

Prairie Conservation Forum

Prairie Ecosystem Management:
An Alberta Perspective

Number 2

Occasional Paper

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PRAIRIE CONSERVATION FORUM

Prairie Ecosystem Management: An Alberta Perspective

A Discussion Document

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February, 1996
Lethbridge, Alberta

Preface

On November 15, 1994, a group of individuals with a broad range of interest in prairie conservation met in Lethbridge, Alberta, for a brainstorming session about a rapidly evolving model for renewable resource management known as "ecosystem management." Most members of the group were helping to organize the 4th Prairie Conservation and Endangered Species (PCES) Workshop in Lethbridge scheduled for February 23-26, 1995. Ecosystem management had been named as one of four theme areas for the workshop; however, committee members had a fuzzy understanding, individually and collectively, of its meaning. There was a sense that it might provide a valuable framework for future decisions about prairie management. Upon the suggestion of the organizing committee chair, Ian Dyson, they agreed to meet to explore the current thinking regarding ecosystem management and to assess its usefulness for prairie management.

The November 15th session began with a presentation by Dr. Brad Stelfox on ecosystem management in the boreal forests (Stelfox 1994). This presentation had been developed for the Alberta Forest Conservation Strategy as an introduction to key concepts of ecosystem management and the implications of applying it to forest management. Considerable discussion followed about how these concepts might be applied to the prairie, and their potential usefulness. There was agreement to work together as a team on more fully developing the key concepts of prairie ecosystem management based on the literature and the team's collective experience, and to present the results to participants at the 4th Prairie Conservation and Endangered Species Workshop - "Sharing the Prairies: Sustainable Use of a Vulnerable Landscape", February 22 - 26, 1995 in Lethbridge, Alberta.

Over a three-month period, the multi-disciplinary group developed a computerized presentation and Draft Discussion Document. Cheryl Bradley and Cliff Wallis worked between meetings to put the committee's ideas into written and graphic form. Committee members reviewed and commented on draft materials, and reached consensus on the content of the presentation and discussion document.

The 45-minute presentation was given by Lorne Fitch and Barry Adams during a plenary session on the first day of the PCES workshop. Over 400 copies of the Draft Discussion Document were distributed in registration packages to workshop participants. A questionnaire regarding the contents of the document was attached. Following the plenary presentation, participants were asked to consider the concepts in the presentation, review the discussion document, and complete the questionnaire. Twenty-two questionnaires were completed and returned. These were summarized and several of the suggestions incorporated into the revised document. The Summary of Responses to the Questionnaire is included in the workshop proceedings.

The purpose of developing a proposed framework for prairie ecosystem management is to provoke thought and discussion about the concepts of ecosystem management and their application to the prairies. Informal conversations at the PCES workshop, a workshop session on ecosystem management, and participants' responses to the questionnaire suggest general endorsement of the framework for prairie ecosystem management as presented in this document. The next important step, however, must be review by a broader audience and consideration of practical application of the concepts. Individuals involved in this initiative are working at clarifying and testing the concepts in their work and encourage you, the reader, to do the same.

Copies of the presentation (slides and speaking notes) on Prairie Ecosystem Management, which is based on this document, are available at cost from:

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1.0 The Prairie Ecosystem

For many Canadians and Americans, the prairie is home. We have a sense of place, of living within, and belonging within, the prairie environment. Each of us has a vision of prairie, of what it was and what it should be. Sharon Butala, a rancher and author who lives in southwestern Saskatchewan, expresses her vision in this way:

"The salvation and foundation of our nation lies in a renewed relationship with Nature as a people, and in a flourishing rural life . . . I see (people living in the country) aware of themselves as vital to the human community in providing the direct link to Nature our species must maintain. I see them as the preservers of a body of knowledge thousands of years old, as caretakers, stewards of the land, and maybe even, in a much better world than this one as the wise men and women to whom others will turn for guidance and healing."

(Butala 1994)

1.1 Definition of Prairie Ecosystem

We all have different visions when we think of the word "prairie" and we have different views about what comprises the prairie ecosystem. For some, it includes fields of grain. For others, it is native grassland with grizzly bears, wolves and free-roaming herds of bison. For some, it includes modern man. For others, it includes only aboriginal people or no people at all.

Ecologists describe an ecosystem as soils, plants, animals, minerals, climate, water, topography and all the ecological processes that link them together. For the purposes of this document, the prairie ecosystem includes two major ecoregions, the grasslands and aspen parkland, and all their parts. We recognize distinctive parts of the prairie ecosystem, but the parts are all interconnected. Differences in climate and parent material across the prairie ecosystem have resulted in distinctive, recognizable units such as aspen parkland, fescue grassland, tall-grass prairie, and mixed-grass prairie. Native grasslands, shrublands and aspen groves, native wetlands (including lakes), river valleys, and sand dunes were key parts of

the prairie ecosystem before settlement. According to Statistics Canada's 1991 census, native habitats now occupy about 25 percent of the prairie landscape with cultivated areas for crops occupying 68 percent, tame pastures 6 percent and cities and towns about 1 percent (Statistics Canada 1992).

The parts of the prairie ecosystem are interconnected with some of its elements moving among the parts. For example, nutrients, wildlife and people move freely among the parts. Manufactured products, like herbicides and fertilizers, and introduced species occasionally move from settled areas to other parts of the ecosystem.

1.2 Key Ecosystem Factors and Processes

Because one of our premises is to observe natural systems, understand functions and apply that knowledge, the first portion of our discussion deals with native prairie ecosystem dynamics. For millennia, the prairie ecosystem

has been affected by dynamic physical forces of climate acting on geologic parent material and life forms through processes such as drought, flood, erosion and deposition (both by wind and water). Soil disturbance is another process— from massive gouging by glaciers before 10,000 years ago, and more

Native Prairie Ecosystem Dynamics

Factor	Process
Climate Acting on: Parent Material & Landform	<ul style="list-style-type: none"> • Drought • Flood • Erosion • Deposition • Soil Disturbance
Fire	<ul style="list-style-type: none"> • Fire -Lightning -Human-induced
Life	<ul style="list-style-type: none"> • Photosynthesis • Grazing • Predation • Decomposition

recently from digging and trampling by prairie wildlife. Fire also frequently acted on the ecosystem, ignited either by lightning or humans. Energy and nutrients flow from plants that fix the sun's energy (photosynthesis) to the grazers (herbivory), the predators (predation), and the decomposers (decomposition). Table 1 lists some key factors and processes of the native prairie ecosystem which are referred to in this document. Other important

Table 1 –
List of Prairie
Ecosystem Factors
and Processes

processes are climatic or geomorphic such as mass wasting and salinization, and biological such as parasitism, commensalism, symbiosis, nitrogen fixation, and soil pedogenesis. All ecosystem processes have varied over time and vary across the prairies.

1.3 Range of Variation in Prairie Ecosystem Processes

Prairie ecosystem processes have always been dynamic and variable; however, there are limits to the variation, barring a major climatic shift and desertification or another ice age, for example. The glaciers destroyed or displaced most prairie life. Current biodiversity on the northern prairies reflects the adaptations of life forms to the variation in ecosystem processes since deglaciation.

The range of variation of processes or disturbance events over time can be measured. For example, data about the magnitude and timing of annual peak flood events are used to develop a flood frequency curve (Figure 1). The flood frequency curve indicates how often a flood of a certain magnitude has occurred over the period of record. The area under this curve can be considered the range of variation. Data show that when a dam is placed on a river, downstream annual floods below the one-in-two year return interval increase in magnitude, whereas those of longer return interval decrease in magnitude. There is less variability. The range of variation, shown as the area under the curve, decreases. If flows were altered so that the peak flood is identical year after year, the curve would be a flat line with no range of variation.

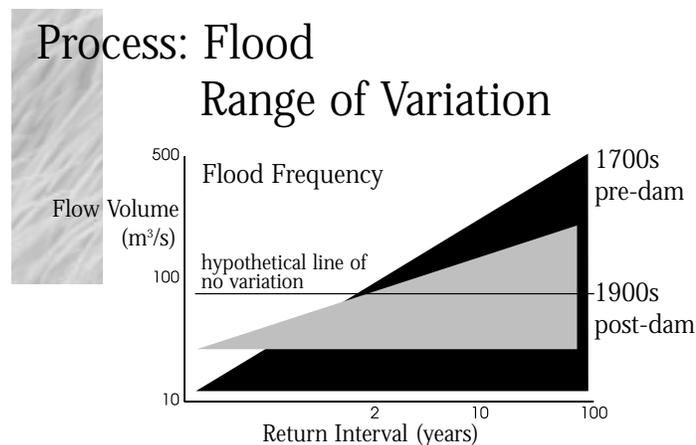


Figure 1 - Range of variation: Flood frequency
(from: Bradley and Smith 1984, Rood and Mahoney in press).

Range of variation in the size, intensity and return interval of key prairie disturbance processes, such as fire, flood or grazing, could be represented on a three-dimensional graph as is shown in Figure 2. Where the axes intersect represents no variation in size, intensity or return interval. High variation would plot close to the end of the axes. Although little actual data are available on the size, intensity and return interval of disturbance events from before settlement, scientific and historical evidence suggests that natural variation was large. For example, sometimes a disturbance such as prairie fire, occurred over hundreds of square kilometres; sometimes it was very small. If the area burned by fires was always the same size, range of variation would be plotted at the zero point of the axis. Occasionally, disturbances were of very high intensity, such as a major flood, although more often they were small to medium events. In some areas, a disturbance such as grazing by large herds of bison may have occurred almost every year at the same time of year, whereas other areas may not have been exposed to bison for several decades. The movement of bison was affected by other disturbances, such as fire. Each ecosystem process affected, or was affected by other ecosystem processes.

Range of Variation -Prairie Disturbances

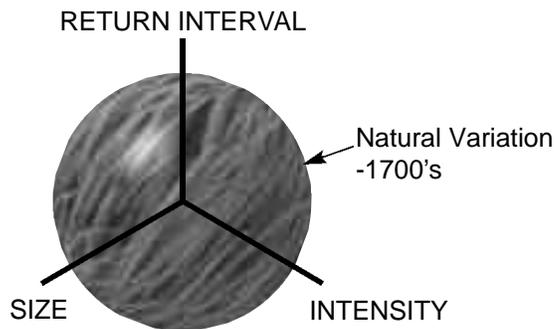


Figure 2 - Range of variation in disturbance size, intensity and return interval.

The sphere in Figure 2 represents a hypothetical composite plot of variation for all prairie disturbances. It crosses the axes of variation in size, intensity and return interval far from the centre to indicate an overall large range in

variation. Prairie species evolved with these disturbances and it appears many species adapted to disturbance or became dependent on it for regeneration or survival. Altering this sphere of variation dramatically, by either making it bigger or smaller, probably would result in the loss of many prairie species.

It is useful to examine what we know about various disturbances or ecosystem processes occurring naturally on the prairie and how these disturbances have changed since the early 1900's.

1.3.1 Erosion/Deposition: Riverine

River floodplains on the prairies support a diversity of vegetation communities, from cottonwood forests to tall shrublands to wetland. This diversity is due to flooding and the processes of erosion and deposition during floods, which result in channel migration. Rates of channel migration are linked to flood frequency. Several studies on the prairies have shown that plains cottonwood depend on floods to create conditions for seeding establishment (Rood and Mahoney 1990; Hughes 1994). If the range of variation of flooding is reduced significantly, which often occurs with dams and diversions, cottonwood forests do not replace themselves and eventually disappear from the floodplain.

1.3.2 Erosion/Deposition: Sand Dunes

Some prairie species are adapted to active sand dune habitats and are found nowhere else. Examples are the kangaroo rat, western spiderwort and some species of grasshopper and tiger beetle. Ecosystem processes responsible for keeping sand dunes active are wind erosion and deposition, mainly in periods of drought. Fire and intense grazing also may have a role to play by reducing the stabilizing effect of vegetation. Comparison of air photos from the 1950's and the 1990's shows that dunes are rapidly stabilizing throughout the prairies (Wallis and Wershler 1988). Many species associated with active dunes are considered rare or threatened. We suspect, but are not sure, that our management of prairie ecosystem processes has resulted in the stabilization of dunes.

1.3.3 Soil Disturbance

By soil disturbance, we mean processes that directly disrupt top soil. Over millennia, primary agents for soil disturbance in native grasslands were probably bison, ground squirrels and badgers. Today, cultivation is by far the dominant agent. In the 1700's, for example, the pattern of wallows and mounds in the prairie ecosystem was small, irregular patches that were widely scattered. These disturbances were ephemeral as animals moved about the landscape. Since the late 1800's, the amount and pattern of surface disturbances have changed dramatically. Surface disturbance from cultivation, cities and roads consists of large rectangles or straight lines that are widespread.

This disturbance occurs year after year in the same place. Today, 95.0 million hectares, or 75 percent of prairie Canada has been cultivated—68 percent (31.6 million ha) of Alberta's prairie, 80 percent (50.0 million ha) of Saskatchewan's prairie and 78 percent (13.1 million ha) of Manitoba's prairie regions (Statistics Canada 1992). In prairie Alberta, there are about 109,600 oil and gas well sites that have been cleared along with associated access routes and pipelines (Kerr et al. 1993). Tourism Saskatchewan (1994) boasts of more road surface than any other province in Canada—a total of 250,000 km (about 150,000 mi.).

Native prairie life for the most part, is not adapted to such a massive and frequent soil disturbance as cultivation. Studies have shown that the number of bird species and abundance decrease dramatically from native parkland and grassland to tame pasture and cultivation (Figure 3). Other effects of cultivation, roads and cities on the prairie ecosystem are fragmentation of habitats and introduction of nonnative species either deliberately for human use or by accident. For example, about 15 percent (275) of Alberta's 1,750 vascular plant species have been introduced, many of which outcompete native species for resources (Moss and Packer 1983). Attempts to control the spread of exotic species such as spotted knapweed, leafy spurge and timothy have proven expensive and largely ineffective.

Process: Soil Disturbances Impacts on Birds

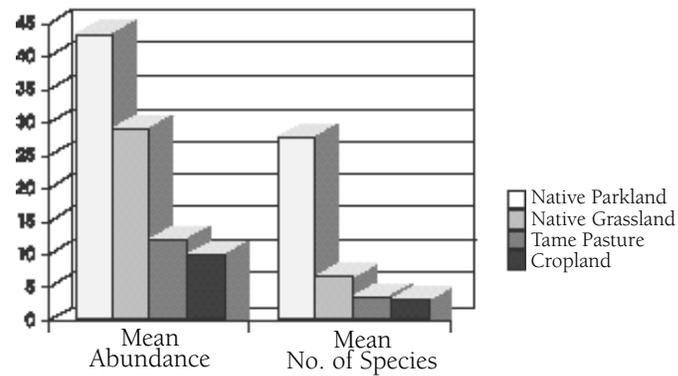


Figure 3 - Comparison of bird populations in native parkland, native grassland, tame pasture and cultivated land.
(from: Prescott et al. 1994b)

1.3.4 Fire

Fire has occurred for thousands of years in the prairie ecosystem, some lightning-induced and others human-induced. Use of fire by North American aboriginal peoples is well documented, whether to aid in hunting by influencing movement of game, to control invasion of woody species, or to reduce invertebrate pests (Anderson 1976). Unlike forests, where stand age or fire scars give clues to fire size, intensity and frequency, evidence of past fires is lacking in the prairies. However, there is speculation that fire probably occurred more frequently on the prairies than in forests, but that the distribution of fire sizes was similar - a lot of small fires, fewer medium ones and a very few large fires (Figure 4). Some sites were subject to infrequent high-intensity fires, and others characteristically experienced frequent, low-intensity fires. For example, moister areas might have burned less frequently, but when they did there was more fuel to burn which increased the intensity of the fire. In the 1900's, suppression of fire by modern society has resulted in a significant decrease in the size and occurrence of burned patches on the prairie. The range of variation is considerably reduced.

Process: Fire

Native Prairie Fire Patch Size and Frequency

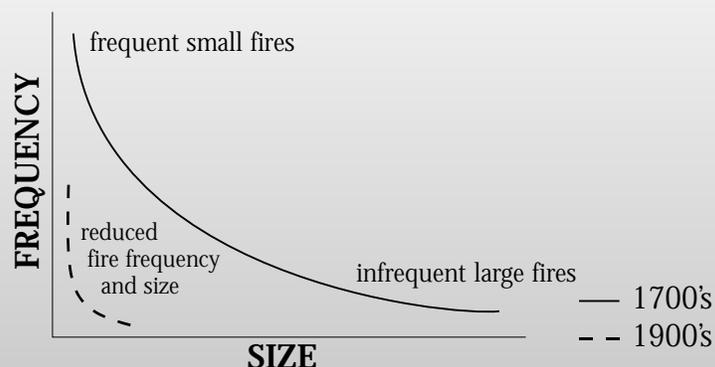


Figure 4 - Range of variation: Fire size and frequency.
(from: Higgins et al. 1986)

Studies of controlled burns in the prairies have shown fire to have important ecological effects on vegetation composition and structure, insect populations and soil properties, including productivity (Appendix II in Kerr et al. 1993). However, we don't know the overall effects of fire suppression on prairie biodiversity. Furthermore, the question is complicated by the effects of grazing, which approximate some of the effects of fire, and by the interaction of fire and grazing. For example, grazing can reduce the intensity of fire by reducing litter build-up and fire can produce a flush of green vegetation which attracts grazers. Both fire and grazing can prevent the expansion of shrublands and woodlands into the grasslands.

1.3.5 Grazing

Much has been written about the demise of 30 to 50 million bison from the plains of North America, but little is known about the role of these huge herds of grazers in the prairie ecosystem. Surely they, and a suite of other large mammals, including elk, pronghorn, deer and bighorn sheep, had a considerable influence on the vegetation that they grazed, browsed and trampled. Historical accounts suggest bison moved in large herds, upwards of 10,000; their migrations were erratic; and where they did graze the

pressure was intense (Roe 1951). Cattle, which evolved in other parts of the world, now graze native grasslands where once there were bison. However, intensive management, such as winter feeding, allows them to survive on the plains of North America. We have gone from an open system where grazing patterns were climatically defined to a closed system where management dictates pattern, timing and intensity of grazing.

Observation of bird and mammal species on the prairies indicates that they evolved and adapted to variation in grazing intensity and timing (Kantrud and Kologiski 1983; Prescott et al. 1994 a and b). Some species, such as mountain plover, McCowan's longspur and Richardson's ground squirrel, are found primarily in more heavily grazed grasslands. Other species, such as Baird's sparrow, Sprague's pipit and meadow vole, frequent more lightly grazed grasslands. Most bird and mammal species on the prairies are adapted to moderate levels of grazing (Figure 5). The same is true for plants (Willoughby 1992).

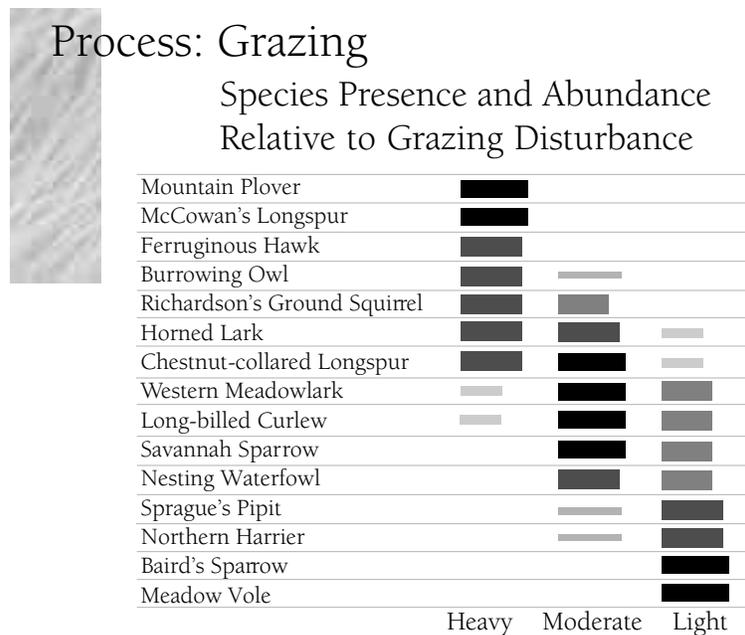


Figure 5 - Species under light, moderate and heavy grazing intensity. (adapted from: Prescott et al. 1994a)

This distribution of wildlife species suggests that variation in grazing intensity on the prairie before settlement was low frequency of lightly grazed areas, high frequency of moderately grazed areas and low frequency

of heavily grazed areas (Figure 6). Current range management strives for moderate grazing pressure and uniform distribution of use. These objectives are implemented with the application of grazing systems that maintain the health of the prairie and avoid degradation of areas where livestock may concentrate, such as riparian habitats. Although certain grazing systems can increase the homogeneity of grassland architecture by concentrating livestock, in practice, most systems are applied with moderate grazing pressure that permit selective grazing, and the creation of overgrazed and undergrazed patches which contribute to landscape heterogeneity on a relatively small scale. Furthermore, the use of grazing systems will allow the creation of planned heterogeneity on a large scale by controlling the grazing pressure and the time of grazing within paddocks. Judicious grazing management can promote biodiversity while maintaining high productivity.

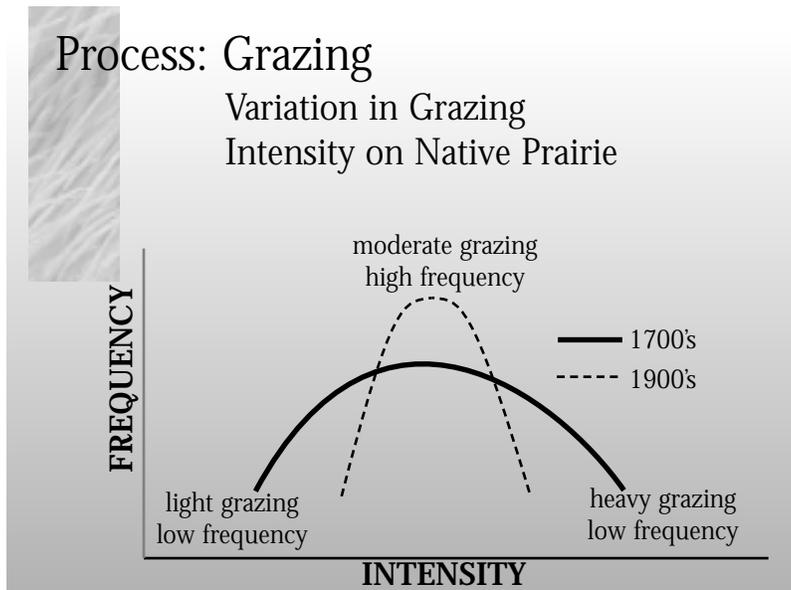


Figure 6 - Range of variation: Grazing intensity and frequency

1.3.6 Predation

Historical accounts indicate there were nine species of mammalian carnivores, besides humans, in the prairie ecosystem before the 1900's. Carnivores are at the top of the food chain and are considered to reflect overall ecosystem integrity. During the 1900's, four of the largest

carnivores have been extirpated from the Canadian prairies (grizzly bear, gray wolf, black-footed ferret and swift fox), three are considered at risk (bobcat, long-tailed weasel and badger), and two are considered not at risk (coyote, striped skunk) (Figure 7). *Homo sapiens* was and continues to be the predominant predator who tolerates few others and the only one whose population has increased dramatically since the turn of the century.

Wildlife management in the 1900's has focused on large predator and prey species considered "game" or "pests." Population dynamics of these species are substantially changed reflecting significant changes in the flow of energy and nutrients through the prairie ecosystem food chain.

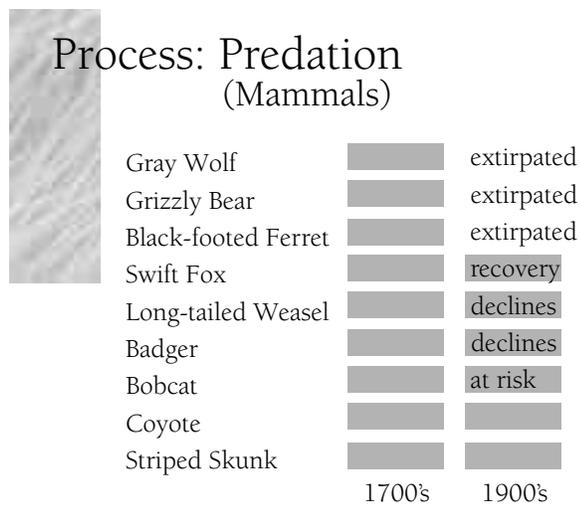


Figure 7 - Status of carnivorous mammals in the Alberta prairies.
(from: *Alberta Fish and Wildlife 1991*)

Our practice of managing for, or against, single species, without considering effects on other species and overall ecosystem function, has allowed several species to fall through the cracks. For example, persecution of ground squirrels as a pest species is believed to have contributed to the decline of burrowing owls and some raptors; and elimination of wolves is believed to have resulted in increases in coyotes, which in turn led to increased predation on swift foxes and contributed to that species' decline. Loss or disruption of habitat is given as the primary reason for decline in most prairie species (Alberta Fish and Wildlife 1991). This might suggest a re-examination of management philosophy.

1.4 Changes in Prairie Ecosystem Dynamics in the 1900's

The foregoing information suggests that many prairie ecosystem processes have changed substantially or are no longer allowed to function as a result of our society's uses and demands. Changes in one process can indirectly affect other ecosystem processes. The cumulative effects of these changes on the prairies have implications for biodiversity and natural resiliency and for sustainability of the system without high economic inputs.

Figure 8 presents a series of images depicting ecosystem processes for various parts of the 1990's prairie ecosystem that contrast with processes in the pre-1900's ecosystem. The processes considered are drought, erosion (wind and water), flood, grazing, decomposition, photosynthesis, soil disturbance, fire, and predation. Decomposition refers to the incorporation of organic matter into the soil by diverse soil micro-organisms. Not all processes are represented. For example, salinization was a pre-settlement process that has been greatly accelerated with changes in land use. Representation of these changes in Figure 8 is qualitative and based on what we now know, or understand about native prairie dynamics.

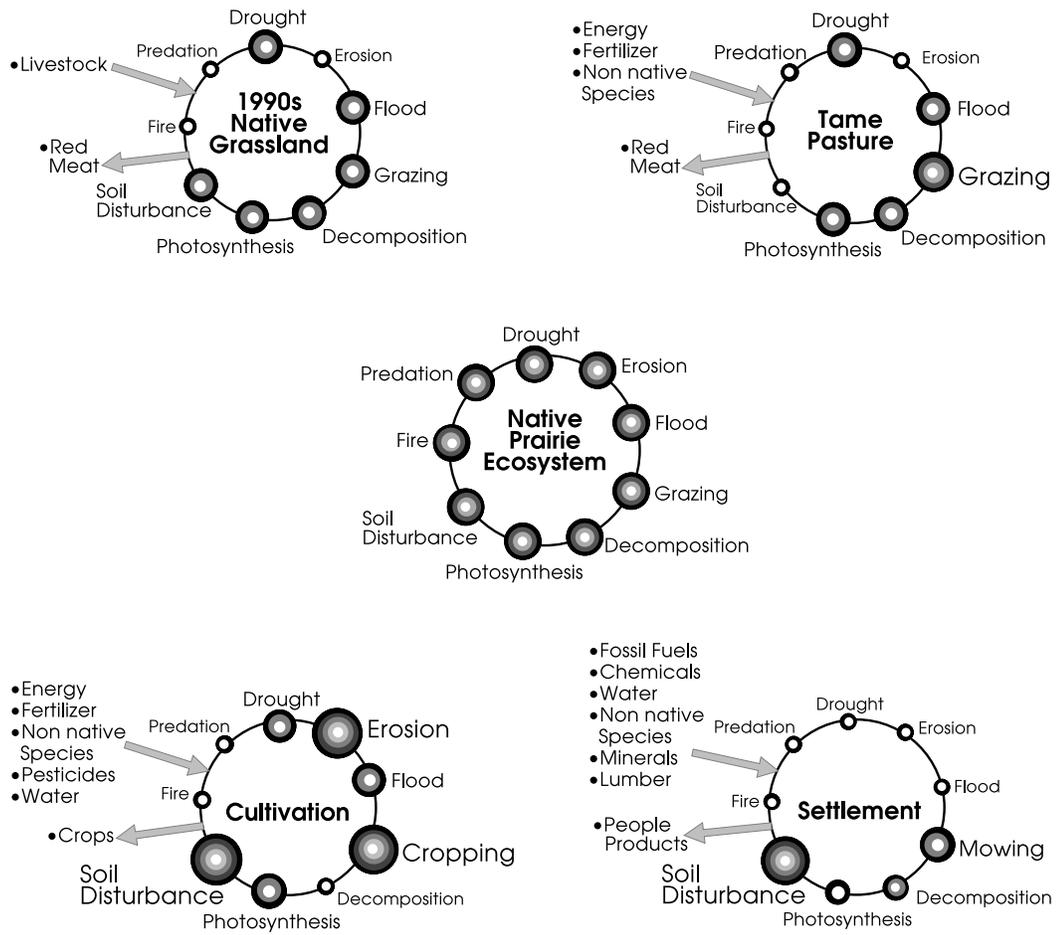


Figure 8 - Prairie Ecosystem Dynamics Under Various Land Uses.

Key concepts depicted in Figure 8 are:

- The native prairie ecosystem is presumed to be in dynamic equilibrium, self-sustaining and resilient to natural variation in disturbances. This dynamic equilibrium is influenced in different ways in different parts of the ecosystem.
- Native grassland in the 1990's is experiencing reduced erosion, fire and predation. Cattle are the primary input and red meat, and other livestock by-products, the primary output. This ecosystem is the least altered from the native prairie of the scenarios being presented.

-
- Tame pasture in the 1990's is experiencing reduced erosion, soil disturbance (at least as an ongoing process), fire and predation. Grazing is increased. The primary output is red meat but more inputs—energy, fertilizer, and nonnative plant species are required than on native grassland.
 - Cultivated cropland experiences decreased fire, predation and decomposition. Decreased decomposition refers to the decrease in diversity of soil microorganisms and in the decline in incorporation of organic matter into the soil. Erosion, soil disturbance and herbivory through cropping are greatly increased. Ecosystem processes are extremely altered from native prairie. Cultivated cropland in comparison to tame pasture requires more inputs: fertilizer, pesticides, fossil fuels, nonnative species and, in irrigated areas, water. Outputs are crops.
 - Cities and towns experience greatly reduced drought (as a result of water management projects), erosion, flood, fire and predation. Soil disturbance is increased. Again, ecosystem processes are extremely altered from the native prairie. High inputs include fossil fuels, chemicals, water, minerals, lumber and nonnative species. Outputs are people and products.

What do these changes in ecosystem process signal?

2.0 Indicators Regarding Ecological and Economic Sustainability and Responses

Just as we have run up an economic debt nationally, we may be accumulating an ecological debt on the prairies. Once seriously disrupted, ecological processes may take many years to recover. There are ecological and economic indications that our current use of the prairies cannot be sustained. These indicators include the following:

- loss of prairie biodiversity,
- loss of soil and soil organic matter and increased salinity,
- increased chemical inputs on cultivated land,
- increased pollutants and salinity in prairie water bodies and groundwater,
- decline in net farm income (cost of inputs rising relative to price of outputs), and
- decline in rural population.

Growing concern about threats to ecological and economic sustainability on the prairies has prompted governments, industry and the not-for-profit sector to work on defining and addressing important issues in prairie management.

2.1 Loss of Biodiversity

Indicators

Relative to other ecoregions in Canada, the prairie ecoregion has a high proportion of the birds and terrestrial mammals that are threatened or endangered (Environment Canada 1991). The southern prairies, southern British Columbia and the Quebec City-Windsor corridor, all of which are characterized by intense development pressures, are the concentration sites of Canada's endangered species (Biodiversity Working Group 1994). In Alberta, 73 percent, or 16 of 22 wildlife species (amphibians, reptiles, birds, and mammals) that are now considered at serious risk rely on prairie habitats (Alberta Fish and Wildlife 1991); and about one-quarter of 324 vascular species considered rare are prairie species (Packer and Bradley

1984; Argus and Pryer 1990). Although detailed assessments of many species are lacking, habitat loss and degradation are the principal reasons given for those known to have declined.

An 11-year study of successional and native grasslands in Minnesota found that the productivity of more diverse plant communities is more resistant to, and recovers more fully from a major drought (Tilman and Downing 1994). Each additional species lost had a progressively greater impact on drought resistance. These authors suggested that these findings might extend to other perturbations such as grazing, late or early frosts, unusually wet or cool years, hail and fire. This study implies that long-term stability of primary production in the prairie ecosystem depends on biodiversity. Such findings raise concerns about resilience and maintenance of productivity on the three-quarters of the prairies that have been converted to species-poor cropland and tame pasture.

Response

The Committee on the Status of Wildlife in Canada (COSEWIC), formed in 1978, has evaluated close to 300 species and efforts are underway to develop recovery plans for birds and mammals classified as endangered. The Prairie Conservation Action Plan was developed in the late 1980's to influence policy and attitudes so as to conserve the biological diversity found in the Canadian Prairies (World Wildlife Fund 1989). In 1994, a federal-provincial-territorial working group developed a biodiversity strategy for Canada, to address growing concern in Canada about preserving biodiversity and to meet Canada's obligations under the United Nations Convention on Biological Diversity, ratified in 1992 (Biodiversity Working Group 1994).

Monoculture cropping systems will continue to be the predominant cropping system in the prairies in the foreseeable future (Statistics Canada 1994). Although inherently unstable, they give high annual yields, create their own economies of scale and use specialization to increase production levels. High inputs will be required to maintain the productivity of lands that are cropped annually.

2.2 Loss of Soil and Soil Organic Matter and Increased Salinity.

Indicators

Soil erosion by wind and water is widespread in the cultivated portions of prairie Canada. Average annual soil loss in the prairie provinces up to 1983 was, by wind, 160 million tonnes and, by water, 117 million tonnes (Prairie Farm Rehabilitation Administration 1983). In 1991, estimates of soil erosion caused by water were highest in Saskatchewan, with soil erosion values estimated at more than 67 million tonnes; Alberta was next, with estimated gross soil erosion value of 22.9 million tonnes; and Manitoba lost 12.6 million tonnes (Statistics Canada 1994). As well, loss of 40 to 50 percent of original soil organic matter has occurred in the brown, dark brown and black soil zones of the prairies as a result of the export of nutrients by crops, tillage and erosion (Government of Canada 1991).

In addition, since settlement, 2.2 million hectares of cultivated dryland in the prairie provinces have experienced salinization as a result of elevated groundwater tables arising from decreased water use by crops as compared to native vegetation (Prairie Farm Rehabilitation Administration 1983). Continuation of these trends would pose a very real threat to long-term stability of agricultural production in the prairie ecosystem.

Response

More than 70 percent of prairie farms are now using at least one erosion control practice, such as strip cropping and conservation tillage, to control the environmental stress imposed by traditional close-row monoculture systems (Statistics Canada 1994). Since 1989, the federal-provincial Permanent Cover Program has turned 517 165 hectares of environmentally sensitive farmland in the prairie provinces to tame pasture (Craig Wood, PFRA, pers. comm).

2.3 Increased Chemical Inputs on Agricultural Land

Indicators

Although initially high, crop yields generally decrease within 20 to 30 years of converting native prairie to cropland because of progressive loss of soil fertility. Since the early 1950's, to counteract this decline, fertilizers have been widely applied to cultivated land. Between 1970 and 1985, application of nutrients, particularly nitrogen and phosphorous, in the form of fertilizer increased between 100 and 1000 percent for individual subbasins in prairie Canada. This increase was in response to both declining native soil fertility and increased yields from improved crop varieties (Government of Canada 1991). Not only does this trend pose questions about sustaining agricultural productivity (ecologically and economically), but also about effects on water quality.

Agricultural pesticides include herbicides, insecticides, fungicides and vertebrate toxicants used to prevent or control weeds, insects, diseases and vertebrate pests. They have been widely used since the 1950's. Between 1970 and 1985, the amount spent on agricultural pesticides increased between 500 and over 1000 percent for individual subbasins in prairie Canada (Government of Canada 1991). The highest concentration of insecticide spraying in Canada occurred in southern Saskatchewan and parts of prairie Alberta in 1985. Pesticides can reach water supplies through a variety of paths.

Response

In the last 30 years, there has been a dramatic increase in the number of farmers who test the soil for plant-available nutrients, allowing them to match fertilizer use to crop needs and minimize the risk of over-applying fertilizer.

Organochlorine insecticides, such as DDT, and mercurial fungicides are no longer used because of their toxicity and residual accumulation. In the 1990's, synthetic pyrethroids, such as deltamethrin and permethrin, are commonly used for insect control. These products have lower acute and chronic toxicities and short lives as residues.

2.4 Increased Pollutants and Salinity in Prairie Water Bodies and Groundwater.

Indicators

Because all life depends on water for survival, water quality is regarded as a good indicator of overall ecosystem health. Pollutants from municipal, industrial and agricultural activities are known to have increased in prairie rivers, lakes and groundwater in the 1900's. However, data to quantify the sources, the amounts and the trends are sparse and sporadic. Data that exist include the following:

- Since testing began in the late 1960's, herbicides, insecticides and fungicides have been detected in prairie rivers; however, usually not in concentrations exceeding the guideline value for protection of aquatic life. Prairie rivers most often were found to contain 2,4-D and lindane (Statistics Canada 1994).
- Some rivers and lakes in the prairies have high nutrient-loadings, but the relative contributions from municipalities, industry and agriculture, as well as trends and environmental implications have yet to be determined. Nutrients (especially phosphorous released into rivers from municipal wastewater treatment facilities are known to result in eutrophication downstream. It has also been demonstrated in the South Saskatchewan River and in the Bow and Oldman rivers that water returning from irrigation systems has concentrations of total dissolved solids up to double what they were before irrigation (Statistics Canada 1994).
- Sampling of groundwater wells, in 1986, revealed 43 wells in Alberta, Saskatchewan and Manitoba to be contaminated, the majority of these from waste disposal or industrial operations (Statistics Canada 1994).

Response

The Prairie Provinces Water Board has established a total phosphorus objective of 0.05 milligrams per litre and a total nitrogen objective of 0.5 milligrams per litre. The Bow River downstream of Calgary has shown improvement since 1982 (Environment Canada 1991).

Under the Canada-Alberta Environmentally Sustainable Agriculture Agreement (CAESA), there are currently studies of the potential impacts of nutrients, herbicides, sediments and livestock waste on surface and groundwater resources in Alberta (CAESA 1994).

2.5 Decline in Net Farm Income

Indicators

In 1975, realized net farm income (income for outputs minus the cost of inputs) in Canada reached a high of about \$2.5 billion. Fall in net farm income in the late 1970's prompted an increase in direct subsidies to farmers. Since 1985, without ongoing programs and special assistance, realized net farm income would have been at zero or negative. Even with these payments, many farmers require income from supplemental sources, usually achieved from off-farm employment. Rising costs of inputs such as pesticides and fertilizer, and demands to provide low-cost foods to consumers, in Canada and other parts of the world, are two factors contributing to a decline in economic stability of the agricultural industry on the prairies (Prairie Farm Rehabilitation Administration 1992).

Response

Recently, governments and the agricultural communities in both Alberta and Saskatchewan have set new strategic directions for their agricultural and food industries. Promoting environmentally sustainable agriculture is an important component of both strategies (Alberta Agriculture 1993; Saskatchewan Agriculture and Food 1993). A joint federal-provincial initiative is underway to develop a National Environmental Strategy for Agriculture and Agri-food. The environmental issues being addressed relate not only to natural resources and environmental quality, but also to pesticide and biotechnology regulations, international trade and public perception about environmental performance.

2.6 Decline in Rural Population

Indicators

The rural population of the prairie provinces declined from about 1.7 million in 1941 to 1.2 million in 1991, while the urban population increased from about 0.6 million to 3.4 million. Of the rural population, the on-farm portion has declined from about 1.1 million in 1946 to about 0.4 million in 1991. On-farm population on the prairies is projected to continue to decrease but at a slower rate than in the past. This trend threatens the economic and social stability of rural communities (Prairie Farm Rehabilitation Administration 1992).

Response

Prairie residents are considering opportunities for diversification of the rural economy in order to maintain viable rural communities.

3.0 Ecosystem Management Principles

"Ecosystem Management" is the handle being put on the emerging view about how to address ecological problems. Contrary to how it sounds, ecosystem management does not presume to manage all components of the ecosystem, but rather to manage our activities so that overall ecosystem integrity is maintained, biodiversity is preserved and an ecologically sustainable flow of benefits is achieved. Ecosystem management is not entirely new, but rather it involves a shift in management focus from sustaining yields of competing resource outputs to sustaining ecosystems. Sound ecological management contributes to economic sustainability. For example, ecologically sound range management translates into a sustainable livelihood for ranchers.

3.1 Suggested Principles

The Ecosystem Management Team that developed this presentation and the draft discussion document suggests four key principles of ecosystem management. These principles, which follow below, could be used to assess how well current policies and programs contribute to sustaining ecosystems.

First Principle: Ecosystem management maintains and restores native prairie so society can derive and sustain all the benefits that flow from it (ecological, economic and social).

This principle requires maintaining blocks of native prairie representative of the full range of native prairie habitats and biodiversity as well as large enough and intact enough to maintain ecological integrity. In some areas of the prairie ecosystem, such as the aspen parkland, fescue grassland and tall-grass prairie, options for maintaining native prairie are extremely limited. Restoration of significant tracts of native prairie may be warranted.

Where industrial incursions occur into native prairie, reclamation objectives under ecosystem management would be to restore to native condition and to avoid or reduce impact as much as possible in the first place.

Second Principle: Ecosystem management attempts to perpetuate and approximate natural factors and processes.

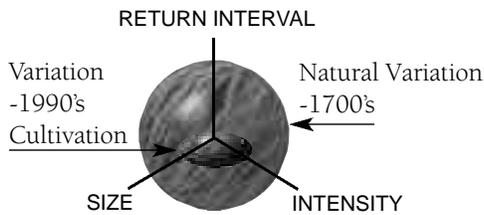
Rather than focusing on individual species and their needs, ecosystem management focuses on landscapes and the dynamic forces such as erosion/deposition, drought, flood, fire, photosynthesis, herbivory, predation and decomposition. By allowing these processes to operate naturally or approximating them through management, it is assumed there will be a better chance of preserving biodiversity (that is, the full range of life forms evolved under and adapted to these processes) and of sustaining the flow of benefits to society.

Cultivation of annual crops, by its very nature, is a dramatic alteration of the natural range of variation in ecosystem processes (Figure 9). However, crop production is an important part of our economy and there will always be cropland on the prairie, provided society is willing to sustain the required inputs. Moving toward ecosystem management on cropland means trying to reduce inputs of fertilizers, pesticides, fossil fuels and water as well as reducing soil disturbance and erosion and enhancing the soil's organic matter. Indeed, examples like crop residue management, the permanent cover program and biological control strategies for weeds and insects are evidence of thinking in terms of ecosystem processes.

Range management, after dealing with the immediate conservation issues of riparian management and broad landscapes that are heavily grazed, needs to manage animal distribution to enhance the range of natural variation (Figure 9). Patchy grazing, with lightly, moderately and heavily used areas is desirable. Use patterns, previously viewed as inefficient, may precisely match the needs of a variety of plant and wildlife species. Range management that overintensifies or homogenizes grazing will reduce the range of natural variation.

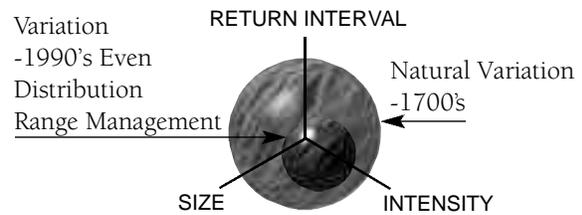
Range of Variation

-1990's Cultivation



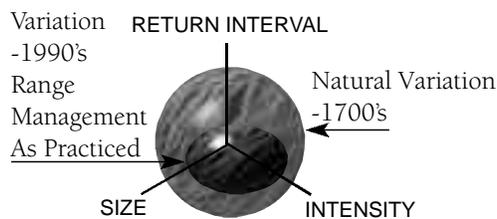
Range of Variation

-Even Distribution Management



Range of Variation

-1990's Range Management Practice



Range of Variation

-Prairie Ecosystem Management

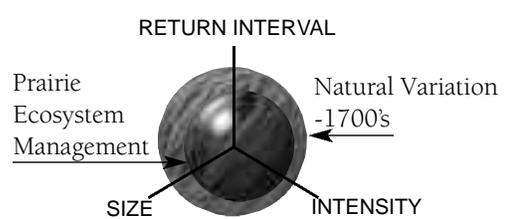


Figure 9 - Hypothetical Range of Variation Under Various Management Practices.

Third Principle: Ecosystem management applies ecological knowledge to prairie management, monitors the results and adapts as required.

Adaptive management is the catchword for this concept. For example, important components of prairie ecosystem management would be monitoring soil condition, water quality, vegetation composition and structure and biodiversity, as well as altering management practices if there are threats to overall ecosystem health or integrity. This principle requires that we have widely agreed-upon measures of ecological health or integrity. Adaptive management can occur on many scales: over the entire prairies, including cultivated areas as well as native grasslands, wetlands, rivers and lakes; and, just as importantly, on the individual ranch or farm.

Fourth Principle: Ecosystem management is multidisciplinary and interjurisdictional.

Ecological boundaries are respected rather than only political ones. Management decisions are made by individuals and teams with a breadth of knowledge, especially about ecology (how natural systems work), but also about the economy and society. For example, biologists would become more aware of agricultural economics and rural life, and landholders would become more aware of prairie ecology, and the two groups would spend more time communicating with each other about common issues. Adopting this principle would help form a common purpose for prairie management.

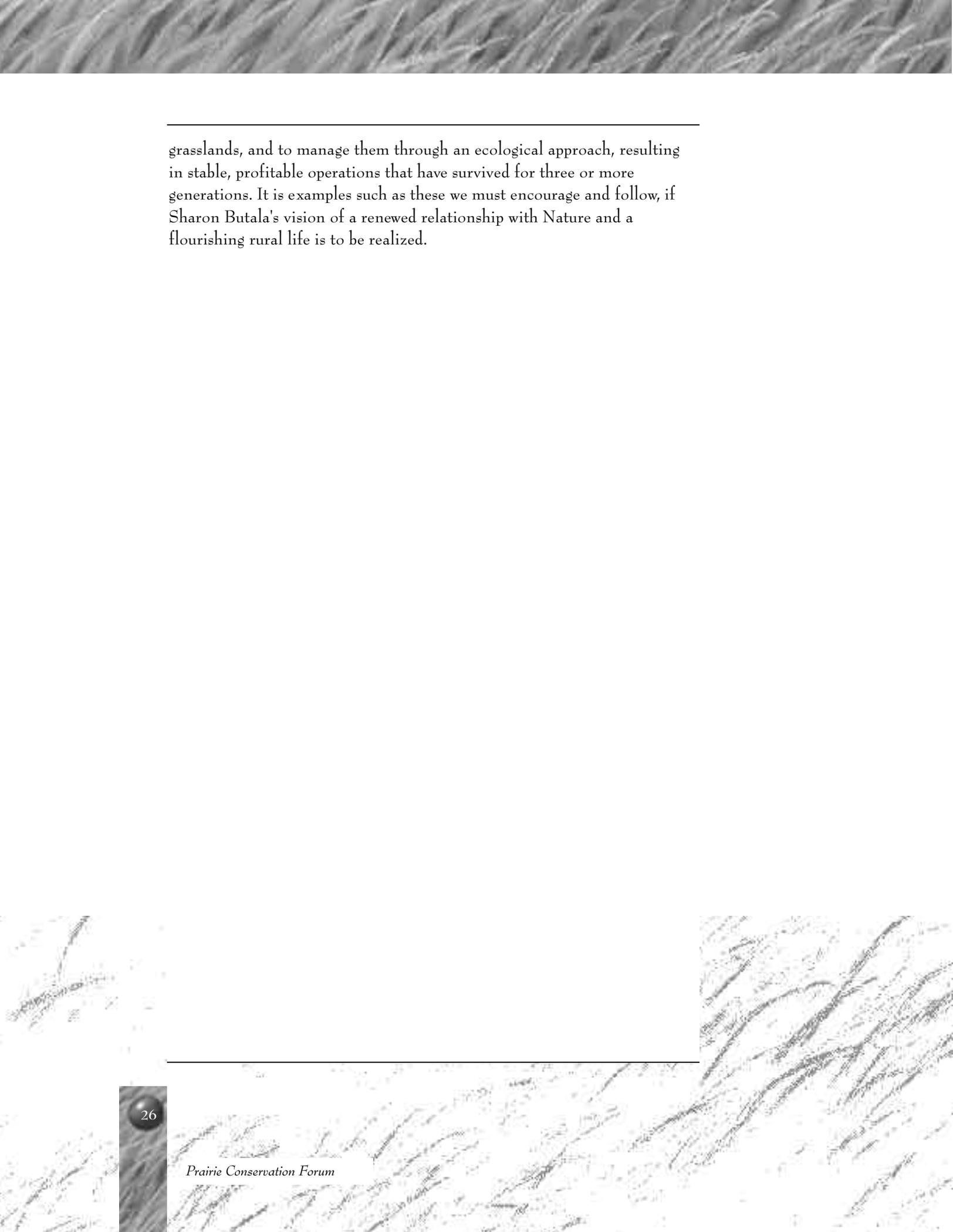
Adopting the principles of ecosystem management could have far-reaching implications for how we manage and live in the prairie; indeed, it could affect how we think about and understand our place in the prairie ecosystem. It will reflect a shift in values away from controlling or living separate from our natural environment to respecting and living within it. We do not yet completely know or understand all the implications of this approach.

3.2 Conclusion

We are becoming increasingly aware as a society that economic and social sustainability is linked to ecological sustainability. In 1952, David Costello, a range scientist and author of *The Prairie World*, summed it up thus:

"People are the greatest of the biological factors. Through their increasing knowledge of ecology, they have within themselves the power to act on their environment for their own greatest good. They will have to apply that knowledge not through edict, arbitrary decision, or economic or political force, but within the limits of natural law, if they are to succeed."
(Costello 1952)

In the prairie, our decisions as individuals and communities will determine how successful we are at managing our activities so that overall ecosystem integrity is maintained, biodiversity is preserved and an ecologically sustainable flow of benefits is achieved. A visible example of such benefits are ranching operations where generations have learned to read the native

The page features a background of a grassland with tall, thin grasses. A horizontal line is positioned above the main text block.

grasslands, and to manage them through an ecological approach, resulting in stable, profitable operations that have survived for three or more generations. It is examples such as these we must encourage and follow, if Sharon Butala's vision of a renewed relationship with Nature and a flourishing rural life is to be realized.

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