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HABITAT INTEGRITY IN CANADA: WILDLIFE CONSERVATION

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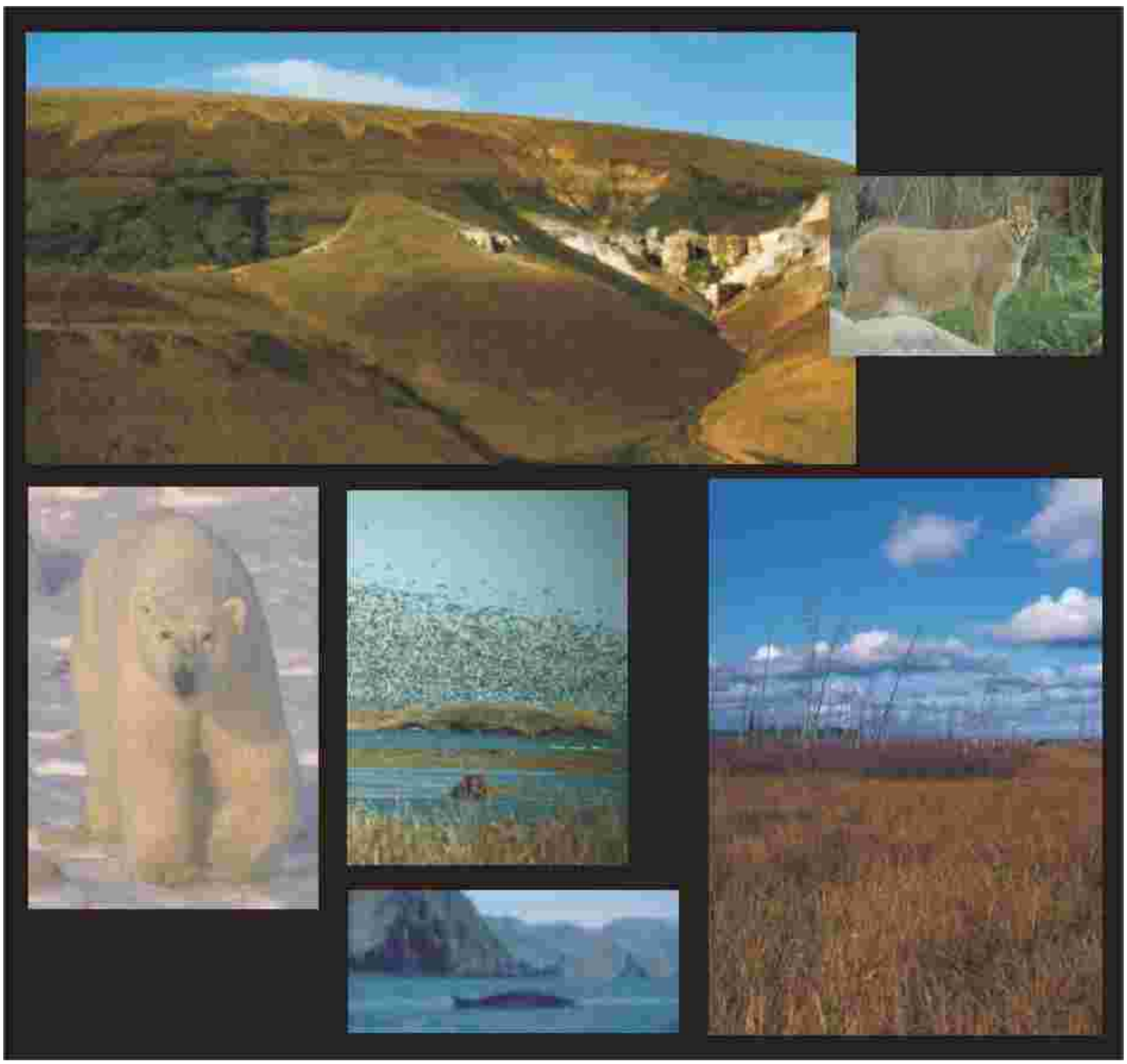

Habitat Integrity in Canada: Wildlife Conservation at the Crossroads

Reaching a Critical Point

Wildlife conservation in Canada has reached a crossroads. Difficult choices will have to be made, if future generations are going to enjoy the wildlife we take for granted today. For the past two centuries, Canadians have been preoccupied with conquering the southern parts of the country --- the grasslands, the forests and the seas. These were the frontiers along the southern band of Canada that had to be transformed into 'useful' working landscapes and seascapes. In this century, we are more concerned about the survival of spaceship Earth and the consequences of our past actions on the mosaic of terrestrial and marine ecosystems. Global crises such as biodiversity, the long-range transport of airborne pollutants, over harvesting of natural resources and climate change have changed the way we think. We can no longer afford to ignore the demands that humans place on nature. Dealing with these issues will require us to plan and act in terms of ecosystems and this is a radical departure from past practices. For wildlife, simply setting aside more protected areas or trying to save species-at-risk will not be enough. Protecting the habitat integrity of Canada's ecosystems will pose new and continuing challenges for policy and decision-making.

The Roots of the Conservation Ethic

By the dawn of the twentieth century, the frontiers across the United States and southern Canada were fast disappearing under the axe and the plow, and successive waves of human migration and settlement. When Theodore Roosevelt became President of the United States in 1901, he made resource conservation the cornerstone of his domestic policy. He called the North American Conservation Conference in 1909, which was attended by representatives of Canada and Mexico (and Newfoundland) that adopted a statement of principles calling upon each government to protect the natural sources of life and welfare. (CCC, 1910)

Canadian participation in Roosevelt's North American Conservation Conference led directly to the creation of the Canadian Commission of Conservation (1909) by Sir Wilfred Laurier. The Commission, an advisory body that was chaired by Sir Clifford Sifton until 1918, was comprised of the Ministers of the Interior, Agriculture, and Mines, and twenty appointed members. Provincial natural resource ministers were also ex-officio members. At least one of the members of the Conservation Commission from each province had to be a tenured university professor, if the province had a university. By the time the work of the Commission had ended in 1921, it had laid the foundation for twentieth century conservation, urban and regional planning in Canada. The multi-use sustained yield perspective of the Commission dominated Canadian thinking up until the Resources for Tomorrow Conference in 1961.

The Canadian Conservation Commission undertook a comprehensive and fairly accurate inventory of our natural resources (1910) and the completion of the map of Canada. The work of describing our commercial natural resources took over fifty years to complete.

The Commission supported the creation of a separate Dominion Parks Branch in 1911. Within parks and other reserves, it promoted practices such as fire suppression, the extermination of predators such as wolves, and the introduction of sports fish (put and take fisheries) for the pleasure of tourists. The Commission also helped establish the network of wildlife sanctuaries, forest reserves, and experimental farms that exists today. It was the first body in 1915 to propose the principle that each generation is entitled to the interest on our natural capital but the principal should be handed on unimpaired to future generations.

The most noteworthy legacy of the Conservation Commission was its lasting influence on wildlife conservation. At the time and settled regions, most migratory birds, large game animals and fur bearing animals were on the verge of extinction. The Commission succeeded in getting the commercial sale of game banned. The approach to wildlife conservation which Charles Gordon Hewitt (1921) outlined then, is still followed today:

> *A species of animal must not be destroyed at a rate greater than it can increase. Further preservation of any part of our native fauna depends upon the maintenance of sufficient of its normal range to permit unmolested feeding and breeding. In other words, killing for recreation or food must be wisely regulated, and the provision of refuges is indispensable (p. 19).*
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> *...Of such protective measures, by far the most important is the establishment of wildlife preserves, refuges or sanctuaries in which native mammals and birds are protected. Such wild-life reserves should include a sufficient area to provide ample summer and winter range for wildlife they intend to protect. They should be as a rule unsuitable for agricultural development. Nor should they include mining or other commercial properties that are likely to interfere with their purpose. So far as possible, the boundaries of such reserves should be well defined, and the necessary steps should be taken within the reserve areas the required protection to the wildlife they contain, and all protective measures should be rigidly enforced (p. 235).*

Unlike modern approaches to conservation, which concentrate on human threats to wildlife, Hewitt (1921) thought that any rational system of wildlife protection must take into account the control of predatory species of mammals and birds - wolves, eagles, falcons and hawks, and inferior species such as loons and kingfishers that feed on fish (p.193).

The 1930's Parks Act subsequently dedicated National Parks for the benefit, education, and enjoyment of the people of Canada and provided that such parks shall be maintained and made use so as to leave them unimpaired for future generations. It reinforced the notion of parks as game sanctuaries and recreational playgrounds. National Parks were promoted as world-class tourism destinations

The publication of Rachel Carson's book *Silent Spring* (1962) about the widespread effects of pesticides transformed public consciousness and inspired the modern environmental movement. Public concern grew about water and air pollution. Contamination of the food chain became identified as a public health issue because of the widespread dread of cancer. The first environment ministries were created and legislation passed in the 1970's to address these concerns about air and water quality. With the energy crisis, public attention shifted to the impact of resource depletion on our economic security and to the environmental impacts of mega-projects. More recently, global concerns such as the loss of biodiversity (charismatic mega-fauna) and implications of climate change for our future survival have come to dominate the public agenda.

Public awareness of these emerging environmental concerns has also led to a profound change in the policies and approaches governing protected natural areas. For example, the 1979 Parks Canada Policy stressed for the first time that the protection of ecological and historical integrity are Parks Canada's first considerations. The goal of the first National System Plan adopted at the time was to protect outstanding representative samples of Canada's landscape. Subsequent steps in the proposed planning process also required consideration of other factors, such as competing land and resource uses, and the impact of parks on the social and economic life of surrounding communities. The scope of system planning was later broadened to include marine protected areas. The 1988 amendments to the Parks Act (the first since the 1930's) formalised the requirement to protect ecological integrity in park zoning and visitor use management. Ecological integrity was defined as minimising human impact on the natural processes of ecological change. Similar measures to examine and foster the integrity of Migratory Bird Sanctuaries, National Wildlife Areas, and other wildlife areas have not yet been taken. A focused approach to planning and managing wildlife habitats needs to be developed.

Conservation and People at the Crossroads

Many ecologists argue that the continued growth in human population and consumption is incompatible with sustaining existing ecosystems and their parts/features, including the persistence of large predators, the continuation of the annual migration of birds and mammals, speciation of large organisms, and the protection and maintenance of native biota (Soulé, 1991). Current estimates of the world's population exceed six billion people. In the second half of the twentieth century, the world's population doubled. Never before has the world's population doubled in anyone's lifetime. In absolute terms, putting the first billion people on Earth took from the beginning of time to about 1830 and adding the last billion took about twelve years (Cohen, 1997; Keyfitz, 1988)

For most of human history until the agricultural revolution started about 10,000 years ago, humans were apparently about as rare or abundant as carnivores or omnivores of comparable weight. Cohen (1997) thinks that the allometric relationship between body size and population density could provide insight into whether the pre-agricultural population of 2-20 million people or the current population of 5-6 billion people is unusual. Generally the more a typical adult weighs, the fewer numbers of individuals per unit land area at any one time. Therefore, if humans took on the role of large tropical herbivores as the result of inventing agriculture, their global abundance should fall in the range from 91 million to 190 million.

For most of the 10,000-year history of settled agriculture, the environmental effects of land-use change have been scattered in time and space. According to Houghton (1994) half the world's croplands were added in the last 90 years, and the land used productively by humans today now comprises 32% of the earth's land surface. In the last century half the world's forests and wetlands were also lost in the quest for food, fuel, and fibre (Johnson 2001.) Soil erosion is now a common problem with soil losses exceeding soil formation rates by a factor of ten (Pimentel ed., 1993)

In the course of human history people have used about 7,000 plant species for food but they now rely on about 20 plant species for food, although at least 75,000 plant species have edible parts (Wilson, 1989). Just three plant species, rice, corn, and wheat, supply 60 % of the world's food supply (PCAST, 1998). FAO (1996) estimates that since the beginning of this century 75% of the worldwide genetic diversity of agricultural crops has been lost.

In 1982, the FAO assessed the capacity of 117 least developed countries to feed themselves based on the cultivation of all arable land. The FAO estimated the maximum population each country might support based on three levels of technology: a) subsistence or traditional farming, b) intermediate farming (some fertilizers, pesticides, improved seeds), and c) advanced farming (the most modern technology, e.g. Iowa corn farming). The FAO concluded that by the year 2000, 64 countries (29 of them in Africa) would be unable to feed themselves if they continued to use subsistence farming techniques. Of these countries, 36 would not be able to feed themselves with intermediate farming technology and 19 would not be able feed themselves even with advanced agricultural technology. As bleak as the FAO projections were, they may have been too optimistic (Pulliam & Haddad, 1994.)

Almost seventy percent of the world's commercial fisheries are fully or over-exploited or in a state of decline (Johnson, 2001; Vitousek et al., 1997; FAO, 1995). Pauly and others (1998) have described the impact of fishing pressure of this magnitude, as fishing down the food web because the average trophic level of the species caught in commercial fisheries has declined since 1950. We are not only unwittingly selecting for less desirable species of fish, but also the extensive introduction of hatchery reared fish has likely reduced the genetic variability and vitality of the remaining fish stocks. For example, over the last 60 years the average size of a Chinook salmon has declined by 50 percent and the average age at maturity has declined by about two years (Upton, 1992). Moreover, the fishing gear used in many cases is non-selective, resulting in very large by-catch, which must be discarded because of commercial considerations or legal constraints, and the gear also extensively damages fishery habitat (McAllister, 1995; Upton, 1992)

Since 1900, the world economy has expanded 20 times, the consumption of fossil fuels has grown by a factor of 300, and industrial production has increased by a factor of 50 (MacNeill, 1989). The global production of chemicals has increased from less than one million tonnes in 1930 to over 400 million tonnes today (CEC, 2000) The consumption of natural resources by modern industrial economies remains very high (WRI, 2000) - in the range of 45 to 85 metric tons per person annually when all materials (including soil erosion, mining wastes, and other ancillary materials) are counted. It currently requires about 300 kilos of natural resources to generate US$100 of income in the world's most advanced economies. Studies show in North America (Rachel, 1989) that only seven percent of industrial throughput winds up as product, that only 1.4 percent is still product after six months, and that per capita waste has doubled over the last generation.

The Biodiversity Crisis and the Habitat Crisis

The biodiversity crisis is really just issue in a chain of other concerns basic related to resource management and human activities. The principles about managing for the long term, for multiple interests and perspectives, within reasonable biophysical limits of ecosystems/the ecosphere, for productive and healthy ends, etc. are virtually the same as sustainable resource development, ecosystem management or sustainable living. Biodiversity issues and initiatives are also a more vogue ways to address the fundamental reliances that wildlife species (i.e. plants, animals, insects, fish) and indeed people have with habitats. Without habitat, there can be no wildlife (WHC, 2001); without habitats and wildlife, we would have no biodiversity.

Humans are withdrawing so much energy, water and resources, and discharging so much pollution and waste to many ecosystems that we have displaced or threaten the survival of other species, and adversely impacted their habitats. Since the 1960's there has been widespread public concern about the loss of charismatic mega fauna such as whales, dolphins, eagles, tigers, pandas, and primates. These creatures are often large, warm-blooded, aesthetically attractive, and regarded as having the capacity for feeling, thought, and pain (Kellert, 1986)

Perpetuation of diversity requires the maintenance of a more or less natural balance between predators, their prey, their food resources, and the land and water base. The over-harvesting or loss of species high in the food chain or the drastic alteration of habitats may trigger undesirable effects (i.e. population explosion of undesirable species). Similarly, harvesting or the loss of organisms low on the food chain may also cause collapse of valued species that consume them (Orians, 1990; Terborgh, 1989; Wilson 1987)

Although scientists and resource managers conceptualise biodiversity in terms of the three levels (i.e. genetics, species, and habitats/ecosystems) more attention has been paid to species loss. However, we do not know even to the nearest order of magnitude the number of species or organisms on earth (Wilson, 1989; May, 1988). Estimates range from 10 to 100 million. Approximately 1.4 million species of plants, animals and organisms have been given scientific names (Ehrlich and Wilson, 1991), and an overwhelming number of them are flowering plants (220,000 species) and insects (750,000 species.) Even the most recent IUCN (2000) global biodiversity estimate of 12.1 million species vastly exceeds its own update of the number (1.75 million) of species that have been identified and scientifically described thus far. Therefore most of the catastrophic extinction scenarios are based on numbers of species that no one has ever seen (Nelson & Serafin, 1992; Mann, 1991). About 11 thousand species of plants and animals are currently thought to be threatened with extinction (IUCN, 2000). About 12 % of the birds, 24% of the mammals, and 30% of the fishes are at risk (IUCN 2000.) Far more critical than known threatened species is our lack of knowledge, particularly of the world's oceans, where only about 15% of the marine species of plants, animals, and micro-organisms have been described (McAllister, 1998; WHC, 2001).

If 99% of all the species that have ever existed on earth are now extinct, then why is it so urgent that we reduce the numbers of species extinctions? The usual answer is that the accelerated rate and unprecedented scale of these extinctions is cause for concern (Norton & Ulanowicz, 1992). All estimates of current extinction rates are higher than the rates at which natural evolutionary processes compensate for losses. It has been claimed that current extinction rates are 40 to 400 times the last mass extinction, 10,000 times the extinction rate before the agricultural revolution, and 150,000 times the natural background rate of extinction (Ehrlich & Ehrlich, 1992). The most recent IUCN (2000) estimate of human induced extinctions is fifty times the natural rate of extinction.

Around 71,000 species of wild animals and plants have been recorded in Canada, and scientists think another 68,000 species have yet to be discovered and classified (EC, 2000; Mosquin et al. 1995; EC, 1996). We understand the ecological function, status, trends and survival needs of less than 3 percent of the recorded species (EC, 2000) In Canada, 49 (25%) of 193 known mammal species, and 47 (11%) of 426 known bird species are thought to be at risk (EC, 2001). Less than five percent of terrestrial and freshwater species are endemic to Canada because most species had to re-establish themselves here following the last great period of glaciation (McAllister, 2000).

Conserving biodiversity, even in protected areas, is going to be an intractable policy problem. The causes of losses affecting genetic, species and habitats/ecosystems are extremely diffuse. The root causes are population growth, and consumption, and the scale of industrial production and monoculture. The proximate causes are habitat loss and fragmentation, overexploitation, introduction of exotic species and diseases, pollution and climate change (Soulé, 1991). The thresholds at which many critical habitat functions and processes begin to breakdown, and the magnitude of the downward spiral are unknown. These losses may not be reversible. We cannot be sure whether or not our corrective actions will make a difference or be a timely difference. Consider mitigation measures for climate change. The benefits of our actions may not be apparent for generations if not centuries. Most of all, there is a lack of consensus about goals, priorities, and the means by which we can conserve habitats and biodiversity in general.

The Path Forward on Habitat Protection

What is the best way to save and protect wildlife and habitat diversity? The current adage is to save the places of greatest diversity. Some place-based suggestions include:

- the specialised niches of endemic species;
- hotspots with rich habitats and species;
- the habitats of keystone or umbrella species;
- habitats-at-risk; and
- ecosystem management.

Endemic species are rare because they have a low adult survival rate and limited range or specialised niche. Although endemic species are more vulnerable to extinction (Pimm, 1997), the strategy of trying to save endemic taxa is like saving living fossils, scientific curiosities unlikely to help protect the evolutionary processes or environmental systems that will generate future biodiversity (Erwin, 1991). Loss of the largest, most abundant or faster growing species is likely to have a bigger impact than loss of rare or endangered species. Remove those species that are hogging the resources, and other species may increase their resource use, minimizing the net functional impact of the species loss (Baskin, 1994)

Another approach has been to try to save the **hotspots**, areas rich in habitats and species. These systems have been thought to be resilient to change, and have often been managed for relatively stable states (Poiani et al, 2000; Chapin, 1998). However, many systems need periods of instability to maintain natural biodiversity (Lemons, 1995). Areas rich in species may not provide adequate habitats for larger vertebrates and some long-lived plant species (Lemons, 1995).

It is also widely believed that by protecting the habitat of the **largest, longest-living or dominant species** that other species will be protected (Lister & Kay, 2000). For example, an area designed to protect large carnivores, with large and diverse habitat requirements, may also maintain prey populations, small carnivores, and the majority of native plants and animals. However, populations of different species fluctuate in complicated ways. In shifting the focus of conservation efforts from single species to guilds or keystone species, we still cannot be sure that all the needs of the desired species will be met because the habitat requirements of different species rarely coincide. As well, the minimum viable population size needed for different species to survive natural stochastic and human-induced events varies considerably. Some would argue that it would be a serious mistake to conserve only the species we perceive to be critical because we are ignorant of the role or existence of most species, while others would argue that many species are more or less redundant (Simberloff, 1998).

Protecting **habitats at risk** is a reactionary mode of conservation. It is most crucial in areas where conservation has been neglected owing to other important lands uses. In some, it represents adaptive management in a broad context as this stage of should be prevented from happenings by proper planning. Conserving biodiversity at the habitat and ecosystem levels means setting whole landscapes and seascapes aside, and protecting their inherent biophysical structure and their characteristic energy flow and nutrient cycling patterns (Lemons, 1995). With the exception of naturally species-poor environments such as boreal forests, where species loss could erase entire functional groups, the diversity of landscapes is more likely to be damaged by land conversion than the extinction of species (Baskin, 1994). If an ecosystem is protected adequately then the assumption is that all of its resident species will also be protected. Therefore, the best way to minimise species loss may be to maintain an ecosystem's functioning (Walker, 1995). Soulé (1996) argues that what's wrong with maintaining or restoring ecological processes is they are generic and can be performed by weedy species. An ecosystem-based strategy may also not precise enough to ensure the survival of endemic species. However, this strategy avoids the destruction of biological assets whose value may not yet be fully understood but which some day may be appreciated.

It has also become a widely held tenet of conservation that biodiversity is crucial to the maintenance of earth's life-support systems and a hedge against catastrophe: as we loose species, we also alter the integrity of processes that maintain soil fertility and water quality, provide natural checks on pest outbreaks, convert carbon dioxide into plant tissue, and support the complex food webs upon which we and other creatures depend (Baskin, 1994). The species that have the biggest impact on function are likely to be the ones that change the amount of water or nutrients available to a community or the frequency of fire, disease or other major disturbances.

The redundancy hypothesis suggests that the highest conservation priority be given to functional groups of species where there is little or no redundancy because redundancy is thought to contribute to an ecosystem's resilience to change (Ehrlich & Walker, 1998; Walker, 1995, 1992). Risser (1995) also argues changes at regional spatial scales from a hundred metres to a hundred kilometres, and at time scales of years to decades, are most likely to drive the relationship between biodiversity and ecosystem function. Goldstein (1999) criticizes this conservation strategy for its failure to provide a consistent criterion for identifying important ecosystem functions or processes, and its failure to link them to the life history requirements of species.

Ecosystem management is a more holistic approach that provides avenues to deal with natural through to modified ecosystems. We often view ecosystems in the context of natural areas or of the world that includes everything except us. Those views are not entirely helpful on their own today. The world consists of natural through to heavily altered ecosystems and that is what has to be dealt with. An ecosystem is better to be thought of as an interacting biophysical system consisting of plants, animals, micro-organisms and people, and of soils, water, rocks, and climate. The degree to which more natural or human modified systems exist various from place to place. Some think of ecosystems one of the building blocks of the earth's surface while others think of it simply as a practical way of looking at the world. Over time, the concept has and will evolve. The challenge will be to develop a conservation strategy that recognises that resources like habitats should be managed as dynamic integrative ecosystems because the physical and biological components and processes are cross-dependent (Wiken and Gauthier, 1998a).

A diversity of points of view and controversy characterise ecosystem management, not so much because of the principles upon which it is based but more so the stage of the science and supporting structures such as monitoring, research and analysis. Some scientists are preoccupied with the distribution and abundance of species. They look at ecosystems as patch works of just living biological communities. Others focus on the ecological processes, structures and components that are necessary to sustain life. They look at ecosystems from a broader landscape and seascape perspectives (Wiken, 1996). Underlying these differences in points of view is the claim by some that evolution and natural selection operates exclusively at the level of the individual organism (Williams, 1966) and therefore conservation plans should be tailored to the life history requirements of species (Goldstein, 1999).

Another issue, which divides scientists, is whether the whole ecosystem is greater than the sum of its parts, and has emergent properties, such as resilience, that can be used to describe its behaviour (Holling, 1973). Trying to maintain the stability of an identified sensitive area, for example, is inappropriate if we view living systems as going through inter-related cycles of growth decline and renewal. Some say that the magnitude and effects of change in dynamic open systems are not predictable: they are the result of the cumulative interaction of small changes that have accumulated, and the pathways followed are an accident of circumstance (Kay, 1991). Critical mechanisms of ecological change are often unknown to science: we either lack signals or the ability to read them. Ecosystem processes also operate either too quickly or too slowly or at scales that are difficult for humans to observe. Moreover, lagged effects are common, meaning that some problems will continue to get worse even after action is taken.

Ecosystem management suffers from the same shortcoming as modern economics. Environmental concerns are often not part of the calculus of economics because economists treat the environment largely as an externality. Ecology for too long has treated humankind as an externality, even though humans and human activities have become a cornerstone in the evolution practically every ecosystem. Even with wildlife-protected areas, we similarly try to treat the surrounding land uses (i.e. agriculture, forestry, mining) as an externality. We can no longer afford to ignore the contribution of humans to local or global habitat change, or to overlook the contributions of modern science and technology (Cinq-Mars and Wiken, 2002).

Habitat Integrity

The concepts behind individual terms like integrity, sustainable development and biodiversity varies. This is not so much because people disagree with the definitions for each of them. It is more because of the interests in having each term interpreted properly for specific circumstances, conditions and places. For example, the issues behind sustainable development in Germany are related but quite different from those in Canada. The history, cultures, stages of resource development, human activities, types of resources, existing acts and policies, etc. all serve to create different priorities, goals and pathways for achieving sustainable development. Germany, for instance, has an extensively modified landscape with very few natural areas whereas Canada has large areas of wilderness and far fewer extensively altered landscapes.

The notion of wildlife habitat integrity could refer to the conditions that exist in nature through to those that exist in heavily modified areas. In the context of nature, it basically refers to *the wholeness of a setting* and, in particular, the wholeness in reference to the natural conditions that sustain inherent wildlife populations and species.

> *Habitat integrity can be more explicitly defined as the system's capacity to sustain native biological and physical properties that have adapted to an area through natural events and processes.*

A very related term 'ecological integrity' (Woodley et al. eds., 1993) has been widely examined in Parks Canada. The concept is a useful way to assess the park's objectives that concern preserving representative ecosystems according to the national parks' framework of natural land and ocean regions.

However, how does integrity get interpreted for various species, conditions and habitat types? What are some of the questions that confront resource managers, policy makers and scientists? The frame of reference for habitat integrity must be derived from both scientific and technical judgments by experts and resource managers as well as by the inherent nature of Canada's habitats and species. Questions of habitat integrity are usually fall into two categories of concern:

1. Firstly, there are questions about how to manage a particular space or a linked series of spaces to sustain habitats and their wildlife.
2. Secondly, there are broader concerns about having a process with the right tools and instruments to improve our abilities to judge and foster integrity objectives.

a) Managing the Integrity of Spaces

Habitats are the spaces that provide the life support systems for wildlife. In Canada, the habitats in the northern latitudes can be relatively pristine and expansive. Human population levels and activities there have been quite limited. In contrast, the habitats in the southern latitudes are largely modified by a long history of agricultural and forestry operations, and human settlement activities. The natural areas that remain are largely remnants.

What are some of the practical considerations in dealing with habitat integrity? In the more northern latitudes of Canada (both land and ocean), planning and assessing habitat integrity can begin largely with natural conditions. The preference for natural over artificially cultured characteristics is based on the belief that the valued attributes of ecosystems as homes for wildlife derive from the natural evolution, and cannot be manufactured or replaced by technology (Angermeir, 2000). Benchmarks for assessing naturalness ideally reflect conditions free of most human influence (Anderson, 1991).

The more modified areas in Canada are associated with the agricultural zones and the commercial forest zones. The integrity of these areas, particularly the agricultural areas, have be been jeopardized severely related to conserving natural features (species, habitats, ecosystems). Conserving the integrity of what remains depends largely on the implementation of progress strategies such as the Prairie Conservation Action Plans and the National Forest Strategy (WHC, 2001). Often the knowledge base that exists on habitat and species prevents many from taking full advantage of strategies like these two.

The integrity of habitats for one species may depend on a series of places very distant from each other and on the corridors that facilitate species to move from one location to another. The grey whales in British Columbia, summer and feed in the Bering Straits off of the Alaskan coasts and migrate to the Gulf of California in Mexico to winter and calf. The Hudson Snipe travels from its summering areas in the Hudson's Bay and fly to wintering areas in southern Argentina. Habitat integrity here is a much bigger problem that involves the practices and governing mechanisms between different countries and continents. If one country fails to protect the habitats and pathways for a species, then integrity is lost.

b) Habitat Size

The largest wildlife are in Canada is the Queen Maud Gulf Bird Sanctuary (i.e. 6 278 200 hectares) and the smallest site (i.e. 0.08 hectares) is in British Columbia (Wiken et al, 1998a). As rule of thumb, the larger the area is, the greater the chance is in maintaining habitat integrity. For many species in the Queen Maud Gulf area this large expanse of territory is good. For several migratory birds, the conservation area provides protection in the summer period when the birds nest and rear their young. For other non-bird species like the muskoxen, the nature of the legislation behind Migratory Bird Sanctuaries is not that helpful. With e barren ground caribou such as the Beverly and Qamanirjuaq Caribou herd, an area like Queen Maud Gulf MBS would be too small. This caribou herd would need large areas of tundra in the Keewatin protected in the summer as well as large taiga areas in northern Manitoba and Saskatchewan.

Of Canada's protected area network, there are only about 750 of these sites that exceed 1 000 hectares. The thousands of other sites that exist are considered to be too small to maintain much to their inherent habitat integrity. They require special attention in land use planning to take advantage of conservation stewardship initiatives that may be available in the areas surrounding and connecting these small-protected areas.

Initiatives like the Baja to Beaufort, Adirondacks to Algonquin and Yellowstone to Yukon are examples of initiatives that are trying to link protected areas of various sizes. In the USA, Canada and Mexico, protected areas have often gotten engulfed by forest, urban and agricultural land uses to the point that it is adversely affecting the wider ranging wildlife species. To avoid further damage, initiatives have been undertaken to build habitat conservation linkages with land owners and managers surrounding key protected areas.

c) Habitat Fragmentation

Fragmentation is an issue in the agricultural and commercial forest landscapes that occupy the southern margins of Canada. Fragmentation is almost a synonym for land use conversion where natural areas get transforms to meet other resource needs such as food production and tree harvesting. The usual way to determine fragmentation is in analysing patch size and distribution. Patches are commonly coded according to land cover types. Another form of fragmentation is one based on land ownership (federal land, private land, provincial lands,) or other items such as land covenants.

The meaning behind patch size, type and distribution depends very much of the kind of wildlife species or habitat types you are trying to protect. Many of the crucial integrity parameters are not well known and attempts to use fragmentation analysis are often encumbered.

d) Time

What time period should be used for determining an integrity benchmark for natural conditions? Habitats have been changing since glacial times and will continue to change into the future especially considering the impacts of climate change. The typical reference period chosen for the western hemisphere often predates European settlement (Mosquin, 2000).

What of seasonal time periods? Various migratory species such as gray whales, Canadian geese, barren ground caribou and Monarch butterflies, have habitat requirements that are seasonal (i.e. summer and winter ranges; calving and nesting grounds). The quality and quantity of habitats throughout the year become a question in integrity assessments.

e) Habitat Variation

Habitats go through various stages of development. Forests and grasslands for example burn and then go through various successional stages of development to reach a mature stage of development and at times into ‘old growth” stages such as in forests. The integrity of the habitat needs to be judged on the expected degree of variation and not some particular stage. This range of variation is natural. Sometimes conservation efforts may get too devoted to preserving a particular stage and thus go against the natural

A habitat with integrity can adjust to natural disturbances without human intervention (Karr, 1990). Conservation of habitat integrity includes representation of ecosystems across natural ranges of variation; protection of total native diversity (species, populations), and the ecological patterns and processes that maintain that diversity;

maintenance of natural disturbance regimes; conservation of viable populations of native species, and reintroduction of native, extirpated species (Grumbine, 1994).

f) Habitat Qualities

Implicit in understanding habitats quality is the notion of understanding the ecosystems of which they are a part. Canada is fortunate in having a national ecosystem framework from it can begin to think of things in ecosystem management terms (Wiken et al 1996). But how and why are ecosystems changing? This is another aspect of habitat quality that needs to be evaluated through monitoring systems. Most of the current and formal systems are quite inadequate in monitoring anything in an ecosystem context (Wiken and Gauthier, 1998). There are few long term records, few monitoring sites that are cross linked, more physical information then biological, still poorly linked information from separate networks, poor coverage in northern and higher elevation in Canada. Al of this makes it tasking to develop a long term, ecosystem view that would address multiple interests in resource conservation.

'Citizen science' programs that consist largely of volunteer workers are complementing more of the traditional monitoring programs. They conduct monitoring programs at mainly the local and regional levels such as the Beach Watch Program, Frog Watch Program, Ice Watch Program and many others but also contribute to national perspectives as through the Breeding Bird Survey (personal communications with Julie Simard). These programs are very effective in engaging and informing the public of trends and baseline statistics on simpler items. Why the work has commonly lacked the desired scientific rigor of traditional programs, they are very significant observations and recent improvements in observation and sampling protocols are contributing to augmenting the technical content.

g) Habitat Insufficiency

How much habitat is enough? When do we reach a stage of critical insufficiency with habitat types? Habitats are designed to meet wildlife needs. In a general way, the wildlife species goal is to have sufficient types and populations across their native range in Canada. For the more popular or hunted species, the population data is moderate to good. There are many species in Canada that are not well understood or even catalogued/documented properly. For most of these species, the population data and trend data is poor, or not available. From a practical standpoint, it would not even be feasible to fully track and understand all of the country's species.

The more pragmatic approach in general is to conserve and manage the different habitat types as a means to foster the integrity of the nation's inherent wildlife species. Using the national ecosystem classification, for example, we known that at the regional level we have about 220 different terrestrial habitats types and these are linked in are more general/national overview way to the 15 broader habitat types (i.e. ecozones). In the marine areas of Canada, there are parallel divisions. At various levels of planning (i.e. national, provincial, regional,) and habitat/ecosystem definition (i.e. ecozones, ecoprovinces, ecoregions,), we have a reasonable amount of information of the types of habitats but we are not that well positioned yet to know how much of a given habitat type is it critical to have and what are the ecological determinants that would indicate whether you have been successful or not. How much of the existing moose habitat in Canada could we loose before we reach a critical point? Simply loosing species numbers or habitat quantity is not the central questions but rather it how much is required to maintained critical and sustaining thresholds for habitats and species. From an ecosystem perspective, there may be sufficiency questions but they may also arise from provincial and territorial management perspectives.

Beyond issues of ‘quantity’, there are direct and indirect ecological considerations for habitat sufficiency. The areas which may be immediately used by moose fore example can be demarcated and managed through various mechanisms from conservation areas through to land stewardship. However, habitats are sustained by many hidden ecological processes and connections that appear seem to be indirectly linked. Wetlands are sustained, for example, by subsurface water flows, by upstream and perhaps quite distant drainage systems, by how water quality and quantity gets affected by surrounding or distant land use activities (i.e. farming, logging,), by the long distant transport of airborne pollutants from other countries/places, etc. The integrity provided to habitats will often require managers and conservationist to look at the immediate habitat setting and requirements for a species (or a group of related species) and then look at the broader landscape and seascape. Various scales and considerations typically come into play when habitats are fully assessed.

Items ‘a’ to ‘g’ are just a number of factors. In sum, habitat integrity encompasses the biophysical composition and structure (measured in terms of an inventory of items) and ecological processes (measured as rates of change and connections) over multiple levels of generalizations. It is assessed in comparison with naturally evolved conditions in a region (Angermeir & Karr, 1994). For example, habitat integrity can be measured in comparison to the historic variety and numbers of native species and habitats (Callicott et al., 1998) and by how well habitats maintain their ecological functions and processes following natural disturbances (Covich et al., 1995).

The goal of conserving habitat integrity is best addressed by maintaining or restoring the diversity of genes, species, communities, and other biophysical elements native to the region. It is a simple strategy consistent with the vision of integrity, which is wholeness. If parts are missing, the habitat is not whole. This definition also justifies active management. It does not mean managing for a steady state or trying to turn back the clock. By managing for historic ranges of variation, processes that may take the ecosystem into the future will also be conserved. It also implies thresholds below which some kinds of human use are compatible and appropriate, and above which conservation agencies could just say no.

The Future of Wildlife Protected Areas

There are about 19 000 protected areas in Canada. About 4 100 protected areas are held by agencies in the federal, provincial and territorial governments. Found throughout Canada, these government sites amount to 99 percent of the area held as protected areas, which is currently near 895 500 square kilometres or 9 percent on the land base and less then 0.1 percent of the ocean base. The non-government sites are more numerous but consist largely of very small sites and sites in the southern margins of the country. There are about 92 different types of protected area designations in the country and this is a reflection of the range of interests and clients. In a very generic way and by their name (not by management focus, by conservation objectives), about53 percent are labelled as parks, 38 percent as wildlife areas, 6 percent as wilderness and 3 percent as others. Some of the earliest efforts to protected areas on Canada's landscapes started in the late 1800s and the earliest efforts to protect areas in Canada's seascapes were initiated around 1919.

Existing protected areas are a reflection of their history and in some ways a prisoner of their past. Often, they have been created through an opportunistic process, being driven by values, whims and tastes of over a century of time. For current interests of wildlife habitat protection and integrity or biodiversity conservation, these facets history in the development of protected areas are useful in showing how past efforts do not necessarily support new goals. Outstanding areas of scenic beauty, for example, do not necessarily include within their boundaries the habitats that are necessary to sustain the native species typical of the area, or do they exclude harmful influences threatening the existence of these species. Even when a protected area is specifically created for wildlife purposes, there are many false assumptions about the boundaries. The view of wildlife areas as fortresses that sequester natural habitats and somehow wall out unwanted changes from neighbouring or even distant places is not realistic. The challenge for practical habitat conservation calls for a coordinated or integrated set of public and private conservation programs (Nelson, 1991).

Strict conservation and protection objectives are not the sole objectives of protected areas such as migratory bird sanctuaries and parks, or in related designations like biosphere reserves and Ramsar sites. Many sites encourage tourists, act as recreation facilities, involve forest and agricultural activities, and may contain small to large human settlements. The Last Mountain Lake National Wildlife Area in Saskatchewan, for example, using controlled cattle grazing as a means to mange the grasslands and to mimic the effects of buffalo grazing. Dealing with a plurality of values, interests and expectations is inevitable in planning and managing protected areas (Nelson & Serafin, 1992). Following in the footsteps of people like Pinchot and Muir (Norton, 1995), we will find it increasingly difficult to find common ground between advocates of wise use, and those who would lock up nature and exclude humans.

The section in the first National State of the Environment Reports (Environment Canada, 1991 and 1996) concerning protected areas, and the State of the Parks Report (1997) showed that Canadian protected areas were undergoing profound changes. The authors attributed changes in habitats and species composition within established protected areas to many factors such as their proximity to settled areas, accessibility by roads and trails, wilderness fragmentation, uncontrolled and overuse by people, fire suppression, invasion by exotic species, and air and water pollution nearby or distant sources.

The function of having various types of protected areas differs. The differences call for the use of different designs or systems. A park that is designed to achieve regional ecosystem representativity can virtually be a standalone area. Wildlife protected areas often have to be designed to account for the migratory pathways of species and the need to have seasonal habitats. Elements like this could require linking protected wildlife areas from a regional through to a continental scale.

Much attention in respect to protected areas is still currently focussed on completing various systems of protected areas by acquiring remnant or large intact wilderness areas. Canada has been far more successful in protecting parts of the landscape then it has in regards to the seascapes. Efforts to acquire and expand the system of wildlife protected areas have gotten out of sync with the capabilities to mange these areas for their intended purposes.

The real new challenge wildlife agencies now face is to conserve the habitat integrity of protected areas. Although we are beginning to be able to describe the relationship among selected species and their habitats, the more encompassing aspects of wildlife and habitat managements are still poorly understood. This will involved the development of a more inclusive view of species and spaces, and a far more fundamental understanding of the ecological processes, dynamics and elements that sustain them. Moreover, this view of habitat integrity through a lens of protected areas cannot be maintained in isolation from regional planning and decision-making processes (CCEA, 1991.) For example:

> What does it mean to protect and maintain biodiversity in protected areas? Does it mean following the wilderness philosophy in which a conservation area in a landscape or ecosystem is largely left alone to evolve in a natural manner, largely devoid of human influence? Does it mean removing people without assessing the effects of their activities on the biophysical characteristics of the area? Or does it mean more active management or intervention through controlled burning, culling of animals or other programs intended to protect and enhance biodiversity and other objectives? If it means the latter, how will biodiversity be defined and by whom? And what is to be done, if the various definitions that are offered prove to be incompatible. (after Nelson & Serafin, 1992 p. 216)

Building a New Consensus

While the language of ‘wildlife’ has captured the popular imagination, it has failed to become the language of public policy. Ecologists and resource managers do not share a common view of the functioning of nature of wildlife habitats and the role of humans in it. Their lack of influence on public policy can be traced to the lack of a common policy goal, of shared decision-making criteria, of a consensual knowledge base, and of shared beliefs about the driving forces of change.

A new conservation ethic is needed for the 21st Century. Habitat integrity is a goal or value. It is a metaphor rather than a scientific concept. Values guide our choices and actions. Real world science helps people make choices. Science and economics can tell us what is feasible and affordable but not what is moral, desirable is or just (Salwasser, 1994). Science contributes to public policy by shaping the perception of the problem, helping people to understand its origins, and helping them to evaluate their options (Ehrlich & Daily, 1993). Habitat scientists and managers will need to reconsider their role in shaping public values and priorities for ecosystems (Yafee, 1998; Lackey, 1995).

There is no consensus among scientists about the desired or preferred conditions they are trying to achieve (Lackey, 1997). For example, scientists realise the value of protecting all levels of biodiversity but it is still not clear what the goal should be - protecting a representative samples of habitat types; the most diverse habitats; or the rarest (Reid, 1999). Habitat integrity must be operationally defined before we can assess alternative conservation strategies or learn from future conservation efforts.

A common conceptual framework is needed to facilitate collaboration and risk communication. There is no generally accepted classification of valued habitat or ecological components, processes or attributes (U. S. EPA, 1994). These are characteristics of habitats and ecosystems that are considered by society to be important and potentially at risk from human activities or natural hazards (U. S. EPA, 1992; Beanlands and Duinker, 1983).

Concerns about valued habitat/ecosystem components, processes or attributes drive environmental decision- making. Generally speaking, habitat/ecosystem concerns do not tend to be highly valued in relation to other life domains or core values. Ecosystem concerns only engage us when more fundamental life domains or core values are threatened: our health and well-being; our standard of living; our way of life; our fundamental understanding and expectations of the world around us (Eyles, 1990).

If the vision of maintaining and restoring the habitat integrity of protected areas is going to be realised, thinking and acting in terms of ecosystems will have to become a more broadly accepted intellectual perspective in conservation. A paradigm defines the conduct of inquiry in a given domain. Paradigms shape how people perceive problems, and filter and evaluate evidence. They also define important working hypotheses. Paradigms also serve ideological functions because, as beliefs about what the world is like, they are used to legitimise or justify courses of action.

Habitat Integrity Agenda

A habitat integrity agenda for the new century should have at least four fundamental objectives:

$ representing the natural range of variation in habitats in a system of wildlife based protected areas;
$ sustaining viable populations of native flora and fauna in natural patterns of abundance and distribution;
$ maintaining natural habitat functions, structures and processes through ecosystem management; and
$ planning and managing important habitats in the context of the broader dynamics and character of the existing landscapes/seascapes.

This agenda unites the competing perspectives of different disciplines. For example, conservation biologists are more likely to focus on species survival, including gene pool and related habitat considerations. Landscape ecologists, on the other hand, will focus on mapping large landscape units, understanding their processes and structures, and managing the stresses that affect them. This agenda also recognises the importance of biotic and abiotic factors, and their cross dependencies. It incorporates all levels of biological organisation, implicitly recognising that many issues may have to be dealt with within different temporal and spatial frameworks (Norton and Ulanowicz, 1992; O'Neill et al., 1986).

The greatest barrier we face in advancing a conservation agenda in Canada is knowledge. Unlike our economic resources that were inventoried and mapped a long time ago, we are virtually ignorant of the nation's habitat and ecosystem diversity. We know more about the Canadian landscapes but far less about marine systems. Canada has the longest coastline in the world and the work of describing the marine ecosystems that lie off our shores within the 200 nautical mile limits has just begun. The extent of our ignorance ranges from the lack of an inventory of the nation's habitat and ecosystem diversity to a lack of understanding of how ecosystems truly function and work. Moreover, our capacity to monitor habitat quality and assess habitat trends is limited to nonexistent.

Many of our assumptions about habitat change need to be reconsidered. The weight of evidence overwhelmingly suggests that any single agent of change cannot explain the loss of habitat integrity and diversity. If we believe the crisis rhetoric, efforts to set aside more areas for nature, and to protect habitats and species-at-risk will be overwhelmed by human settlement patterns, energy and resource demands, and pollution. Therefore, a conservation agenda must recognise that human activity is now the driving force of habitat change.

We cannot turn back the clock and we cannot fully anticipate the future. There are no longer any habitats that are unaffected by human activities to some degree. We suffer from what Reichman and Pulliam (1996) have called the last pioneer syndrome- each generation accepts the world as it is when they arrive, including the built environment, but is intolerant of any substantial changes during its life-span. Returning regional habitats and ecosystems to pre-settlement conditions is not a realistic goal. Nor is it realistic to expect that we will be able to reduce human population growth and consumption to the levels that existed prior to the agricultural revolution. Ultimately, the success of our conservation efforts will be judged by the continued survival and the adaptation of people and other living things to change. In the meanwhile, unnecessarily destructive and wasteful resource harvesting, extraction and land-use practises, especially where they threaten un-protected and protected wildlife areas, have to receive considerably more attention in a renewed conservation agenda.

Habitat integrity is nature's way of allowing a variety of living and non-living things to survive and evolve in different places. Current environmental policy is based on the notion that it is feasible to trade off an ecosystem's productivity against its diversity or capacity to buffer the harmful effects of change. Attempts to manage habitat and ecological variables that normally fluctuate has led to the creation of spatially homogeneous ecosystems over landscape scales that are more likely to suffer catastrophic declines, brought on by disturbances that could previously be absorbed (Walters 1986; Holling 1978.) In today's global economy, natural systems are under assault and are breaking down. The strength of interactions within an ecosystem must differ by orders of magnitude from interactions with the rest of the ecosphere, for the system to be able to shelter and nurture biodiversity (O'Neill et al., 2000). Moreover, if anything remotely resembling the sustainable development scenarios envisioned by Bruntland Commission (WCED, 1987) were realised, most of the world's biodiversity seems destined to disappear (Ehrlich & Wilson, 1991).

The success of any policy or action agenda depends on public support. An wildlife and habitat literate public is capable of understanding the contribution that natural ecosystems make to their well-being, and that, without the conservation of vital living resources, their future is at risk. Therefore, it is important that habitat specialist and conservationists enter these policy debates, and educate the public about the consequences of failing to protect the habitat integrity of natural as well as modified areas.

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