1 INTRODUCTION

Biodiversity is the variability among all living organisms – within species, between species and of ecosystems – resulting from four billion years of evolution.

Biodiversity supports human societies ecologically, economically, culturally and spiritually. Despite its importance, ecosystems are being degraded and species and genetic diversity are declining at an alarming rate. This is due to the impact of a number of forcing agents, including a changing climate, growing human populations and increasing resource consumption.

The global decline in biodiversity is now recognized as one of the most serious environmental issues facing humanity. A global goal has been defined: to reduce the rate of biodiversity loss by 2010.

1.1. The United Nations Convention on Biological Diversity (1992)
http://www.cbd.int/

In response to current and impending losses in biodiversity, the United Nations enacted the United Nations Convention on Biological Diversity (CBD) in 1993. Canada was the first industrialized country to sign and ratify the CBD in 1992. There are presently 189 parties to the CBD: 188 member states and the European Community.

The three objectives of the CBD are:

- the conservation of biodiversity;
- the sustainable use of biological resources; and
- the fair and equitable sharing of the benefits that result from the use of genetic resources.

Scientific studies now make it clear that the climate is changing at regional and global levels and that many ecosystems are already being impacted by these changes. Climate change has been described as one of the major challenges of the 21st century to conserving biodiversity, combating desertification and ensuring the sustainable use of natural resources. The threats it poses to ecosystems are compounded by the fact that humans have altered the structure of many of the world's ecosystems through habitat fragmentation, land degradation, pollution and other disturbances, making ecosystems more vulnerable to further changes. Responses to deal with these threats will require improved scientific understanding of the linkages between the climate, biodiversity and the processes of desertification, along with an enhanced "environmental forecasting" capability to predict potential biodiversity and land-use changes.

It should be noted that in a country as vast as Canada, there are significant differences over short distances and time scales in the changing climate, its variability and extremes. Given the number of scientific studies that point to differing localized rates of species and ecosystems adapting or maladapting to the changing climate, it is clear that Canada – which can ill afford to lose even a single species – is in danger of losing multiple ones (Environment Canada, 2003).

1.2. The United Nations Framework Convention on Climate Change (1992)
http://unfccc.int/2860.php

The United Nations Framework Convention on Climate Change (UNFCCC) seeks to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that will avoid dangerous human interference with the climate system. Because the climate of the future will eventually respond to all of the GHGs accumulated in the atmosphere over time, even cutting future GHG emissions to zero will not stop most changes. Hence, ecosystems and communities will still need to adapt to change even if anthropogenic emissions were to cease immediately.

Climate change is likely to have significant impacts on most or all ecosystems, since the distribution patterns of many species and

communities are determined to a large extent by climate. However, the ways in which ecosystems and biodiversity respond to changes in climate are rarely simple. At the most basic level, changing patterns of climate will alter the natural distribution limits for species or biological communities. In some cases, it may be possible for species or communities to migrate in response to changing conditions if there are no significant barriers to migration. Rates of climate change will also be critical, and these will vary at regional and even local levels. The maximum rates of spread for some sedentary species, including large tree species, may be slower than the predicted rates of change in climatic conditions.

The most vulnerable ecosystems will include those habitats where the first or initial impacts are likely to occur, those where the most serious adverse effects may arise and/or those where the least adaptive capacity exists. These include, for example, Arctic, mountain and island ecosystems. Tools and guidance in the form of scientific predictions of ecological states are essential to pinpoint priority ecosystems and to guide climate change response options.

Organisms and ecosystems have a natural but limited ability to adjust to climate change. It is clear that as the climate has cooled and warmed over the past hundreds of thousands of years, the various major ecotypes and the animal communities that inhabit them have shifted cyclically to the north and south. Projected climate change, driven primarily by human-induced causes, is faster and more profound than anything in the past 40,000 years and probably even the last 100,000 years (IPCC, 2007). The United Nations Intergovernmental Panel on Climate Change (IPCC) Working Group II report suggests that 20-30% of global plant and animal species are likely to be at higher risk of extinction if increases in global average temperature exceed 1.5-2.5°C.

1.3. The United Nations Convention to Combat Desertification (1994)

http://www.unccd.int/

The United Nations Convention to Combat Desertification (UNCCD) promotes an innovative approach to managing dryland ecosystems and arid regions. It defines desertification as "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities" (Millennium Ecosystem Assessment, 2005). It also acknowledges the consequences of desertification: losses in biological and economic productivity, as well as complexity, in croplands, pastures and woodlands.

The UNCCD recognizes that combating desertification is critical to improving conditions in developing countries, particularly the least developed. To combat desertification and mitigate its effects, it outlines long-term integrated strategies that focus simultaneously on improved productivity of land and the rehabilitation, conservation and sustainable management of land and water resources. Its chief mechanism for implementing these strategies is through the development of action programs to manage dryland ecosystems and arid regions (UNEP, 1996).

To address the underlying causes of desertification and drought and identify measures to prevent and reverse them, action programs have been detailed for Africa, Asia, Latin America and the Caribbean, and the Northern Mediterranean (UNEP, 1996). The UNCCD also recognizes that the implementation of the UNFCCC, the CBD and related environmental conventions will play a significant role in combating desertification.

1.4. The Canadian Biodiversity Strategy (1995)

http://www.cbin.ec.gc.ca/

At the United Nations Conference on Environment and Development in 1992, more than 156 countries and the European Union signed the CBD. That same year, Canada affirmed its commitment to the CBD through the

production of two key documents: The Canadian Biodiversity Strategy and The Science Assessment on Biodiversity.

By ratifying the CBD, Canada committed itself to the development of a national strategy and, under the direction of the Canadian Biodiversity Office, the federal, provincial and territorial governments agreed to the Canadian Biodiversity Strategy in 1995. As an overarching document, it serves an important role in identifying international and national contexts for biodiversity, defining a vision and outlining many directions for biodiversity conservation.

The current decline of global biodiversity is a strong cross-cutting issue that has the gravity and urgency to integrate decision-making and mobilize individuals and agencies. Canada, like many countries, recognized the significance of this global biodiversity challenge, including the difficult task of integrating many diverse science and policy issues. To some, this was seen as an exercise in building cooperative policy structures and management agreements while to others, it was a singular opportunity to share biodiversity observations and knowledge in the field, the laboratory and the classroom.

The emerging Canadian Biodiversity Strategy had the following vision (BCO, 1995): "A society that lives and develops as a part of nature, values the diversity of life, takes no more than can be replenished and leaves to future generations a nurturing and dynamic world, rich in its biodiversity."

The strategy's five goals are to:

- conserve biodiversity and sustainably use biological resources;
- improve our understanding of ecosystems and increase our resource management capability;
- promote an understanding of the need to conserve biodiversity and sustainably use biological resources;
- maintain or develop incentives and legislation that support the conservation of biodiversity and sustainable use of biological resources; and

- work with other countries to conserve biodiversity, use biological resources sustainably and share equitably the benefits that arise from the utilization of genetic resources.

The strategy's guiding principles are:

- biodiversity has ecological, economic, social, cultural and intrinsic value;
- all life forms, including humans, are ultimately connected to all other life forms;
- all Canadians depend on biodiversity and have a responsibility to contribute to biodiversity conservation and to use biological resources sustainably;
- all Canadians should be encouraged to understand and appreciate the value of biodiversity and participate in resource and air, water and land-use decisions;
- an ecological approach to resource management is central to achieving biodiversity conservation and the sustainable use of biological resources;
- development decisions must reflect ecological, economical, social and cultural values;
- healthy and evolving ecosystems and the maintenance of natural processes are prerequisites for *in-situ* conservation of biological diversity and the sustainable use of biological resources;
- *ex-situ* measures may be required to support the conservation of some species and populations and are essential to ensuring the sustainable use of many agricultural, forest and aquatic resources;
- the knowledge, innovations and practices of indigenous and local communities should be respected, preserved and maintained, and used with the support and involvement of those who possess them;
- conservation of biodiversity and sustainable use of biological resources should proceed on the basis of the best knowledge available, using approaches which must be refined as new knowledge is gained; and
- biodiversity conservation requires local, regional, provincial/territorial, national and global co-operative action and a sharing of knowledge, costs and benefits.

Two strategic directions were identified for Canada. The first, the sector approach, promotes the integration of biodiversity conservation into management agencies such as agriculture, forestry and aquatic. The second, the eco-region approach, functionally integrates science, issues, agencies and people within and across ecological boundaries using the ecological framework.

Concurrently, a science team composed of government, university and private sector scientists was commissioned by Environment Canada to undertake a science assessment. Operating on a separate mandate from the national strategy, the science assessment reviewed current scientific understanding and offered recommendations that were specifically targeted at relevant science and policy initiatives (BSAT, 1994).

The resulting 215-page document, with an accompanying 15-page executive summary, included a conceptual overview followed by specific chapters that focused on the compatibility of major land uses with the protection of biodiversity and environmental stressors, such as genetically modified organisms, environmental pollutants and atmospheric change.

The science assessment chapters were submitted for peer review, followed by a policy workshop. The final assessment contained both scientific and policy recommendations and, more importantly, the science-based rationale for the proposed actions. The science assessment was well received nationally and internationally.

1.5. The Millennium Ecosystem Assessment (2001)
http://www.millenniumassessment.org/en/index.aspx

The global Millennium Ecosystem Assessment (MEA, 2005) further clarified the impacts on biological diversity and emphasized that protecting biodiversity is in the self-interest of all humans and their societies. Biological resources are the pillars upon which civilizations are built. Loss of biodiversity threatens essential ecosystem goods and services, while also interfering with the earth's hydrological, weather and climate systems. The various "goods and services" provided by ecosystems include:

- provision of food, fuel and fibre;
- provision of shelter and building materials;
- purification of air and water;
- detoxification and decomposition of wastes;
- stabilization and moderation of the Earth's climate;
- moderation of floods, droughts, temperature extremes and the forces of wind;
- generation and renewal of soil fertility, including nutrient cycling;
- pollination of plants, including many crops;
- control of pests and diseases;
- maintenance of genetic resources as key inputs to crop varieties, livestock breeds, medicines and other products;
- cultural and aesthetic benefits; and
- the ability to adapt to change.

1.6. White Papers: Assessment of Knowledge Gaps (2008)

In 2008, it was concluded that in order for Canada to move forward on the climate change/biodiversity issue in accordance with its national and international agreements, knowledge gaps needed to be identified in a number of key areas. To meet this objective, Environment Canada

commissioned a series of six white papers identifying knowledge gaps in climate change and biodiversity science, governance, implementation, management actions, adaptation and other issues.

This white paper, "Climate Change and Biodiversity: Implications for Monitoring, Science and Adaptive Planning," is organized into three primary sections: 1) Climate Change, Variability and Extremes; 2) Biodiversity; and 3) Integrated Approaches.