PROTECTING ECOLOGICAL PROCESSES

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Introduction

Environmental protection is key to continued life on earth as we know it. The intent is to act as a counterbalance to pollution and pro-development forces in our technological societies.

Less commonly agreed upon are what needs protection. In the past, just as now, concerned persons have thought they knew what required protection: historically, this has first been rare and endangered species, then habitat, then ecosystems. Now, with the globalization of environmental concerns, environmental protection is concentrating on preserving the diversity of life, biodiversity.[19]

As the twentieth century hurtles to a close, the conventional wisdom says that protecting biodiversity protects everything else. Biodiversity is life's chief adaptive dimension. Hence, the diversity of life is its most important defence against severe and unpredictable disturbances. In the past, these disturbances have tended to be climatic, but now they are mostly human-caused, and even some of these may be climatic. The conclusion is that if we maintain biodiversity, nature will look after itself.

Yet, useful as it is, biodiversity is a slippery subject on which to rely as the chief protection goal. Biodiversity is a human idea about a state of being. Nature is not static, but dynamic. It changes continuously, whether influenced by human actions or not. Diversity is an important condition that enables life to adjust to changes, but the life system processes are as fundamental to a healthy nature as biodiversity itself. In nature, biodiversity helps to maintain ecological processes, and vice versa. The purpose of this article is to look at the need and means to maintain existing ecosystem processes in Canada's prairie provinces.

Ecological Processes and Ecosystem Dynamics

Before beginning a discussion on the protection of ecological processes, it is necessary to define the term "ecological processes." A useful definition is "ecological processes include all the physical processes and the plant and animal activities which influence the state of ecosystems and contribute to the maintenance of their integrity and genetic diversity, and thereby evolutionary potential" (Rickleffs and others[12]).

Rickleffs and others[12] recognise five major ecological processes that operate in all ecosystems: (1) biogeochemical (earth) cycles, especially the water cycle, (2) energy flow, (3) mineralization of organic matter in the soils and sediments, (4) storage and transport of minerals and biomass, and (5) regulation of the processes in (1) through (4),

often by the activities of animals. These are functional or short-term ecosystem processes only. The long-term or evolutionary processes are system reactions to major outside disturbances, such as those imposed by severe climate change or by human developments. To understand these long-term processes it is important to review the ecosystem concept as it is viewed today.

The above definition uses the term "ecosystem." The meaning of this word has remained remarkably stable over the years, but ideas of how ecological processes work have changed dramatically in the last two decades. Odum's[8] definition of an ecosystem — "any area of nature that includes living organisms and nonliving substances interacting to produce an exchange of materials between the living and nonliving parts is an ecological system or ecosystem" — remains valid. While this definition relates to real places on the earth, note that it leaves the definition of the exact boundaries of an "area of nature" up to the observer, making this ecosystem concept partly subjective.

Regarding ecological processes, briefly, the idea of plant succession leading from a disturbed state to a "climax" self-perpetuating stage was adopted by early ecologists as an important ecosystem process.[1,17] Then Odum[9] initiated a switch to energy exchange as the chief ecosystem process. Yet Odum's "strategy of ecosystem development" was a succession of sorts as well, leading from energy instability following disturbance to equilibrium instead of to "climax" vegetation.

Later some ecologists became dissatisfied with the ecosystem concept. A few went so far as to suggest that ecosystems exist only in the minds of theorists but not in nature, and attempted to replace the ecosystem concept with the idea of a nature consisting of randomly determined patches with no real order or structure.[11] More recently, based on an idea from physics that self-organising systems are inherent in nature, the ecosystem concept again enjoys full theoretical status.

Schneider and Kay[16] describe the new ecosystem theory: "Ecosystems are viewed as non-equilibrium [subject to unpredictable intervals] structures and processes, open to material and energy flow ... species that survive in ecosystems are those that funnel energy into their own reproduction..." They state that "left to their own devices, living systems are self-organising, that is they look after themselves." Interestingly, this new definition of an ecosystem is what many have thought it to be all along. The road to the obvious often is more convoluted than we think.

The major problem in ecosystem management looming from this theory is that very little is known about disturbance thresholds in system processes, and research to discover them can be dangerous because it is possible only to guess at the thresholds without observing ecosystems actually collapsing in the face of disturbances. The only answer here may be direct observation of ecosystems that already have collapsed or are collapsing due to overuse by humans. Clearly the best defence against ecosystem collapse is treading on nature as lightly as possible, maintaining the full complement of ecosystem diversity. Again, this is nothing more than applying common sense.

Having looked at ecological processes and ecosystems, it is important to identify the forces that govern

the primary ecological processes functioning in ecosystems. Clearly, the "most enduring features of the environment are relatively stable landforms." [10] Add climate and life forms and the result is an ecosystem with its entire array of functioning, dynamic, interacting processes. Change the landform or the climate or both, and processes will change permanently, causing the ecosystem to evolve. Thus if the change is too sudden and severe, the ecosystem cannot adjust and return to its old functions, evolving instead into something quite different and often unpredictable, not a good result from an environmental management viewpoint.

Health of Prairie Ecological Processes

Having identified the major ecological processes that function within ecosystems, some obvious questions relating to our Canadian prairie provinces come to mind. Have any of the major ecosystems in the prairie provinces already experienced collapse? The answer to this is "yes." The original grassland-parkland ecosystem dominated by the Plains Bison, is gone completely, along with the key predators, Wolves and Grizzly Bears. The new dynamics are totally different from the old in what remains of the native grassland and parkland, let alone the cultivated areas.

The impact to the humans present on the original grassland-parkland ecosystem was also enormous. The economic collapse was total as the original people became dependent upon European invaders for a time. It would be the sheerest arrogance of our technological society to assume that the same could not happen to it with continued over-exploitation of resources. The resources and the economic base are different, that is all.

The smaller wetland, valley, and hill ecosystems within the greater grassland area have fared somewhat better, but they are under continuous and accelerating assault by a variety of forces, attempts to stop them notwithstanding. The problem of draining wetlands for agricultural expansion is well known and note that over half of the wetlands are gone already and the assault is not ceasing.[5,6]

Streams continue to be dammed for flood control and water supply management. The smaller lakes are becoming polluted due to nutrients coming in from urban sewage and dissolved fertilisers. The stream valleys are relatively intact in many places, except where they are subjected to cottage developments and to flooding and erosion by reservoirs. The hilly areas are in better shape, but disturbances by agricultural and industrial interests occur in some places.

Which Ecosystems are in the Most Immediate Danger of Collapse?

The original grassland-parkland ecosystem already has collapsed, and remaining altered portions of it are under assault as discussed above. Likely, the wetlands are in the most immediate danger.[13] The situation with some smaller lakes is not far behind. Some may be surprised that the agricultural ecosystem which replaced most of the native grassland itself is in danger due to soil depletion and salinisation. Clearly, agricultural scientists and farmers are aware of this situation, but awareness of what happens and preventing it from happening do not always go together.

In the northern boreal forest and tundra there is still time to prevent the disasters that have occurred farther south. Timber is being clearcut, yes, but forest harvesting companies are preparing environmental impact assessments of their plans, and these must receive an airing by the public before they are acceptable to governments.[2] Additionally, the International Standards Organisations (ISO) is demanding that wood products be obtained and manufactured in environmentally acceptable ways before major buyers will purchase them. Already the new management plans look much better than the old ones, as the emphasis in forest management switches from sustainable timber yield to sustainable forest ecosystems.[2]

In the forest-tundra transition zone, where there are few commercial tree stands, the greatest present dangers to the ecological processes are from mining activities, physical destruction of too many Barren-ground Caribou, and disruption of caribou migration patterns. These dangers, while present, are not imminent, and the potential for this ecosystem to avoid collapse as happened in the grassland is excellent, given continued vigilance by the environmental and local communities.

In the forest-tundra transition zone, migrant caribou-predator systems tend not to be in balance. Predators, being territorial, especially when breeding, cannot travel freely with migrating prey, so for a large part of each year they are left with a drastic reduction in available prey, severely limiting their own numbers.[7] This means that prey populations are not regulated by predators, and increase until regulated eventually by food supply or disease. In our forest-tundra ecosystem, such a relationship has created the happy situation of providing an excess of Barren-ground Caribou during most years so that many are available for harvesting by indigenous humans. Disrupting the caribou migration process leads to a completely rearranged ecosystem with new operating processes followed by collapse of an important part of the regional economy.

What Process Disruptions Would Trigger Entire Ecosystem Collapses?

Examples abound of humans causing severe ecosystem process disruptions. The nature and extent of the disastrous results vary with the ecosystem. The Serengeti-Mara grassland-woodland ecosystem in eastern Africa, for example, has many species of migrant and sedentary antelopes, and predators. Removing one species would cause problems, but adjustments likely would occur, the system adapting to the changes because of the existing high level of biodiversity. In simpler ecosystems, such as our grassland-parkland region and the forest-tundra transition zone, removal of the keystone herbivore can cause a cascade of disasters among other species dependent on these herbivores. With the grasslands, this happened just over one hundred years ago. In the north, such an ecological disaster can be prevented. The Cree people, who are among the First Nations of that part of Canada, know that humans and nature are interconnected in a circle of life and that maintaining the harmony is needed for continued productive life.[4] The rest of us could learn from them.

Stopping or changing the timing of water flows in streams and polluting them can cause process collapse. Rearranging landforms, as happens when strip mines are not reclaimed,

can have such an effect too, if a large area is covered or a local ecosystem is removed. The examples are legion. In fact, removal from or major disruption of the functioning of any one or more of the processes discussed here can trigger chaotic collapse of an ecosystem, with totally unpredictable results. Serious disturbance to any one ecosystem process would seriously affect more than one process at the same time. Such a situation not only would speed up any collapse, but would increase its severity.

What Process Collapses Would Be Most Dangerous to the Human Inhabitants?

Which are the most dangerous ecosystem disturbances to humans is dependent on the economic system. The collapse of the economy on the North American plains was caused by destruction of the primary resource, the Bison. A similar ecological catastrophe is possible in caribou country. Urban societies would collapse if the agricultural ecosystems ceased producing massive quantities of food, industrial raw materials became unavailable, or the transportation system stopped working. Imagine the chaotic result if all these functions stopped together.

Although modern technological societies have assumed the role of regulators of animal and plant populations, control may be elusive. This potential already is shown by pests becoming resistant to pesticides, difficulties in controlling invader animal and plant species, and even overuse of parks by humans wishing to commune with what is left of nature.

The most dangerous ecological process collapse to humans and to natural areas would be a cumulative collapse; an instance in which two or more ecological processes undergo fundamental change at one time. Human adaptability is cultural, not genetic, which makes humanity an extremely versatile species, an adaptation denied other species because of their dependence on the much slower genetic adaptation. For example, changes in the food chain and regulation processes may not be catastrophic to humans, as they can occupy most of the levels on the food chain themselves. Energy flow disturbances, however, especially to artificial ecosystems such as agricultural lands, can be very damaging to human economies. Combine that with a collapse of normal soil processes, and a significant change in a fundamental earth cycle, especially climate, and the ecological changes that occur then may be enough to make large areas of land uninhabitable by humans.

Discussion and Conclusions

Our knowledge about ecosystems is imperfect, and we may never know it all.[14] A process is a human concept subject to theoretical change as well as being a real event in a real ecosystem. How may we integrate our knowledge of prairie ecological processes into environmental management strategies that will work? Ecological processes are real, functioning in real ecosystems filled with growing, moving, eating, living things. So how may we ensure their future, despite change caused by our human excesses? Based on the information and discussion presented here, the following recommendations arise logically:

- no matter what the development, whether agriculture, forest harvesting, mining, or even urban sprawl, ensure landform and water system integrity;

- as much as possible, retain lands and waters in a natural state and manage them with minimal interference;
- change agricultural practices so that natural soil processes are not further jeopardised;
- pay much closer attention to reducing the emission of greenhouse gases so as to avoid human caused climate change, potentially the most fundamental process change of all;
- manage keystone herbivore species so as not to alter migration and other movement patterns, thereby avoiding food chain collapses;
- retain the overall age and species patch mosaic, with the patches near enough to each other so as not to lose genetic continuity, ensuring continued biodiversity;
- ensure stakeholder input into all resource use and environmental management decisions;
- ensure that First Nations and other local people, people who live within the natural ecosystems, are not only consulted for management decisions but sit at the management tables themselves.

How may we go about protecting ecological processes? The answer is simple to think about, yet it is anything but simple to implement: leave nature alone. The more fundamental question we need to address is how we humans can continue to live within the ecosystems of which we are part and which we now dominate without causing such severe disturbance that the systems collapse.

Some ecologists recommend that a change from the old human-centred ethic toward a land ethic, will do the job by changing our mind-set in favour of ecosystem management.[13,14,18] I too believe that such a fundamental change in our human attitude is essential, but I also believe that it is not enough, nor is an appropriate ethical change guaranteed by any means.[3] Human actions are not necessarily guided by ethics. Continued action on our part is required, ethic or no ethic. Encouraging glimmerings of such action actually are occurring, witness the power of the International Standards Organisations and the switch to ecosystem based land and water management by many industries. Yet the root cause of this change is public demand. Continued vigilance and education are key in this regard. Without the support of local people who make a living off the land, the actions will not continue in the long run.

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Plurals:

a siege of herons, a spring of teal, a company of widgeon, a cast of hawks, a covert of coots, a flight of swallows, a plump of wildfowl, a badelyng of ducks, a congregation of plovers, a murmuration of starlings, an exultation of larks.