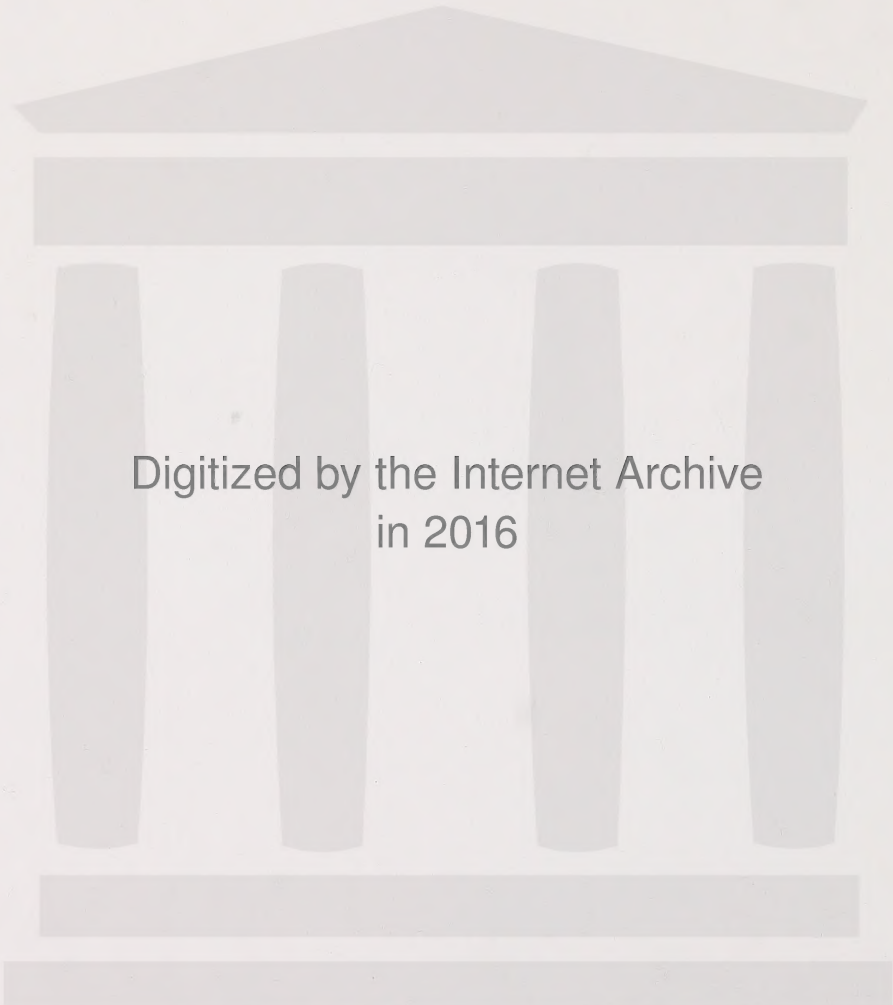
Saving the Strands of Life

Alberta's Biodiversity

A Discussion Paper Prepared for the
Alberta Conservation Strategy Project



Saving the Strands of Life

Alberta's Biodiversity

Prepared by

Maryhelen Posey

Published by

Environment Council of Alberta

February 1992

Alberta
ENVIRONMENT COUNCIL OF ALBERTA

Distributed without charge as a public service.

Original printed on recycled paper

Additional copies of this publication may be obtained from:

Environment Council of Alberta
4th Floor, 9925 —109 Street
Edmonton, Alberta
T5K 2J8

Phone (403) 427-5792
Fax (403) 427-0388

This report may be cited as:

Posey, M. 1992. *Saving the Strands of Life: Alberta's Biodiversity*. Edmonton: Environment Council of Alberta. ECA92-PA/CS-S18.

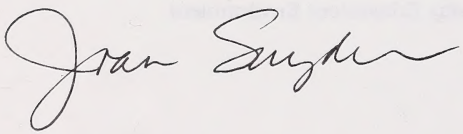
ECA92-PA/CS-S18

FOREWORD

In late 1985, the Public Advisory Committees to the Environment Council of Alberta began working toward a draft conservation strategy for Alberta. The Public Advisory Committees (PACs), comprising representatives of some 120 nongovernment organizations, are in many ways an ideal organization for developing a strategy that should touch the lives of all Albertans. The PACs bring together many diverse viewpoints. We are nonpartisan, and we have members from across the province. Since the early days of the project, we have welcomed non-PAC participants, and have been delighted to receive the contributions of civil servants, industry spokespeople, academics, and the general public.

We have made much progress since 1985: the *Prospectus for an Alberta Conservation Strategy* was published in 1987; many meetings and workshops have been held; in 1990 the *Alberta Conservation Strategy — Framework for Action* and the *Framework in Brief* were published; and with this publication; 18 sectoral discussion papers have been released. These documents have been presented, for consideration, to the Alberta Round Table on Environment and Economy which is charged with preparing a sustainable development strategy for Alberta.

Because there are as many opinions on our best future direction as there are Albertans, we welcome comments. Alberta's strategy will be only as good as the work that goes into preparing it. Please send any comments on this discussion paper or others in the series, or the *Framework for Action*, to the Environment Council of Alberta at the address given on the copyright page. I would also encourage you to make your opinions known at public hearings, consultations, or other events which relate to sustainable use of our resources. Let's treat Alberta as if we plan to stay!



Joan Snyder
Chairperson
Conservation Strategy Steering Committee
Public Advisory Committees to the Environment Council of Alberta

ABOUT THIS DISCUSSION PAPER

Biological diversity is a relatively new term, or concept, which defines and encompasses a natural phenomenon that has existed since creation. *Saving the Strands of Life* defines the concept of biological diversity and focuses on the importance of maintaining a broad, diverse spectrum of this resource. With the information contained in this report, decision makers will be better able to include biodiversity in public discussions of environmental issues.

ACKNOWLEDGEMENTS

Several people contributed to the development of this paper and far more to reviewing it. The list that follows is by no means complete; whether from shyness or modesty, some of our contributors remain anonymous.

Special thanks go to Peter Achuff, Per Andersen, Charles Bird, Brian Braidwood, Judd Bunnage, Sheri Dalton, Dorothy Dickson, Bert Finnamore, Val Geist, Jim Helm, Shirley Henderson, Robert Holmberg, Geoff Holroyd, Peter Karsten, Dan McIsaac, Stan Navratil, Wayne Nordstrom, Miles Scott-Brown, Pat Seymour, Phil Stepney, Robyn Usher, Jan Weijer, Karen Wheeler.

Members of the former Renewable Resources Subcommittee held valuable general discussions at meetings over many months. Several members also made the effort to contribute beyond comment at meetings: Ted Drouin, Harvey Gardner, Elmer Kure, Adrienne Lacombe, Joan Snyder, Don Stiles. Many of the staff at the Environment Council of Alberta offered comments: Dave Buchwald, Archie Landals, John Lilley, Kim Sanderson, Cal Webb. This paper was undertaken as a result of enormous encouragement from Mike Kelly. Pat McIsaac did a great deal of the research work and writing.

Lorna Allen of the Natural Areas Program at Alberta Forestry, Lands and Wildlife as well as Julie Hrapko and the staff at the Provincial Museum made a tremendous contribution to this report by sharing their scientific knowledge of Alberta's flora and fauna.

Brian Free of the Environment Council was invaluable to the entire development of the paper, re-researching and re-writing large sections, and Margaret Hughes typed several versions. Elizabeth Alke, as editor, made sure what went down on paper was actually what we meant and coordinated the production and artwork.

ABOUT THE COVER ART AND ILLUSTRATIONS

Artist John Maywood created the sensitive cover art and drawings contained in this report. They complete the objectives of this report by providing readers with a feel for what is at risk when Alberta's biodiversity is eroded. The flora and fauna on the cover include: hare bells, a mountain sheep, a common garter snake, arctic grayling, western wood lily, fritillary butterfly, and a canvasback duck. The border design represents strands of DNA.

Maryhelen Posey

Table of Contents

Tables

Figures

Chapter One

Introduction

Close your eyes and visualize a prairie scene...thousands of bison move slowly across an expanse, from horizon to horizon, of short, tough grass. A plains grizzly at the edge of your vision is fishing in a small stream. A bird of prey hovers overhead, possibly a peregrine falcon or a ferruginous hawk. A swift fox is stalking a ground squirrel for its dinner. At night you hear the howl of a pack of prairie wolves....

With your eyes open, the scene is different. Cattle graze in fields fenced off from adjacent fields of alfalfa or wheat. The stream may be dammed to provide water for livestock, and it may flow through a culvert under a road. The ground squirrels go about their business free of anxiety about the swift fox; and if there is a bird of prey overhead, it is very unlikely to be a peregrine falcon or a ferruginous hawk. Most of the moving objects will be vehicles on the road or in fields. Perhaps you might hear the spindly piping of an irrigation system. At night only the coyotes will raise their voices in competition with the sound of the engines of passing trucks.

A few thousand plains bison, or hybrids from them, exist on reserves or ranches. The plains grizzly and the prairie wolves are gone. The swift fox is the subject of intensive breeding and reintroduction efforts; and the peregrine falcon and the ferruginous hawk are endangered.

The prairie scene of our past is gone forever and a great deal of biological diversity with it.

WHAT IS BIODIVERSITY?

The term biological diversity, or biodiversity, is a relatively new way of describing a very old, very complex, natural phenomenon.

This phenomenon can be measured scientifically by contrasting differences in the genetic makeup of organisms. To the senses, biodiversity is apparent in the subtle differences between characteristics of individuals within a species. For example, biodiversity can be seen in the different characteristics of the wood bison and the plains bison, rust-resistant strains of wheat and those that are susceptible, and the diverse characteristics of different species, from polar bears to butterflies.

Biological diversity manifests itself at a larger scale in natural ecosystems such as open grassland and aspen forest. Each ecosystem has a distinct community of plants and animals, and complex cycles of water, nutrients, and energy. Biodiversity is also a part of the natural functioning of interconnecting ecosystems.

Hence, the term biodiversity is most often used in a collective sense to describe

> *the variety of the world's plants, animals, and other organisms, including their genetic variation and the ecological complexes in which they live.*
>
> *— World Conservation Strategy*

WHY ALL THE FUSS?

Until recently, only a few scientists were particularly concerned about loss of biodiversity. The extinction of some specific species, usually a species either particularly useful or attractive, was cause for more widespread concern. Protection of the endangered giant panda, for example, which is exceptionally cute and nonaggressive, has inspired enormous public support.

Conversely, many people would be only too pleased to hear that mosquitoes were endangered. Yet, their loss would be as much a disaster as that of the panda. In fact, when a futuristic research project, Biosphere II, a model for a possible space station, was being designed, it was found necessary to include the mosquito as part of the life-support system (Strauss 1988).

Today, more and more people are becoming concerned with accelerating losses of species and habitats. The reasons for this concern are numerous and varied: they range from practical to ethical.

On a practical level, science and industry are concerned because whenever some characteristics of a species are bred out, whether deliberately or by accident (through selective breeding or extinction), some of the genetic resources of that species are lost.

Although the loss of any one species or ecosystem can be tolerated, all biological diversity has value. The greater the diversity that can be retained, the greater the variety of future conditions we are prepared for. Predicted or unanticipated changes in climate or a new disease, for example, may mean that agriculturists have to cultivate new breeds or crop strains that will thrive under the changed conditions or that will cope with a new biological threat.

On an ethical level, the beauty of some species or ecosysytems alone seems worth maintaining, just as great works of art are preserved. In the same way, the long existence of the earth's many lifeforms confers a powerful right to their continued existence.

Humankind's sense of relationship to other inhabitants of the earth has grown in recent years to extend beyond pretty or charismatic species to include a sense of stewardship for all occupants of this planet. And many people now recognize that there is an ethical obligation to maintain natural ecosystems which will support life and provide enjoyment for future generations.

The main objectives of this report, therefore, are to increase public awareness of the importance of biodiversity, especially as manifested in Alberta's six biogeographical zones, and to motivate readers to support initiatives that conserve and protect these resources.

Chapter Two

Benefits of Biodiversity

Alberta's flora and fauna provide the living components of the ecosystems on which we depend. From an environmental perspective, they contribute to the cycling of nutrients, cleansing of water, and maintenance of soil quality. From an aesthetic perspective, they greatly enrich Alberta's landscape.

In addition to providing these benefits, Alberta's natural biological communities support commercial interests such as forestry, commercial fishing, trapping, and tourism. Introduced domesticated species support agriculture and horticulture in Alberta, and some of Alberta's indigenous animals and plants, including bison, elk, and saskatoon berries, are being raised or harvested for commercial purposes. Even native plant seeds, some of which are now available in commercial quantities, provide stock for reclamation of disturbed land areas.

The following overview of the benefits of biodiversity provides the rationale for preserving this resource as a whole. The individual benefits of Alberta's environmental resources are documented in more detail within the other discussion papers in the Alberta Conservation Strategy.

AGRICULTURE AND FOOD SUPPLY

Crops

Much of the food supply used by the human race is based on very few plant species. Several thousand species are known to be edible, but only about 150 have ever become important enough to be included in agricultural trade. And as trading interactions have shifted toward a global economy, the trend has been to commercially produce fewer and fewer species (Plotkin 1988). Today fewer than 20 plant species contribute as much as 80 percent of the world's food supply (Nations 1988). Of this 80 percent, wheat, rice, corn, potatoes, barley, cassava, and sorghum are by far the most important in feeding the world's people (de Groot 1988).

The modern emphasis in food production is to maximize yield from the crop species that are grown and traded. Plant breeders are constantly working to develop new commercial plant varieties which give better crop yield, nutritional quality, physical durability, responsiveness to different soils and climates, and resistance to pests and diseases (Plotkin 1988). This process of crop improvement involves crossbreeding commercial varieties with the native relatives from which the cultivated plants were originally developed. This must be an ongoing process as insect pests and diseases can adapt quite quickly (within five to ten years) to the resistance level of a new strain of wheat (Ehrlich and Ehrlich 1981). Sudden changes in weather over a few seasons can also greatly disrupt the success of new and improved crop varieties.

Given the very narrow genetic base from which most of our food supply is currently derived, maintaining biological diversity is important from several perspectives.

Future development of crop varieties will be severely hampered if the wild ancestors of our domesticated crop plants are destroyed. It is impossible to predict the exact production problems which plant breeders may some day be called upon to solve with new strains of crop species. Regardless of future needs, it is essential that

countries of origin maintain habitats that support healthy populations of the undomesticated relatives of current crop varieties. Without this habitat maintenance, the plant breeder will have no reserve of genetic material from which to draw.

Furthermore, it is valuable to maintain native populations of all types of edible species for the potential they have to become new food crops. Often traditional subsistence agriculture crops have been set aside or even completely lost in areas where attempts have been made to modernize agriculture. Introduction of modified varieties of crops such as rice and wheat have increased the amount of food which can be produced on the land, but new varieties often replace traditional crop strains.

The genetic diversity of the traditional plants is thus being replaced by genetically uniform monocultures of introduced varieties. Unique populations that are well-suited to the conditions of a particular region are becoming extinct. As well, the increased yield of the introduced varieties can often be maintained only with appropriate handling and additional inputs of water, fertilizer, and pesticide (Ehrlich and Ehrlich 1981). In developing countries, these expensive requirements seriously detract from the usefulness of the crop variety to farmers with very limited resources.

Domestic Livestock

Plants are not the only important source of food for humans. Animal products provide American consumers with about 70 percent of their protein, 80 percent of their calcium, 60 percent of their phosphorus, 40 percent of their iron, 35 percent of their energy, nearly all of their vitamin B-12 and many other essential vitamins and minerals (CAST 1984).

There is some evidence that the rate of consumption of animal products in developed countries like the United States has reached a plateau. However, an increase in demand for animal food products can be expected in the developing nations (CAST 1984). The use of livestock for performing work in agriculture, forestry, and general construction is also very important in developing nations.

As with agricultural crops, domestic livestock constitute a narrow selection of genetic resources bred from ancient breeds of cattle, sheep, swine, and fowl. Modern chickens were developed from small Asian jungle fowl; swine were developed from the Asian and European boar. Preservation of these ancient breeds and their relatives is necessary to provide animal breeders with the resources to develop more productive livestock with improved adaptations or resistance to diseases.

In addition to preserving species already proven through domestication, it is important to preserve other wild animals that offer potential for fulfilling human needs. The ostrich, cane rat, plains bison, and Tilapia fish, for example, are now being raised domestically in different parts of the world.

However, it is impossible to know what animal species will provide for the needs of future generations. Agriculture will in the long term be strengthened and stabilized if the maximum array of options for livestock development and improvement remain open, and if these options are based on the retention of existing biological diversity.

MEDICINE

People have a long-standing tradition of using plants and animals from the wild to prepare medicines to alleviate illness or injury. Herbalists and medicine men or women from societies all over the world have over centuries built up a store of healing knowledge. Having an intimate knowledge of their environment, they were able to use the natural resources from their region and then pass on the information and techniques to the next generation and the next.

In more recent times the scientific and analytical studies of biochemistry and medicine have developed numerous drugs based on the active components present in domestic plants or other wild species. For example, foxglove, a mem-

ber of the snapdragon family, provides us with an important drug called digitalis which is used in the treatment of chronic heart failure (Ehrlich and Ehrlich 1981).

Plants

There are, in fact, about 119 pure chemical substances extracted from flowering plants that are used in medicine throughout the world today. These drugs are derived from fewer than 90 species (Farnsworth 1988) and approximately three-quarters of these compounds are used for purposes which are the same as or related to those for which the source plants were traditionally used.

Flowering plants also appear to have developed antibiotics and fungicides in their tissues as a means of defending themselves from bacterial and fungal disease and feeding insects. Chemicals of this nature found in native plant species may aid researchers who must deal with the ongoing problem of drugs becoming less effective as disease-causing microorganisms develop resistance to them.

Animals

Domestic animals play a much more significant role than wild animals in providing source materials for medicines. Most of the drugs from animal sources that are used by western medicine are derived from domestic species. For example, thyroid hormone is derived from sheep and hogs, insulin and vasopressin from cattle and hogs, and estrogens from the urine of pregnant mares (Prescott-Allen and Prescott-Allen 1982).

Traditional medicine in many parts of the world utilizes wild animal products, such as bear gall bladders and antler velvet; though western medicine attributes little benefit to such remedies, a substantial commercial market for such products exists (both legally and illegally) and will likely continue to do so.

Biomedical research is where wild animals play a very significant role. The primates are essential for the production and testing of vaccines, safety testing of drugs, and research into malaria, cardiovascular diseases, cancers, hepatitis and several other diseases (Prescott-Allen and Prescott-Allen 1982).

Primates are not the only class of animals that may reveal cures to certain human diseases. A new class of microbe-killing chemicals has been discovered in the skin of the African clawed frog; these chemicals may improve treatment of burns, cystic fibrosis, and other human ailments (Weisburd 1987). Scientists also believe that other compounds secreted by these frogs as a defence against predators could improve the understanding and treatment of nervous system disorders such as Parkinson's disease.

Research into exotic species of wild animals has also made contributions to medicine. In terms of human physiology, for example, squid have served an important role in investigations of how nerves function. Fruit flies, mice, Guinea pigs, wasps, salamanders, African clawed frogs, sea urchins, and butterflies are just a few of the animals that scientists have used to gain an understanding of genetics and embryology and thereby of human heredity and development (Ehrlich and Ehrlich 1981).

Despite these advances, dilemmas arise with the use in biomedical research of species whose populations are threatened in the wild. There is no easy solution to choosing between benefit to human medical knowledge and the rightful existence of a species. Possible options include utilizing populations of captive-bred animals while allowing natural populations to survive in the wild. As well, if the widest range of animal species possible is allowed to exist in nature, a variety of organisms may be available which will provide equivalent benefit to medical research without stressing the population of any particular species too greatly.

Current knowledge of human illnesses is also a factor when considering the potential value of wild species as sources of medically useful compounds. Ehrlich and Ehrlich (1981) make the comment that *Penicillium notatum*, the mold from

which penicillin was developed, would not have appeared very useful in the 1860s when the role of bacteria in causing disease was not yet understood. Similarly, it is now impossible to predict if a particular species may hold the key to what is at this time a poorly understood or unknown disease. Given the remarkable benefits to humans of the drugs currently developed from wild species, it seems wise to maintain for future researchers the maximum of raw material possible by conserving biological diversity now.

PLANT PRODUCTS

Trees

In addition to fruits, nuts, and other foods, trees produce a wide array of other valuable products. Wood and wood fibre for lumber and paper manufacture are obvious examples. Certain tree species are valuable for other commercial products: rubber, gum, and cork, for example.

The variety of product qualities required for modern applications necessitates the conservation of a wide diversity of tree species. For example, different trees have different growth characteristics and wood quality, which are suited to different products. Many species, especially in tropical regions may even have fibre with useful properties that are currently unknown (Ehrlich and Ehrlich 1981). Tree geneticists and breeders need the maximum diversity of genetic material from which to develop commercially desirable wood sources.

Continuous fluctuations in marketplace demands for wood products with specific characteristics are a second consideration when tree growers decide which tree species to preserve. For example, the size and shape of timber valued for ship building a few hundred years ago may be quite inappropriate for modern furniture or cabinet building. Pulp and paper manufacturing technology also changes, and so do the specific attributes of the wood required.

Different species may increase in value if technology and the marketplace can find a use for them. New technologies in the manufacture of wood panels and pulp have led to an increase in interest by the Canadian forestry community in aspen and poplar (Corns 1989). Genetic improvement to develop more suitable hybrids of aspen will likely be pursued in future (Doucet 1989). This means that even for aspen, once considered a weed species in the commercial forest, genetic resources for future research potential are necessary and important.

Other Plant Products

Plants also yield a great many chemicals which have application in industry. Species which contain fatty acids useful for making soaps, detergent, surfactants (substances that, in liquid form, reduce surface tension), and lubricants are available. Oil from the jojoba shrub, native to the Sonoran desert, can substitute successfully for oil traditionally obtained from the now-endangered sperm whale. Before this discovery, sperm-whale oil was the only commercial source of liquid-wax esters for lotions, hair care products, high performance lubricants, and even transmission fluid (Hinman 1986).

Fortunately, many everyday synthetic products such as plastics, fertilizers and adhesives (currently made from petroleum and petroleum byproducts) can now be synthesized from plant products. These so-called botanochemicals are destined to become increasingly important as raw materials for industry (Plotkin 1988).

Furthermore, the marketplace success of some products derived from renewable biological resources demonstrates the potential value of as yet unrecognized species. For example, rayon, a cellulose product, is currently replacing nylon, a petroleum product, in some uses. Use of rayon, which is derived from a renewable resource, constitutes a positive step toward long-term conservation of nonrenewable fossil fuels. In the future, biomass — plants grown to be burned in power plants or converted to other fuels—may be an important energy source. Species appropriate for

this type of operation very likely have no commercial use at present and unrecognized potential for the future (Ehrlich and Ehrlich 1981).

ANIMAL PRODUCTS

Economically important animal products include wool and fleece from sheep, cashmere and angora from goats, camels and llamas, beeswax from honey bees, downfeathers from waterfowl, silk from silkworm cocoons, leather and fur from various animals. Many of these commodities are produced by domesticated animals. Breeding programs that utilize the genetic resources available in different populations have the potential to improve the qualities of harvested products.

TOURISM AND RECREATION

The value of native plant and animal species extends to tourism and recreation. Ecotourism is a growing phenomenon in which particular species or communities attract international visitors.

In Costa Rica, tourism, especially ecotourism, is more significant to the local economy than coffee and bananas because these cash crops are grown on plantations that belong to foreigners (Butler and Roberts 1990).

Closer to home, hundreds of people travel to Churchill, Manitoba, to view the polar bears that were once considered only a nuisance by local residents. Seal watching and whale watching bring tourists to Canada's coastal communities. Point Pelee National Park in southern Ontario has become a world-famous destination for birdwatchers to observe the great concentration of migrating songbirds, hawks, and other birds. Bird watching is the fastest growing recreational activity in the world and in North America, birdwatchers spent over $40 billion in 1989 (Butler 1990).

Alberta's flora and fauna also attract tourists. Big game animals, readily seen in our mountain national parks, are a big draw. Beaverhill Lake near Tofield is gaining an international reputation as a viewing site for migrating waterfowl, and rare trumpeter swans nest in Saskatoon Island Provincial Park near Grande Prairie. Both common and endangered species have tourism potential.

In recognition of Alberta's potential to develop tourism benefits from its wildlife, the Alberta government has developed a Watchable Wildlife program, and a joint venture of government, industry, and conservationists has developed a guide to Alberta's wildlife viewing hot spots (Alberta Forestry, Lands and Wildlife 1990).

Alberta's beautiful mountain landscapes with their azure blue lakes and carpet of forest attract tourists from all over the world. These tourists inject new money into the Alberta economy and form the basis for an important tourist industry. Albertans themselves enjoy their natural heritage through camping, hiking, hunting, fishing, and other outdoor pursuits.

DISCUSSION

The future value to humankind of each and every species is unknown. These limits of knowledge provide a common-sense argument for preventing the loss of any individual species or natural community of organisms. Changing environments and differing human needs may confer considerable practical or economic value to species of which we are now totally unappreciative.

Chapter Three

Alberta's Biological Resources

AN OVERVIEW OF THE RESOURCE

Alberta has six natural ecological regions (Figure 1). Each encompasses a rich variety of flora and fauna and is fairly distinct in terms of vegetation, soils, landform, and to a certain extent wildife. The existence of a total of 17 distinctive subregions, which themselves support a rich diversity of plants and animals, further attests to Alberta's vast biological resources.

The wildlife of Alberta includes 90 species of resident mammals, 250 species of resident breeding birds, 50 species of fish, 8 species of reptiles, and 10 species of amphibians (Alberta Fish and Wildlife Division 1984). Some species are limited to a specific habitat, while others are more broadly distributed. Many other migratory birds and mammals are found in Alberta as they move between distant summer and winter ranges.

In terms of vegetation, botanists have identified about 1,755 species of flowering plants in the province (Packer and Bradley 1984). About 600 species of mosses and hundreds of other primitive plant species occur in Alberta.

There are also tens of thousands of species of insects and other invertebrates in the province, many of which have yet to be catalogued.

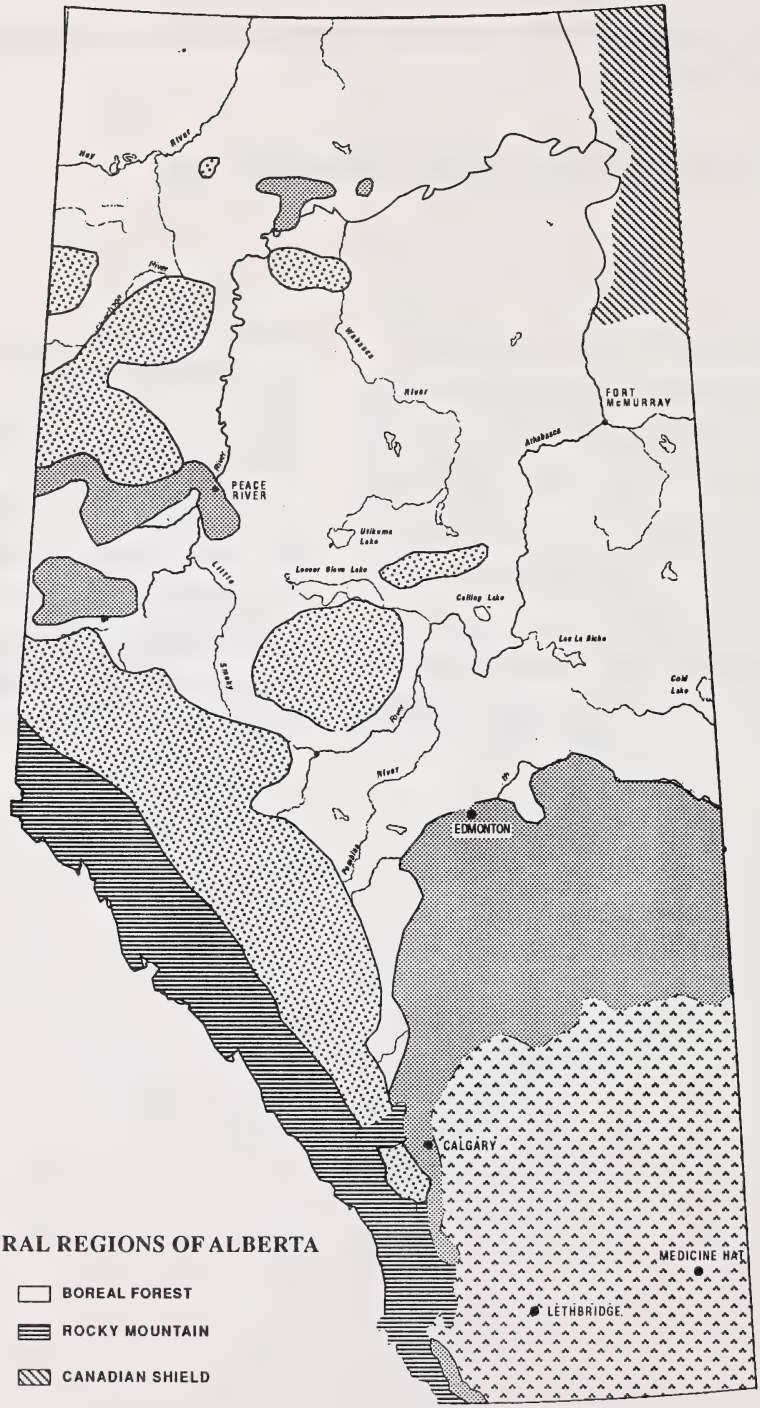


Figure 1: NATURAL REGIONS OF ALBERTA

SOURCE: Adapted from Alberta Recreation and Parks (1990)

Table 1: Alberta's Natural Regions

(Square Kilometres)

GRASSLAND		
Mixed Grassland		61894
Northern Fescue		20318
Foothills Grassland		8930
	Total	**91142**
PARKLAND		
Central		63823
Foothills		3122
Peace River		14373
	Total	**81318**
FOOTHILLS		
Main		67757
Northern Outliers		14299
	Total	**82056**
BOREAL		
Subarctic		30790
Hay River		50360
Peace River Lowlands		29578
Mixedwood		232502
	Total	**343230**
ROCKY MOUNTAIN		
Montane		6299
Alpine and Subalpine		38074
	Total	**44373**
CANADIAN SHIELD		
Kazan Upland		7245
Athabasca Plain		11821
	Total	**19066**
TOTAL LAND AREA OF ALBERTA:		**661185**

GRASSLANDS

Three grassland subregions form the prairie in the southern half of the province and cover 14 percent of the Alberta landscape. Historically, the major influences on this landscape were roaming herds of bison and fire, both natural grassfires and fires set by Natives.

(Natives burned scrub for the grassland area so that buffalo would herd together and be easier to hunt. Since the arrival of European settlers, fires have been largely controlled and the bison virtually eliminated.)

Domestic cattle now provide grazing pressure on grasslands and cultivation has eliminated indigenous vegetation from most of the prairie.

Where it still exists, native prairie grassland supports a wide variety of wild plants and animals. Grasses are the predominant vegetation, and in drier regions cactus and sagebrush are more common. Where there is more precipitation, a mixture of taller spear and wheat grasses and shrubs such as buckbrush, silverberry (wolf willow), saskatoon, and chokecherry prevail.

Although wild bison have been eliminated from the Alberta prairie grasslands, other wild ungulates are still present. Pronghorn antelope are well-adapted to the prairie landscape and to some extent have adjusted to the agricultural environment. White-tailed deer and mule deer are found in the river valleys and coulees. Coyotes have become the main large predator, as prairie wolves and plains grizzly bears have been eliminated. Small mammals, such as ground squirrels, mice, and voles are preyed upon by a variety of prairie hawks and owls. Alberta's only lizard, the eastern short-horned lizard, inhabits dry coulee slopes in the very south of this region. Other reptiles in this region include prairie rattlesnakes, bull snakes, and garter snakes.

Prairie wetlands are oases in this arid environment; they support a wide variety of flora and fauna. For example, prairie potholes, one of the many types of wetlands, are important as feeding grounds and breeding habitat for a large component of North America's waterfowl. Many shorebirds and other waterfowl stop on the prairies during spring and fall migrations to and from their northern breeding grounds and southern wintering areas.

Despite their importance to wildlife and ecological functions, prairie wetlands have been drastically reduced. Only 60 percent of prairie wetlands remain and three-quarters of the adjacent uplands have been cultivated (Holroyd 1990: pers. comm.). Duck populations are at an all time low.

needle and thread, or spear grass; grama grass; prickly-pear cactus; burrowing owl; pronghorn antelope

PARKLAND

The central parkland lies between the boreal forest to the north and west and the prairie grasslands to the south and east. Other parkland areas are found in the foothills south of the Bow River and near Grande Prairie and Peace River. Fescue grasslands interspersed with groves of aspen and poplar are the characteristic vegetation.

This region, which covers 12 percent of the province, is a transition zone that is continually changing as fires and land clearing offset the establishment and expansion of aspen groves. It has experienced extensive modification for agriculture and urbanization.

Both woodland and grassland species inhabit the parkland region. White-tailed and mule deer are abundant, and moose are expanding their range into parts of the aspen parkland. Beaver, muskrat, ground squirrels, and snowshoe hares are preyed upon by weasels, fox, coyotes, great horned owls, and other carnivora. Furthermore, the parkland contains the most diverse bird fauna in North America (Robbins et al. 1986). Warblers and grouse inhabit the aspen groves and ducks and geese breed in the many lakes and wetlands of the aspen parkland.

trembling aspen, Tennessee warbler, common wildrose, chorus frog, long-tailed weasel, white-tailed deer, gadwal ducks, twinning honeysuckle

FOOTHILLS

The foothills form a transition zone between the Rocky Mountains and the Boreal Forest and certain elements of both of these regions are found here. Extensive forests of lodgepole pine cover most of the main foothills with spruce-fir forests becoming more common in the northern portion and northern outliers (near Swan Hills). Lakes and marshes are relatively uncommon, although other wetlands, such as bogs and fens, are found in valley bottoms. Animals of the neighboring boreal forest are relatively abundant, with mountain fauna more common in the southern foothills.

lodgepole pine, venus slipper, elk, cutthroat trout , gaillardia, honeybee

ROCKY MOUNTAIN

Along Alberta's western border, the Rocky Mountains dominate the landscape. Certain elevations mark distinctive changes in plant communities.

Spruce-fir forest with stands of lodgepole pine, Engelmann spruce, alpine fir, and alpine larch extend up the mountain slopes to the treeless alpine meadows. Mosses, heather, saxifrages, and other flowering plants add vibrant color to the alpine meadows that carpet some of the mountain landscapes above the treeline. In some mountain valleys, warm winter chinook winds create a distinctive environment for Douglas fir and limber pine. These montane ecosystems are especially important and unique areas in the province.

Several animal species are restricted primarily to this mountainous region. Bighorn sheep, mountain goats, pika, golden eagles, and other species inhabit the higher elevations. In the valleys, elk, moose, mule deer, cougar, and wolf are found. Mountain habitats sustain a variety of birds including white-tailed and willow ptarmigan, dippers, and Clark's nutcracker. Several species of coldwater fish, such as trout and mountain whitefish, inhabit the rivers and streams of the Eastern Slopes.

mountain goats, three-toothed saxifrage, alpine anemone, alpine townsendia, dwarf bitter root, white-tailed ptarmigan, alpine larch

BOREAL FOREST

The largest natural region in Alberta is the boreal forest, covering approximately 52 percent of the province. White spruce, black spruce, balsam fir, larch, and jack pine are common coniferous species. Trembling aspen, balsam poplar, and birch are very common in boreal mixedwoods. Large areas of treed muskeg or peatlands are found in this region.

The boreal forest is home to a variety of large mammals, such as moose, white-tailed and mule deer, black bear, and wolves. Many furbearers, such as lynx, marten, fisher, beaver, and squirrel inhabit the northern forests. Old growth forests support a variety of specialized species, including woodland caribou, and many orchids and fungi. A variety of songbird species are summer residents of the boreal forest and migrate to tropical areas for winter.

Hunting, fishing, and trapping are important throughout the region. The major industries in the boreal forest are based on timber harvesting, conventional oil and natural gas extraction, and oil sands development.

teal ducks, Morrel mushrooms, red squirrel, white spruce, woodland caribou, common pink wintergreen, common loon

CANADIAN SHIELD

The Canadian Shield extends into the northeast corner of Alberta around Lake Athabasca and covers almost 3 percent of Alberta's surface area. Here there are shallow soils and exposed bedrock with jack pine woodlands and rocky outcrops. Lichens and mosses are common groundcover and black spruce bogs predominate in the many depressions.

Animal life is less abundant than in other regions with most boreal forest species represented. Many subarctic birds and mammals may also be found in this region.

stunted jack pines, sandhill crane, water lobelia, black spruce, caspian terns, brown deer mouse

DOMESTIC AND INTRODUCED SPECIES

Alberta's domestic and introduced species contribute to the province's biodiversity and economic well-being. Many crop species developed in Alberta, canola, for example, are cultivated internationally. Similarly, a large number of cattle breeds and other livestock are raised in Alberta and their semen exported for breeding purposes. Alberta apiculturists have also bred a variety of honey bee that can overwinter here and in similar northerly climates.

Exotic upland game birds, such as ring-necked pheasants and gray (Hungarian) partridge and a number of introduced fish species, such as eastern brook trout and brown trout, have succeeded in establishing themselves in Alberta, sometimes competing successfully with indigenous species.

Many varieties of vegetables, fruits, and ornamental plants suited to Alberta's climate, some of them developed locally, are grown here. Some of these have escaped and established themselves in native plant communities. Although forestry in Alberta utilizes some native tree species, as forestry practices become more intensive, the importance of selected or even specially bred strains increases continually, and in the long run, some forest areas may be effectively as domesticated as a wheat field.

Chapter Four

Threats to Biological Diversity

The composition of Alberta's native flora and fauna is changing. Many changes occur naturally as species expand or contract their distribution range in response to natural factors. Over time, a succession of different species may inhabit a particular location. However, human influence has become an overriding factor and the result tends to be a reduction in biological diversity.

In Alberta, threats to biological diversity take the form of changes to habitat as well as direct reductions of populations. These threats are present in Alberta as well as distant tropical habitats, and the combination of changes in local and distant habitats has implications for many species, especially migratory birds.

Even species specifically developed for human use face some threats. Varieties of domestic livestock which may once have been common in some parts of the world, may be lost through lack of incentive to breed them. Sometimes these strains are specifically well-suited to extreme conditions of some kind but may be less productive than others under modern agricultural practices. The same is true of plants; the pressure for increased productivity or ease of harvesting under conditions of intensive cultivation may result in the disappearance of some strains.

CHANGING LAND USE

The greatest threat to Alberta's biological diversity is the conversion of natural habitat to human uses. Historically, agriculture has been the primary motivation for land conversion. Early settlers ploughed up millions of hectares of prairie grassland to plant their crops. As a result, virtually none of the tallgrass prairie remains in Canada. Cultivation and domestic grazing have also taken their toll of mixedgrass prairie, with only about one-quarter of this habitat remaining, primarily on poorer soils. A large expanse of nearly undisturbed mixedgrass prairie is found in the Suffield Military Range near Medicine Hat. Native northern fescue grassland, found almost entirely in Alberta, has been reduced to 27 percent of its original size as a result of cultivation. Much of the remaining fescue grassland is heavily grazed by cattle and continues to be converted to tame pasture or cropland (World Wildlife Fund Canada 1988).

As Alberta's settlement patterns mature, urbanization is an increasing factor for habitat conversion. Urban centres are expanding onto adjacent prairie habitat and agricultural lands. Our largest cities, Edmonton and Calgary, are situated on some of our province's best agricultural land. However, urbanization is less of a threat to biological diversity than conversion of natural habitat for agriculture. Urban landscapes often support a mixture of native and exotic plants and animals. In agriculture, there is a stronger tendency to discourage natural diversity in favor of domesticated monocultures, such as cereal crops.

In our forests, land is cleared for agriculture, oil and gas exploration and development, mining, and transportation and utility corridors. A major expansion of agriculture has occurred in the northern Peace River Region and large oil sands developments are operating near Fort McMurray. Timber harvesting also modifies the forest habitat, replacing mature stands with younger stages of forest succession. The new forest is

different from a natural one because only certain tree species are replanted and other native species, such as balsam fir, are not. Major forest industry expansion has recently been announced which will greatly increase the area of forested land subject to timber harvesting.

All disturbances of land, even small trails in forested areas (where beaten down or disturbed soils are ready to receive seeds) create opportunities to introduce new plant species. We sometimes do it accidentally, with seeds carried on vehicles and even on the soles of shoes. Some of these introduced species compete very well within the natural community to the potential detriment of the native species. Timothy grass, for example, can sometimes out compete native grasses in Alberta's foothills.

It is not only land use that has changed. Alberta's waterways have also been altered. Construction of dams converts large sections of rivers into reservoirs and alters the downstream flow, affecting hundreds of kilometres of river habitat. Many lakes and wetlands have been drained, stabilized, consolidated, or otherwise manipulated. These changes greatly affect the aquatic communities, but do not always reduce their biological diversity. With in-stream reservoirs, for example, river species are replaced by lake species of aquatic plants and animals, increasing the overall diversity within the river system. However, it appears that some species face repeated losses of habitat with little or no increase of habitat to balance the losses. As more and more aquatic ecosystems are transformed or reduced the survival of these species may be threatened.

HUMAN PREDATION AND PEST CONTROL

In addition to land conversion, human predation (hunting, trapping, and poisoning) can threaten animal populations. The plains bison almost disappeared in the late 19th century as a result of large-scale slaughter. Prairie wolves and plains grizzly were eliminated by early settlers. An outbreak of rabies in the early 1950s precipitated an eradication campaign that in concert with the disease itself, greatly reduced the red fox population in Alberta. Furthermore, efforts to control prairie dog and ground squirrel populations in agricultural areas led indirectly to the loss of the black-footed ferret in Canada.

Today, sport hunting and fishing are regulated to protect animal populations. However, these limitations can be difficult to enforce. Poaching, especially of trophy animals, continues to pose a threat to some populations, even in our national parks. Increasing recreational access to wilderness areas stresses animals sensitive to human disturbance and exposes game animals to greater hunting and fishing pressure.

Some wild animals, such as bears, wolves, coyotes, and elk living near farms and ranches, pose a nuisance to agricultural operations, and there are government services to discourage or eliminate these animals. Some wildlife species are monitored for diseases. For example, foxes, skunks, and bats are monitored for rabies. It is unlikely that such control programs threaten these animal populations, but there are eradication programs for some introduced pests, such as the Norway rat.

WASTES AND CHEMICALS

Other human activities that have little to do directly with plants and animals may be as damaging as predation or changing land use. Pollution of our waterways can threaten populations of aquatic plants and animals. Municipal sewage, runoff from cultivated fields and cattle feedlots, effluents from pulp mills, petrochemical plants and many other industries, all discharge pollution to Alberta's major rivers. Organic pollution can stimulate growth in nutrient-poor waters, favoring certain species. At high levels of organic enrichment, however, the environment becomes stressful and fewer species can survive. Inorganic wastes, such as salt, heavy metals, and acids, inhibit growth and reduce the biological diversity of the river system.

Many chemicals are intentionally introduced into the environment. Pesticides, including insecticides, herbicides, and fungicides are used with increasing frequency. Large-scale applications of pesticides upset the controls and balances of natural ecosystems and sometimes eliminate nontarget species. In rural Alberta, a wide variety of pesticides are applied to crops and rangeland to control agricultural pests. In forested parts of the province, there is a growing demand for large-scale application of pesticides to enhance commercial timber production. Pesticide use is not restricted to rural areas. Many municipalities spray for mosquitoes and tent caterpillars and urban residents liberally use chemicals as they battle weeds and insect pests in lawns and gardens. Mosquito control in Edmonton may be indirectly responsible for the local decline of purple martin, which feed on dragonflies, a major predator of mosquitoes (Holroyd 1990: pers. comm.). The effects of such chemicals extend far beyond the target species, since predators will ingest the same chemical as they consume poisoned prey (see Figure 8).

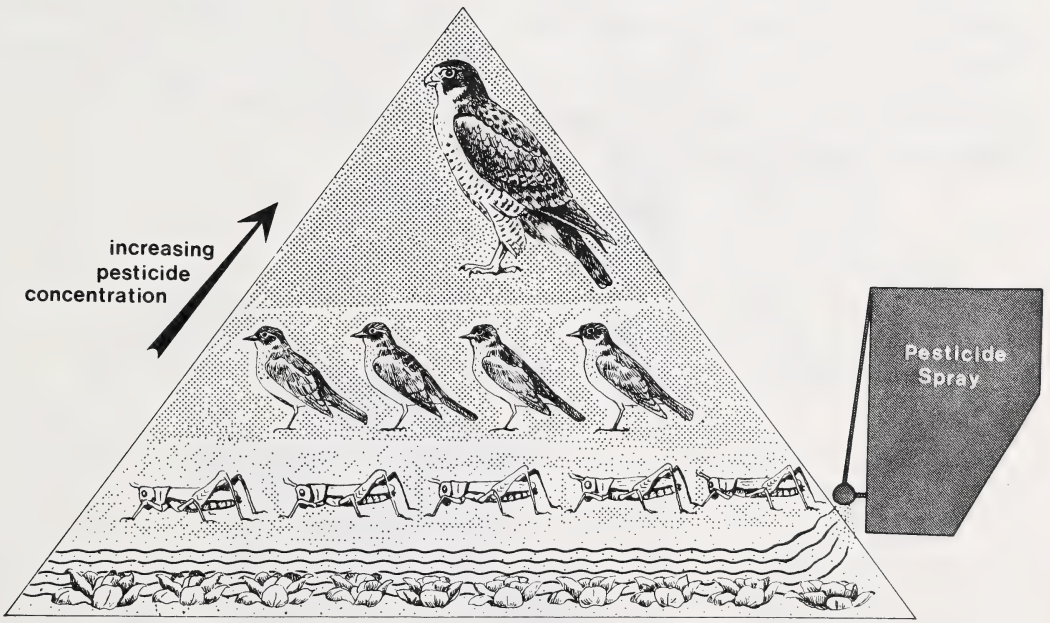


Figure 8. Effects of Pesticides on Nontarget Species

CLIMATE CHANGE

Climatic factors can also threaten populations, especially those near the limit of their species' range. A period of drought or series of hard winters can eliminate these fringe populations. Such losses are costly because fringe populations are often reservoirs of uncommon genes and of potentially great value to the overall species gene pool.

Many scientists warn that the earth is undergoing a major climatic change; the cumulative impact of these changes is often referred to as global warming. Primarily as a result of human activities, such as combustion of fossil fuels and deforestation, the concentrations of carbon dioxide and other greenhouse gases in the atmosphere are expected to increase substantially during the next several decades. This could cause a warming of the atmosphere, which may have profound effects on Alberta's environment (see Figures 9a and 9b) (Lilley and Webb 1990).

Changes in seasonal temperature and precipitation patterns would cause major shifts in biogeographic zones, such as the prairie and boreal forest. Drought may become a more common threat to prairie agriculture. The grasslands and aspen parklands are expected to expand northward as the southern border of the boreal forest recedes (Zoltai 1988); and expansion of the boreal forest northward may be impeded by slow dispersal rates of tree seeds and the poor quality of the soils. In Alberta's mountains, the warmer climate may permit forest vegetation to expand into higher elevations at the expense of alpine communities.

These changes, if they occur, will have profound implications for Alberta's flora and fauna. The abundance and distribution of species will change. Some uncommon species may increase in number while some common species may become rare. Predicting which species will adapt or perish is difficult, thus underscoring the importance of conserving as wide an assemblage of flora and fauna as possible. (A more detailed description of the effects of climate change is contained in *Climate Warming? Exploring The Answers* (Lilley and Webb 1990).)

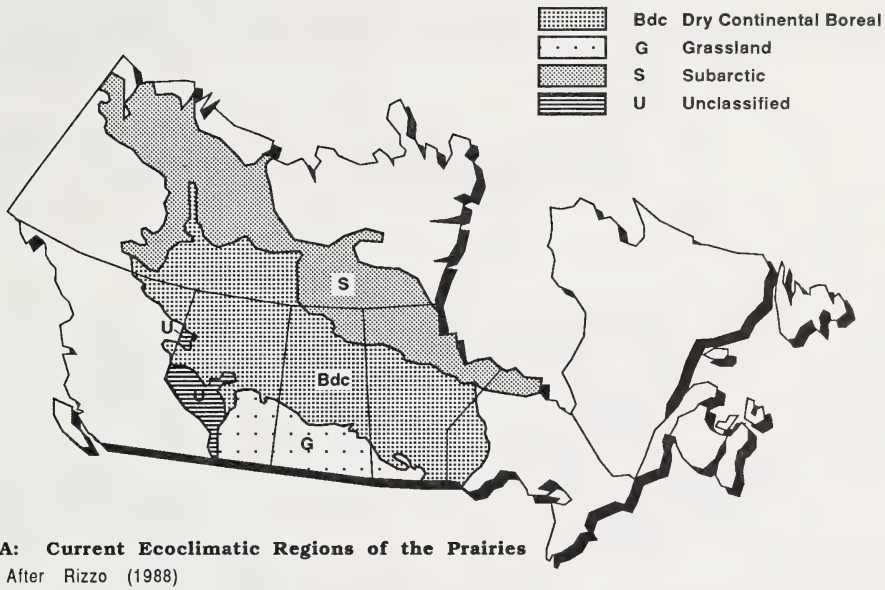


Figure 9A: Current Ecoclimatic Regions of the Prairies
Source: After Rizzo (1988)

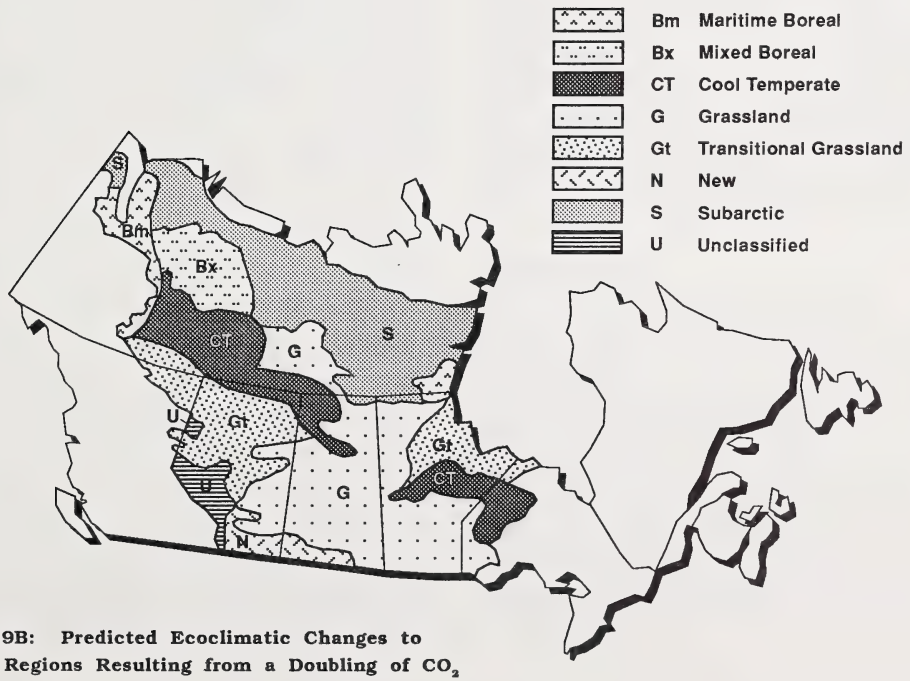


Figure 9B: Predicted Ecoclimatic Changes to Prairie Regions Resulting from a Doubling of CO_2
Source: After Rizzo (1988)

Chapter Five

Preserving Biological Diversity

Active intervention is necessary in the face of the many threats to Alberta's flora and fauna. Some existing programs focus on habitat, while others focus on protection of specific animal and plant populations. Both approaches are necessary to preserve Alberta's biological diversity.

Protection of adequate parcels of natural habitat, both for common and rare species, is the most effective strategy for preserving Alberta's biological diversity. These parcels must be large and diverse enough to maintain viable populations of all the species in the ecosystem. Furthermore, it is wisest to set aside several areas for each ecosystem to ensure that a single local disaster, such as fire or flood, does not destroy an entire ecological resource. Representation of various stages in the development of a type of ecosystem is also important; because, for example, old growth forests support very different communities than do young forests.

To date, efforts to protect ecosystems and the species within them include the creation of parks, sanctuaries, and other designated areas in ways that afford various degrees of protection. A system of zoning for various management purposes also affects the level of protection on other public lands. Cooperative programs between government, nongovernment organizations, and private landowners have been used to protect habitat on private lands.

Protection initiatives that more directly target plant and animal species include federal and provincial legislation and strategies pertaining to wildlife management. Import and export laws also protect Alberta's domestic and wild species, and as a last resort, man-made environments such as zoos and botanical gardens are used to preserve species populations.

This chapter describes general initiatives that affect all animal and plant species in Alberta, including domestic livestock, commercial crops, and introduced species.

HABITAT PROTECTION

Ownership of the land and its resources is an important consideration in developing effective programs to protect habitat. A large portion of Alberta's land base is public, or Crown land. Management of these lands is the responsibility of the provincial and sometimes federal governments. Privately owned lands are also important, especially in the prairie and aspen parkland regions. For these regions, maintaining natural habitat on private land is vital.

Public Lands

There are several approaches to habitat protection on Crown lands. One is to designate specific lands as parks or reserves and establish regulations to protect them. Federal and provincial legislation permit the establishment of a variety of types of parks and reserves that contribute to the preservation of biological diversity. Just over 10 percent of Alberta's landscape is under some form of protective legislation (Swinnerton 1991). The degree of protection varies among the different designations.

A second approach to habitat protection on public lands is to manage them with conservation as a guiding principle. An example of such a management program may be seen in the Rocky Mountain Forest Reserve. This forest reserve is an area adjacent to the mountain national parks extending from the Cardinal River east of Jasper, south to Waterton Lakes National Park. It was established to conserve forests and forest vegetation and to protect mountain watersheds. While the Forest Reserves Act regulates other uses, including recreation, domestic grazing is a dominant focus of management efforts within this one area. Other measures to protect this forest reserve can be implemented if required, such as restrictions on travel and commercial activities.

Federal Lands

National parks protect natural areas of national significance. In Alberta, there are five national parks encompassing a total of 54,084 square kilometres. These include Banff, Jasper, Waterton Lakes, Elk Island, and Wood Buffalo national parks. There are also four migratory bird sanctuaries and three national wildlife areas in Alberta. Large military reserves, such as the Canadian Forces Bases at Wainwright and Suffield, provide some protection for natural ecosystems, as their use is sporadic and generally does not involve cultivation.

Provincial Lands

Within the provincial system of public land classification, there are several designations that contribute to the preservation of biological diversity. The Provincial Parks Act regulates the activities that take place within provincial parks. The Wilderness Areas, Ecological Reserves, and Natural Areas Act is perhaps the most conservation-oriented legislation.

Provincial Parks — Provincial parks are primarily established to provide recreational opportunities of various kinds, from those that are highly structured, such as golf or alpine skiing, to unstructured activities, like back-country camping. The degree to which provincial parks provide ecosystem protection depends on the extent to which the specific ecosystem can withstand the type of recreation involved, but hunting is prohibited, and industrial activity is highly controlled (Swinnerton 1991).

Wilderness Areas — Wilderness areas provide the greatest level of protection. Access is limited to foot travel, and no hunting, fishing, or industrial activity is permitted. Three wilderness areas have been established in Alberta's mountain region adjacent to Banff National Park: White Goat, Siffleur, and Ghost River wilderness areas.

Ecological Reserves — Ecological reserves are intended to preserve representative ecosystems and unique examples of biological or physical features. In 1991, there were 13 ecological reserves in Alberta. However, their small size (to date) limits their effectiveness as ecosystem preserves.

There are a number of restrictions on the activities that are permitted in ecological reserves. These areas can be used for scientific study, and permission to collect specimens for this purpose within the reserve may be given. Except where indicated as part of a management strategy, the use of motorized vehicles, or hunting, trapping or fishing within ecological reserves is normally prohibited. Domestic grazing is usually permitted within these reserves even though, in some cases, it may be damaging. Aside from existing mineral extraction, industrial development is not permitted.

Natural Areas — Public lands designated as natural areas receive some protection. By the end of 1990 there were 119 natural areas in Alberta. Generally, these are parcels of public lands having local importance for nature studies or recreation. Sometimes these areas provide habitat for rare plants or animals or they feature important habitat. For example, the Beaverhill Natural Area is an important staging area for

migrating waterfowl and the Wagner Natural Area has several rare species of orchid.

Regulations can be established to limit activities or industrial development in these areas. Whether or not activities in natural areas are effectively regulated depends on whether or not the area has a management committee with a management plan. For example, a management committee controls all access to Plateau Mountain Ice Cave.

Zoning Management

In addition to designating certain areas for special status, other public lands can be managed to conserve biological diversity. In support of the government's policy of favoring multiple use on Crown lands, a planning process for public lands throughout the province has been developed. The intention is to facilitate multiple use in most areas. This may include habitat protection domestic grazing, recreation, buildings or other facilities, timber harvesting, mining, and so on.

Integrated Resource Plans are prepared to provide direction for land use on public lands. Within these plans are zones which have been established to indicate priority uses and other activities that should be restricted or prohibited. Some zones are intended to place priority on conserving the natural environment. Prime Protection Zones identify sensitive, high elevation terrain where activities like mining, petroleum exploration, and motorized vehicles should not be permitted. Critical Wildlife Zones delineate areas of importance to local wildlife where activities like intensive recreation and industrial development should not be permitted.

Although zoning offers some protection for natural habitat, the restrictions on activities do not have force of law; they are only guidelines which enable civil servants to issue permits for activities on Crown lands and for private developers planning new projects on Crown lands. Furthermore, most of the Integrated Resource Plans prepared to date pertain to the Eastern Slopes Region; progress toward specific management plans in the rest of the province has been slow.

Private Lands

Privately owned land is usually held for some intensive use, such as farming or habitation. These lands are managed according to landowner goals, experience, and ability. Taxation laws and regional economics influence the decisions private landowners make about these lands. Thus it takes special programs to preserve biological diversity on private lands.

Many landowners appreciate the local diversity of their area and will take steps to maintain habitat on their land voluntarily. It is important that they have an understanding of the needs of wildlife and how to provide for those needs. Education along these lines is very important. Economic incentives are also effective for conserving habitat on private lands.

Landowner Habitat Retention Program

The Landowner Habitat Retention program is one such program active in four areas of the province: Red Deer and Minburn counties and the Eastern and Bow River Irrigation districts. Landowners participating in the program are offered cash incentives to maintain or improve wildlife habitat on their land and enter into formal agreements to forgo agricultural use of specific areas, or to modify agricultural practices. This may include converting cropland to dense nesting cover for waterfowl, reducing livestock grazing in deer habitat, or taking one cut of hay instead of two in waterfowl nesting habitat.

Funding for the Landowner Habitat Retention program has come from Wildlife Habitat Canada and the Alberta government's Buck for Wildlife program which is funded by the sale of hunting and fishing licenses and donations from conservationists. Although this program is being considered for provincewide application, additional funding has not been secured, thus preventing further expansion.

North American Waterfowl Management Plan

The North American Waterfowl Management Plan, a $1 billion program aimed at restoring wetland habitat in prairie Canada and the USA, has been underway since 1986. Both federal governments signed the agreement for this plan, thus committing themselves to a 15-year program to revitalize declining populations of migratory ducks, geese, and swans. Of the 32 regional habitat priorities identified in the plan, the prairie pothole region of Canada and the USA is ranked highest (Prairie Habitat Joint Venture n.d.).

The Prairie Habitat Joint Venture, a component of the North American Waterfowl Management Plan, is expected to spend $590 million in Alberta, primarily in the aspen parkland (Ibid.). A large portion of these expenditures cover incentives for farmers to maintain dense nest cover adjacent to wetlands, create nesting structures, and retire hay and pasture lands from agricultural production (Ibid.). Other incentives will be offered to convert marginal croplands to perennial cover, adjust pasture management, compensate crop damage by feeding waterfowl, demonstrate conservation farming, and support other conservation activities.

Land Purchases

As an alternative to offering incentives to the landowner, private land that has important fish or wildlife habitat can be purchased and returned to the public domain, where it can be managed to enhance the natural habitat. Wildlife Habitat Canada, Ducks Unlimited Canada, and the Nature Conservancy of Canada are often involved in these purchases and in associated habitat enhancement programs. Cooperative public and private ownership/management projects also exist. The Cross Farm, donated to the provincial government by the owner and managed by the Nature Conservancy of Canada, is one example. The Ward Ranch, which was purchased by the government, is now managed for the benefit of wildlife species by the Alberta Fish and Game Association, Ducks Unlimited Canada, Wildlife Habitat Canada, and Alberta Forestry, Lands and Wildlife.

SPECIES PROTECTION

Some programs to preserve biological diversity focus specifically on plants and animals rather than habitat. Both common and rare populations are currently protected, with varying degrees of success, from threats within Alberta and from introduced pests or diseases. Several protection strategies are outlined below.

Legislation Affecting Indigenous Species

Both federal and provincial governments have laws and policies concerning the protection of indigenous species. The Canada Wildlife Act gives the Federal Minister of Environment authority to take measures in cooperation with provincial governments for the protection of any wild animal in danger of extinction. The Canadian Wildlife Service is engaged in several programs related to preserving endangered species. The Migratory Birds Convention Act is based on a convention between Canada, Mexico, and the United States aimed at cooperative management of migratory birds, including most waterfowl, shorebirds, and songbirds.

The Federal Fisheries Act allows the passage of regulations for the conservation and protection of fish, the exportation of fish, and the movement of fish between provinces. In the past, however, this legislation has been underutilized, and a long history of delegation to the provinces has established a precedent which weakens the political authority of the federal government to act on its provisions.

Though there is no provincial legislation regarding endangered species, the Alberta government does have policies regarding the preservation of animal species. The Fish and Wildlife Policy for Alberta, for example, states that the government will ensure that wildlife and fish populations will be protected from severe decline

and that viable populations will be maintained (Alberta Energy and Natural Resources 1982).

Government initiatives for the protection of endangered or threatened plants and animals include the Policy for the Management of Threatened Wildlife in Alberta (Alberta Fish and Wildlife 1985). Habitat protection initiatives also consider the needs of endangered and threatened species.

Import and Export Controls

Animals—Restrictions on the importation of livestock to Canada are set by the Federal Animal Disease and Protection Act and associated regulations. There are no restrictions on the breeds of livestock imported, but very strict limitations apply to potential carriers of disease or parasites. Certificates of health issued by the country of origin and/or extensive quarantine periods and inspection of the animals by Canadian veterinarians are required.

Restrictions generally apply according to species and country of origin. For example, llamas may not be imported from South America because foot and mouth disease is prevalent there (Delver 1989: pers. comm.). No livestock is imported from Africa because of the many diseases and parasites that occur on that continent. Some livestock is imported from Europe and fewer restrictions exist between Canada and the United States. Zoo animals must meet the same requirements as livestock before they are allowed into Canada.

The importation of animal semen faces restrictions similar to those on animals. Cattle embryos are imported from some countries and are washed with special solutions to remove parasites and pathogens. Sheep and swine embryos will not be imported until a satisfactory washing treatment is developed for them (Delver 1989: pers. comm.).

Wild animals coming into the country must be quarantined for 21 days and certified as healthy. Under the Alberta Wildlife Act, provincial permits are also required for the importation of any wildlife or exotic animals into Alberta. Domestic animals and most pet species are excluded from this requirement. The purpose of this control is to prevent the importation and subsequent escape of non-native animals that could displace or interbreed with indigenous animals. It also serves to prevent the importation of animal diseases and parasites. However, inadequate reliable information on testing and appropriate quarantine periods for wild species means that disease and parasite control is only assured in the case of domestic livestock.

The expansion of game farming in Alberta has greatly increased the demand to import ungulates, such as elk, into the province. However, many risks are associated with importing these animals and no importation of big game animals is currently allowed.

The potential for importing diseases and parasites which can infect wild ungulates is a concern. An outbreak of tuberculosis in game farm elk in late 1990 emphasized the importance of this concern.

Elk, white-tailed deer, and mule deer may not be brought in from outside the province. This regulation attempts to prevent the introduction of brainworm. Under the Provincial Health Act, four species of turtle are not allowed into Alberta because they may carry *Salmonella* bacteria, which can infect people if brought into contact with human food. The Provincial Minister of Forestry, Lands and Wildlife can order any wildlife, exotic animal, or domestic livestock seized, quarantined or destroyed should he or she believe that the animal poses an ecological threat or genetic danger to native wildlife.

Plants — The movement of plants into Canada is regulated by federal legislation. The Plant Quarantine Act places restrictions according to plant species, country of origin, and sometimes the season of year. As with livestock, the main focus is on diseases and parasites that could be brought into Canada with the plant material and not the introduction of exotic species. The

regulations are being revised, however, to include some control of the importation of weeds (Koivisto 1989: pers. comm.).

There are also provincial education programs that warn the travelling public about importing weeds or other pests. Water milfoil, an aquatic plant, can be transferred from lake to lake by boaters and Dutch elm disease can be transported in firewood. Hay brought in from BC may be subjected to inspection for scentless chamomile and refused entry if it is found. Municipalities also have some control over management of species designated as noxious weeds.

PRIVATE INITIATIVES

Over the last decade, conservation groups and foundations have played an increasing role in preserving natural habitat and endangered species. These efforts include funding initiatives, land acquisition, program management activities carried out by specialists, and approved stewardship programs carried out by volunteers.

Volunteer funding sources include private and corporate donations and government contributions to volunteer programs. One of the most important funding initiatives of nongovernment sources is that of World Wildlife Fund Canada (WWFC). It has funded numerous projects aimed at saving rare, threatened, and endangered species and habitats. World Wildlife Fund Canada acts as a bank and regulatory body; it takes contributions and holds and distributes funds for various approved projects.

In 1989, World Wildlife Fund Canada launched a ten-year campaign called Endangered Spaces. The program organizers propose that the ecological values of all natural regions of Canada be protected in a respective representative area by the year 2000. A target of protecting 12 percent of Canada's lands and waters was set. In Alberta, only the Peace River Lowland and the alpine and subalpine regions of the Rocky Mountains are adequately protected by virtue of the national parks. The Government of Alberta has not endorsed the Endangered Spaces program.

The Wild West program is another example of a cooperative, volunteer-funded World Wildlife Fund Canada project. It constitutes one initiative within WWFC. Funding contributors range from volunteer groups to corporate sponsors. This million-dollar program supported the development of the Prairie Conservation Action Plan which included population surveys of uncommon Alberta species such as painted turtles and ferruginous hawks. This WWFC Conservation Plan also sponsored searches for rattlesnake hibernacula (cavities where snakes hibernate) and the captive breeding of swift foxes for reintroduction to the wild. The Wild West program has been completed, and a new three-year program called Prairie for Tomorrow currently pursues similar objectives.

Wildlife Habitat Canada is another nonprofit organization pursuing conservation goals. Over the past five years it has been involved with programs designed to encourage landowners and industries such as agriculture and forestry to modify their practices to conserve wildlife habitat. The monetary value of its contributions to Alberta conservation initiatives add up to over $1 million.

Ducks Unlimited Canada, a private organization supported primarily by North America's waterfowl hunters, is very much involved in enhancing wetland habitat for waterfowl production. Active in Alberta since 1938, Ducks Unlimited Canada has contributed over $45 million to wetland projects over the years. Similar organizations have been formed by anglers. Trout Unlimited has supported fisheries enhancement projects and the recently formed Western Walleye Council has supported research on walleye fisheries in Alberta.

Conservation organizations are also involved in managing nature reserves. The Clifford E. Lee Nature Sanctuary near Edmonton is owned by the Canadian Nature Federation and managed by a local committee. The Wagner Natural Area Society manages a unique bog near Edmonton, contain-

ing several rare orchid and other species. Many other conservation groups promote conservation of endangered species and habitats through local stewardship programs, lobbying, and education. In Alberta, the Federation of Alberta Naturalists and its affiliated clubs, Canadian Parks and Wilderness Society, Alberta Wilderness Association, Alberta Fish and Game Association, Alberta Native Plant Council, Swift Fox Conservation Society, and many other organizations contribute hours of volunteer work to the conservation of Alberta's flora and fauna.

EDUCATION

The principal cause of the difficulties in maintaining biological diversity is the historic lack of understanding of its nature and importance. While this situation has begun to change, more understanding is needed, particularly in view of the importance of private action in preserving habitat.

Not long ago, general interest materials on environmental topics and environmental education programs were extremely narrowly focused on specific issues or species. With the growing research emphasis on interrelationships among species and systems, environmental education of all kinds has turned toward an ecosystem approach. This approach accommodates increased discussion of biological diversity.

As it becomes easy for anyone, from the serious student of biology to the casual reader or television watcher, to explore the complexities of biological diversity, the ease of introducing and carrying out programs to maintain it will increase. (For a more detailed look at environmental education in Alberta, see *EE2000: Environmental Education for a Sustainable Future*, published by the Environment Council of Alberta.)

Chapter Six

Saving Endangered Species

Despite efforts to preserve Alberta's plant and animal species, extinctions have occurred. The prairie wolf and plains grizzly, subspecies of the animals present in northern and mountain regions, and the passenger pigeon have disappeared (World Wildlife Fund Canada 1988). And the swift fox, black-footed ferret, yellow-cheeked vole, wood bison, and greater prairie chicken have been extirpated; populations do exist elsewhere but they are no longer found in Alberta in the wild (Alberta Fish and Wildlife Division 1985).

While reintroduction of extirpated species is being attempted, for example, as it has been with the wood bison and swift fox, this practice is very difficult and expensive. Furthermore, the ongoing disturbance of the natural landscape in Alberta from settlement, agriculture, natural resource utilization, and pollution of air, water, and soil neutralize or sabotage reintroduction activities. Reintroductions will continue to be ineffective without supporting habitat and species protection policies and legislation.

MAMMALS AND BIRDS

Among all native species in Alberta, the greatest body of knowledge exists for mammals and birds. Census of populations and various types of research on biology and habitat requirements have been done for some species, and knowledge continues to grow as observations are made by academic researchers, students, professional biologists from within and outside of government agencies, and amateur naturalists. The Breeding Bird Atlas project of the Federation of Alberta Naturalists is an excellent example of cooperation in this regard.

National Initiatives

Because many species occupy large ranges extending into several provinces, a national approach to identifying endangered species has been taken in Canada. In 1976, for example, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established. COSEWIC is composed of scientific experts from government and private conservation organizations. It has no legislative or management responsibility, but rather functions to evaluate and determine the biological status of potentially endangered wildlife species. COSEWIC produces an annual list of species using the categories of extinct, extirpated, endangered, threatened, and vulnerable. The Committee also will de-list species whose populations increase to a point at which they are no longer at risk.

To directly aid the mammal and bird species that are in trouble, Canada established a Strategy for the Recovery of Nationally Endangered Wildlife in Canada (RENEW) in autumn 1988. The RENEW Committee consists of wildlife directors from provincial and territorial agencies, the Canadian Wildlife Service, and three national private conservation organizations: the Canadian Wildlife Federation, World Wildlife Fund Canada, and the Canadian Nature Federation.

RENEW is establishing a recovery team for each species listed as endangered or threatened by COSEWIC. These teams consist of scientific experts and people from the government agencies directly responsible for managing the species. They will create recovery plans for the endangered species that will include information on factors adversely affecting the species, research required to understand how to rehabilitate the species, and a specific management program designed to increase the species population.

Many of the bird species which require assistance are migratory, and it is sometimes necessary to establish programs at one end of the migratory pattern to offset damage which the population suffers elsewhere. While establishing new international programs is never easy, the fact that recovery projects are invariably cheaper and more successful if they address the source of the problem should encourage attempts at further international cooperation.

Table 2: Species Designation Chart

Endangered	A species whose presence in Alberta is in danger of extinction within the next decade.
Extinct	Any native species that no longer exists anywhere.
Extirpated	Any native species of fauna or flora that no longer exists in the wild in Alberta, but survives elsewhere.
Rare	Any native species that occurs in low numbers or restricted areas and is secure.
Threatened	A native species that is likely to become endangered if the factors affecting its vulnerability are not reversed.
Vulnerable	Any species that exists in low numbers or in very restricted areas where status could worsen unless remedial actions are taken.

Source: Adapted from Alberta Energy and Natural Resources (1985)

Provincial Initiatives

With respect to Alberta itself, the Wildlife Act proclaimed in 1987, contains a regulation which lists 12 species considered to be endangered. These species are the peregrine falcon, whooping crane, wood bison, swift fox, burrowing owl, ferruginous hawk, woodland and barren-ground caribou, piping plover, mountain plover, trumpeter swan, and white pelican. It is illegal to hunt these species for any reason and severe penalties apply.

The Alberta government has also established the Policy for the Management of Threatened Wildlife in Alberta (Alberta Fish and Wildlife Division 1985). The goal of this policy is to restore species populations in Alberta to viable levels and four general approaches — monitoring, protection, short-term management strategies, and long-term management strategies — have been identified to accomplish this.

Monitoring

The first and foremost priority is to monitor the populations of endangered species and investigate species which are suspected by experts to be experiencing population declines or increased vulnerability for habitat disruption. Examples of species currently being monitored include the Baird's sparrow, ferruginous hawk, and woodland caribou.

Protection

Protection of species known to be endangered is the second priority in preventing their extinction. This protection aspect of provincial policy focuses on regulating human consumptive activity and habitat destruction. For example, government legislation enables cabinet to establish sanctuaries such as ecological reserves which prevent disturbance to the wildlife population itself and the landscape on which it lives.

Provincial legislation also enables establishment of land-use guidelines to reduce the impact of industrial, recreational, and agricultural activities on endangered mammals and birds. These guidelines should be based on research and field investigations which identify the important requirements of the species.

Legal protection of endangered mammals and birds is afforded by the Alberta Wildlife Act. Infringement of its regulations is punishable through fines and imprisonment. While this protection is essential, it is difficult to enforce.

Short-Term Management Strategies

If protection of a species and its habitat does not seem to bring about the recovery of a population, there are more active forms of management which may be used. These include:

1) alleviating problems of competition, predation, parasitism, and disease which the species faces;

2) providing extra food and protecting the natural food source to ensure its availability;

3) increasing reproductive success by protecting nesting or breeding areas or providing artificial sites. For example, baskets on poles provide nesting sites for ferruginous hawks;

4) manipulating aspects of reproductive biology. For example, "dummy" eggs can be placed in the nest of a peregrine falcon to replace cracked or infertile eggs, and later replaced with captive-bred nestlings;

5) captive breeding in special facilities;

6) transplanting animals to suitable areas; and

7) improving the habitat where a species lives.

All of these techniques are expensive, labor intensive, short term and must realistically be viewed as stopgap measures (Alberta Fish and Wildlife Division 1985).

Long-Term Management Strategies

To provide the best possible long-term management of Alberta's endangered mammals and birds under provincial policy, the Fish and Wildlife Division is creating management plans for each of the 12 endangered species identified by the Alberta Wildlife Act. The ultimate goal is to bring populations to a level where the species is no longer at risk. With this goal in mind, the plans will provide biological information on the species and on activities that will aid the species' recovery. These activities will often be site-specific and may include protecting or developing habitat, educating the public, or transplanting individual animals from one area to another.

AMPHIBIANS, REPTILES, AND FISH

Often, little is known about the natural history of amphibian, reptile, and fish species. To date, for example, endangered wildlife management has focused on species much more visible and, to some, more aesthetically pleasing than the great plains toad or western silvery minnow. Current designation by COSEWIC is at best a preliminary assessment of Alberta populations in these categories. As information continues to be gathered about populations of amphibians, reptiles, and fish, threatened species from these groups should begin to receive management attention.

National Initiatives

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) includes amphibians, reptiles, and fish in its listing of endangered species. The Strategy for the Recovery of Nationally Endangered Wildlife in Canada (RENEW) addresses itself to establishing recovery plans for each of these groups; however, endangered species of fish will not be dealt with in the initial activities of the RENEW Committee.

Provincial Initiatives

In 1984, the Fish and Wildlife Division published a status report on the fish and wildlife resource in Alberta. It describes Alberta's ten species of amphibians (salamanders, frogs, toads) and eight species of reptiles (turtles, lizards, snakes). In this document (Alberta Fish and Wildlife Division 1984) the western painted turtle and plains hognose snake were said to be endangered; the eastern short-horned lizard threatened; the long-toed salamander rare; and the northern leopard frog experiencing serious population decline.

Other researchers (Butler and Roberts 1987; Cottonwood Consultants Ltd. 1986) have arrived at similar designations and have added two more species to the list. The great plains toad is felt to be endangered and the plains spadefoot toad potentially threatened. As well, these researchers have concluded that populations of the northern leopard frog have declined to a point where it should be considered a threatened species. Furthermore, the work of these researchers indicates that the grey tiger salamander, a distinct subspecies of the widespread and quite common tiger salamander, may only occur in a limited area along the central Saskatchewan border. These uncommon populations may require consideration for preservation as well (Butler and Roberts 1987).

Despite this evidence of concern, no amphibian or reptiles are listed as endangered in regulations under the Wildlife Act. Alberta Fish and Wildlife has provincial responsibility for the protection and management of amphibians and reptiles. However, fish species in Alberta come under a rather complex arrangement of joint federal and provincial control. The federal government under the jurisdiction of the Fisheries Act has legislative power over fisheries throughout Canada, but in Alberta the provincial government manages freshwater fisheries, fish habitat, and hatcheries. Alberta's Wildlife Act does not include fish species under its jurisdiction; therefore no fish are formally identified by the province as endangered species.

The Banff longnose dace, a small fish found only in the outflow of the Cave and Basin Hotspring near Banff, is a subspecies of dace now thought to be extinct. The western silvery minnow is considered to be rare in Alberta (McAllister et al. 1985); it is found only in the South Saskatchewan and Milk rivers. Fishing for lake sturgeon has been restricted since 1940 as they are considered to be endangered. These fish are, at present, relatively abundant only in the South Saskatchewan River near Medicine Hat, although they were once found in the North Saskatchewan and Brazeau rivers (Alberta Fish and Wildlife Division1984).

INVERTEBRATES

Invertebrates include insects, worms, and other animals that do not have backbones. Since we lack even a proper inventory of the invertebrate populations in the province, it is impossible to know to what extent individual species may be threatened or endangered. Furthermore, the current state of knowledge about the life cycles of such species is almost certainly inadequate to establish protection or recovery programs. As has been emphasized earlier, protection of large enough tracts of sufficiently diverse habitats must serve as the principal line of defense against losses in this category of species.

PLANTS

Knowledge of and general concern for endangered species of plants seem traditionally to lag behind that for endangered wild animals. For example, there is inadequate knowledge of the distribution and biology of Alberta's native plants to establish which, if any, are endangered. Botanists instead deal with rare species, a category which can be defined in several ways. Generally, rare plants are considered to be those having small populations within Alberta. The species may be either restricted to a small geographical area or may occur sparsely over a wide area. Some species considered rare in Alberta are those for which this is the furthest extent of their widespread geographic range (Kershaw 1987). To the south or west, for example, these same species may be quite common.

Because of their small numbers, rare plants are the most likely to be threatened with extinction should environmental conditions change, either naturally or due to human activities. As many as one-quarter of Alberta's native plants (about 360 species) have been identified as rare (Packer and Bradley 1984). In order to determine whether any of these species is endangered, one needs extensive knowledge about the species' habitat needs, its present population size, factors controlling its population size, and possible threats to the population. This information is available for very few of Alberta's rare species. Large geographic areas have not been adequately surveyed to determine the species growing there and access to the information which does exist can be difficult as there is no central registry for such data.

Steps have been and are being taken, however, to improve the biological information available on these species and raise public awareness of the problem of rare and endangered plants. Lists of rare plants have been published for Alberta, firstly in 1978 by the National Museum of Natural Sciences (Argus and White, 1978) and in 1984 by the Provincial Museum of Alberta (Packer and Bradley 1984). The 1984 checklist includes maps showing the distribution of each of the species within the province. A more detailed four-volume manuscript was published in 1987 by Alberta Forestry, Lands and Wildlife (see Fairbarns et al. 1987; Wallis 1987a; Wallis et al. 1987a; Wallis et al. 1987b). This document, *The Rare Vascular Flora of Alberta,* summarizes the available information and attempts to establish population status both within and outside the province of those rare species on the 1984 Packer and Bradley checklist.

The Rare Vascular Flora of Alberta also highlights the need to identify several species in southern Alberta as endangered. The sand verbena, western spiderwort, and smooth goosefoot, are rare in Alberta and in Canada. These three

species are associated with active sand dunes in the Grassland Natural Region (mixed-grassland subregion) and there is some concern regarding the loss of active sand habitats due to dune stabilization. The western blue flag is restricted to a few sites in moist meadows in the same natural region (foothills subregion) and is considered threatened in Alberta.

Status reports on these four rare species are currently being prepared for submission to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These reports will summarize all that is currently known about these species. This includes species distribution, numbers (historical and present), habitat characteristics, population biology, land ownership, known cultivars and threats. On the basis of these reports, formal COSEWIC status of rare, threatened or endangered may be given these plants. Designation on the COSEWIC list of endangered species would considerably increase the profile of these rare plants and hopefully aid in efforts to save and expand the existing populations (Wallis 1989).

Provincial Initiatives

The Alberta Native Plant Council (ANPC) is a nongovernment organization. It was established in 1986 in response to the strong interest in rare plants expressed at the Endangered Species in the Prairie Provinces workshop in Edmonton, January 1986. Objectives of the ANPC include coordinating information and activities on native plants, informing government, industry and the public on plant management and protection, encouraging native plant research and developing conservation actions and guidelines for the wide use and protection of native plants. As well, the Alberta Natural and Protected Areas program (part of the Government of Alberta's Forestry, Lands and Wildlife Department) is producing a series of fact sheets entitled *Alberta's Rare Plants* which describe what constitutes a rare plant and which highlight particular species of concern.

Overall, the need exists for much greater attention to rare and endangered plants in Alberta especially in the area of interdepartmental cooperation and legislation. For example, there currently is no single government agency in Alberta formally responsible for the management and protection of wild plants.

Species that are protected are managed by the agency which administers the particular area of land on which they grow. Alberta Recreation and Parks, Canadian Parks Service, and Alberta Forestry, Lands and Wildlife are examples of such agencies. While these agencies may protect areas specifically to aid the survival of an endangered plant species, often vegetation is changed or destroyed as a result of other priorities, usually recreational, with little thought to the status of individual plant species growing there.

Furthermore, none of the natural resource management agencies have any specific rare plant management policy. As a result, direct recognition of rare plants is often absent when planning, assessment, and administration of natural resource management programs are carried out (Achuff 1987).

INTERNATIONAL REGULATIONS

International trade of endangered plant or animal species is tightly controlled. Canada is one of 98 countries who are signatory to the Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES). For over 20,000 species on the control lists, permits are required for import or export. This includes individual animals and plants as well as parts or artifacts made from them, such as turtle shells, tanned hides, and most ivory jewellery. In Canada, CITES is enacted under the Export and Import Act. Enforcement is very limited, however, due to the very small number of properly trained personnel stationed at ports of entry; for instance, for all of Alberta, the Yukon and the Northwest Territories, there is one officer stationed in Edmonton (Kerr 1990: pers. comm.).

Table 3: Canadian Animals and Plants Regulated by *CITES
(*Convention on International Trade of Endangered Species of Wild Flora and Fauna)

CITES Appendix 1 – Endangered

Mammals

- black-footed ferret
- wood bison
- blue, bowhead, right, humpback whales
- eastern cougar
- sperm and fin whales

Birds

- whooping crane
- Eskimo curlew
- peregrine falcon and gyrfalcon
- bald eagle
- Aleutian Canada goose

Amphibians, Reptiles, and Fish

- leatherback turtle
- shortnose sturgeon

Plants

- none

CITES Appendix 2 – Threatened

Mammals

- bobcat
- lynx
- grizzly bear
- northern elephant seal
- all whales not listed in Appendix 1
- western cougar
- wolf
- polar bear
- river and sea otter

Birds

- sandhill cranes
- all owls, eagles, and falcons not listed in Appendix 1
- all hummingbirds

Amphibians, Reptiles, and Fish

- bog turtle
- rubber boa

Plants

- all cacti
- all orchids
- wild ginseng
- pitcher plants

CITES Appendix 3 – Other Species

- walrus

There are three control lists established by CITES. Animal species in CITES Appendix 1 (see Table 3) are endangered, and permits are required from both the exporting and importing countries. Permits issued in this category are generally for museum artifacts, such as ivory and hides, or for animals for breeding programs in certified zoos. Permission will not be given if commercial gain is involved.

The 1988 panda exhibit at the Calgary Zoo offers an example of how these specific CITES permits are applied. Permission was given for the exhibition because the pandas were shown by a nonprofit organization as part of an educational program that contributed to public support for panda protection and helped raised funds for this cause.

Appendix 2 of CITES lists threatened species for which permits are required from the exporting country, but not from the importing country. The species listed in Appendix 3 of CITES are not endangered or threatened, but it is desirable to regulate their international trade for other reasons.

EX SITU CONSERVATION

At times, when removing plants and animals from the wild is the only option for preserving a species, man-made environments are also used for out-of-habitat, or ex situ, conservation activities. Zoos and botanic gardens, two examples of ex situ conservation sites, contribute to public appreciation and protection of biodiversity in indirect and direct ways. They expose the general public to common and rare plant and animal species through leisure and educational activities and often house scientific research projects.

Zoos

Zoos play an important role in breeding and raising endangered species in captivity. The international zoo community has created Species Survival programs. Zoos in North America, Europe, the Pacific Rim, and other parts of the world participate in this and other similar programs. The objective of these programs is to manage the entire captive population of certain endangered species according to a genetic masterplan. To achieve such a comprehensive objective, zoos conduct extensive exchange schedules of individual animals. This approach to breeding ensures that the genetic resource of the entire population is utilized. Sometimes the gene pools included in these programs can be greater than the genetic diversity of small, fragmented wild populations.

There are species which exist only in zoological gardens and a rapidly growing list of species facing certain extinction. The Species Survival programs are designed to maintain these animals in captivity and attempt to maintain them ex situ as a species bank. In some cases, such salvaged populations may be restored to the wild, and some successes have been achieved in this regard. Some species that were limited to captive populations, but have since been successfully reintroduced to the wild, include the Hawaiian goose, golden lion marmoset, and several others.

Zoos, however, are poor substitutes for secure, wild populations. The small size of these captive populations exposes them to catastrophic losses, and the limited variety available in captive gene pools can lead to inbreeding. Zoo environments are not always conducive either to successful reproduction or to good replication of the natural spread and mix of genes needed for survival in the wild. Furthermore, reintroduction is often difficult even when the original causes of extirpation have been eliminated. Difficulties occur because habitat sometimes changes and many associated species may have been lost from the area during the absence of the species targeted for reintroduction.

Botanic Gardens

Botanic gardens function throughout the world as collections of living plants. These collections are maintained for a variety of purposes — viewing pleasure, education, economics, medicine,

science, and more recently, for the conservation of rare or endangered plants.

There are several botanic gardens and plant collections in Alberta. Some Alberta zoos, such as the Calgary Zoo, Botanical Garden & Prehistoric Park, also have extensive botanic collections. Several other botanic gardens are dedicated to plants alone. The University of Alberta Devonian Botanic Garden near Edmonton, for example, is an active member of the international botanic garden community. Approximately 40 species in cultivation at the Devonian Botanic Gardens are considered to be endangered species in some parts of the world.

Cultivation of these endangered plants in man-made environments cannot be viewed as an adequate solution to the endangerment faced by these species in their native habitats, since the climate, soil types, and associated plant and animal community cannot be the same as in the original habitat. This reduces the overall success of such cultivation and changes the ways in which the genes in the population are redistributed over several generations.

After extended periods of such ex situ cultivation, the gene pool may be so different that reintroduction to the original community becomes impossible. It is, however, a safeguard against the complete extinction of the species from the planet and hence provides a valuable service.

Given the important role that botanic gardens can play in ex situ conservation of endangered plant species, there has been international coordination among botanic gardens for many years. In 1979, the Threatened Plants Committee of the International Union for the Conservation of Nature and Natural Resources (IUCN) established the Botanic Gardens Conservation Coordinating Body. This Body was created to assist botanic gardens in their conservation activities, in particular by providing a scheme for sharing information on the work and threatened plant holdings of individual institutions. In 1987, these functions were taken over by the IUCN Botanic Gardens Conservation Secretariat. The international network of botanic gardens involved in conservation of global plant diversity continues to grow. Through the Secretariat, technical guidance and general information are disseminated and the coordination of international conservation activities is assured.

In addition, universities and government departments conduct plant propagation and conservation programs. The techniques they use include maintaining seed banks, tissue cultivation, transplantation, and propagation of living specimens.

Seed Banks

Seed banks are very important for the preservation of crop plants and their wild relatives. The Plant Gene Resources of Canada was established in 1970 to coordinate the collection, storage, and evaluation of crop genetic resources in Canada. Species held in collection across the country include wheat, barley, oats, tomato, millet, oilseeds, and alfalfa. Internationally, the Food and Agriculture Organization of the United Nations operates the International Board for Plant Genetic Resources (IBPGR). The IBPGR operates in all areas of the world and facilitates the exchange of genetic resources among all countries. It is also involved in research on the preservation and utilization of crop germ plasm (Coulman 1988).

Seeds serve as convenient packages for storing organic genetic material and this packaging enables scientists to redistribute them easily. At seed banks, scientists collect seeds and store them under conditions of low temperature and humidity. Fresh seed is produced by growing out the plants before the germination rate of the stored seeds becomes too low (Coulman 1988). However, as plants are grown over several generations to produce new seed it is possible that some genetic selection may occur in favor of those plants which best tolerate long term artificial seed storage. On the other hand, genetic changes can also occur when plants are cultivated over a long period under artificial conditions, rather than kept in a seed bank (Thompson 1974). In either

case, different selection pressures apply than those that would be acting naturally on the plant in the wild. Some loss of genetic diversity may occur in either the stored plant seeds or in the cultivated specimens.

Tissue Culture

Tissue culture is another technique for conserving plant species. Using this technique, many plants can be produced in test tubes on a special nutrient gel. Growth of new plants occurs vegetatively from portions of an original plant, as is commonly done with many houseplants. All offspring are genetically identical to the original plant, and even though many individual plants can be produced from the tissue culture, they constitute a very limited reserve of the species' gene pool. Moreover, both seed banks and tissue cultures are expensive to establish and operate, and less reliable than keeping wild places for plants to grow naturally.

Transplantation

Transplantation of rare native plants to new environments is an unreliable technique. Frequently the introduced plants die because the exact environmental conditions which they require are not present. Many plants, such as orchids, grow only in association with certain other plants or fungi. Also, transplanting species often disrupts the habitat into which they have been introduced. Transplanting in an attempt to recreate a plant community which has been lost is seldom successful over the long term and is very difficult because of the many critical and interacting environmental factors. Reintroduction of extirpated plant species is a technique of last resort and should not be considered as an alternative to protection of the plant in the wild (Fahselt 1988).

Living Specimens

Long-lived perennials that may take many years to reach reproductive maturity, such as many tree species, are best kept as living specimens. These plants will eventually provide a seed source. This is particularly valuable for those species whose seeds cannot be stored. Careful planning and monitoring of live plant collections is important to ensure that different species do not hybridize and that different groups of individuals from the same species retain their genetically unique characteristics.

Chapter Seven

Future Outlook

Biological diversity is fundamental to individual ecosystems and, ultimately, the entire biosphere. As biodiversity is eroded and our environment becomes more uniform, the earth's natural systems may become more susceptible to disruption. These systems may also become less able to successfully adapt to major environmental change.

Avoiding such a crisis will require determination and political will, for the threshold at which some resources may be lost is very near, and the challenge of avoiding such a crisis is very complex.

In terms of time, information needs, and decision making the crisis is illustrated by the plight of the woodland caribou of west-central Alberta. In addition to the fact that declining numbers of caribou have been evident for many years, the recent expansion of forestry operations may affect critical habitat, and certain data must be sought before new logging activity seals their fate.

The obstacles to preserving biodiversity are further complicated, in general, by the intricacies involved in mitigating the effects of many small, seemingly unrelated developments — cottages, golf courses, oil and gas exploration, roads, water supply, and gravel extraction — that affect particular ecosystems. Integrating these uses will require new decision-making procedures because the impacts of these activities are not normally evaluated at the same time by the same government agency.

RECOMMENDATIONS

Three main, interrelated initiatives should be pursued to meet the challenge of protecting Alberta's biodiversity. These include 1) protection of the representative ecosystems within each natural region, 2) the establishment of an effective system for making, reviewing, and monitoring the decisions that affect biodiversity, and 3) public education about the value of biodiversity.

Protection

There is no substitute for retaining biological resources in their wild state.

This requires preservation of habitat, yet Alberta's system of ecological reserves is far from complete. Only three of the seventeen natural subregions are adequately protected. Progress is being made, but very slowly because political will appears to be lacking.

Protecting representative ecosystems first requires that a thorough inventory of Alberta's ecosystems be established. Within each broad ecosystem category, specific communities which represent the diversity of that ecosystem should be identified, especially those systems that include unusual species or species at risk. In addition, an inventory of the status of land (private/Crown, level of protection) within each ecosystem should be developed. This expanded ecosystem inventory will provide the background information on which to base a cohesive system of protection for our biological resources, a system in which individual decisions are not counterproductive.

Decision Making

Decisions that affect Alberta's biological resources are made by government, industry, and private individuals; therefore, it is important that these parties recognize that biodiversity is a valuable resource worth protecting.

The Alberta Conservation Strategy, of which this report is part, provides a useful framework for such decisions. This framework is now in the hands of the Alberta Round Table on Environment and Economy, and it is hoped that the Round Table will champion the importance of biodiversity as part of the sustainable development policy they create for Alberta.

Current mechanisms that assist decision making regarding Alberta's biodiversity include the Integrated Resource Plan process (see page 33) and the new Natural Resources Conservation Board (NRCB). These initiatives provide avenues for public input on resource management plans and assessments of individual projects.

To date, the extremely slow progress of integrated resource planning raises questions about the system's effectiveness and the government's commitment to it. For example, after almost 15 years of planning, only the public lands in the Eastern Slopes Region are effectively regulated by completed plans. Other areas, such as the northern boreal forest, have no regional plan in place; and, major land-use decisions, such as those related to massive pulp mill projects, have been made without completed conservation plans for the areas affected.

The NRCB may provide better assessment of individual projects, but cumulative impacts of many individual projects may escape evaluation. The board's resolve to include protection of biodiversity as a criterion for its decisions remains untested.

In general, greater political will, interdepartmental cooperation, cooperation between nongovernment organizations and interest groups, and enforceable legislation (rather than just policy) for conservation and protection initiatives would further the cause of preserving Alberta's biological diversity.

Public Education

Widespread understanding of the scientific, social, and political issues affecting biodiversity is closely related to public decision making and resource protection activities. Knowledge can motivate and direct effective action.

While there are numerous organizations and government departments that provide environmental education programs and information, individuals should not overlook informal educational opportunities available through the various nonprofit environmental organizations and community and service groups. Participation in such group activities can be both informative and effective in terms of having an immediate positive impact on the environment. Here are a few suggestions:

- visit and support local wildlife viewing areas,
- learn about local biological resources, protected areas and their current management, and network with local specialists,
- make such activities a family or service group project,
- learn about relevant issues so that you can participate in public forums in an informed manner.

Conclusion

The breadth and complexity of the challenge of preserving biodiversity assures that no one need lack a chance to contribute, regardless of the specific skills or interest he or she brings to the task.

Since the biodiversity of the planet as a whole is of benefit to all of its people, we must also remember to consider our contributions to maintaining or destroying resources not actually on our doorstep. The preservation of biodiversity in Alberta is a splendid opportunity to think globally and act locally.

References

Achuff, P.L. 1987. Rare vascular plants in the Rocky Mountains of Alberta. In *Proceedings of the workshop on endangered species in the Prairie provinces.* G. Holroyd et al., editors. Edmonton: Alberta Culture. Provincial Museum of Alberta Natural History Occasional Paper no. 9.

Alberta Agriculture. 1988. *Agriculture in Alberta.* Edmonton: Alberta Agriculture. Agdex 000-25.

Alberta Energy and Natural Resources. 1982. *Fish and wildlife policy for Alberta.* Edmonton: Fish and Wildlife Division, Alberta Energy and Natural Resources.

Alberta Fish and Wildlife Division. 1984. *Status of the fish and wildlife resource in Alberta.* Edmonton: Alberta Energy and Natural Resources.

Alberta Fish and Wildlife Division. 1985. *A Policy for the management of threatened wildlife in Alberta.* Edmonton: Alberta Energy and Natural Resources.

Alberta Fish and Wildlife Division. [n.d.] *What is a rare plant?* Edmonton: Alberta Energy and Natural Resources. Alberta's Rare Plants Fact Sheet no. 1.

Alberta Forestry, Lands and Wildlife. 1990. *Alberta wildlife viewing guide.* Edmonton: Lone Pine Publishing.

Alberta Recreation and Parks. 1985. *Policy statement for the development of recreation and parks.* December draft. Edmonton: Alberta Recreation and Parks.

Ambrose, J.D.; Rice, P.F. 1988. Guidelines for ex situ conservation in Canadian botanical gardens and arboreta. *Canadian Plant Conservation Programme Newsletter* 3(1):2-10.

Argus, G.W.; White, D.J. 1978. *The rare vascular plants of Alberta.* Ottawa: National Museum of Natural Sciences, National Museums of Canada. Syllogeus no. 17.

Butler, J.R.; Roberts, W. 1987. Considerations in the protection and conservation of amphibians and reptiles in Alberta. In *Proceedings of the workshop on endangered species in the Prairie provinces.* G. Holroyd et al., editors. Edmonton: Alberta Culture. Provincial Museum of Alberta Natural History Occasional Paper no. 9.

Corns, I.G.W. 1989. Ecosystems with potential for aspen management. *Forestry Chronicle* 65(1):16-22.

Cottonwood Consultants Ltd. 1986. An overview of reptiles and amphibians in Alberta's Grassland and Parkland Natural Regions. Unpublished manuscript prepared for Wild West Program, World Wildlife Fund Canada: Calgary.

Coulman, B.E. 1988. Plant gene resources: worldwide collection and preservation. *Agrologist* 17(3):4-5.

Council for Agricultural Science and Technology. (CAST). 1984. *Animal germplasm preservation and utilization in agricultural science and technology.* Ames, IOWA: CAST. Report no. 101.

de Groot, P. 1988. New life in old crops. *New Scientist* 118(1607):44-48.

Dobzhansky, T. 1970. *Genetics of the evolutionary process.* New York: Columbia University Press.

Doucet, R. 1989. Regeneration silviculture of aspen. *Forestry Chronicle* 65(1):23-27.

Eco/Log Week.1990 Zebra mussels continue proliferating. *Eco/Log Week.*18(27):4.

Economist.1988. The vanishing jungle. *Economist.*15 Oct.: 25-28.

Ehrenfeld, D. 1970. *Biological conservation.* New York: Holt, Rinehart and Winston.

Ehrenfeld, D. 1988. Why put a value on biodiversity? In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

Ehrlich, P.; Ehrlich, A. 1981. *Extinction: the causes and consequences of the disappearance of species.* New York: Ballantine Books.

Environmental Education Advisory Committee to the Environment Council of Alberta. 1989. *EE2000: Environmental Education for a Sustainable Future.* Edmonton: Environment Council of Alberta. Sector report for an Alberta conservation strategy.

Fahselt, D. 1988. The dangers of transplantation as a conservation technique. *Natural Areas Journal* 8(4):238-244.

Fairbarns, M.; Loewen, V.; Bradley, C. 1987. *The rare vascular flora of Alberta. vol. 1: A summary of the taxa occurring in the Rocky Mountain Natural Region.* Natural Areas Technical Report no. 29. Edmonton: Alberta Forestry, Lands and Wildlife. Publication no. T/155.

Farnsworth, N.R. 1988. Screening plants for new medicines. In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

Given, D.R. 1987. What the conservationist requires of ex situ collections. In *Botanic gardens and the world conservation strategy.* Proceedings of an international conference, Las Palmas de Gran Canaria, 26-30 Nov. 1985. D. Bramwell et al., editors. San Diego: Academic Press.

Hinman, C.W. 1986. Potential new crops. *Scientific American* 225(1):33-37.

Iltis, H.H. 1988. Serendipity in the exploration of biodiversity: what good are weedy tomatoes? In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

International Union for the Conservation of Nature and Natural Resources (IUCN). 1980. *World conservation strategy.* Gland, Switzerland: IUCN.

Johnson and Weichel Resource Management Consultants. 1986. Vanishing heritage. Unpublished manuscript prepared for the Saskatchewan Natural History Society, Raymore, Saskatchewan.

Kershaw, L. 1987. Rare plants in the Prairie provinces: a discussion of terms and distribution characteristics. In *Proceedings of the workshop on endangered species in the Prairie provinces.* G. Holroyd et al., editors. Edmonton: Alberta Culture. Provincial Museum of Alberta Natural History Occasional Paper no. 9.

Lilley, J.; Webb, C. 1990. *Climate warming?: exploring the answers.* Edmonton: Environment Council of Alberta.

McAllister, D.E.; Parker, B.J.; McKee, P.M. 1985. *Rare, endangered and extinct fishes in Canada.* National Museum of Natural Sciences. Ottawa: National Museums of Canada. Syllogeus no. 54

Nations, J.D. 1988. Deep ecology meets the developing world. In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

Packer, J.G.; Bradley, C.E. 1984. *A checklist of the rare vascular plants in Alberta.* Edmonton: Alberta Culture. Provincial Museum of Alberta Natural History Occasional Paper no. 5.

Plotkin, M.J. 1988. The outlook for new agricultural and industrial products from the Tropics. In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

Prairie Habitat Joint Venture. [n.d.] *Prairie habitat: a prospectus.* North American Waterfowl Management Plan. Edmonton: Canadian Wildlife Service.

Prescott-Allen, R.; Prescott-Allen, C. 1982. *What's wildlife worth?: economic contributions of wild plants and animals to developing countries.* London and Washington, D.C.: International Institute for Environment and Development.

Randall, A. 1988. What mainstream economists have to say about the value of biodiversity. In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

Rizzo, B. 1988. The sensitivity of ecosystems to climatic change. *Canada Committee on Ecological Land Classification Newsletter* 17:10-12.

Robbins, C.S.; Bystrak, D; Geissler, P.H. 1986. *The breeding bird survey: its first fifteen years, 1965-1979.* Washington, D.C.: Fish and Wildlife Service, United States Department of Interior. Resource Publication no. 157.

Strauss, S. 1988. Return to Eden. *Globe and Mail* May 28: section D-1.

Strong, W.L; Leggat, K.R. 1981. *Ecoregions of Alberta.* Edmonton: Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. ENR Technical Report no. T/4.

Swinnerton, G. 1991. *People, parks and preservation.* Edmonton: Environment Council of Alberta. Discussion paper for an Alberta conservation strategy.

Thompson, P.A. 1974. The use of seed-banks for conservation of populations of species and ecotypes. *Biological Conservation* 6(1):15-19

Wallis, C. 1987a. *The rare vascular flora of Alberta. vol 2: A summary of the taxa occurring in the Canadian Shield, Boreal Forest, Aspen Parkland, and Grassland Natural Regions.* Edmonton: Alberta Forestry, Lands and Wildlife. Publication no. T/164.

Wallis, C. 1987b. Critical, threatened, and endangered habitats in Alberta. In *Proceedings of the workshop on endangered species in the Prairie provinces.* G. Holroyd et. al., editors. Edmonton: Alberta Culture. Provincial Museum of Alberta Natural History Occasional Paper no. 9.

Wallis, C. 1989. Conservation action committee successful in obtaining contracts to prepare status reports for four of Alberta's rare native plant species. Edmonton: Alberta Native Plant Council. *Iris Newsletter* 4 (winter).

Wallis, C.; Bradley, C.; Fairbarns, M.; Loewen. V. 1987a. *The rare vascular flora of Alberta. vol. 3: Species summary sheets.* Edmonton: Alberta Forestry, Lands and Wildlife. Publication no. T/155.

Wallis, C.; Bradley, C.; Fairbarns, M.; Loewen. V. 1987b. *The rare vascular flora of Alberta. vol. 4: Bibliography.* Edmonton: Alberta Forestry, Lands and Wildlife. Publication no. T/155.

Weisburd, S. 1987. Frog defense: make snakes yawn. *Science News* 132(14):215.

Wilson, E.O. 1988. The current state of biological diversity. In *Biodiversity.* E.O. Wilson, editor. Washington, D.C.: National Academy Press.

Wilson, E.O., editor. 1988. *Biodiversity.* Washington, D.C.: National Academy Press.

World Commission on Environment and Development. 1987. *Our common future.* New York: Oxford University Press.

World Wildlife Fund Canada. 1988. *Prairie conservation action plan.* Toronto: The Fund.

Zoltai, S.C. 1988. Ecoclimatic provinces of Canada and man-induced climate change. *Canadian Committee on Ecological Land Classification Newsletter* 17:12-15.

Personal Communications

Delver. L. 1989. Agriculture Canada. Calgary.

Holroyd. G. 1990. Research Scientist. Canadian Wildlife Service. Edmonton.

Kerr. G. 1990. Canadian Wildlife Service. Edmonton.

Koivisto, G. 1989. Agriculture Canada. Edmonton.

Related Publications

Renewable Resources Subcommittee, Public Advisory Committees to the Environment Council of Alberta. 1989. *A Place For Wildlife.* Edmonton: Environment Council of Alberta. Discussion paper for an Alberta conservation strategy.

Renewable Resources Subcommittee, Public Advisory Committees to the Environment Council of Alberta. 1990. *Our Dynamic Forests: The Challenge of Management.* Edmonton: Environment Council of Alberta. Discussion paper for an Alberta conservation strategy.

Usher, R.; Scarth, J. 1990. *Alberta's Wetlands: Water in the Bank!* Edmonton: Environment Council of Alberta. Discussion paper for an Alberta conservation strategy.

Webb, C. 1987. *Reserves for Nature.* Edmonton: Environment Council of Alberta. Discussion paper for an Alberta conservation strategy.