Beaver Hills Initiative

Ecological Primer - What Makes the Beaver Hills So Special?

Background

The Beaver Hills area lies east of Edmonton in the Beaver Hills/Cooking Lake moraine, a geomorphological feature that encompasses 1572 km^2 (607 mi^2). The hummocky "knob and kettle" terrain of the moraine forms a patchwork of depressional areas, many of which support wetlands and small lakes.

Terrain and soil conditions limited the extent of past agricultural clearing and the area remains extensively forested with aspen and in some areas, spruce woodlands. Land use in the area is administered by municipal, provincial and federal agencies. The Beaver Hills lie within five counties (Strathcona, Leduc, Beaver, Lamont and Camrose; Figure 1).

There are several federal and provincial protected areas located entirely within the Beaver Hills, including Elk Island National Park, the Ministik Bird Sanctuary, the Cooking Lake - Blackfoot Recreational Area, Miquelon Lake Provincial Park and a number of smaller provincial natural areas. Nearby, there are other ecologically significant areas that are ecologically linked to the Beaver Hills. Beaverhill Lake, a designated RAMSAR site (a Wetland of International Importance), lies to the east and the North Saskatchewan River is within 5 km to the northwest.

It is the combination of local geomorphology, hydrology, and climate that has created the unique natural ecosystem of the Beaver Hills. Its poor agricultural capability helped prevent extensive clearing, and helped retain its natural features. The resulting biodiversity and natural greenspace stand in contrast to the surrounding agricultural, urban and industrial lands, in which natural habitat has been reduced to smaller discontinuous patches. The Beaver Hills are truly a distinct feature on the regional landscape.

Land Use Challenges

The Edmonton capital region, the fastest growing metropolitan region of Canada, is immediately adjacent the Beaver Hills. Although past land use in the Beaver Hills has mainly been restricted to agriculture (grazing), demand for recreational, urban and country residential land use is placing increasing pressure on the area.

The unique qualities and the extensive natural areas of the Beaver Hills are valued by both area residents and Albertans. The shared resources this area offers - clean and abundant drinking water, clean air and biological diversity - are valued components of a currently viable ecosystem. The Beaver Hills Initiative developed from a collective recognition among government agencies and locally-active environmental groups that for this ecosystem to remain sustainable, growth and development must consider these shared resources, and their sensitivity to development.

The Beaver Hills, like all ecological landscapes, function as a unit. The interaction between hydrology, soils, terrain and climate have produced the mosaic of boreal forest and wetlands that in turn support the biodiversity and greenspace we value. In order to conserve these values, land use management must consider both the components and their interactions. The sections below provide an overview of the key components of the Beaver Hills ecosystem, their interactions, and the threats to the system as a whole, as background for the development of future land use policy.

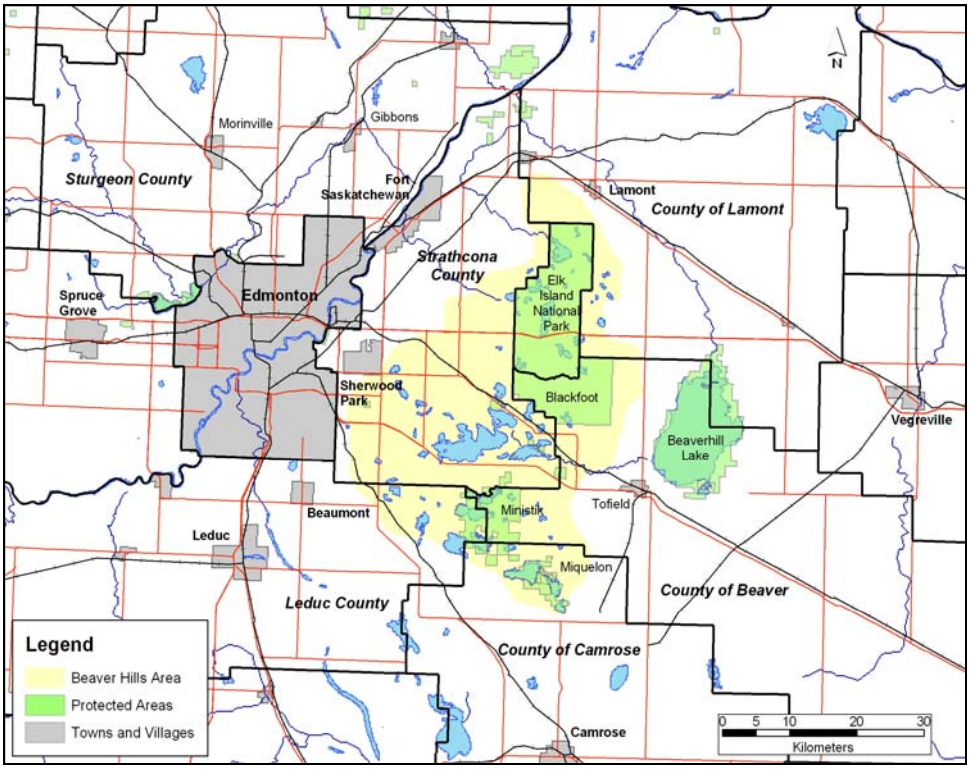

Figure 1. The Beaver Hills Initiative Area

Geomorphology, Soils and Climate

The Beaver Hills are distinctly different from the surrounding lands in terms of their soils, terrain and climate. These features have indirectly contributed to another obvious difference: the extent and type of natural vegetation present.

The Beaver Hills/Cooking Lake moraine is a "dead-ice" or stagnant moraine, formed during the retreat of the glaciers about 9000 years ago (Geowest 1997). Glacial advances ground the underlying bedrock into 'till', coarse to fine debris that was pushed into ridges and mounds as the glacier moved forward. Later, when the glaciers receded, these features remained deposited on the landscape and formed the terrain we see today.

During glacial retreat, the adjacent lands were flooded by glacial Lake Edmonton, but stagnant ice islands remained captured between mounds of till deposits in the Beaver Hills. An equivalent process occurs during spring snowmelt, when deeper pockets and banks of snow caught up in hollows and ditches remain isolated within increasingly snow-free fields.

Eventually, the remnant ice island melted, leaving the complex hummocky (knob and kettle) terrain characteristic of the current landscape. The glacial lakebed of the surrounding lands, in contrast, was left a relatively level plain, with minimal relief. Today, the Beaver Hills form a raised landscape feature (about 750 m above sea level (ASL)), distinctly visible from the surrounding level plains (about 640 m ASL).

Soil development is influenced by underlying parent material (in this case, glacial till), drainage and overlying vegetation. The scattered network of sloughs, bogs and small lakes within the Beaver Hills have moderate drainage through small streams (Geowest 1997). The upland soils resulting from these conditions are predominately the Grey Luvisols commonly found in woodland areas, although Grey Solodized Solonetz soils are also found across the moraine. Black Chernozems, the highly productive soils of agricultural zones, occupy the surrounding plains.

Soils in turn determine agricultural potential, which is much lower in the moraine than that of the adjacent lands (Figure 2). The lack of agricultural

suitability is one reason why the Beaver Hills have retained extensive natural woodland habitat, while the adjacent lands have largely been cleared.

Climate, too, can affect soil development as well as vegetation. Although only a short distance from Edmonton, weather in the Beaver Hills can be quite different. In fact, the Beaver Hills were originally identified as a disjunct natural subregion based on their similarities in climate and soils with the northern boreal forest (Strong and Leggat 1992). Although monthly temperatures are typically closer to those of the Central Parkland natural subregion that surround the Beaver Hills, precipitation is about 20% higher than either the Central Parkland or the Dry Mixedwood Boreal subregion to the north. The wetter conditions in the Beaver Hills, in turn, promote plant communities and soils more characteristic of the boreal subregion than the Central Parkland.

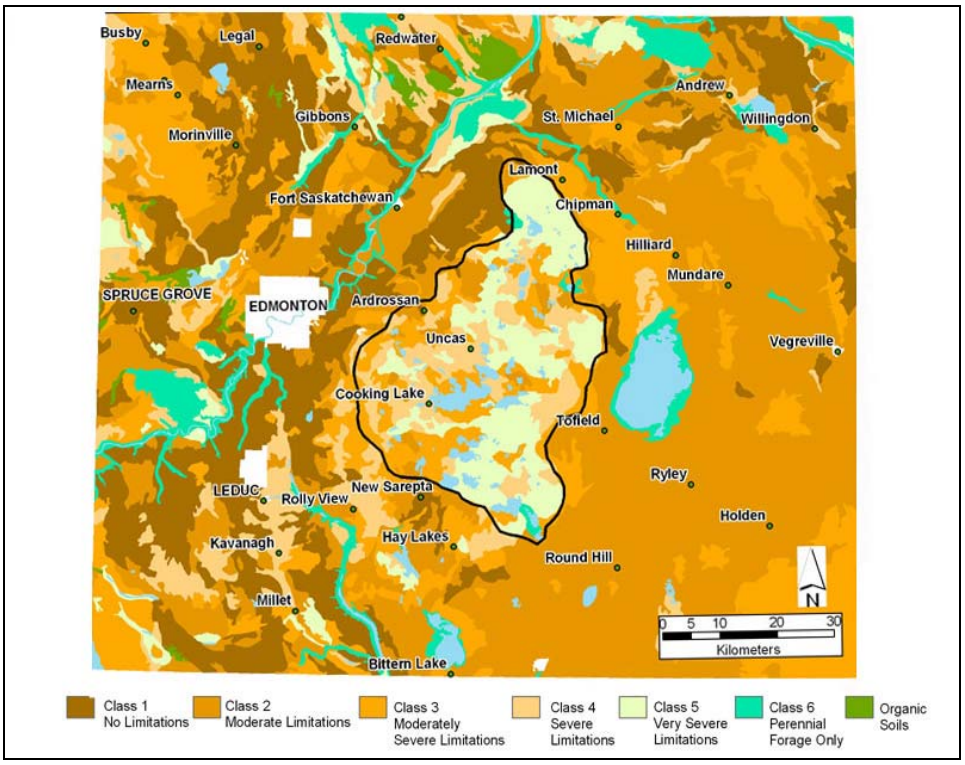

Figure 2. Agricultural Capability of the Beaver Hills and Surrounding Lands (Source: Geogratis)

Surface and Groundwater

Hydrologically, the knob and kettle terrain of the Beaver Hills plays an important role in the regional ground and surface water cycle. Effectively, the moraine functions as an extensive groundwater recharge area, transferring surface water into aquifers that in turn supply some of the other major water features of the region, including Cooking Lake, Beaverhill Lake and the North Saskatchewan River (Geowest 1997, Mitchell and Prepas 1990).

Surface water collects in the many wetlands and small lakes across the moraine, most of which have no outlet streams. The accumulated water percolates through the underlying sediments and into aquifers below. Some of that groundwater flow later emerges in small creeks and lakes within the moraine (e.g., Cooking Lake, Halfmoon Lake, Islet Lake, Astotin, Ross and Point-au-Pins Creeks). Flow from the small streams originating in the Beaver Hills passes across the surrounding, lower plains, eventually releasing into Beaverhill Lake and the North Saskatchewan River (Figure 1).

Although the moraine retains much of the precipitation within the various wetlands and small lakes, surface-collected flows are not entirely absent. In fact, there appears to be a complex interaction between groundwater and surface water flow that supplies many of the

waterbodies in the moraine and, to a certain extent, the surrounding plains.

The few internal drainage systems within the moraine collect surface flow and direct it, through the moraine and into larger waterbodies on the surrounding plains. Cooking, McFadden, Halfmoon and Antler Lakes, for example, are connected to Hastings Lake by Cooking Lake Creek. In most years, surface flow remains in this internal drainage system, but in wet years, these flows spill over into the creek, through Hastings Lake and then continue east toward Beaverhill Lake. Similarly, other creeks carry excess flow from the northwest moraine to the North Saskatchewan River (Figure 1).

Habitat and Biodiversity

The Beaver Hills area is part of the Dry Mixedwood Boreal Forest Natural Subregion (Achuff 1994), a transitional zone between the southern Aspen Parkland and the other northern boreal forest subregions. There are three disjunct areas representing this natural subregion in the province. The Beaver Hills comprise the smallest of the three, an island within the Aspen Parkland that is separate from a nearby larger band of Dry Mixedwood extending from the Cold Lake area west, then south toward Calgary (Figure 3).

Because of its transitional location and relatively undisturbed habitat, this part of the Dry Mixedwood Boreal Subregion supports a high diversity of plant and animal life. This ecological subregion has been called the most productive of the boreal subregions for wildlife, mainly because of the diversity of habitats available within it and productive shrub growth (Strong and Leggat 1992).

Up to 48 mammals, 152 birds and 8 amphibians and reptiles have been reported to occur within the Beaver Hills (Geowest 1997). Reflecting the transitional nature of this section of the boreal zone, this list includes both boreal species (moose, black bear, lynx) and grassland species (sharp-tailed grouse, mule deer). Waterfowl and wetland songbirds are abundant and diverse communities can be found on wetlands throughout the area.

Under the Canada Land Inventory system, a federal program that identified "productive lands" based on soil, vegetation, management practices and climate, the Beaver Hills were classed as having either "only slight limitations to the production of ungulates" or "no significant limitations to production". The abundant small wetlands throughout the Beaver Hills were rated as good to excellent for waterfowl production based on abundant food and cover. Cooking and Hastings Lakes are both considered key waterfowl habitat and Beaverhills Lake to the east is listed as a RAMSAR site, a wetland of international significance.

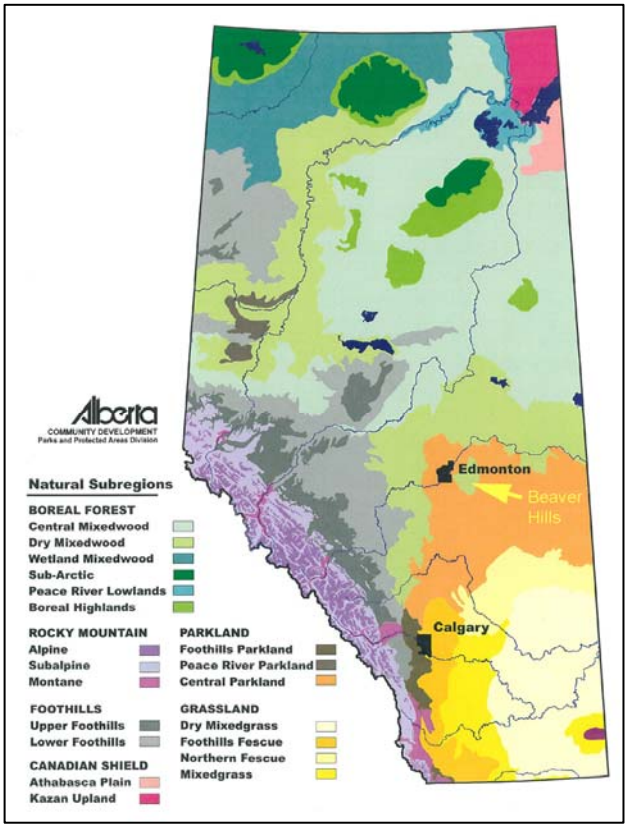

Figure 3. Natural Subregions of Alberta (Achuff 1994)

A number of provincially rare plants and wildlife species occur within the Beaver Hills, in fact, rare species records are more frequent in the Beaver Hills than in the surrounding agricultural plains, and clustered in a band between the protected areas of Elk Island National Park and Miquelon Provincial Park.. Figure 4 shows records of species ranked as S1, S2 and S3 provincially (<6 records, 6-20 records, 21-100 records in province, respectively) by the Alberta Natural Heritage Information Center (ANHIC). ANHIC is part of a national and global network dedicated to tracking population status of plant and wildlife species.

Many of these records are of plant species, but piping plover, peregrine falcon, Canadian toad and northern long-eared bat have also been observed. Colonial nesting sites for pelicans and herons, significant due to the sensitivity of these breeding birds to disturbance, are also shown on Figure 4.

The frequency of rare species records is likely related to the natural habitat available in the Beaver Hills relative to that in adjacent, agricultural lands. The protected areas that run the length of the Beaver Hills are also a factor: the lower level of human use in these zones helps provide secure habitat for these species. Secure populations in turn help foster populations in adjacent, unprotected "buffer" lands.

The value of the Beaver Hills to rare species is best illustrated by the trumpeter swan, a species still legally protected as an endangered species in the province, but recently delisted by ANHIC to an S3 rank, and nationally to Not At Risk status. The delisting was due in part to successful reintroduction in locations across the country, including Elk Island National Park. As the EINP population has grown, young birds have begun breeding on small lakes in the lands adjacent the Park. The fact that these birds are very sensitive to disturbance in nesting areas provides strong evidence of the habitat suitability of these 'buffer lands' and their importance to sustaining viable wildlife (and plant) populations.

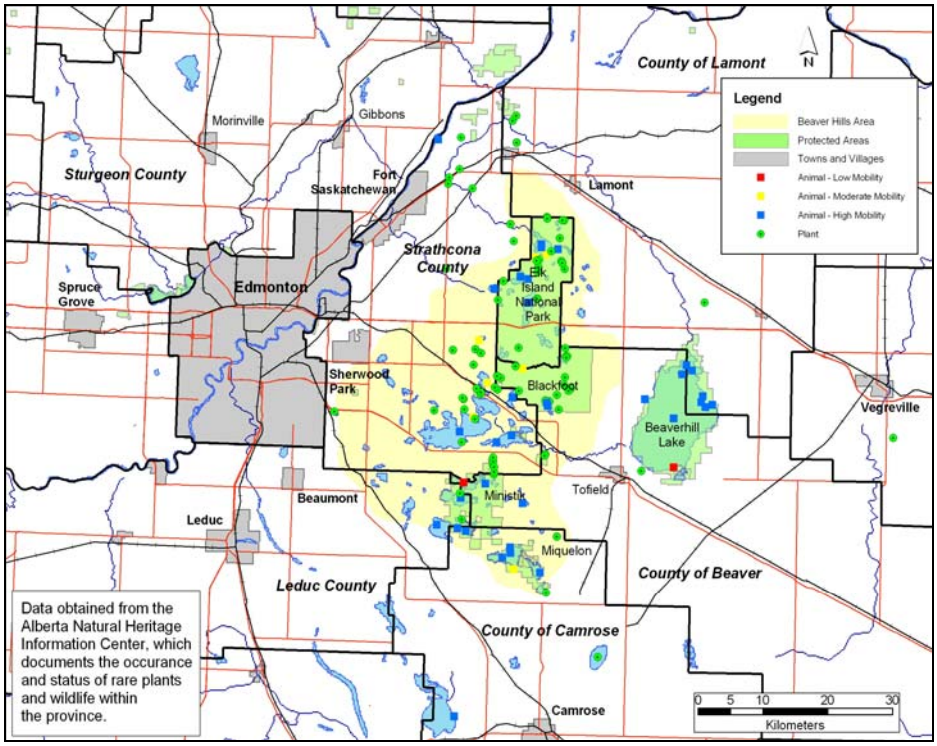

Figure 4. Rare Plants and Wildlife in the Beaver Hills (Parks Canada 2003)

Ecological Linkages

Areas of high biodiversity owe some of their success to the extent of connectivity to other, adjacent natural habitat. Biodiversity is maintained through duplication of both populations and habitat, at successive geographic scales. The vegetation community (e.g., a wetland) offers resources to support healthy local populations of plants and wildlife. The regional ecosystem and larger natural subregion offer diversity and abundance of habitat that sustain a broad array of species and support many localized populations. Many separate populations provide protection from chance events (like drought) that cause extensive mortality. The surviving populations can bolster those suffering decline, revitalizing them through dispersal of juveniles and seeds, provided the declining sites area accessible.

The ability for both plant and wildlife species to move within each of those geographic scales is critical to their survival. Natural areas with linkage to other, nearby natural habitat can function as a broader network, and help support larger, regional populations of species. Linkages allow genetic exchange and through access to other natural habitat, facilitate re-colonization of vacant habitat created by disturbance or chance events. Protected areas within such a network are a valuable component of a linked system as they often support secure populations that serve as a source of immigrants. The Beaver Hills provide an excellent example of a linked network, as they contain all of these components of an effective "network".

The Aspen Parkland surrounding the Beaver Hills has experienced considerable conversion of the landbase to human use, so that remnant natural habitat is relatively patchy and limited. The extent of clearing is dramatically illustrated in Figure 5, a LANDSAT satellite image of the Beaver Hills and surrounding lands. The Beaver Hills, with its extensive forests and wetlands, remains predominately green, particularly on the east side, indicating relatively continuous forest cover. The surrounding plains, in contrast, are predominantly pink and purple, indicating extensive clearing and development.

Permeability, a measure of connectivity, is likely still high within the Beaver Hills, especially compared to the adjacent plains. Small bands of green extend north and south into the adjacent lands, indicating linkage with the adjacent natural subregions. Because of this internal and external continuity of natural habitat, the Beaver Hills provides an effective network of natural areas, as well as an important regional link between the larger boreal forest subregion to the north and the remaining natural lands in the Aspen Parkland to the south.

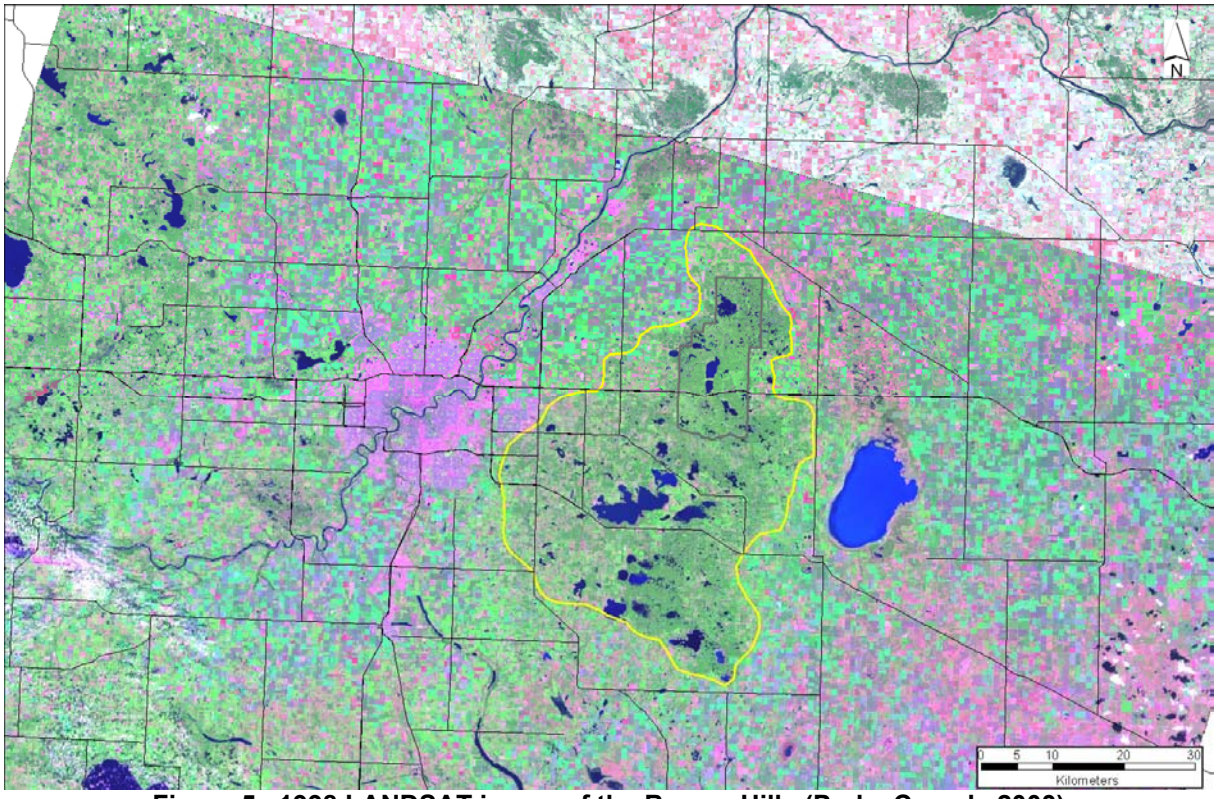

Figure 5. 1998 LANDSAT image of the Beaver Hills (Parks Canada 2003)
(Green indicates vegetation cover, pink and purple, cleared and developed lands. Section to the north was taken later in the year, resulting in color tone differences)

Sustaining the Beaver Hills

Sustainability in the ecological sense refers to the ability of an area to continue to exist as a vigorous, biologically diverse ecosystem regulated by natural processes. Sustainable ecosystems change through time, but continue to be dominated by native species, even when conditions on surrounding lands have changed to a more developed state.

Sustainability from an socio-economic standpoint has a similar definition. A sustainable area would be able to maintain an economically diverse base that would be able to respond to changing markets. It would also continue to support a healthy residential environment by fostering a high quality of life.

In the Beaver Hills, quality of life and at least some of the economic potential is closely tied to the natural state of the area. To manage sustainability in this case, the natural ecosystem, the economic potential and social factors must all be considered. There must be a balance between development and ecological function, so that one does not diminish the ability of the other to persist. Understanding the factors regulating the natural system will be an important first step in setting management goals for a sustainable Beaver Hills.

Managing Sustainably - What's It Take?

Natural communities are not static, nor do they oscillate around a particular ecological state, always returning to a 'normal' community type (Primack 2002). Instead, natural communities are dynamic: the ecosystem shifts to a new state in response to time or disturbance. The habitat and species we see in an area now will change as the site succeeds to new vegetation communities over time or responds to disturbance (e.g., windthrow, fire). In deciding that we want to maintain natural areas with some level of development, we must accept this characteristic and accommodate it in our management approach.

A dynamic ecosystem is regulated by three inter-related components: ecosystem structure (physical features of habitat) and composition (biological communities) are tied to function (Noss 1990). Simply put, these are the ingredients that determine the direction of the processes that regulate the ecosystem. For example, a wetland supports vegetation and wildlife distinct from more upland habitat. Starting as a sedge-bounded pond, such a site might evolve over time to an open pond surrounded by dense cattails and then to one with cattails and dense willow along its edge. Chemistry and seasonal fluctuation of water are functional aspects that regulate change in this system, but that change is restricted by the wetland's physical features (water, soil types) and biological communities (wetland species).

The interdependency of ecosystem structure, composition and function are critical to effective management. To sustain natural areas, we need to ensure that ecosystem structure and composition are maintained - i.e., that the ecosystem continues to function effectively. If ecological functions are intact, ecosystem structure and composition are perpetuated. For this reason, we need to design conservation efforts that focus on *natural ecosystem processes*, rather than the ecological community itself. Using our wetland example, we want to ensure that the wetland persists, not just cattails. So what are these ecological processes, and how do we ensure that they are effectively managed?

Island biogeography theory as described by MacArthur and Wilson (1967) and subsequent authors is now widely used in designing protected areas networks. This includes examples similar to the Beaver Hills, where a network of protected lands lies within a more developed landscape (e.g., Banff and Jasper National Parks and the adjacent foothills). The theory explains how core protected areas, the islands surrounded by development, can effectively maintain ecological functions that act within and between them.

Eleven aspects of effective protected area network design have been identified based on this theory and are listed in Table 1. Qualitative examples of management effectiveness along a continuum of good to poor are also provided in the table.

Table 1. Aspects of Conservation Network Design (Primack 2002)

Conservation Aspect	Less Effective		Most Efffective
Proportion of ecosystem protected	Partial	← →	Entire
Protected area size	Small	← →	Large
Fragmentation	Fragmented	← →	Unfragmented
Number of protected areas	Few	← →	Many
Connectivity	Isolated	← →	Connected by corridors
Configuration of protected areas	Isolated	← →	Aligned in series (stepping stones)
Habitat diveristy (within and among protected areas)	Homogenous	← →	Heterogenous
Shape of protected area	Irregular	← →	Round
Variation in protected area size	Only large reserves	← →	Mix of small and large reserves
Managment regime	Reserved managed individually	← →	Reserves managed regionally
Integration with human activity	Humans excluded *	← →	Human use buffered

* Management designed to exclude humans is difficult to enforce and inappropriate use could result.

The Beaver Hills, in their current state, comprise a network of protected areas surrounded by buffer lands with various levels of human development. Outside the moraine is a second buffer area - a matrix of agricultural, industrial and urban land use. On the continuum scale in Table 1, the Beaver Hills would score mainly on the Most Effective management side.

- The area includes several core protected areas of various sizes, surrounded by less developed buffer lands and aligned in a series as stepping stones.
- Connectivity exists between core protected areas within the moraine and between the moraine and adjacent natural subregions.
- The moraine supports high biodiversity and habitat diversity.
- Protected areas are mainly large blocks with smooth edges and minimal fragmentation, rather than irregular shapes more susceptible to external disturbance.

The proposed regional management approach for the Beaver Hills would address the last two aspects of effective protected area network design: regional management of a protected area network and buffered human use around the protected areas. Buffering human use effectively means limiting the extent of fragmentation and human activity immediately adjacent protected areas. Ideally, land use in the buffer lands surrounding the various protected areas across the Beaver Hills would concentrate development in the outer buffer lands and be less intensive near the protected areas.

The Beaver Hills - A Unique Resource

Until now, the Beaver Hills have experienced limited development pressure because of their complex terrain and low agricultural potential. As the demand for recreational, urban and country residential and other land use grows, the Beaver Hills have come under increasing development pressure. Sustainable regional management of this area is the goal that gave rise to the Beaver Hills Initiative. The challenge now is to develop suitable management plans, beginning with establishing management goals for the area as a whole.

The Beaver Hills has many ecological, social and economic assets that could be the focus of management. With respect to ecological values, the area performs several critical ecological functions. The wetlands perform a critical role in regional hydrology. They are the key components of a complex system that collects and filters surface water, which in turn supports waterbodies and aquifers that extend beyond the Beaver Hills.

The extensive forests and wetlands scattered across the moraine provide habitat to a diverse group of plants and wildlife, including several rare species. As the largest relatively undeveloped natural area separating the northern boreal forests to the north from the Aspen Parkland in the south, it serves as an important corridor linking the adjacent natural regions. Connectivity and secure habitat with low levels of human activity will be critical for the current diversity of species, including rare species, to persist.

The Beaver Hills already have many of the key building blocks of a well-planned ecological network of conservation areas. Core protected areas are currently surrounded by more developed lands that form successive buffer zones with higher levels of development. Only regional land use guidelines to manage human use of those buffer lands remain to be completed for an effective ecological network plan.

Developing a regional approach to land use planning will require identification of management goals: first for the Beaver Hills as a unit, later, for the buffer lands within that unit. This document provided an overview of the key ecological features of the Beaver Hills, with the aim to support discussion regarding management goals for these resources. Management planning requires a focus in order to be effective. Developing consensus on the resources of the Beaver Hills most valued by land managers, councils and the public will facilitate the next step - developing specific land use policies to sustain those resources effectively.

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