Prairie Restoration in the 21st Century

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Today, tallgrass prairie is the most decimated ecosystem in North America. Much of the 150 million hectare (315 million acres) mid-continent grassland was converted to cropland in two major assaults in the 19th and 20th centuries: (1) the conversion of 63 million ha (150 million acres) of the tallgrass prairie to cropland (1815-1890) in the westward movement of settlement (Smith 1992), and (2) the "great plow-down" of 15.2 million ha (32 million acres) in the southwest Great Plains (1909-1929) for wheat production and resulting in the "Dust Bowl" of the 1930s. In a survey of 16 states and provinces, Samson and Knopf (1994) determined that approximately 4% pre-settlement prairie remained. Montana was not included in the survey and current acreage for South Dakota and Oklahoma was not available.

Those of us living in the agriculturally dominated tallgrass prairie region could always take solace in the fact that significant amounts of prairie remained in the mixed grass and short grass prairies to the west, especially on the northern plains.

However, a third major assault of the prairie has accelerated within the past decade; mixed grass and short grass prairies along with reclaimed Conservation Reserve Program grasslands of the northern Great Plains are being converted to row crops at an alarming rate. Primary affected states and provinces are Alberta, Manitoba, Montana, Minnesota, Nebraska, North and South Dakota, and Saskatchewan. A Nature Conservancy study gauged this grassland conversion as occurring at an annual rate of 1.1%, faster than deforestation of the rain forest. It is unlikely there will be any abatement in this assault. As population increases with accompanying energy and food demands, we can anticipate the loss of many of the last holdouts of grassland areas. Technological advances in agriculture made the impossible possible. Now, what remains is fair game for commodity crop production.

In this century, we will witness additional conversion of natural habitats to agricultural and industrial landscapes, and ultimately into degraded land. The mid-continent grassland of North America could be virtually eliminated from the landscape. Because so much has been lost, restoration is the only way forward. The 21st Century may come to be known as the Restoration Century. If so, are we, prairie restorationists, prepared to meet the challenge?

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Meeting that challenge isn't going to be easy. We will need to be prepared for a long, hard-fought battle and learn to appreciate small victories along the way. I want to suggest some considerations to keep in mind in preparing for prairie restoration in this new century. The list is not comprehensive and you may want to add other considerations.

Considerations:

- Include a strong preservation component in the overall plan
- Build upon past restoration achievements
- Encourage cooperation between practitioners and restoration ecologists
- Clarify restoration terminology
- Modify society's perception of the value of natural systems
- Revisit goals and measurements of success in restoration
- Think big and outside the box
- Don't oversell restoration

Include a strong preservation component in the overall plan

Preservation must be a priority in any prairie ecosystem recovery plan. There is abundant evidence that preserving ecosystems is far less expensive than restoring them (Cairns 1993). Furthermore, it is virtually impossible to recreate a prairie as complex and diverse as the pre-settlement prairie. I have been involved in prairie restoration for 40 years and have come to realize that I cannot replicate the effects and products of 10,000 or more years of interaction and adaptation. Consequently, each year that I am involved in prairie reconstruction, I become a more ardent preservationist. The very small remnants are important even though they may be unsustainable "living museums" with smaller, less stable plant and animal populations that are vulnerable to being eliminated by disease, drought and other disturbances and are too isolated to be recolonized. However, they have value as references for restorations and provide seed that adds to the gene pool of future projects.

Build upon past restoration achievements

In the past forty years, practitioners of prairie restoration have made significant advances in reconstruction procedures and techniques. Seeding rates of prairie grasses were reduced 5x or more; forbs and sedges were added to the all-grass mixtures; seed mixtures are now specifically designed for a site and formulated by seeds per square foot or square meter rather than pounds/acre or kilograms/hectare; the height of establishment mowing has been decreased and the frequency of mowing increased; extensive tilling (plowing, disking and harrowing) for site preparation has been replaced with glyphosate application; and more attention is given to drilling depth. Most reconstructions are still seeded in the spring although some are being fall or dormant seeded. There is an ongoing debate regarding the advisability of using a drill or broadcast seeder when planting. High quality source-identified seed is available at a reasonable price and is increasingly used in plantings. The use of western cultivar and non-local ecotype seed has been greatly reduced. Unfortunately, uninformed novices can still purchase prairie seed mixtures with species not endemic to a particular area. And, there is still fussing about local ecotypes even though source-identified regional ecotype seed is available and the use of western cultivars is limited.

Cooperation between practitioners and restoration ecologists

Many of the advances in prairie restoration procedures and techniques in the 20th century were the result of trial and error or fortuitous experiences involving little use of scientific methodology. Hobbs and Norton (1996) in discussing a conceptual framework for restoration note, "What is clear is that restoration ecology has largely progressed on an ad hoc, site- and situation-specific basis, with little development of general theory or principles that would allow the transfer of methodologies from one situation to another." Anderson (2010) asserts that one of the driving forces for the non-scientific approach of some restorationists has been a sense of urgency that there is not sufficient time to wait for the results of rigorous scientific studies. Cabin (2007) supports that perspective, "Thus, if one's goal is to accomplish ecological restoration as quickly and efficiently as possible, a trial-and-error/intelligent tinkering-type approach might often be better than using more rigorous, data intensive scientific methodology."

For the extensive prairie restoration that will likely be required in the Restoration Century, it is essential that proven techniques and procedures be used to maximize project successes and minimize failures. Past variations from reconstruction to reconstruction due to seasonal and annual weather variations, differing use-histories of the sites as well as soils and physiographic variations have resulted in the opinion that it is impossible to formulate standardized methods. Consequently, much of the information regarding procedures and techniques has been anecdotal, derived from word of mouth experiences of practitioners. Although anecdotal information is valuable, it is not always applicable to new projects. Lack of definitive restoration procedures has allowed the perpetuation of mythical planting guidelines, untenable recommendations by agencies regarding seeding times and management practices, and the use of non-endemic seed mixes that create exotic, single-season flowering splashes. For example, in our area, so-called “Midwest adapted” mixes contain seed of species from California, Colorado and the Southwest.

No doubt, we are all concerned about the rapid and continuing degradation of natural landscapes and the need for restoration. Scientists and practitioners should work cooperatively toward a common goal of insuring the success of future restorations. Techniques developed by practitioners need be tested and verified to determine if they can be used to formulate broad principles of prairie restoration. Clewell and Reiger (1996) suggest that restoration ecologists should define the needed research questions and then seek the support of practitioners and the public for their ideas and approaches. Additionally, practitioners may pose new techniques to be tested.

Modify society’s perception of the value of natural systems

Much depends on how society values land in general and natural land in specific. From an ecologist’s perspective, biologically rich grasslands and wetlands cleanse the water of huge river basins, moderate climate change and support a web of life that includes thousand of unique plants, birds and other animals. Consequently, many conservationists within the general public feel these ecosystems should remain intact or be restored and encourage governmental agencies and conservation organizations to do so.

Others don’t see it that way, they argue that, “America was founded on a grand idea, private land ownership, so you can do what you want with your property.” Furthermore, a South Dakota farmer maintains, “productive land is an improvement over land in its natural state.” He is espousing the 17th century philosopher, John Locke, who believed that land could only acquire value through human labor, and wilderness land was worthless until improved by mankind. A Minnesota farmer who had just converted 23 ha (55 acres) of previously untilled land to soybeans by removing 225 semi-truck loads of large boulders feels his sweat equity has doubled the value of that land. He looks at an adjacent 830 ha (2,000 acre) of protected prairie and sees land that is of no value to his community and asks, “How much land do they need?” referring to the few bird watchers, prairie enthusiasts and hunters who make use of it (Marcotty 2012b).

Society was slow to realize that we had so changed the landscape that tallgrass prairie could not recover without human assistance. Consequently, at the beginning of prairie restoration at the

University of Wisconsin in the 1930s, we were behind in prairie conservation, both preservation and restoration. The success of projects of several Midwest “restorationists” in the late 1960s and 1970s stimulated much interest in prairies and prairie reconstruction. In the past 40 years, interest in and support of prairie preservation, reconstruction and remnant restoration expanded to the general public, conservation groups, students, public agency personnel and private companies. Businesses providing prairie related products multiplied and grew to include native seed growers, landscaping companies, nurseries, equipment companies and chemical companies. Prairie plantings have become more common in urban areas as homeowners and corporations increasingly use native prairie plants to landscape their property. In Iowa, we progressed from no native seed growers in the 1960s to 8 or more currently.

Governmental agencies, conservation organizations and local groups have become more involved with prairies. Private prairie groups such as Nature Manitoba, the Iowa Prairie Network, The Prairie Enthusiasts, Grand Prairie Friends, Wild Ones, and Save the Prairie Society formed to promote prairies, save prairie remnants and contribute to prairie restoration. State and national private non-profit organizations such as The Nature Conservancy, Nature Conservancy Canada, the Audubon Society, Ducks Unlimited (Canada and United States), Pheasants Forever, Alberta Native Plant Council, Native Plant Society of Saskatchewan, Tallgrass Ontario, the Iowa Natural Heritage Foundation and the Missouri Prairie Foundation added prairie restoration and management to their preservation and protection activities. Departments of transportation in several states began to use prairie plants in rights-of-way as a part of their roadside vegetation management program. Most Iowa counties adopted an Integrated Roadside Vegetation Management (IRVM) program based on prairie plantings. Federal agencies such as the U. S. Federal Highway Administration, the USDA-Natural Resources Conservation Service and Environment Canada - Canadian Wildlife Service, have financed prairie-related programs. In the U. S., the Conservation Reserve Program (CRP) alone has funded the planting of hundreds of thousands of acres of prairie species on highly erodible soils of marginal farmland. Cooperative ventures between private conservation groups and agencies have also increased. For example, Nature Manitoba initiated the Tallgrass Prairie Preserve Project that is now jointly supported by Nature Conservancy Canada, the Province of Manitoba and local municipalities. In addition, the Prairie Conservation Action Plan originated by World Wildlife Fund Canada’s Wild West Program attributes much of its success in the three prairie provinces of Canada to the involvement of nearly 100 stakeholders.

In spite of the increased interest in prairie, conversion of prairie to agricultural and industrial use is continuing. Record high commodity prices as well as rising global demand for food and energy, and advances in farm technology have tempted many landowners to convert prairie patches, pastures and waterways into more lucrative row crops. Furthermore, certain federal policies such as crop insurance remove the risk of farming marginal lands. In my darker moments, it seems the gains we have made in conservation are often shoved aside for economic considerations or human interests. Not only do we discount the aesthetic and cultural aspects of prairie, but we also ignore the ecological services.

Obviously, gaining majority support of society is not going to be easy.

Clarify restoration terminology

Restoration Ecology is a relatively new science. Terminology is evolving and terms are often used interchangeably. When you are working on a particular project, it doesn't make much difference what you call it as you have set your goals and are working toward them. However, when you talk about projects with others, terminology becomes more important. The Society for Ecological Restoration (SER) has put considerable effort in defining terminology related to restoration. In 2004, they published the *SER International Primer on Ecological Restoration* with suggested terminology and definitions. Some of those terms and definition are in Appendix A.

I would like to present two examples of mixed terminology usage.

Kline and Howell (1987) in *Restoration ecology: A synthetic approach to ecological restoration* edited by Jordan, et al. distinguished two basic approaches to prairie restoration. One approach involved creating prairie on a site with no existing prairie species and the other approach consisted of improving a degraded remnant containing relict prairie species. They didn't distinguish them by name even though the initial stages of the two processes involve different procedures and techniques.

To distinguish the two approaches to prairie restoration, we began to use the term *reconstruction* in the late 1980s when referring to prairie plantings on sites with no relict prairie species. The decision was based on that fact that you have to reconstruct a historic building when nothing remains to be restored. Use of the term, "reconstruction," in Iowa had become generally accepted when Carl Kurtz (2001) published his book, *A Practical Guide to Prairie Reconstruction*.

Improving a degraded remnant with relict species involves the use of specific practices designed to reduce the degradation, upgrade the existing prairie vegetation, remove invasive species, and possibly return extirpated species to the site. Selecting an acceptable term for this process was more difficult. Restoration was not appropriate, in my opinion, because it is a broader term and includes both processes. It was interesting to note that in one section of *The Tallgrass Restoration Handbook* (Packard and Mutel 1997), the term "rehabilitation" is used for this process while in another section it is called "remnant restoration." "Rehabilitation" had been commonly used to refer to the repair of ecosystem processes without particular attention to species composition and community structure. However, when upgrading a degraded remnant there is usually concern about species composition. Therefore, it seemed that "remnant restoration" was the most appropriate descriptor for upgrading prairie remnants (Table 1). That is the term we use in *The Tallgrass Prairie Center's Guide to Prairie Restoration in the Upper Midwest* (Smith, et. al 2010)

TABLE 1: TYPES OF PRAIRIE RESTORATION

PRAIRIE RESTORATION	
RECONSTRUCTION	**REMNANT RESTORATION**
NO PRAIRIE SPECIES PRESENT-CROPLAND	DEGRADED REMNANT WITH PRAIRIE SPECIES

Upon first reading the title of this conference, I wondered "What was the definition of reclamation?" I was referred to the presentation by Mark Majerus at the 2011 Conference . He defined reclamation as the process of returning disturbed land to a condition that approximates the original site condition and is habitable by the same or similar plants and animals which existed on the site before disturbance. His source for the definition was a 1994 paper by Redente, Cottis and Schuller. You will note that the SER Primer has a somewhat different definition: Reclamation is commonly used in the context of mined lands in North America and the UK. The main objectives of reclamation include the stabilization of the terrain, assurance of public safety, aesthetic improvement, and usually a return of the land to what, within the regional context, is considered to be a useful purpose. Revegetation, which is normally a component of land reclamation, may entail the establishment of only one or few species. As is often the case, the lines between different types of ecosystem repair are blurred, the Primer goes on to say that more ecologically based reclamation projects can qualify as rehabilitation or even restoration. As these repair processes occur along a gradient, it is difficult to delineate the interfaces between them. I think we are all talking about the same thing during this conference. However, a discussion of prairie reclamation might differ if the conference were being held in the coal strip-mining region of Illinois and Indiana.

Revisit goals and measurements of success in restoration

To meet the need for prairie restoration in the 21st century, we must protect, manage and study the remaining remnants, restore the degraded ones and reconstruct new ones to insure there is sufficient prairie in the future. It is imperative that we increase prairie on the landscape.

To accomplish this huge task, we need revisit the goals and measurements of success of prairie reconstruction. The long-standing goal of recreating prairie that replicates pre-settlement prairie may have to be modified. While an admirable goal, it is impossible to attain because (1) the prairie is a dynamic ecosystem that is constantly changing and evolving, and (2) the confluence of land, climate, biota and Native American culture that created the tallgrass prairie is gone and will never occur again (Simpson 2008). As interesting, exciting, and romantic it is to read about the prairies of the past, we can't recreate them.

To meet the needs of the future, it may be more important to increase the number of assemblages of prairie species that thrive and form a functioning prairie ecosystem rather than attempting to recreate a prairie of the past. Helzer (2012) suggests that we restore the viability of the fragmented prairie landscape with the species and processes that enable the ecosystem to function and flourish rather than attempting to recreate what we infer to be the historical prairie. That said, I don't want to deter those who desire to attempt to reconstruct prairies for historical or educational purposes. These reconstructed prairies are an important component of the restoration spectrum, but they are not sufficient to meet the large scale of prairie that will be needed. We need to promote techniques and processes that will enable us to reconstruct large scale prairies that will be colonized by insects, birds and other animals in an agriculturally dominated landscape. Two ways to accomplish this task are (1) incorporating prairie into the agriculture system and (2) forming large prairie complexes on the agricultural landscape.

Incorporating into the agricultural system

Native prairie species mixtures appear to have great promise as bio-energy feedstock. Perennial prairie plants are carbon negative and produce greater net energy gain than row crops because (1) after initial establishment they require little or no energy input such as cultivation, fertilizer, pesticides and irrigation, (2) they sequester excess CO_2, and (3) the entire above ground portion of the plant is used rather than just the fruit or seed. As prairie grows well on non-prime, nutrient-poor agricultural soils, it would not displace food crops from higher quality agricultural land. Although a prairie planting for bioenergy production usually lacks the diversity of a prairie restoration, it is a way to increase prairie on the landscape and also serves as an alternative agriculture. Certainly the lessons learned from prairie restoration will be helpful in maximizing biomass production.

Reconstructing prairie in strategically placed locations within watersheds to take advantage of the water retention capabilities of prairie vegetation would effectively slow and/or reduce outflow of stormwater and reduce erosion. Prairie has great capacity for interception and infiltration of rainwater, holding a considerable portion of the rainfall at its entry point into the watershed. The extensive interception of rainwater is a result of the surface area of foliage being 5-20 times greater than the soil surface beneath it (Weaver 1954). An acre of big bluestem can intercept approximately 48 metric tons (53 tons) of rainwater during a one-inch rainfall event (Clark 1937). In addition, the extensive root systems of prairie vegetation increase the soil's ability to take up and hold water via infiltration. The roots create air pockets and channels in the soil as well as adding large quantities of organic matter. Organic matter has the ability to hold up to 90% of its weight in water and also cause clumping and aggregation formation that increases soil porosity. Increased water infiltration and stable soil aggregate formation can reduce soil erosion. Calculations of the universal soil loss equation indicate that increasing soil organic matter from 1 to 3 percent can reduce erosion by 20 to 33 percent (Funderberg 2011). Miller and Jastrow (1986) found that water-stable, macro-aggregate levels of soil content were 39% in cropland under continuous corn at Fermilab. Levels in prairie reconstructed on that cropland approached those of a nearby prairie remnant (93% of soil content) by the fifth growing season after planting, and statistically equaled the prairie remnant by the eighth growing season.

Initial results of a watershed study at Neal Smith NWR by a team from Iowa State University indicate that prairie vegetation is effective in capturing both soil and water. They observed that prairie plantings in 10% of the watershed would reduce sediment loss by 95% compared to no-till practices (Helmers et al. 2008).

Wes Jackson (2012), co-founder of the Land Institute, maintains that it is essential that we understand the prairie ecosystem as it interfaces with agriculture so we can move from an industrial to an environmental way of thinking. For more than three decades, the primary focus of the Land

Institute has been to utilize perennial crop species to replace or supplement annual crops (Jackson 2008). This new paradigm for agriculture develops sustainable farming as a functional mimic of the prairie ecosystem utilizing a perennial polyculture system involving diverse plantings of perennial grasses, legumes, and composites (Piper 1996, Jackson and Jackson 1999). Incorporating perennial polyculture as a significant component into our agricultural landscape provides some of the ecological services of the prairie with only slight modifications to the agricultural economy.

Laura Jackson in *The Farm as Natural Habitat* (Jackson and Jackson 2002) suggests that returning to long crop rotations coupled with livestock production in the Upper Midwest would provide several elements of the prairie ecosystem. She lists continuous physical protection of the land by perennial plants, a diversity of plants whose life cycles takes advantage of different seasons, a food web including broadly grazing ruminant herbivores, a large portion of the landscape in pasture or hay dominated by grasses and herbs, and organic nitrogen supplied by manure and legumes.

<u>Assembling large complexes</u>

A challenge for the future is to assemble provincial or statewide networks of interconnected pieces. To some degree, parts of such networks are already being put into place. For example, many governmental agencies (federal, state and county) have committed to programs preserving quality prairie, restoring degraded prairie remnants and reconstructing new prairies. If native remnants are managed or restored to a high degree of biodiversity, they can serve core areas within a larger network. Prairie can be reconstructed around them to enlarge the prairie network and provide buffers to the adjacent agricultural lands. This network could be comprised of a mix of county, state, privately owned preserves or federal conservation plantings utilizing native prairie mixes, native pastures, and roadsides with prairie vegetation established as a part of Integrated Roadside Vegetation Management (IRVM) programs.

A cooperative network of prairie preserves, restorations and reconstructions was recently proposed in Minnesota. On July 30, 2012, the Minnesota Dept. of Natural Resources, U.S. Fish and Wildlife and ten conservation groups including The Nature Conservancy, Pheasants Forever, and the Audubon Society announced an ambitious 25-year plan to preserve and restore a portion of the vanishing prairie that once occupied two-thirds of Minnesota. State and federal agencies are combining resources with conservation groups to secure $3.5 billion. The funds will be used to acquire or protect more than 917,000 ha (2.2 million acres) to create a network of interconnected native and restored prairies, wetlands and other grasslands along the west edge of the state (Marcotty 2012).

Establishment of Integrated Roadside Vegetation Management (IRVM) programs on roadsides within the mid-continent prairie region have great potential for interconnecting prairie areas. IRVM programs are ecologically based upon the use of vegetation of native plant communities that are best adapted to that area. These stable, diverse, long adapted native communities tend to maintain themselves and resist weedy invasion. IRVM programs include management of existing roadside prairie remnants and planting new prairie after construction or disturbance (Smith 1995). Eventually these roadsides could form an extensive network of corridors connecting the entire region. The Iowa IRVM Program, established in the most agriculturally altered and road-intensive state or province in North America, is an excellent model for such a program. Iowa has more than 313,000 ha (750,000 acres) of roadsides that occupy approximately 2.1% of the state's total land area. IRVM was implemented in Iowa in the mid1980s and has proven to be highly successful. It is amazing that the Iowa DOT and 90% of the 99 counties are utilizing natives in roadside vegetation management.

Think big and outside the box

Using prairie to address environmental concerns allows us to incorporate more prairie into the landscape. While not fully replicating prairie, the more utilitarian prairie plantings will provide elements and ecological services of that ecosystem. Appreciation of these benefits may improve society's perception of their value. Hopefully this will increase support for maintaining and restoring a more natural world to counteract the potential for environmental degradation by ever increasing human population.

The scale of prairie reconstruction has increased considerably since its inception almost 80 years ago. The early prairie reconstructions were measured in tens of hectares or acres. Betz (1986) and his group increased the magnitude of reconstruction by a factor of 10 in 1974 as they began a proposed 300 ha (700 acre) planting at Fermi Lab in Batavia, IL. Currently, the Fermi Lab Prairie consists of 500 ha (1200 acres). Two decades later much larger reconstructions/restorations appeared. Most prominent were the 3500 ha (8600 acres) prairie and savanna reconstruction and remnant restoration project that began in 1991 at Neal Smith National Wildlife Refuge near Des Moines, IA, and the multi-community reconstruction and remnant restoration project initiated in 1996 on 8,000 ha (19000 acres) at Midewin National Tallgrass Prairie near Joliet, IL.

The need for large-scale restoration of prairie is readily apparent if one examines maps that show the wide scattering of prairie remnants. Several states within the former tallgrass prairie region have less than 0.1% of prairie remaining. Even those states further west in the mixed and short grass region with larger percentages of original prairie remaining have greatly fragmented remnants. To create the large prairie complexes discussed in the previous section, some row crop fields, especially those on marginal agricultural soils, will need to be converted to prairie. Restoration has progressed to the point where techniques and procedures have the capability for large-scale prairie reconstruction. With sufficient incentives, current row cropland could be returned to prairie on a grand scale.

Don't oversell restoration

Though we cannot recreate the original prairie, restorations and reconstructions provide an opportunity to actively assist in the recovery of a degraded, damaged or destroyed ecosystem. However, we must avoid creating the impression that reconstructed prairies can replace prairie preserves. Planners or developers should not be encouraged to consider mitigating a prairie remnant with a reconstructed prairie. Schramm's (1992) goal of reconstructing a facsimile of original prairie is sufficient to meet the need for more prairie on the landscape.

The admonition of authors (Morgan, Collicutt and Thompson 1955) of *Restoring Canada's Native Prairies: A Practical Manual Prairie* summarizes my concern very well. "Prairie restoration is NOT a substitute for conserving existing native prairie areas. We are now just beginning to understand the complex process of restoration, and how to heal damaged native prairies. This is no reason, however, to be less vigilant in protecting original prairie ecosystems. These areas are the benchmarks from which any restoration starts. In our lifetime at least, even the best restored prairie will pale in comparison to the real thing that took centuries to evolve."

The increase in the ongoing loss of prairie concerns me. Some of my concern is personal. I enjoy walking on the prairie, reading and thinking about prairie, and introducing others to prairie. I'm nostalgic about prairies. If they ever offer time travel fellowships to the early 19th century, I'm like to be one of the first to queue up for the opportunity. However, my concern for prairie loss is more than personal. Prairie is not only a part of our cultural or biological heritage, it also provides invaluable, essential ecological services.

Hopefully, people will eventually come to understand, appreciate and be committed to living more sustainably and in harmony with nature, and not apart from it as consumer and destroyer of it.

In closing, I want to make it perfectly clear that I am not proposing we restore all the pre-settlement prairie or even a major portion of what has been lost. Our society is notorious for being reactive rather than proactive. So, I do propose that we reconstruct sufficient prairie to avoid reaching a critical point where the prairie landscape is so diminished that its ecological services are lost. I don't want us to reach that point and have to flirt with ecological collapse before we begin to act.

When all is said and done, regardless of the difficulty in meeting the challenges of prairie restoration for the 21st century, the societal, ecological, and economic gains will be well worth the effort and perhaps essential to survival for all.

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