critical importance of discontinuities and irregularities. Some plant species survive best in buffalo wallows, those shallow ponds or dust bowls where bison tear up the ground on a fairly regular basis. Other plants' seeds don't have much of a chance of germinating or surviving except in the disturbed patch of soil where a pocket gopher is burrowing, or where a badger overturned the burrow while hunting the gopher. Most important perhaps is fire, without which eastern tallgrass prairies are invaded by trees and cease to be grasslands. These disturbances are critical to the species diversity of the prairie, and we are increasingly focusing on the importance of the dynamic change as a badger rips a patch of soil free of plants and weedy species' seeds colonize that patch, to be replaced by longer lived perennials and finally the dominants. If an area does not have continuously changing disturbed areas, it will be much poorer in species diversity. The same model applies to animals: some are characteristic of stable areas, some move from disturbance to disturbance.

Knowing that a prairie without fire or the full component of mammals (bison to badgers) is almost certainly going to have a different composition of plants (and all other organisms) than the natural prairie had poses novel management issues. Not all sites are suitable for bison, but managers have to consider what kinds of disturbance they permit and what consequences ensue. It sounds weird to suggest grazing cattle on a prairie reserve every third or fourth summer, but to maintain species that depend on grazing-based disturbance may require such a scheme as a practical solution.

These changes in the ways ecologists view the functions of ecosystems, including prairies, have both subtle and surprising consequences. Clearly it is essential that people interested in the Great Plains are kept apprised of the shifts in ecological thinking and test them against their own observations. Our current synthesis is unfinished business and can only benefit from ongoing critical analysis.

With this in mind we engaged in a symposium on grasslands, and members of various fields talked across disciplines.

The two articles that follow represent the impressive breadth of ideas presented at the

symposium, from land use comparisons to the ways people have seen the prairies.

In the first essay, James F. Hoy and Thomas D. Isern write of "Bluestem and Tussock: Fire and Pastoralism in the Flint Hills of Kansas and the Tussock Grasslands of New Zealand." They compare and contrast the history of fire management on two grasslands a world apart. The similarities and differences between these lands and their management are intriguing and should stimulate detailed analyses of how much the European heritage drives the development of agriculture and human culture in colonized areas, as well as how much ecological systems shape human responses. Perhaps the most telling point they make, however, is that there is little consciousness in either Kansas or the South Island of the other site's experience. Here are different grazing lands where fire has been used, abused, and promoted, and each is working out sustainable land-use methods in splendid isolation. Readers should consider their personal reaction: is a broad worldwide comparison valuable, or are different grasslands of the world so distinctive that they really cannot learn anything practical from each other? As we say on exams, defend your point of view. In any event, the comparative method has much to tell us as scholars and has clearly not been exploited to its full potential.

In the second essay, Joni L. Kinsey looks at the European encounter with the grasslands of central North America, focusing on the ways painters portrayed them. One thing that is striking, as soon as she draws it to your attention, is the tendency for painters to look past the grasses and the grassland for a focal point. Grasslands did not conform easily to the artistic traditions of the Age of Expansion, so artists either superimposed the conventions onto the landscape or ignored them. Recent artists are creating new approaches, shaped by special characteristics of their grassland environment, but as Kinsey clearly illustrates, it is a grassland now substantially different from presettlement. The interactions of environment in shaping and being shaped by its residents continues.

These were the kinds of outcomes we hoped for when planning the symposium: opportunities to see grasslands in a new light.

KATHLEEN H. KEELER
School of Biological Sciences
University of Nebraska-Lincoln

## NOTES

1. P. G. Risser, E. C. Birney, H. D. Blocker, S. W. May, W. J. Parton, and J. A. Wiens, *The True Prairie Ecosystem* (Stroudsberg, Pennsylvania: Hutchinson Ross, 1981), p. 129.
2. See F. E. Clements, *Plant Succession: An Analysis of the Development of Vegetation*, Publication 242 (Washington, D.C.: Carnegie Institution, 1916).
3. Jared Diamond, "Must We Shoot Deer to Save Nature?" *Natural History* 92 (1992): 2-8.
4. D. C. Costello, *Prairie World* (Minneapolis: University of Minnesota Press, 1970); O. J. Reichman, *Konza Prairie, A Tallgrass Natural History* (Lawrence: University Press of Kansas, 1989).
5. See also N. F. MacDonald and S. E. Hygnstrom, "Little Dogs of the Prairie," *NEBRASKAland* 69 (1991): 24-31.
6. R. T. Paine, "A Note on Trophic Complexity and Community Stability," *American Naturalist* 137 (1969): 791-815.