THE STATE OF CANADA'S FORESTS 1992

Forestry Canada Forêts Canada

Canada

The State of Canada's Forests 1992

Third Report to Parliament

Canada's Green Plan

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Message from the Minister

I am honoured to table before Parliament the third annual report on the state of Canada's forests. Nineteen ninety-two will be remembered as a remarkable year for the forging of new alliances among the many different groups that have an interest in our forests.

Three achievements in particular will significantly influence the way Canada's forests will be managed in the future. The first involved the development of a new national forest strategy following months of nation-wide public consultations with representatives of industry, labour, the provinces, and environmental and Aboriginal groups. The Canadian Council of Forest Ministers is now working with those groups to draw up five-year action plans.

The year 1992 also marked the establishment of a nation-wide network of large-scale model forests, which will be used to practice and demonstrate new concepts in integrated, sustainable forest management in Canada. Funded under the Government of Canada's Green Plan, the model forest sites will be managed by community partnership groups representing a broad cross-section of interests. My provincial colleagues are important partners in this endeavour.

Finally, Canada played a leadership role in the negotiations that led to the ratification of a set of guiding principles on the management of the world's forests at the United Nations "Earth Summit" in Brazil, last June.

As stewards of 10% of the world's forests, we all have a stake in the sustainable development of a resource that has provided the foundation of Canada's prosperity, and that is a vital part of the very life-support system of our planet. Perhaps our biggest accomplishment in 1992 was that the various members of Canada's forestry community worked together more closely than ever before in pursuit of this common goal.

Frank Oberle
Minister of Forestry

Highlights

A YEAR OF CHANGE

Forests cover nearly half of the Canadian landscape and are a dominant feature of our economy, culture, traditions and history.

Canada is one of the few developed nations still richly endowed with large areas of natural forests. The growing awareness and appreciation that Canadians have for the different values in their forests, ranging from timber, wildlife and watersheds, to recreation and biodiversity, are bringing about considerable change in the way Canada manages its forest resources.

CANADA'S FORESTS

Among major forest nations, Canada is unique in that most of its forests (94%) are publicly owned. The remaining 6% belong to more than 425 000 private landowners. Of the public lands, provincial governments own 71%, and the federal government owns 23%, most of it in the territories.

Of the 416 million hectares of total forest land, an estimated 46 million hectares, or approximately 11%, are protected from harvesting by legislation or policy, and are left in their natural state. A little more than half of Canada's forests are considered commercial forests, capable of producing timber and a variety of non-timber benefits. Only 112 million hectares of commercial forest (27% of the total forest land) are currently accessible and managed for timber production. A further 157 million hectares are open forests, comprised of natural areas with small trees, shrubs and muskegs.

NEW PARTNERSHIPS

New approaches to forestry are resulting in new partnerships among those with an interest in Canada's forests. After 12 months of public consultation, Canadian governments and representatives of a broad cross-section of interest groups developed a common vision and strategy to manage Canada's forests in a sustainable manner. Their commitment to the new strategy — entitled *Sustainable Forests: A Canadian Commitment* — was ratified by the signing of the first-ever Canada Forest Accord on March 4, 1992.

As part of Canada's Green Plan, the federal and provincial governments, along with various other partners, announced a unique network of model forests that will serve as a testing ground across the country for new economically and ecologically sound approaches to forest management.

Canada played an active role in the debate on the sustainable development of forests at the United Nations Conference on Environment and Development in Brazil, in June 1992. An agreement was reached on a set of international principles to guide the sustainable management of forests worldwide.

ENVIRONMENTAL STEWARDSHIP

Advances continue to be made with respect to protecting environmental quality. The use of pesticides in forestry continues to decline. Over the past decade, the forest area treated with insecticides, both biological and chemical, has decreased by 80%. Despite a 10% increase in planting between 1988 and 1991, the use of herbicides was reduced by 13.6%.

New government regulations and the use of new technologies are resulting in significant environmental improvements to pulp and paper mills. Between 1988 and 1992, chlorine use by the industry was reduced by 60%. In 1992, two mills began producing totally chlorine-free kraft pulp. As a result of those changes, 90% of dioxins and furans have been eliminated. Under the new federal regulations that came into force in 1992, kraft pulp mills must reduce dioxins and furans in effluent to non-measurable levels by the end of 1993. In addition, 15 mills capable of producing recycled-content newsprint opened between 1990 and 1993, increasing Canadian capacity more than tenfold.

CHALLENGING TIMES

The Canadian industry continues to restructure to remain competitive in world markets. During the past 20 years, Canada's share of world forest products exports has remained relatively constant, ranging between 18 and 23%. Production has increased considerably, reflecting improvements in productivity and the industry's investments in new technology. The current level of employment, however, is similar to the early 1970s. In 1992, there were 289 000 direct jobs and 440 000 indirect jobs, a decrease of 10% since 1990.

SUSTAINING CANADA'S FORESTS

The 1991 harvest of 162 million m^3 was well below the national allowable annual cut (AAC), estimated at 252 million m^3. Despite the adequate national supply, some shortages of high-quality softwood timber exist at the local level. Several provinces are reducing their AACs to reflect the growing demands on Canada's forests for values other than timber, such as wilderness and recreation.

Between 1982 and 1991, there was a net increase of 2% or 554 million m^3 in the volume of commercial timber. More than 17 million hectares of forest were regenerated over the same 10-year period. However, the area of forest that had not been successfully regenerated with commercial species 10 years after harvesting increased by 1.29 million hectares, to 4.37 million hectares (less than 2% of the commercial forest). The area of forest depleted by natural causes, such as fire, insects and disease, continues to exceed the annual harvest.

IMPORTANT DISCOVERIES

Science is providing us with an in-depth knowledge of the role of forests as part of the Earth's life-support systems. Discoveries range from natural insecticides, to genetic engineering, new wood composites, and forest fire prediction and detection systems.

Science is improving our understanding and management of forest ecosystems.

CHAPTER ONE

CANADA'S FORESTS

NEW CHALLENGES, NEW THINKING

FOR MANY CANADIANS INTERESTED IN CANADA'S FORESTS, 1992 WAS AN UNFORGETTABLE YEAR — A YEAR OF CONSIDERABLE CHANGE. THROUGHOUT IT, FORESTS WERE A HOT TOPIC OF DISCUSSION IN CANADA AND AROUND THE WORLD. WHETHER YOU WANTED TO TALK ABOUT TRADE, SUSTAINABLE DEVELOPMENT, THE ENVIRONMENT, NEW INVESTMENT, INDUSTRIAL RESTRUCTURING, FOREST MANAGEMENT, OR INTERNATIONAL AFFAIRS, THERE WERE MORE THAN ENOUGH ISSUES TO CHOOSE FROM, AND MORE THAN ENOUGH PEOPLE WILLING TO DISCUSS THEM. SOME PEOPLE MAY REMEMBER 1992 AS A YEAR OF CONSULTATION, OF FORGING NEW ALLIANCES AND PLANNING NEW STRATEGIES. IN CANADA, DIVERSE GROUPS ESTABLISHED NEW PARTNERSHIPS TO MANAGE A NETWORK OF 10 MODEL FORESTS. A NUMBER OF IMPORTANT PROVINCIAL COMMISSIONS LISTENED TO THE PUBLIC'S VIEWS, AND WORKED TOWARD DEVELOPING A CONSENSUS ON DIFFICULT FORESTRY ISSUES. IN MARCH, A YEAR-LONG PROCESS OF PUBLIC CONSULTATION CULMINATED AT A NATIONAL FOREST CONGRESS, WITH THE UNVEILING OF A NEW NATIONAL FOREST STRATEGY AND THE SIGNING OF THE CANADA FOREST ACCORD.

People from all over the world participated at the United Nations Conference on Environment and Development (UNCED) in Brazil, where agreement was reached on a set of guiding principles for the sustainable development of forests.

Nearly half of Canada's land base is forested — almost three times the forest lands of Europe. Canada is unique in that most of our forests (94%) are publicly owned.

ECONOMIC IMPORTANCE

Shipments (1990)	$46.9 billion
Exports (1991)	$20.6 billion
Balance of trade (1991)	$17.3 billion
Employment (1992)	729 000
Forestry communities	350

Seventy-six percent of Canada's terrestrial mammals and 60% of its bird species are forest dwellers.

Other people may look back and remember 1992 as the year Canada's manufactured forest products industry started to recover from the worst period in its history. Despite record shipments, weak prices for pulp and newsprint led to substantial losses (an estimated $1.6 billion) for the pulp and paper industry.

Before assessing the year in further detail, it is important to provide an overview of Canada's forests to describe how they are managed, and what their economic, environmental, social and cultural significance is for Canadians.

CANADA'S FORESTS — AN OVERVIEW

Canada's forests are crucial components of the natural environment. Forests moderate our climate, regulate our water systems, prevent erosion, improve the quality of the air we breathe, and provide wildlife habitat. Our forests also provide an important backdrop for recreation, and are enjoyed by an increasing number of tourists.

Of the 416 million hectares of forest in Canada, some 46 million hectares (nearly equivalent to all of France) have been protected from harvesting by legislation or policy. Approximately 236.7 million hectares are considered commercial forests, capable of producing both timber and non-timber products. However, only about 112 million hectares, or 27% of the total forest land base, are currently managed for timber production.

Approximately 71% of Canada's forests are owned by the 10 provincial governments. Each province has its own forest legislation, regulations and standards through which it confers harvesting rights, and assigns forest management responsibilities to the private sector. The other 23% is federally owned, most of it in the two territories. Approximately 6% of Canada's forests is held by more than 425 000 private landowners. (*Ownership data is provided for total forest land. Previous reports provided ownership for commercial forests only.*)

Forest management is a matter of provincial jurisdiction, but the federal government is involved in such areas as trade, market development, pesticide regulation, employment, environment, international affairs, and economic development. The federal Department of Forestry works closely with other federal departments, the provinces, industry and others to promote the sustainable development of Canada's forests and the competitiveness of its forest sector.

CANADA'S FORESTS		million hectares
Heritage forests[a] (protected from harvesting by legislation)		22.8
Commercial forests (capable of producing timber and a variety of non-timber products)		236.7
— Managed forests[a] (currently managed for timber production)	112	
— Unallocated forests (currently unallocated and unaccessed)	100	
— Protection forests (unavailable for harvesting by policy)	24	
Open forests (small trees, shrubs and muskegs)		156.6
Total forest land		416.2

[a] Preliminary estimates

Source: Forestry Canada

1992 — THE YEAR IN REVIEW

NEW THINKING FOR CHANGING TIMES

A new national forest strategy, *Sustainable Forests: A Canadian Commitment*, was released at a national forest congress in Ottawa in March 1992 *(see page 16)*.

In June 1992, the results of a nation-wide competition were announced, identifying a network of 10 model forests. Each site is a working-scale model of sustainable forestry managed by a partnership of key interest groups *(see page 54)*.

The first-ever Canada Forest Accord was signed by governments and industry, and by Aboriginal, environmental and forestry organizations.

NEW COMMITMENTS FOR PROTECTED AREAS

In the fall, the federal, provincial and territorial ministers of Parks, Wildlife, Environment and Forests committed governments to protecting 12% of Canada's natural areas in parks or reserves.

Twenty-two of the 39 natural regions are now represented in Canada's national parks system. In May, British Columbia announced its intention to develop a protected areas strategy, which will include a schedule for decisions on protected areas. The province will double the area designated as protected areas before the year 2000. In November, the Alberta government announced the establishment of six new natural areas, adding a further 2 429 hectares to the province's protected natural landscapes. Ontario, Manitoba and Nova Scotia are now drafting strategies to complete their networks of natural areas. In Prince Edward Island, more than 10 unique or rare forest cover types were designated under the *Natural Areas Protection Act*. In addition, new strategies to ensure the conservation of unique old-growth forests are underway in Nova Scotia and Ontario.

The federal government, through the Green Plan, has pledged to create 18 new parks by the year 2000, completing the national parks system. The new National Forest Strategy commits Canada's forestry community to working toward completing a network of protected areas.

In 1992, the province of British Columbia released its new strategy for old-growth forests. The strategy was developed over a two-year period, and involved more than 90 participants representing universities, environmental groups, the forest industry, private consultants, and government. The strategy outlines a three-year action plan to conserve representative areas of old growth, and to develop and use forestry practices that conserve or create favorable old-growth conditions. In addition, 14 new old-growth sites were added to the province's list of areas under study for protected status.

The British Columbia strategy highlights the difficulty in defining what constitutes an old-growth forest. Differing views and positions exist regarding how much old growth exists and how much should be available for harvesting. The strategy identifies the additional research required, and outlines what actions need to be taken to improve inventories and better describe old-growth characteristics.

Current inventory information indicates 5.2 million hectares of mature coastal forests in British Columbia that could be considered old growth. Approximately 200 000 hectares are located in parks and reserves. An estimated 3 million hectares are not available for harvesting for a variety of economic and environmental reasons. The remaining 2 million hectares are considered available and suitable for harvesting; it would take more than 50 years to cut this amount at current harvesting rates.

FOREST MANAGEMENT

In 1992, the federal government signed new agreements with the provinces of Alberta and Quebec, as well as the first-ever forestry agreement with the Northwest Territories.

Newfoundland and Labrador, Saskatchewan and the Northwest Territories are working with interest groups to develop long-term integrated forest management plans to satisfy both timber and non-timber values. In New Brunswick, new forest management plans emphasize wildlife habitat. Mature softwood-forest habitats must be maintained on each licence, and habitat management activities must be promoted within deer-wintering areas.

The Ontario government completed its first-ever comprehensive audit of regeneration success in its Boreal forest. The audit, conducted by an independent panel, showed that 96% of the areas logged between 1970 and 1985 have regenerated successfully. The report noted, however, that the species composition of the forest changes after logging, which may affect the commercial timber supply.

The British Columbia Ministry of Forests began a timber-supply review in 1992 to document the short- and long-term availability in each of the province's 36 timber-supply areas. Allowable annual cuts will be revised where necessary.

NEW FOREST POLICY INITIATIVES BASED ON EXTENSIVE PUBLIC DISCUSSION AND CONSULTATION

- *1992 marks the first full year of operation under the new* Forestry Act *in Newfoundland and Labrador, and commits the Forest Service to the principle of sustainable development. The Act provides for 20-year timber licences for future wood allocations, instead of the old system of 99-year licences.*
- *In Nova Scotia, a new wildlife strategy based on extensive consultation is nearly complete.*
- *In Ontario, an independent forest policy panel began extensive public consultations across the province to develop a new policy framework for sustainable forests.*
- *In a document entitled* What You Told Us, *Manitoba released the results of its public consultations on new forest policies for sustainable development. These policies will be ratified, and a document on follow-up applications will be produced in late 1993.*
- *In Saskatchewan, an integrated management plan is being developed that will support a broad, long-term strategy for the province's forests.*
- *The British Columbia Ministry of Forests is currently developing a forestry practices code to provide a more substantive legal basis for enforcing sustainable forestry practices.*
- *In the Northwest Territories, a community-based planning process is underway to draft an integrated resource management plan for the communities of Fort Liard and Nahanni Butte.*

Reforestation and other silvicultural programs aimed at improving the growth and health of Canada's forests have more than tripled since the 1970s. However, fire, insects and disease continue to play major roles in the dynamics of the forest.

A HERITAGE FOR TOMORROW

Tree Plan Canada is based on partnerships — Canadians working together to plant up to 325 million seedlings.

In April 1992, the Government of Canada launched a national tree planting and care program. Community groups, schools, municipalities, charitable organizations, corporations and individuals are all partners in the program. Planting projects in rural and urban areas focus on land reclamation, soil stabilization, wildlife habitat enhancement, energy conservation, and park development.

In Saskatchewan, more than $1.5 million was earmarked for tree planting and seedling improvement to double the number of seedlings being planted by government. The expansion of Alberta's provincial tree nursery and research laboratory was completed at a cost of $8.6 million. This facility now has the capacity to produce 33 million seedlings per year. A long-term reforestation program was established in the Northwest Territories. For the first time, seedlings were planted on a prepared site.

FOREST INDUSTRIES — ANOTHER TOUGH YEAR

Tough times for Canada's forest industries continued in 1992, although there were encouraging signs toward the end of the year, as lumber prices increased to record levels — up about 50% over 1991 averages.

Despite shipments of 25.5 million tonnes in 1992 (an increase of 2.8% over 1991), the pulp and paper industry lost $1.6 billion. Pulp prices in 1993 will likely continue to be low, due to the existing global oversupply and the large new mills in Brazil and Chile. However, with the overall shipments of pulp and paper forecast to increase between 3 and 4% next year, and with firming prices, particularly for newsprint, the industry should break even by the fourth quarter of 1993. Three paper mills closed their doors permanently in 1992, resulting in approximately 10 000 jobs lost. On the positive side, one new specialty paper mill and five new de-inking plants began operations.

Industry and labour announced a collective strategy for the competitiveness of Canada's forest industries. The strategy, entitled *Canada's Forest Industry: A Strategy for Growth*, was developed by the Forest Sector Advisory Council (FSAC), which advises the federal ministers of Forestry, and Industry, Science and Technology. Developed as part of the federal government's Prosperity Agenda, the new Strategy made over 100 recommendations on finance and investment, trade, training and adjustment, research and development, and the forest resource. The Canadian Council of Forest Ministers (CCFM) is reviewing the recommendations, and the federal government will respond to the FSAC report in 1993.

ENVIRONMENTAL REGULATIONS

Many older mills have been granted a one-year extension for complying with the new federal environmental regulations on effluent discharges. Several provinces have also established their own regulations.

New federal environmental regulations for pulp and paper mills came into effect in 1992.

The National Water Research Institute of Environment Canada recently conducted a study on the effect of pulp and paper mill discharge on water quality. Preliminary results indicate that the by-products of the chlorine-bleaching process do not appear to be the major cause of fish toxicity. Research is ongoing to discover the likely cause.

SOFTWOOD "WARS" CONTINUE

The imposition of a countervailing duty followed an investigation by the U.S. government, which concluded that Canadian softwood lumber products were subsidized and injured American producers. Canada challenged this decision under Chapter 19 of the Free Trade Agreement. On May 6, 1993, the Subsidy Panel instructed the U.S. Commerce Department to reconsider their findings and to report back by early August. The Injury Panel will issue its report in July.

In July 1992, the United States imposed a 6.51% countervailing duty on shipments of Canadian softwood lumber products.

In July 1992, a two-year Canada – European Community research project demonstrated how heat treatments and other procedures could control any pinewood nematode infestations in lumber.

In late 1992, Canada and the USA reached an agreement on new plywood standards, which resulted in lower plywood tariffs. However, some Canadian plywood producers believe that full harmonization of the standards has not been achieved. Efforts are underway to ensure that all types of Canadian plywood are given full market access.

INTERNATIONAL — RAISING THE PROFILE OF FORESTS

Recently, Canada's record and achievements in forest management and production processes have been called into question, both domestically and internationally, by certain special interest groups. In October 1992, the CCFM initiated a national program to ensure that accurate information is available in Canada's major international forest products markets.

A set of international guiding principles on forests was agreed to at UNCED, the conference held in Brazil in June 1992 *(see page 68).*

National Forest Strategy

A BLUEPRINT FOR CHANGE

Members of the Canadian forestry community, listed below, endorsed the Canada Forest Accord and pledged their cooperation, assistance and energies toward the goal of sustainable forests, nationwide.

Minister of Forestry, Canada

Minister of Renewable Resources, Northwest Territories

Minister of Renewable Resources, Yukon Territory

Minister of Forests, British Columbia

After a year of public discussion, 12 Canadian governments, along with organizations representing the interests of naturalists, wildlife, Aboriginal people, foresters, labour, private forest landowners, academics and forest industries, agreed on a common vision and strategy to manage and protect forests in a sustainable manner.

Their commitment is reflected in the signing of the first-ever Canada Forest Accord and in the release of a new national forest strategy, entitled *Sustainable Forests: A Canadian Commitment.* The Strategy is a blueprint for change in Canada's forests. Nine strategic priorities were identified, and 96 commitments are to be acted on over the next five years. The representatives also consented to be publicly and independently evaluated on how well they fulfill their commitment to implementing the concept of sustainable development.

WHAT IS THE NEW NATIONAL FOREST STRATEGY?

The Forest Strategy is intended to guide the actions of Canada's forest community — actions that will help implement sustainable development policies and programs in Canada's forests over the next five years. The goal of the new Strategy is to ensure that Canada's approach to forest management includes a range of both timber and non-timber values (such as recreation, wilderness, biodiversity and wildlife), while protecting the integrity, health and diversity of our forest ecosystems.

WHY A NEW STRATEGY WAS DEVELOPED

In 1987, the report of the United Nations Commission on Environment and Development (better known as the "Brundtland Report") challenged the world to embrace sustainable development as a means of preventing continued and irreparable damage to the

Earth's natural environment. The Commission's report defined "sustainable development" as economic development that would meet the needs of present generations without compromising the ability of future generations to meet their needs. The implementation of this deceptively simple concept continues to challenge countries around the world.

Canada and other nations have been working to respond to the challenges of sustainable forest development. Following the release of the Brundtland Report, and recognizing society's changing attitudes toward forests, the Canadian Council of Forest Ministers (CCFM) set out in 1990 to achieve a consensus on broad new directions for forest management.

HOW THE STRATEGY WAS DEVELOPED

Views were sought from a wide range of Canadians at a series of regional meetings and through written submissions. Two forums were held to solicit the unique perspective of Aboriginal people, who have a traditional link with forests. Successive drafts of the Strategy were publicly reviewed, and through a national workshop and hundreds of letters, phone calls and faxes, Canadians shaped the final priorities and actions outlined in the new Strategy.

Finally in March 1992, the Strategy was debated, revised and endorsed at a national forest congress. This concluded the most extensive national discussion on forestry in Canada's history, and was marked by the signing of the Canada Forest Accord *(enclosed).*

Although the consensus was gratifying, the biggest challenge lies ahead in meeting the Strategy's commitments and implementing its action plans.

WHAT THE NEW STRATEGY WILL DO

The Strategy recognizes that it is only by ensuring the diversity and health of our forest ecosystems that we, and future generations, will continue to derive important economic, environmental, social and cultural benefits from our forests. Consequently, a key goal of the Strategy is to further our knowledge of how to manage forest ecosystems. Actions to achieve this goal include:

- completing an ecological classification of our forest lands, which will allow us to describe and map the many different forest ecosystems in Canada;

Minister of Forestry, Lands and Wildlife, Alberta

Minister of Parks and Renewable Resources, Saskatchewan

Minister of Natural Resources, Manitoba

Minister of Natural Resources, Ontario

Minister of Natural Resources and Energy, New Brunswick

Minister of Natural Resources, Nova Scotia

Minister of Energy and Forestry, Prince Edward Island

Minister of Forestry and Agriculture, Newfoundland and Labrador

Alberta Forest Products Association

Association of University Forestry Schools of Canada

- increasing our research to gain a better understanding of forest ecosystems, how they function, and how they are influenced by human activities and natural forces;
- developing working definitions of biodiversity *(the CCFM will hold a national conference on this topic by 1995);* and
- working with parks agencies and the public to complete a network of protected areas in Canada by the year 2000.

REVIEWING AND CHANGING OUR FORESTRY PRACTICES

Providing a sustainable yield of timber has always been an important goal of forest management in Canada and elsewhere. In recent decades, Canadians have recognized different forest values. The challenge is to refine and develop forestry practices that respect other values and maintain the health of our forest ecosystems. The Strategy contains some key commitments that will enhance forestry practices in Canada, including:

- expanding our forest inventories to go beyond present information on timber, to include the broader range of plant, animal and site information that is needed to manage forest ecosystems;
- by 1995, reviewing and, if necessary, changing the way we cut, plant and tend forests to ensure that our practices suit the characteristics of different ecosystems, while taking into account aesthetic and other values;
- promptly regenerating all harvested areas, using methods that will provide a diversity of habitat appropriate to the area;
- minimizing the use of chemicals in the forest, and increasing our research into other ways of making forests less vulnerable to insects, disease and competing vegetation; and
- implementing a national network of model forests where the principles of sustainable development can be tested and applied.

RESPONDING TO DEMANDS FOR MORE PUBLIC INPUT

Canadians have expressed their desire for a greater say in forest stewardship. The Canada Forest Accord recognizes that Canadians are entitled to participate in determining how their forests are used and the purposes for which they are managed. A number of commitments aimed at increasing public involvement include:

- ensuring that by 1993, the public has the opportunity to be involved in developing forest policies, preparing land-use plans, and developing management plans for public forests;
- ensuring that by 1994, the results of formal reviews of the licences to harvest resources from public lands are available to the public;
- by 1995, completing public reviews of our forest policies to ensure that they meet the requirements for sustainable development; and
- improving the information available to the public through a national forestry database, regular reports on the state of Canada's forests, and a set of national indicators to measure our progress in achieving sustainable development.

ADJUSTING TO STAY COMPETITIVE IN WORLD MARKETS

The health of Canada's forest industry, and its ability to provide jobs and economic benefits for Canadians are determined by its competitive position in world markets. Many communities are dependent on forest industries for their survival. Special efforts must be made to help them adapt to the significant changes that are occurring as the industries try to stay competitive. Commitments under the Strategy include:

- putting a special emphasis on diversifying our industries to provide a variety of timber and non-timber products and services, and encouraging investment in value-added production;
- increasing the capacity of mills to use wastepaper in making paper products;
- assessing the opportunities to expand the timber supply, and holding a national conference to review the results by 1994;
- identifying Canadian forest products that are manufactured from sustainable forests and environmentally sound technologies;
- upgrading mills to meet national environmental standards; and
- involving communities in local adjustment programs to deal with the changes brought on by industry downsizing or closures.

OTHER KEY COMMITMENTS TO CHANGE

FINDING THE ANSWERS

The implementation of sustainable development places new demands on our scientific community for information, knowledge, and new forestry and manufacturing technologies. Throughout the

Canadian Federation of Woodlot Owners

Canadian Forestry Association

Canadian Institute of Forestry

Canadian Nature Federation

Canadian Pulp and Paper Association

Canadian Silviculture Association

Canadian Wildlife Federation

Council of Forest Industries of British Columbia

International Woodworkers Association, Canada

Maritime Lumber Bureau

Strategy, many areas are highlighted where additional research is required. This includes finding ways of increasing our investment in research, broadening the membership of boards advising on research priorities so that they reflect the needs of all forest stakeholders, improving our technology transfer, and expanding our research networks in Canada and throughout the world.

DEVELOPING NEW SKILLS

The new technologies needed to implement sustainable development will make some jobs in the forest obsolete, while creating a demand for people with new skills. A forecast of employment and training needs will be completed by 1994, to identify the priorities where labour, industry and governments can work together to put in place new training programs and strategies. Canada's forestry schools will review their curriculum to meet the challenges of sustainable development. The CCFM will assess the feasibility of a certification system for forest workers.

INVOLVING ABORIGINAL PEOPLE

Forests have always been fundamental to meeting the cultural, spiritual and material needs of the Aboriginal people of Canada. The goal of the Strategy is to increase the participation of First Nations in forest land management, to ensure that forestry practices respect Aboriginal and treaty rights, and to increase the economic benefits that Aboriginal people derive from forestry activities in Canada. Key to this goal is the development of an Aboriginal forest strategy that recognizes the need to regenerate forests on reserve lands, and to empower Aboriginal communities to manage their forest resources.

A STEWARDSHIP ETHIC FOR PRIVATE FORESTS

More than 425 000 private landowners in Canada collectively own over 19 million hectares of commercially productive forest land. The Strategy outlines measures to improve the incentive to practice sound forest stewardship on private lands. These measures include ensuring that programs support a range of timber, recreational and environmental values; completing a review of the impact of the taxation system on the stewardship of private forest lands in Canada; and increasing efforts to develop and market a wider range of products, and to reforest marginal agricultural lands.

FULFILLING OUR GLOBAL RESPONSIBILITIES

The Strategy commits Canada to maintaining the extent, diversity and health of its forests, and to increasing its research into the role of forests in sustaining the health of the planet. Canada will also pursue internationally accepted standards of sustainable forest management. Lastly, the Strategy underscores Canada's commitment to working with other nations by providing professional, technical and financial support.

PUTTING THE NEW STRATEGY TO WORK

Achieving a broad consensus on new directions for forestry was a significant realization; putting the Strategy into action is probably an even greater challenge for Canada's forest community. The CCFM has agreed to act as a "trustee" of the document, thereby assuming overall accountability for its implementation. A National Forest Strategy Coalition will oversee implementation of the Strategy, and evaluate and communicate its progress. Membership in the Coalition is broadly based and includes all of the signatories of the Canada Forest Accord. By June 1993, each member organization will prepare an action plan to identify how their organization can best implement the Strategy.

However, some important results have already been achieved: a new network of model forests has been announced; professional foresters and several industry associations have developed new codes of practice; employment forecasts have been completed for some segments of the industry and for Aboriginal forestry; and a set of international principles for the sustainable development of forests was agreed to in June.

(Readers are invited to read the complete text of the Strategy, entitled Sustainable Forests — A Canadian Commitment, *March 1992.)*

National Aboriginal Forestry Association

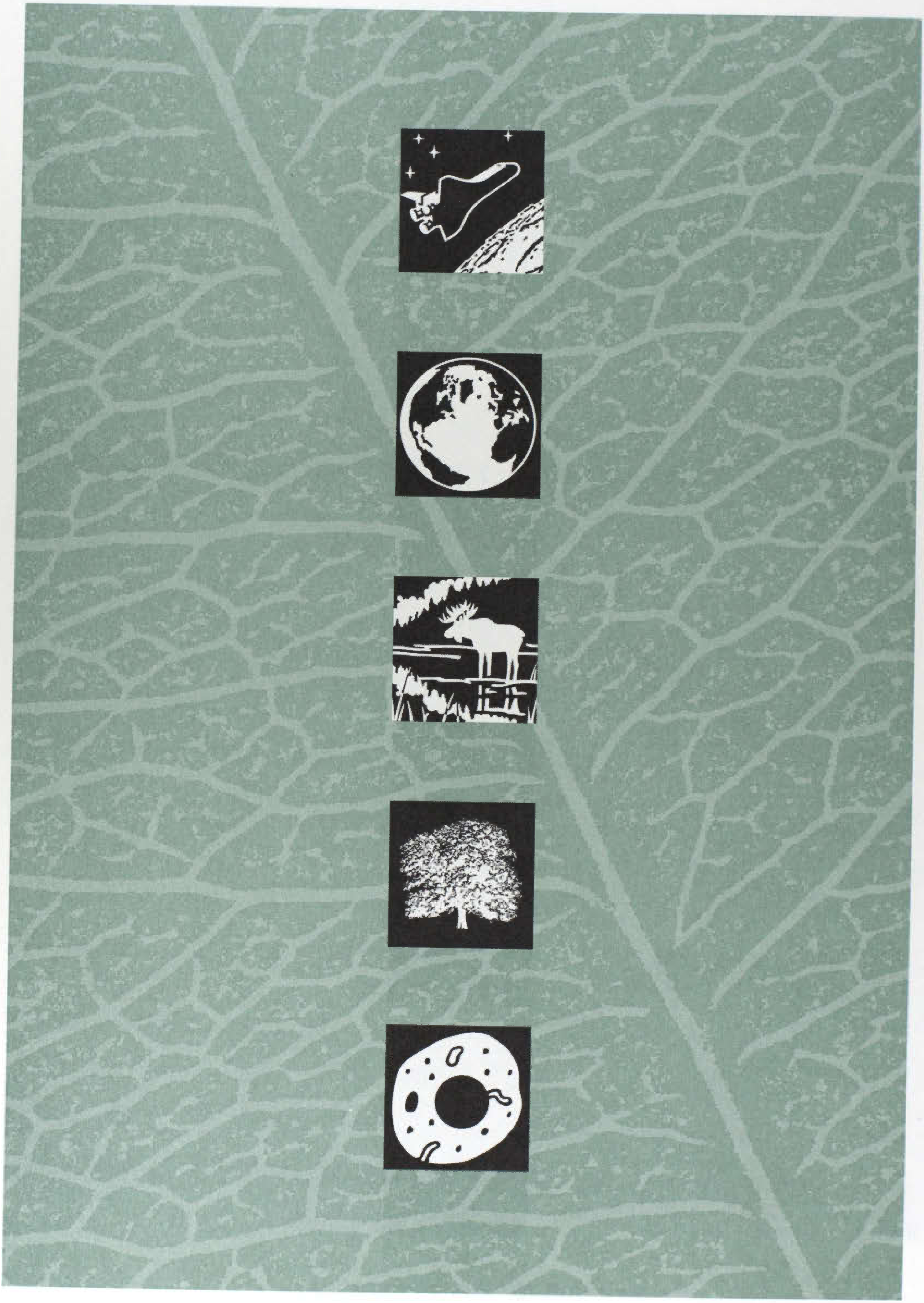
National Round Table on the Environment and the Economy

Ontario Forest Industries Association

Prince Edward Island Nature Trust

Wildlife Habitat Canada

Canada's goal is to maintain and enhance the long-term health of our forest ecosystems for the benefit of all living things, both nationally and globally, while providing environmental, economic, social and cultural opportunities for the benefit of present and future generations.



CHAPTER TWO

FOREST SCIENCE

A JOURNEY OF DISCOVERY

FROM THE SPACESHIP *Discovery*, ROBERTA BONDAR, LIKE OTHER ASTRONAUTS BEFORE HER, REMARKED UPON THE BEAUTY AND FRAGILITY OF PLANET EARTH — A SINGLE, GLOBAL ECOSYSTEM SUSPENDED IN THE VASTNESS OF SPACE. THE SPACE AGE HAS MADE PEOPLE AWARE OF THE UNIQUENESS OF OUR PLANET, AND OF OUR RELIANCE ON ITS ATMOSPHERIC ENVELOPE AND ECOLOGICAL STRUCTURES. WE HAVE ONLY JUST BEGUN TO REALIZE THE EXTENT TO WHICH FOREST ECOSYSTEMS AND THE ENTIRE GLOBAL LIFE-SUPPORT SYSTEM ARE INTERDEPENDENT, AND HOW THAT LIFE-SUPPORT SYSTEM IS, IN TURN, DEPENDENT ON A HEALTHY FOREST COVER. SCIENCE PROVIDES US WITH AN IN-DEPTH KNOWLEDGE OF THE INTER-CONNECTEDNESS OF THE WORLD'S FORESTS, AND OF THE NEED TO PROTECT AND USE THEM WISELY. IN CANADA, FOREST USE AND MANAGEMENT HAVE BEEN DRIVEN BY DIFFERENT PHILOSOPHIES, EACH A PRODUCT OF CHANGING PUBLIC VALUES AND NEEDS. EARLY EUROPEAN SETTLERS VIEWED FORESTS AS BARRIERS TO SETTLEMENT AND CLEARED THEM FOR FARMLAND.

Science enables us to understand the inner workings of forests, trees and ecosystems.

The focus, priorities and methodologies of Canadian forestry research have changed substantially.

Timber was removed whenever and wherever needed on the assumption that the supply was essentially endless. Over time, the focus shifted to harvesting timber as efficiently as possible, and to preventing losses from fires and insects. About 25 years ago, attention turned to more intensively managing forests through silvicultural techniques such as planting and thinning, and to promoting multiple uses of forests by setting aside areas for recreation, wildlife, and water protection. This was followed by an attempt to combine, rather than compartmentalize, these different uses of the forest. Today we are entering a new period that focusses on managing entire forest ecosystems.

Forestry research is as diverse and complex as the forests themselves and occurs on a number of different levels. In this chapter, we begin at the global level, exploring science's contributions to our understanding of forests as part of the Earth's life-support systems. From there, we discuss the role of science in improving our understanding and management of forest ecosystems. We then move further down the scale, to focus on the tree and its products. Finally, we examine the expanding field of research on plant tissues and the secrets of the cell.

THE EARTH — A NEW PERSPECTIVE

Since the Earth and life itself were formed, they have been modified in countless ways. For millennia, people did not influence these changes. Today, however, the human species is having a significant impact on the global environment. The links between humanity and climate change, acid rain, deterioration of the ozone layer, and desertification are widely accepted within the scientific community. As major ecosystems, the world's forests are inextricably linked to many global environmental issues. The stewardship of 10% of the world's forests brings both obligations and opportunities. Canada must act responsibly when managing the natural resources under its care; it can also make an important contribution to the advancement of knowledge about forests and environmental issues. Current research programs on climate change, biodiversity, and the relation between forests and the carbon cycle are just a few examples of how the scientific community is responding to global environmental challenges.

CLIMATE CHANGE — A HOT TOPIC

Hardly a day passes without the issue of climate change appearing in the news media or scientific literature. The world scientific community generally agrees that global warming is inevitable. Some studies suggest that average temperatures will increase in Canada, particularly in the Prairies, and that some areas will experience a decrease in rainfall and soil moisture.

Over the past five years, climate change has become a research priority. Current research concentrates on developing better means of forecasting climate change and predicting the response of forests, on developing systems to monitor change, and on increasing our understanding of forests and the "carbon budget" — the balance between carbon release and carbon accumulation.

POTENTIAL EFFECTS OF GLOBAL WARMING

- *changes in the growth rates of trees and other vegetation*
- *changes in the species composition of forests*
- *shifts in forest boundaries*
- *increases in forest fires*
- *changes in insect and disease outbreaks*

The Carbon Budget

The buildup of greenhouse gases is believed to be one of the primary causes of climate change. Among the gases associated with the greenhouse effect are carbon dioxide, methane, nitrous oxide and CFCs (chlorofluorocarbons). Many of these gases, such as carbon dioxide, occur naturally, but their levels and concentrations in the atmosphere are influenced by human activities.

Although most of the world's carbon is contained in oceans and fossil fuel deposits, a considerable amount is temporarily stored within land-based ecosystems, of which forests are by far the largest. Consequently, the world's forests have an important influence on both the removal of carbon from the atmosphere as they grow, and on the release of stored carbon into the atmosphere as a result of wildfire or decay, or through such activities as harvesting or burning logging debris.

The main sources of increased carbon dioxide in the atmosphere are energy consumption and deforestation.
Each year throughout the world, the combustion of fossil fuels

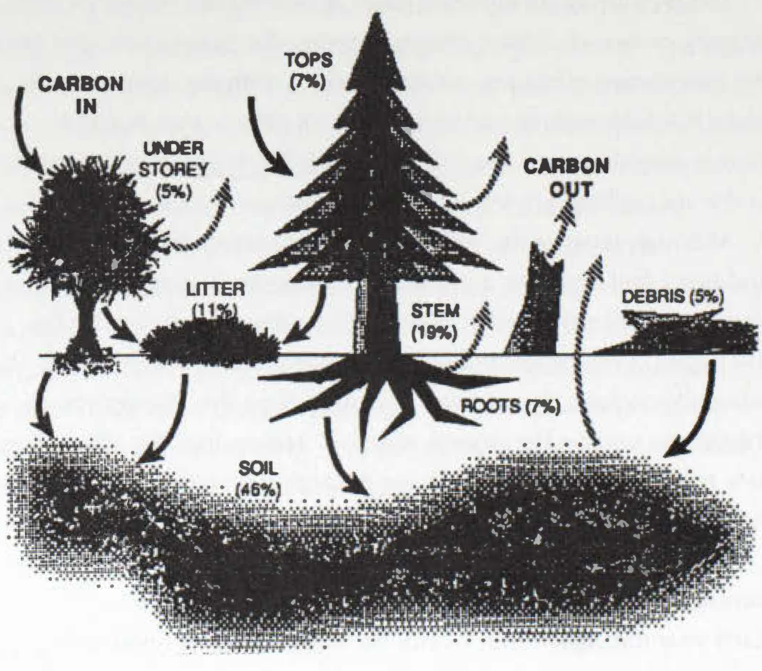
(oil, gas and coal) releases between 5 and 6 billion tonnes of carbon into the atmosphere in the form of carbon dioxide. As many as 2 billion more tonnes result from clearing tropical forests.

Canada's contribution to the annual increase in global concentrations of atmospheric carbon dioxide is roughly 2%, or between 110 and 130 million tonnes. Of this, the Canadian forest sector contributes 12 to 14 million tonnes; 5 million tonnes from the burning of fossil fuels, and 7 to 9 million tonnes from the burning of biomass, primarily during forest fires.

In 1986, after allowing for the carbon released by decomposition, burning and the use of fossil fuels by the forest industry, Canada's forests, forest soils, peatlands and forest-sector activities acted as a net temporary store of 72 million tonnes of carbon (*for further discussion, see page 79*).

The growing of forests for energy can reduce the need for fossil fuels. Like fossil fuels, biomass releases carbon into the air when burned. However, growing forests reabsorb this carbon, effectively recycling it. During the past 15 years, the use of forest biomass for energy in Canada has nearly doubled (from 4 to 7% of total energy use). Research under the ENFOR (ENergy from the FORest) Program has improved harvesting and transportation systems, created techniques for growing forests for energy, and produced a national forest biomass inventory.

The total amount of carbon in Canada's forests and forest products is about 225 billion tonnes.



Earth, Wind and Fire

Recent evidence indicates that biomass burning in its various forms (deforestation, clearing land for agriculture, burning grasslands, forest fires, etc.) has a major impact on atmospheric chemistry. Through the International Geospheric Biosphere Program, Canada is playing a lead role in assessing the effect of biomass burning on the Earth's atmosphere.

Scientists are also assessing the impact of biomass burning in South America and South Africa on the air chemistry and weather patterns over a large portion of the Earth. Canadian forestry experts, along with scientists from France, Germany, Belgium, the United States, Zimbabwe and South Africa, are investigating fire behaviour in large experimental fires conducted in Kruger National Park, South Africa, in 1992. Those fires were monitored in three ways: from the ground, from specially equipped aircraft, and from satellites. Canadian forest scientists are also using satellite data to monitor forest fire occurrence in Russia's Boreal forests, and will include those estimates of atmospheric emissions in their world totals.

AREA BURNED

Source: Forestry Canada

Boreal Explorers

The northern coniferous forest, known as the "Boreal forest," grows in a broad band around the Earth between the arctic tundra and more temperate regions. It is the dominant forest type in both Canada and Russia.

The Boreal Ecosystem Atmosphere Study (BOREAS) was initiated to enable scientists to learn more about how this important forest region functions. This cooperative project involves several Canadian government departments and agencies (Forestry Canada, the Canada Centre for Remote Sensing, the Atmospheric Environment Service, and the Natural Sciences and Engineering Research Council), various American organizations (the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, and the National Science Foundation), and universities in both countries.

Boreal forests are believed to play an important role in regulating the climate of the globe.

In 1993 and 1994, nearly 200 of North America's foremost climate change experts will conduct research involving surface, airborne and satellite measurements on two 400 km² sites, one near Prince Albert National Park in Saskatchewan, and the other near Nelson House, Manitoba. The information they obtain will be used to improve our knowledge of the interaction between the Boreal forest and the atmosphere, and to predict the response of the ecosystem to climate change.

Forest scientists will also be involved in a longer-term study to help fill the gaps in our information and understanding of terrestrial ecosystems and global environmental change. The Northern Biosphere Observation and Modelling Experiment is currently in the planning stages, but has been confirmed as part of the international Earth Observing System, a major NASA project. Over the next 15 years, Canadian scientists will have access to an extraordinary array of satellite data collected by NASA.

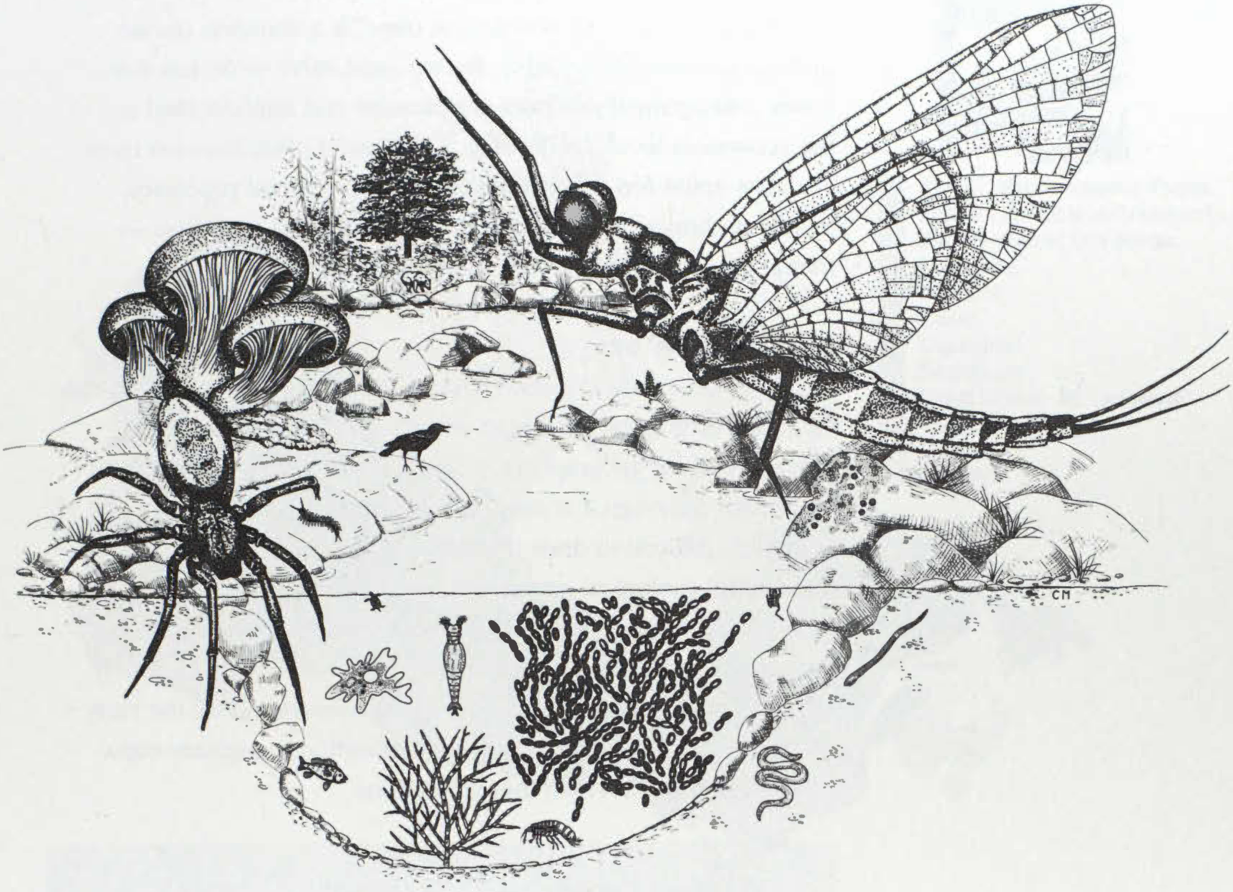
BIOLOGICAL DIVERSITY — A SPICE OF LIFE

The amazing diversity in the world's forests developed over thousands of years as species appeared and disappeared, and it continues to evolve in response to an ever-changing environment. Scientists do not yet fully understand why an ecosystem maintains a high level of diversity, or what roles are played by each species within the ecosystem. It is clear, however, that biological diversity is essential to the continued functioning of a healthy ecosystem. For this reason, forest management must respect the diversity of forests to ensure that they will be able to adapt to changing environmental conditions.

The world's forests are an ecological mosaic, an intricate and dynamic web of plants, animals, insects, fungi and microorganisms constituting the most complex terrestrial ecosystems on Earth.

Recent studies indicate that there are about 300 000 species of animals, plants and microorganisms in Canada; at least 200 000 of them reside in forests. About 76% of terrestrial mammals and 60% of bird species depend on Canada's forests. Animals, trees and other plants are the most visible elements of the forest ecosystem; however, far greater diversity is concealed. Microorganisms are responsible for many processes, such as decomposition and nutrient cycling, that are fundamental to a healthy forest ecosystem. However, biodiversity is more than simply the number of species. Genetic diversity and ecosystem diversity are also important components.

Forest ecosystems are constantly changing. This is true even of the old-growth forests on the West Coast. The Boreal forest landscape is dominated by the effects of large-scale disturbances such as wildfires; West Coast forests are shaped by smaller-scale disturbances such as insect infestations and harvesting. Forest management should take into account the scale at which natural



disturbances occur, and ensure that the essential processes that maintain biodiversity are not disrupted. *(The illustration above shows the relative number of species within different groups of organisms in Canada's forest ecosystems).*

Canada is working to conserve the biological diversity of its forests in several ways. The federal, provincial and territorial governments have protected-area programs that promote the establishment of parks, wildlife sanctuaries and reserves. Under the federal Green Plan, Forestry Canada is supporting the establishment of protected areas that are representative of Canada's forest regions. Through the Model Forests Program, operational techniques to maintain biodiversity will be developed and tested in major forest regions. New strategies to ensure the conservation of unique old-growth forests have been developed by Nova Scotia, Ontario and British Columbia. Non-governmental organizations such as the World Wildlife Foundation also play a major role through such initiatives as the Endangered Spaces Program.

Studies of British Columbia's coastal forests have revealed that each square metre of forest floor may be home to over a thousand species of microorganisms.

ECOSYSTEMS — A WIDE-ANGLE VIEW

"You can't see the forest for the trees" is a common phrase that has an element of reality, for we must strive to do just that. Forest management practices are planned and implemented at the ecosystem level. To develop a successful plan, foresters must visualize entire forest ecosystems and their internal processes, involving thousands of species — from microbes to moose — interacting in a constantly changing environment.

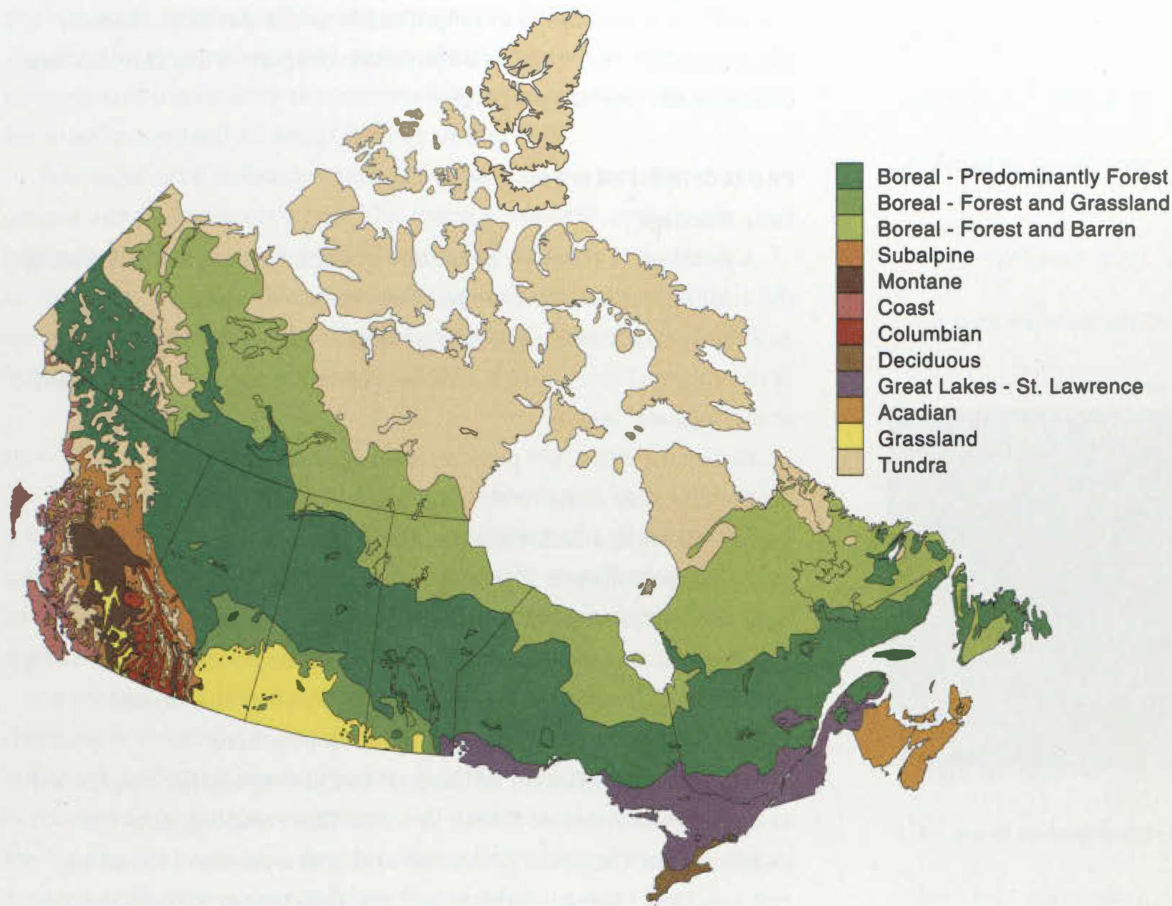
MAPPING THEM OUT

Viewing Canada in terms of forest diversity is a challenging task for forest ecologists, who must characterize and classify forest regions, and for geographers, who must draw lines around them on a map. Although it is easy to draw lines on a map, it is extremely difficult to draw them in a way that delineates meaningful ecological zones.

A hallmark achievement of forestry research in the 1960s was the classification of the forest regions of Canada. It is still widely used today as a national ecological reference. Based on the early work of Canadian ecologists, this classification recognizes eight forest regions subdivided into 90 sections.

Forestry in Canada has a 65-year tradition of site classification. Early work was based almost solely on vegetation. In the 1940s and 50s, G. Angus Hills, a soil scientist, initiated the use of soils and site productivity in his site-classification work in Ontario, and Vladimir Krajina, a forest ecologist, established the biogeoclimatic approach, using climate, soils, topography and vegetation in British Columbia. In the 1990s, a myriad of systems have been developed, yet all rely to some degree on the approaches of the pioneers.

In recent years, there have been a number of attempts to develop more comprehensive national, hierarchical forest classification systems. One such system uses vegetation, landforms and climate as its main criteria. This system subdivides Canada into 15 ecozones, 45 ecoprovinces, 177 ecoregions, and 5 428 ecodistricts. The large number of ecological units in this system is indicative of the ecological diversity within Canada's landscape.



Every province uses one or more ecological classification systems in its forest management activities. With the widespread availability of Geographic Information System technology, ecologists are able to manipulate large amounts of biological and physical data to develop classification and decision-support systems. Those systems are likely to become the forest manager's main tool in determining the most ecologically sound approaches to forest land management.

Today's challenge for classification specialists is to try to achieve a national consensus on the approach, standards of description, and terminology needed to develop a more comprehensive national ecological database on forest ecosystems.

A knowledge of forest ecoregions is beneficial to many scientific disciplines. Forest geneticists, for example, have shown that the geographic source of tree seed used to regenerate a forest is extremely important. Provinces have established regulations that restrict the transfer of seed into zones where it might be poorly adapted. This practice will help Canada avoid the indiscriminate seed transfers that were an unfortunate chapter in the early history of European forestry practices.

PROTECTING FORESTS

Early Warnings

The 1992 data from ARNEWS indicate that no large-scale decline in the health of our forests is directly attributable to atmospheric pollution. In the Maritimes, however, damage to trees of several species from ground-level ozone has been indicated.

A number of research programs in Canada focus on monitoring the health of forest ecosystems. Two examples are the Acid Rain National Early Warning System (ARNEWS) project at the national level, and the North American Maple Project (NAMP) at the regional level.

Under the ARNEWS project, national data on soils and vegetation were used to develop an acid rain hazard map for forests. As well, a national monitoring network of 106 sample plots was established. Today the ARNEWS network is being linked with similar forest-health monitoring systems in the United States and Mexico. Canada plans to take the lead in developing a biomonitoring network for forest health in all of the Boreal and temperate forests of the Northern Hemisphere.

An earlier assessment of damage to Quebec's sugar maples led to the establishment of NAMP in 1988. This sampling network included four Canadian provinces and seven eastern U.S. states, and involved Forestry Canada and the U.S. Forest Service. Results indicate that the maple decline was not caused by air pollution, but rather by several years of extreme drought and cold winters.

Nature's Insecticides

Before the words "ecology," "ecosystem" and "biodiversity" became popular, the use of synthetic chemicals to control insect pests was common. However, in the 1960s, the public became aware of the damage caused by DDT and other chemical sprays. We now know that the "cure" for insect outbreaks at that time was potentially more harmful than the problem. Today other synthetic chemicals, such as fenitrothion, are subjected to much more stringent testing and are much safer products than DDT. Nevertheless, public pressure to ban the use of all such chemicals remains.

The challenge for scientists is twofold: to ensure that synthetic chemicals are rigorously tested before being applied in the safest possible manner; and to find more environmentally benign alternatives for the control of forest pests. Baculoviruses, pheromones, entomopathogenic nematodes, and the bacterium *Bacillus thuringiensis* are just some of the types of biological controls and insecticides that are available. Canada's scientists are now recognized as world leaders in this field.

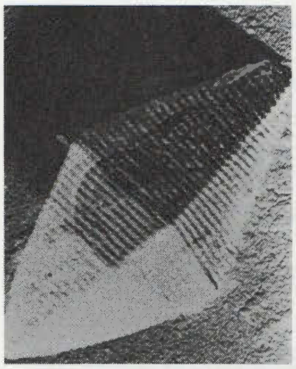
Scientists have isolated certain microbes that act as natural control agents for insect pests. The forest ecosystem and particularly the soil are natural reservoirs of such control agents as parasites, bacteria, viruses, nematodes and fungi. In addition, researchers are investigating the use of natural products extracted from plants.

In recent years, scientists have developed an array of biological controls as alternatives to synthetic chemicals.

B.t. — Bacteria from the Soil

The best-known biological insecticide developed by Canadian scientists is the bacterium *Bacillus thuringiensis*. *B.t.* is a natural bacterium that occurs in soils everywhere. *B.t.* was discovered in 1915, but it was not until 1980 that an effective and economical application was developed for its operational use.

At present, *B.t.* is our only biological alternative to the synthetic chemical fenitrothion for protecting the forest from the spruce budworm and other similar insects. It is the preferred control agent in most of Canada. Unfortunately, *B.t.* cannot be used against all kinds of insect pests and, under certain climatic conditions, it may not be as effective as fenitrothion. Furthermore, it can have an adverse effect on certain non-target moths and butterflies. Research efforts, particularly those by a Canadian university-government research network called "BIOCIDE," are focussed on developing new *B.t.* strains and toxins.



After an insect larva ingests B.t., *a protein body known as a "crystal" is converted by digestive juices into a toxic protein that destroys the lining of the larva's gut. The larva stops feeding and dies in a few days.*

Insect Viruses

Scientists continue to search for other, even more benign control agents. Two university-industry-government research networks — MICROBIONET, coordinated from Forestry Canada's Forest Pest Management Institute in Sault Ste. Marie, Ontario, and INSECT BIOTECH, a centre of excellence located at Queen's University in Kingston, Ontario — are part of this search for the next generation of biological control agents. They are concentrating their efforts on the natural viruses of insects, particularly a microbe known as a "baculovirus."

Baculoviruses are rod-shaped viruses capable of infecting only one insect or a few closely related species. Insecticides based on these viruses are considered environmentally safe. A number are being developed or have been registered in Canada.

The difficulty in finding effective natural pest control agents, such as viruses, is only part of the problem. The other major challenge is producing sufficient quantities. In 1992, a pilot plant was established at the Forest Pest Management Institute to produce new biological control products. The first product of this facility will be a virus that could be marketed throughout the world to control gypsy moth outbreaks.

Research on the spruce budworm could become the catalyst for a biotechnology-based industry far removed from forestry. In 1990, Canadian scientists discovered an entomopoxvirus that has the potential to produce genetic material of great medicinal value to humans and animals.

Fatal Lures

Scientists have also delved into the sex lives of insects. Sex-attractants or "pheromones" have been identified for more than 20 pest species, and are used in special traps set out in the forest. They enable scientists to detect infestations and design efficient control measures.

One such pheromone is effective against bark beetles, which are serious pests of the spruce, fir and pine stands in Alberta and British Columbia. When placed on trees, the pheromone has the effect of a "no vacancy" sign. It tricks the beetles into thinking that the tree already has a high concentration of insects.

Scientists have received two patents for the production of pheromone traps: the MULTIPHER™ trap is now marketed worldwide, and a newer product, LUMINOC™, combines the use of pheromones and light to trap insects.

Discriminating Microbes

In addition to the successes with *B.t.*, viruses and pheromones, there is considerable promise for using fungal pathogens, nematodes, parasites, growth regulators, and natural plant products to control forest insect outbreaks. Collaborative research is underway to explore each alternative.

The success of biological insecticide programs can be measured by the extent to which synthetic chemicals are replaced by biological agents. Another measure of success would be an overall reduction in the need for aerial spray operations. Research is underway to develop forest tending and harvesting methods that may reduce the need for spray operations. In addition, computerized decision-support systems are being developed to provide the best options for forest protection while ensuring ecological diversity. As we move into the next century, we hope to have more environmentally acceptable control options, and expect considerable improvement in our ability to maintain healthy forests without massive spray operations.

Forestry Canada and Rohm and Haas Canada Inc. are cooperating in the development of a novel insecticide. MIMIC® is an insect growth-regulating compound that appears to be highly effective against spruce budworm, but is relatively low in toxicity to non-target organisms. The registration of this product will contribute significantly to the goal of providing environmentally safe and effective alternatives to more toxic chemical insecticides.

Nematodes are microscopic creatures that live in the soil and carry a bacterium that can infect and kill a number of different insects. They have the potential to replace lindane, a standard chemical treatment used to control pests in forest nurseries.

Tree Doctors

Most of us have dealt with a disease on a backyard tree, shrub or favourite rose bush. Like human diseases, forest diseases are naturally occurring. Many can be tolerated, but others must be controlled if we are to protect trees and other forest vegetation. The main diseases affecting Canada's forests are root rots, rusts, cankers and stains that result in death or reduced growth, as well as considerable loss in commercial value, aesthetics and recreational opportunities.

The concept of disease protection has evolved from crisis management to a more long-term approach. In this way, diseases such as white-pine blister rust, which devastated the once magnificent white pine stands of eastern North America, can be controlled within acceptable limits.

Many diseases are caused by pathogenic fungi. "Mycoherbicides" made from these fungi may be a viable alternative to the synthetic chemical herbicides used to control weeds that compete with young trees. BICOVER is a new national network established under Canada's Green Plan that brings together university and government scientists to work on studies of natural agents for vegetation control.

Each year, a root-rotting fungus known as "armillaria" destroys 14 million m³ of wood in Ontario. Scientists are developing a method to use harmless fungi to "immunize" trees against armillaria infection.

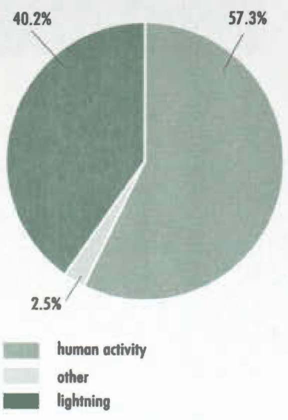
Dutch elm disease was accidentally introduced into the United States in the 1920s in logs imported from Europe. It subsequently swept through eastern North America, wiping out a high proportion of stately elms in many of Canada's cities and towns. In the 1970s, forest pathologists in Ontario produced a fungicide that is injected into the root flares of the elm as a control measure. They also developed a bark spray to prevent overwintering of bark beetles, which transmit the disease.

More recently, scientists have isolated the genes that control the ability of the Dutch elm disease pathogen to attack elm trees. Scientists are investigating whether the fungus will lose its ability to harm the tree if these genes are removed.

Another approach focusses on the defense mechanisms that trees use to ward off diseases. Through biotechnology, we may be able to enhance the disease immunity of the next generation of elms.

In the 1970s, a disease known as "corky root" was killing about a million Douglas-fir and spruce seedlings each year in forest nurseries in British Columbia and the northwestern United States. Scientists found that summer fallowing of the infected soils, followed by tilling could control the disease. This procedure is now used extensively in the Pacific Northwest, and has saved the forest industry about $25 million.

NUMBER OF FIRES (1991)



Source: Forestry Canada

Fire in the Forecast

The heat energy produced by a large raging forest fire over a 30-minute period is equivalent to a small nuclear explosion. The only recourse for the inhabitants of communities threatened by a major fire is evacuation; the only hope for control is prolonged rain.

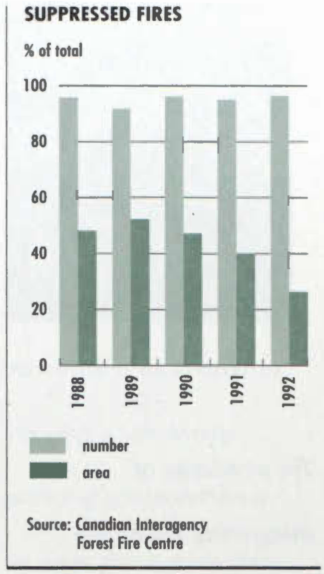
But fire is an important part of the natural cycle of change and renewal in the forest, and has both positive and negative effects. Early strategies focussed on eliminating fire; today it is recognized that fire, like other elements in the ecosystem, plays an important role in maintaining ecological diversity.

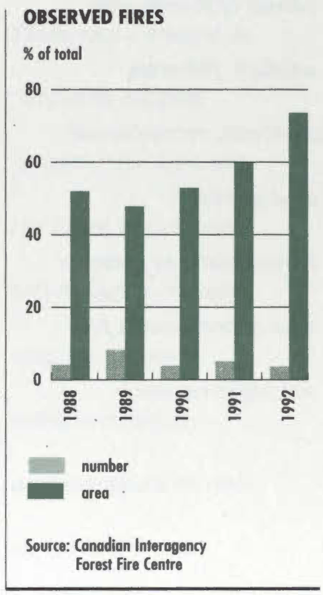
Fire researchers investigate ways of detecting, predicting and preventing fire. The tools they have developed, from manuals to computer systems, are crucial to forest fire management.

When looking at a forest, a fire specialist sees each tree species as a type of fuel, and considers the many ways in which the terrain and other factors — such as temperature, humidity, wind and precipitation — might affect the spread of fire. The Fire Weather Index takes all of these factors into account to help predict outbreaks and to inform the public of the risk of fire.

The Canadian Forest Fire Behaviour Prediction System was recently completed, following 20 years of cooperative research by scientists and forest managers. The System predicts the rate at which a fire will spread, as well as its consumption of fuel, its intensity, and other important characteristics. The system is used by fire managers across Canada to develop tactics and strategies, and to efficiently dispatch crews and equipment. It can also be used as a management tool when forest managers plan fires to promote the regeneration of a forest. Although the System is a new tool, it has quickly gained international recognition, and is now used widely.

Many regions, particularly in central Canada, are prone to violent lightning storms with little if any precipitation. On a stormy summer's day, lightning may strike up to a thousand times, causing numerous fires. Canadian scientists have developed automatic lightning detection networks that map every strike almost instantaneously, and send the data to a central computer system. Hundreds of radars and weather stations also feed into the system. The system provides fire managers with information on weather conditions, the risk of fire, the location of lightning strikes, the status of fires, and the location of crews and equipment. But it can also be used to predict the behaviour of existing fires, to determine where new fires may occur, and to reallocate crews and equipment.





Forest managers suppress some fires and start others in the interest of good land management. Fire management has changed enormously since the days when fire rangers took their canoes into the bush for months at a time with hand tools and a water bucket. Fire rangers used to survey the landscape from lofty towers, now they predict fires and provide strategies based on the information obtained from computer systems and electronic lightning networks. First priority is usually given to inhabited areas or productive forests, but nature is allowed to take its course in many remote locations.

Scientists have recently developed an infrared scanner that can be installed in a small aircraft. It penetrates smoke cover and locates previously undetectable fires.

These two fire management systems have revolutionized Canada's ability to quickly detect and combat fires. They are in use in most provinces and territories, and have been the subject of considerable international interest. In 1993, they will be combined to form a new generation of fire management systems. Continued research will ensure that Canada retains its position as a world leader in fire management.

GENTLER PRACTICES

The challenge of integrating the timber values of forests with wildlife, fisheries, aesthetic, recreational and spiritual considerations presents new opportunities for scientific research.

Today we are entering yet another period of forest management — one that builds upon past experience, but focusses on integrating all forest values. This shift in emphasis to a complete forest ecosystem or "landscape ecology" perspective has been prompted by the concern expressed by forest managers, politicians, environmentalists, researchers and the public at large about how Canada's forests are being managed.

Forest scientists can promote this landscape ecology perspective by generating knowledge that will lead to a better understanding of the patterns and functioning of forest ecosystems. Through application of this knowledge, we can approach the goals of sustainable development.

Until recently, a large part of Canada's forest management research effort focussed on growing and harvesting timber. Research work included understanding how forests grow, forecasting future yields of timber, developing new and more efficient harvesting systems and equipment, and regenerating and tending a new forest for commercial use.

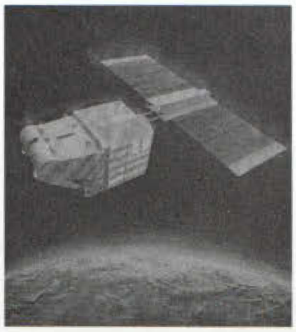
Bringing It All Together

Forest managers recognize the need to integrate a variety of forest values and to manage entire ecosystems to ensure diversity across the landscape. To do this, they must incorporate a wide variety of information into their planning of forest management operations, including data on soils, climate, harvest patterns, wildlife populations, and terrain. Newly developed computer systems allow forest professionals to consult with other experts, to make decisions quickly and accurately, and to visualize the impact of their decisions. Ultimately, research will provide a new generation of systems that will allow forest managers to predict the long-term impact of their decisions on the ecosystem.

Researchers are also trying to assess the impact of human activities on the forest landscape. A number of studies indicate that the fragmentation of the deciduous forest of eastern North America, which occurred as land was cleared for farming, has greatly reduced the habitat of migratory songbirds that prefer continuous mature forest. Ground-nesting bird species are particularly vulnerable. However, the population of some wildlife species, such as deer, has increased.

Do harvesting operations in the Boreal forest also have a negative impact on songbirds? Research undertaken in Ontario by the Canadian Wildlife Service indicates that, although the composition of the bird population is different, there are few major changes in the migration patterns, nest locations, and feeding habits in uncut and cut Boreal forests. The Boreal forest cover is still largely uninterrupted, whereas the deciduous forest is interspersed with farmland and urban areas.

A study in the balsam fir forests of Newfoundland has shown wide differences between the bird and animal populations in unlogged forests and those in the mature forests that have developed following clearcut logging. Grey-cheeked thrushes, black-backed woodpeckers, red crossbills, pine martens, and field voles were all found largely or entirely in unlogged forests. By contrast, ovenbirds, black-throated green warblers, pine siskins, snowshoe hares, and deer mice were all more abundant in forests that had once been harvested.



Research is underway to develop a whole new array of computer tools to assist forest managers. These tools, known as "decision-support systems," incorporate the latest in computer technology, computer mapping systems, satellite imagery, and computer models to forecast forest conditions.

Growing New Forests

Sustainable forestry involves a cycle of cutting, site preparation, regeneration, tending, and then cutting once again. Researchers are continuing to develop new techniques to ensure that the land is capable of maintaining a vital and productive forest ecosystem. Site preparation methods are being assessed for their impact on biological diversity and future site productivity.

In the black spruce forests of central Canada, researchers considered harvesting, site preparation and regeneration together, and devised several careful logging techniques that do not damage young trees and that eliminate the need for expensive site preparation and replanting. The techniques also reduce the need for chemical herbicides and alleviate the visual impact of logging. This new approach is now being adopted by provincial and industrial forest managers in much of Canada's black spruce forests.

In the Prairies, aspen was always considered a weed tree that interfered with the establishment of white spruce forests — the mainstay of the forest industry in that area. Researchers employed by the Prairie provinces, Forestry Canada and the Forest Engineering Research Institute of Canada (FERIC) have developed techniques for growing two forests on the same land at the same time. In the past, aspen trees that competed with young spruce seedlings were treated with herbicides. Now those trees are allowed to grow for about 40 years before being removed and used by the pulp and paper industry. The undamaged spruce understorey is left on the site until it is ready to be harvested. This system more closely resembles the natural development of that particular forest ecosystem, and ensures that a wide variety of habitats are maintained for wildlife, while providing timber for industry.

The control of competing vegetation is being tackled in unconventional ways as alternatives to chemical methods are sought. For example, natural enemies of weeds are being used, ranging from sheep to microbes.

SOME SIGNIFICANT DEVELOPMENTS IN FOREST MANAGEMENT RESEARCH

- *knowledge and standards governing the collection and use of tree seed to ensure that seedlings come from high-quality trees and are grown only in areas that are climatically suitable;*
- *efficient nursery systems capable of producing in excess of 1 billion tree seedlings a year, and new techniques, such as growing trees in containers;*
- *an array of new prescriptions, techniques and equipment to control weeds, and to space, thin and tend young forests;*
- *new techniques, including aerial photography, satellite imagery and computer mapping systems, to update and automate forest inventories and forecast forest growth;*
- *new knowledge to help minimize the impact of harvesting and road building on streams, steep slopes, and ecologically unique or sensitive sites;*
- *information on changes in plant and animal communities resulting from harvesting and the use of machinery.*

New Approaches to Harvesting

Harvesting machinery and techniques are changing. Currently, about half of Canada's forest harvesting is done with "full-tree" systems, in which entire trees, including tops and branches, are removed from the forest site. Twenty-eight percent of harvesting is done with "tree-length" systems, in which the trunks are removed and the branches are left in the forest. Nine percent is done with "short-wood" systems, in which the trunks are cut into shorter lengths (usually 2.44 m) in the forest after the tops and branches are removed. The remaining 12% of harvesting is done by chipping the trees on site. The Canadian Pulp and Paper Association predicts that by the year 2000, we can expect full-tree logging to decrease to about 20%, tree-length logging to increase to between 40 and 50%, and shortwood and chips to increase to between 15 and 20% each.

New information on nutrient cycling in forest ecosystems indicates the need to reduce full-tree harvesting to keep more nutrients on the harvest site and to maintain future growth and productivity levels.

Recent studies by FERIC have also demonstrated how forest harvesting operations could be changed to minimize the environmental effects of current clearcut harvesting methods. These include building logging roads and trails as far apart as possible; harvesting under frozen or snow-covered conditions, and better positioning trees when they are felled to avoid disturbing the soil; reducing the size of clearcuts; logging areas in irregular shapes to improve their appearance and to enhance wildlife conditions; and using wide and flexible tires on harvesting equipment to prevent ground damage.

Researchers at the University of British Columbia have developed a computer simulation model to predict the long-term ecological impacts of alternative forest management systems. The FORCYTE model predicts changes in the flow and amount of nutrients in the forest, and in other key ecological processes as a result of different silvicultural and harvesting treatments.

Simple improvements in machine maintenance reflect a shift in environmental behavior. For example, the hydraulic systems on forest machinery can now run on vegetable or biodegradable oil. New technologies, such as robotics, artificial intelligence and biotechnology, offer real promise for the future. A continually evolving social climate and changing environmental concerns provide a dynamic context for further scientific research.

We must ensure that we continue to derive economic benefits from Canada's forests in a way that is sustainable and respectful of the environment.

TREES IN THE SPACE AGE

We now turn our attention to the tree, for it is at the tree level that many changes in forest products research are occurring. As the industry focusses on extracting the maximum value from each log, researchers are shifting their attention to issues such as reducing the environmental impact of manufacturing processes, utilizing previously neglected species such as aspen, and developing products of higher value.

LASER LUMBER

Sawing logs is definitely not what it used to be. Lasers, x-rays, "ion clouds," expert systems and biotechnology are the new tools of change. In a pilot plant, MacMillan Bloedel employees use x-ray technology to locate defects inside logs and boards. A three-dimensional image is fed into a computer that designs the best cutting pattern.

New technology has even had a major impact on drying and sorting lumber. Considerable research has gone into determining the best ways of drying combinations of commercial species such as spruce, pine and fir that are in high demand overseas. The Forintek-Novax moisture sensor uses infrared remote-sensing technology to determine the surface moisture content of individual pieces of lumber. The sensor sorts lumber according to its moisture content, so that pieces with similar moisture levels can be dried at the same time. This reduces warping and twisting, and improves the efficiency of both the kiln and the planer. The new technology is already in use in British Columbia, where it is effective even on frozen lumber.

Automatic sorting of lumber by wood species is now possible with a technology known as "ion mobility spectrometry" (IMS). As the lumber moves through the sawmill, a remote infrared laser heats the wood, and vaporizes chemicals from the wood surface. This vapor is analyzed by an IMS detector and within 0.2 seconds, the species is identified and the lumber is sorted accordingly.

There is still a large amount of lumber sold in "green" or unseasoned condition. Such lumber is highly susceptible to attack by sapstain fungi, which can discolor the lumber and cause it to deteriorate. In the past, deterioration was prevented by treating the wood with chlorinated chemicals, but public concern has led to the development of new antisapstain products by Forintek and Canadian Forest Products Ltd. These products, F2 and Eco-brite, have been patented and marketed. Scientists at Domtar Ltd. have recently developed and patented a new preservative formulation, and researchers at Forintek have achieved promising results with borate chemicals for wood protection that are colorless, odorless and more environmentally benign.

Parallam consists of thin strands of Douglas-fir veneer bonded with waterproof resins, which are cured under high pressure and heat to form long, continuous sheets.

NEW-AGE WOOD

A new Canadian waferboard product marked the beginning of a forest products revolution in the 1970s. This product, marketed as ASPENITE™, is an alternative to plywood, and is made from aspen, which was previously considered a weed. Waferboard, or "oriented strand board" as it is now known, has become a world commodity.

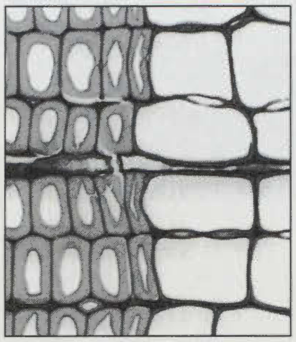
In the past 20 years, scientists at MacMillan Bloedel have developed an array of successful products, such as Parallam or parallel strand lumber, from low-quality, small-diameter trees. The sheets can be factory-cut into structural timbers up to 30 m in length for use in non-residential construction. Parallam is now owned and marketed worldwide by Trus Joist MacMillan, a joint venture between Trus Joist Corporation of Boise, Idaho and MacMillan Bloedel, of Vancouver, British Columbia.

Many new wood composites are being developed for a rapidly expanding market. Recently, the Parallam and waferboard technologies were combined to produce TimberStrand™,

Some of the pioneering research work in solid wood products has gained Canadians international recognition. In 1982, Professor Ricardo Foschi of the University of British Columbia was awarded the prestigious Marcus Wallenberg Prize — the "Nobel Prize" of forestry research — for his work on the assessment and prediction of the structural reliability of buildings fabricated from wood and wood products. Mr. Derek Barnes and Dr. Mark Churchland of MacMillan Bloedel received the prize in 1987 for developing the product Parallam. The Wallenberg prize is presented by the King of Sweden.

an aspen-based material used to make window and door components. In addition, Canadian Forest Products Ltd. has developed an advanced wood-fibre plastic composite for the automobile industry.

A NEW LOOK AT AN OLD "KRAFT"



Converting wood into paper and paperboard products is a complex process. As illustrated, wood consists of cellulose fibres bound together by lignin. The cellulose can be extracted by applying heat in conjunction with chemical and mechanical treatments. The resulting fibre is used to manufacture pulp and paper. Research has been instrumental in improving these complex processes and in developing new products.

Until the late 1960s, research activities in Canada focussed on the traditional mainstay products of the industry, i.e., newsprint and market kraft pulp. This research was conducted by the Pulp and Paper Research Institute of Canada (PAPRICAN), a number of companies, and several Canadian universities. Key improvements include the Papriformer and twin wire technology, which became the universal standard in papermaking machine technology.

In the early 1970s, the supply of wood in some regions was no longer inexhaustible, and energy was becoming more expensive. The focus of research shifted to reducing energy consumption, improving the amount of fibre extracted from wood, and reducing the pollutants produced by pulp and paper mills. A decade later, increasing competition in traditional products led to the development of new products such as lightweight papers. Research concentrated on improving the high-speed production of these high-quality papers, as well as newsprint and other types of papers.

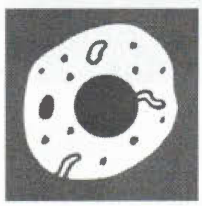
In the 1990s, research continues to focus on improving wood yield and lowering production costs. Increased emphasis is being placed on more efficient use of wood waste and on lesser-used wood species, particularly hardwoods. Research is also addressing environmental concerns, especially those involving dioxins and furans, two compounds produced in the pulping and bleaching of wood. At the same time, the industry is adapting its mills to recycle wastepaper *(see page 59)*. Environmentally related research is estimated to have tripled, and now represents 40 to 50% of total research efforts.

More and more resources and expertise are being pooled through research networks. For example, PAPRICAN, industry and others collaborated to address the dioxin issue. Also, the Mechanical and Chemi-mechanical Pulps Network was established in cooperation with the Canadian pulp and paper industry as one of the federal government's 15 networks of Centres of Scientific Excellence. For two years, this independent, country-wide network, which involves PAPRICAN, 10 universities and one government laboratory, has been engaged in research to improve mechanical pulps and mill productivity. Its work is considered one of the largest research projects on a single topic ever undertaken in the Canadian pulp and paper industry. The establishment of links with other networks has demonstrated the benefits of pooling scientific expertise and resources, and is indicative of the future of research.

The industry is now taking a long-term view of the impact of processes and products. This entails research into the development and use of substitutes for chlorine and chlorine compounds in the pulping and bleaching processes, the control of production systems to contain and recycle pollutants, and the recycling of pulp and paper products.

With an eye to the future, MacMillan Bloedel Research recognized the need for environmentally friendly packaging as an alternative to steel drums for the bulk shipment of non-hazardous fluids. Intensive research led to the development of a unique packaging system called "SpaceKraft" — a seamless, multi-walled box-like container with an inner plastic liner. This cardboard container comes folded, but when filled, it holds 1 250 litres of liquid and takes up 20% less space than five 250 litre steel drums. This safe, durable and biodegradable container has been an environmental and commercial success.

SECRETS OF CELLS AND GENES



Research at the level of the tree is understandable. We can visualize the tree, and we can see and touch the products derived from trees. However, to maintain the technological advantage of Canada's forest industry and to alleviate environmental concerns, much research is now focussed at the level of the cell.

CULTURED CELLS

In the 1980s, a major effort in biotechnology was the development of a regeneration process called "somatic

Through cryogenics, we can store minute quantities of valuable germplasm and preserve considerable genetic resources in small facilities.

embryogenesis" within conifer species such as spruce. This tissue-culture process allows us to produce unlimited numbers of seedlings from a single tree seed in a very short time. The technique has already been tested in the laboratories of the National Research Council, British Columbia Research, and Forestry Canada. The next step is to develop nursery techniques using somatic embryogenesis to produce millions of tissue-culture seedlings on a commercial scale. Scientists are also attempting to develop artificial conifer seeds and to automate the tissue-culture process.

As stated earlier, the issue of biodiversity is being addressed through such strategies as the protection of wilderness areas. Biotechnological research is also focussing on conserving biodiversity by preserving the genetic material from plants and animals.

Cryogenics research involves freezing tissue cultures at -140°C to stop cell metabolism and allow indefinite storage. Cryopreservation permits the safe storage of tissue culture from improved trees and also from endangered germplasm. As part of Canada's Green Plan, Forestry Canada recently completed cryogenics facilities at the National Forest Genetic Resources Centre in Chalk River, Ontario. Canada will be able to export this expertise to countries where the problem of endangered trees is acute, particularly in the tropics.

Tissue-culture research can also be applied to the pharmaceutical industry. Research is currently underway to produce "taxol" by using tissue-culture techniques and by chemical synthesis. These techniques, if successful, could help us manufacture the drug in a lab instead of harvesting yew trees.

SPECIALTY GENES

Canada is at the forefront of research on tree genes. A better knowledge of trees at the molecular level will increase our understanding of how they function. Tree molecular biology is a relatively new discipline, but already scientists are on the threshold of some exciting discoveries.

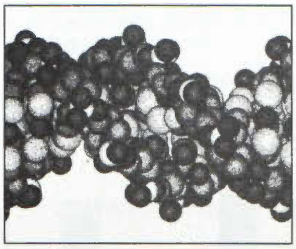
The genes that control cell growth and development have been identified in conifers. An understanding of how these genes function will provide tools that may enable us to influence the rate of tree growth.

Canadian scientists are collaborating with scientists in Sweden on research into the tree genes that determine wood quality. Genes that regulate tree growth and the production of lignin in poplar have been isolated. By modifying lignin, we hope to increase the content of cellulose fibre in wood, and reduce the amount of chemicals required to produce pulp.

The most recent biotechnological breakthrough by Canadian scientists was the production of transgenic spruce tissue cultures. "Transgenic" refers to the technique that introduces new genes into a tree. Adapted from a method developed for crop plants, this technique consists of bombarding tree cells with DNA-coated microparticles. The foreign genes are subsequently integrated into the host cells. Further applications of genetic engineering may lead to increased tree growth, greater resistance to insects and disease, and improved wood quality.

Researchers are now pioneering the use of molecular biology to help evaluate the genetic diversity and composition of groups of trees. Through this research, genetic or chromosome "maps" will be prepared. This information will be valuable in determining if the genetic make-up of Canada's forests is changing, and if certain "populations" are at risk.

Protecting genetic diversity is an important component of an overall biodiversity strategy. Canadian scientists are developing testing techniques and guidelines to assess the possible impacts of biotechnological products in natural ecosystems and to regulate their use.



Gene mapping is used to identify the DNA of species of trees.

BACK TO EARTH

When an astronaut views Earth from the window of *Discovery* or a molecular biologist views a cell through the lens of a microscope, both are attempting to improve their understanding of how the planet and the cell function. Some forest scientists, using space technology, study the forest as a living system spanning thousands of kilometres. Others explore deep into cell structures and individual molecules, where the scale is in micro units.

Despite this enormously broad and varied approach, all research activities are linked by a common goal. Scientists attempt to develop the best methods of managing forest ecosystems while balancing the many demands placed on the forest in terms of its productive capacity and long-term health.

The history of forestry research in Canada is short compared with the life of a tree. Yet we have gained considerable knowledge.

Recently, a chemical called "taxol", which is extracted in small quantities from the bark of yew trees, was found to be a promising new anti-cancer drug.

Forest science crosses the boundaries of medicine, space research and environmental science, and utilizes the latest technology — from neural networks in computers and computational vision in robotics, to genetic transformation in biotechnology.

Putting this knowledge to use will improve our management of forest ecosystems. And Canada will not be the only nation to benefit from these efforts; the products of our research will be made available around the world.

A floating cell and the Earth suspended in space are intertwined in ways beyond our comprehension. If the human species is to remain an integral and responsible part of this web, it is imperative that we advance and develop our understanding of the biological systems that support life.

By producing the cancer drug "taxol" from plant tissue culture, molecular biologists are helping to conserve the Pacific yew tree. If climatologists can better understand the relation between the northern Boreal forest and the Earth's carbon cycle, we may be able to moderate the effects of climate change through forestry practices. As forest engineers develop new products using small trees, different species and waste materials, we may be able to conserve more old-growth forests.

The various disciplines of forestry research are intertwined. Each element, though seemingly disconnected, is part of a larger strategy focussed on sustainable forest ecosystems and the wise use of forests for present and future generations.

This chapter has focussed on how science is changing the way we look at and manage our forests. Canadian forestry must continue to adapt to the rapid social, economic and environmental changes around the world. The challenge is clear — to survive, we must adapt. Our ability to do so will be determined largely by the knowledge generated through our efforts in science and technology.

FORESTRY RESEARCH EXPENDITURES

Total forestry research expenditures from governments, universities and industry in 1990 were $343 million, a decrease of $13 million compared to the previous year. Significant changes in research since 1990 will likely result in a small increase in expenditures. Over the past decade, forestry research expenditures have represented about 0.7% of the value of shipments — a figure that places Canada in the lower-middle range of developed countries, a position it occupies in many other fields of research.

Over the past five years, the federal government's expenditures in forestry research have represented about 30% of the national total. Most of this has come from Forestry Canada, but a number of other federal departments and agencies also support research relevant to forestry (including the National Research Council, the Natural Sciences and Engineering Research Council, Environment Canada, Energy, Mines and Resources Canada, Agriculture Canada and ISTC).

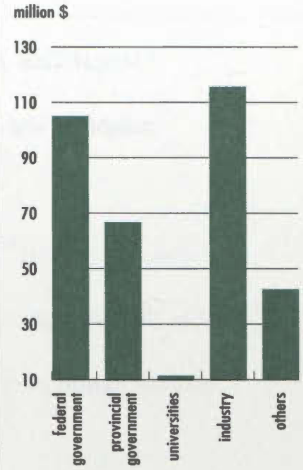
The provinces currently support close to 20% of total forestry research. Provincial activities are generally of an applied nature, concerned with solving forest management problems and applying new technologies in forestry operations.

Universities undertake about 10% of the nation's forestry research, principally with funding received from governments and industry. In addition to the seven university forestry schools, a number of universities contribute to forestry research in a wide range of disciplines, such as biology, wood chemistry and the social sciences.

There are three cooperative industrial forestry research institutes in Canada. FERIC (Forest Engineering Research Institute of Canada), FORINTEK Corporation and PAPRICAN are responsible for research in forest engineering, solid wood products, and pulp and paper, respectively. They are supported financially by industry and by the federal and provincial governments. Over the past 10 years, the total annual budget for these three institutes has increased from $26.8 million to $51.2 million.

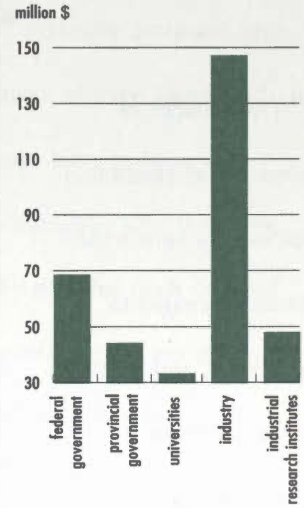
A number of companies also undertake research, although some of these efforts were curtailed during the recent recession. Between 1981 and 1992, annual expenditures for industrial research increased from about $80 million to about $144 million.

RESEARCH AND DEVELOPMENT EXPENDITURES (1990)
-SOURCES OF FUNDS



Sources: Statistics Canada/Forestry Canada/ Industrial Research Institutes

RESEARCH AND DEVELOPMENT EXPENDITURES (1990)
-PERFORMERS



Sources: Statistics Canada/Forestry Canada/ Industrial Research Institutes

SOME NOTABLE NEW RESEARCH PROGRAMS

- *Networks of Centres of Excellence, through which awards have been made to PAPRICAN (Pulp and Paper Research Institute of Canada) and Queen's University;*
- *technology and innovation agreements between Industry, Science and Technology Canada (ISTC) and MacMillan Bloedel (5 years, $45 million), and between ISTC and PAPRICAN (5 years, $20 million);*
- *Partners in Sustainable Development of Forests under the federal Green Plan (5 years, $50 million);*
- *federal-provincial/territorial forestry agreements (5 years, nearly $100 million).*

POINTS OF VIEW

"MacMillan Bloedel, Forgacs explains, views research as an ingredient in the process of adapting the company to change."

AN INTERVIEW WITH DR. OTTO FORGACS

Senior Vice-President, Research, MacMillan Bloedel Limited

The forest industry in Canada has been criticized for not investing enough in research and development. MacMillan Bloedel, however, is one of several exceptions. It is a company with a long commitment to R & D, one that has an enviable record of innovation and new product creation.

Dr. Otto Forgacs, Senior Vice-President, Research, has been director of R & D at MacMillan Bloedel for 20 years.

"Research is what you do when you know that you can't do things tomorrow the way you are doing them today, and you don't know what to do," he quips, quoting Charles Kettering, past research director at General Motors.

"I like that definition because it points to the motivation for research without exactly defining what skills are necessary. That's important, because they can be anything from strict scientific skills, to engineering and marketing."

MacMillan Bloedel, Forgacs explains, views research as an ingredient in the process of adapting the company to change. Moreover, the urgency for change and the magnitude of those changes are now greater than they have ever been throughout the history of the company.

"I think we could survive for a number of years without doing R & D, but I'm convinced that if the company doesn't continue to be innovative, it isn't going to be around for a whole lot longer."

In recent years, the annual budget for R & D has remained fairly steady around $20 million, employing between 110 and 140 people. Numbers go up and down as projects grow, mature and are completed. Also, MB shifts resources to meet new needs as they arise. But Forgacs makes it clear that the policy, as much as possible, is that research and development must be ongoing.

"The breadth of research at MacMillan Bloedel is very wide: from processes to products, and from cost reduction to environmental compliance."

Some critics have suggested that the reason the Canadian forest industry as a whole has invested so little in research and development is that it produces mainly commodity products, and thus can "get away" without it. Forgacs points out that his company has a more sophisticated approach.

"The amount of research and development you do on any product is related to its life span. Newsprint, for instance, really hasn't changed that much in 20 years. There's nothing wrong with having a much lower level of R & D for that type of product."

There are indications that product lifetimes are likely to shorten. "So," notes Forgacs, "there is probably more need now for increasing R & D in this industry than there's been at any time in the past."

Experience has shown MacMillan Bloedel that it takes at least five years to develop a new product and bring it to market. Some take considerably longer. For instance, Parallam®, a composite wood product suitable for engineered beams, headers and posts, took 20 years to get to market.

"We did a lot of soul searching with that one. Some of us recognized the coming need for it, but within the company it wasn't broadly supported for the first 15 years."

"I don't have faith in R & D in any religious way," Forgacs explains. "It's a management function, and if it's managed badly you're better off not having it. R & D tends to live on its track record and unfortunately, a lot of experience and practice are required to manage it effectively. Companies that have had very small and weak R & D efforts might come to the wrong conclusion: that R & D isn't needed. Rather, they should examine their shortcomings in the ability to manage the function."

Then he adds, "Personally, I think that companies that aren't doing R & D are labouring under a serious handicap."

"We do research on things we sell, rather than things we buy."

"To really innovate, you have to have ideas, and you have to have a champion who is willing to stick his neck out and persuade the people who still embrace conventional thinking that he should be allowed to do this crazy thing."

"The key issue, Dottori suggests, is whether management can justify a long-term approach to investors who usually don't want to wait four or five years for returns."

"So there is a fundamental philosophy that grew out of necessity. Using R & D, we developed new products and have managed to survive and grow."

AN INTERVIEW WITH FRANK DOTTORI

President and CEO, Tembec Inc.

There is probably no better example of the difference that research can make to a corporation than Tembec Inc. To this forest products company, operating in Quebec and Ontario, it has clearly meant the difference between success and failure.

Tembec was formed in 1972 by a group of managers and employees from a pulp mill in Temiscaming, Quebec, after the mill had been shut down. With some government help, the turnaround was made possible by a management approach that encouraged innovation and focussed on research and development.

Frank Dottori, President and CEO, explains: "The mill was shut down because research and development had not been carried out. There was an inadequate wood supply at the time and severe environmental problems."

"We developed products using the tree species that were left in the area, rather than basing ourselves 100% on spruce, as the previous company had. We developed technology to use jack pine and later, to use aspen, maple, hemlock and other species."

Dottori emphasizes, though, that to run a successful research and development program, the company had to take a long-term view of business. "In the short term you can react to economic conditions, but for long-term viability we have to focus on at least a 10-year period. Over that time, there will be some very severe cycles in the industry, both up and down."

That flies in the face of what he sees as the general corporate culture in the forest industry, which is driven by the need to respond to quarterly reports.

"A company that is successful on a long-term basis can have disastrous results in the short term. Tembec is no different. But we have marched on in spite of the recession, investing and continuing research and development."

"Too often in this industry, pressure from investors puts management into a survival mode where they focus more on their personal survival than on long-term corporate goals. We make it very clear to investors that Tembec does its business plans on a minimum of five years, and looks at a 10-year horizon."

Another requirement for research and development is creative thought, and Tembec has written creativity into its corporate objectives.

"There are people who think that creativity and research are very complicated processes, and they are. But I always tell such people that taking a banana, an orange, some grapes and an apple, and chopping them up into a fruit cocktail is creativity. You've developed a new product by rearranging existing ones."

"We feel that economics and environment are parallel objectives," notes Dottori. "One of our primary economic objectives is to minimize waste. That's driven by economics more than environment. If you process a tree and you get a 50% yield, then 50% is waste, and you don't have a very economical operation. But if you develop new technology that allows you to use 75%, you've now cut your waste by half and at the same time, you've increased your output by half."

"We set up a subsidiary company called "Envirotem" that is developing new technology to provide secondary and tertiary treatment of mill and industrial effluent in a more economical way."

Dottori cautions, though, "We still don't have as diversified a product range as most pulp and paper companies across North America. If you look at U.S. companies, one of the reasons they are more successful and have more stable earnings is that they are also more diversified."

But that clearly is the direction Tembec is taking, and it intends to use liberal doses of creativity and research to get there.

"A hallmark of this company is not only its innovation, but also its wide range of products. The list is extensive, from specialized pulps and hardwood flooring, to laminated veneer lumber, fine papers, and ethanol."

Model Forests

A PRACTICAL APPROACH TO THE SUSTAINABLE DEVELOPMENT OF FORESTS

The model forests will serve as a testing ground for new, economically and ecologically sound approaches to forest management — approaches that can be applied on a working scale.

Ever since the release of *Our Common Future*, the 1987 report of the World Commission on Environment and Development, countries around the world have been grappling with the challenge of how to put the principles of sustainable development into action. As part of its new National Forest Strategy, Canada has helped move this international effort forward by establishing a unique network of 10 model forests across the country.

WHAT IS A MODEL FOREST?

A model forest is a working-scale forest between 100 000 and 1 500 000 hectares in size. The network of proposed sites covers more than 7 million hectares — an area larger than all of the forests in Germany. A model forest is managed for a sustainable supply of timber, but must also integrate a range of other important values, for example, water quality, biological diversity, wildlife habitat, community stability, and recreational, cultural or spiritual values. Each model forest is managed by a partnership of organizations and individuals who have an interest in the forest and who must decide on the particular objectives for which it will be managed.

The objectives and work plan for each model forest reflect a consensus among the partners that was achieved through a process of consultation and discussion.

The model forests are expected to use the most ecologically sound forestry practices, and will be linked to an expanded program of research.

HOW MODEL FOREST PARTNERSHIPS ARE UNIQUE

The Model Forests Program began with a national competition. It had been decided early on that model forest projects should be formed at the local level, and that groups should determine their own membership and propose their own concept of sustainable

forestry. After the proposals were carefully and painstakingly reviewed, a National Advisory Committee on Model Forests recommended the 10 most appropriate projects.

The partnership groups in the model forests are all unique and include a wide range of interested parties: provinces, forest industries, First Nations, recreationists, community organizations, private landowners, government agencies, environmental and conservation organizations, and academics. The number of partners is different for each site; the Foothills Forest of Alberta, for example, has 70 partners.

The idea behind the partnerships or committees is to develop a consensus among the different interest groups by fully discussing any conflicts or trade-offs at the earliest stage of forest management planning. By including different viewpoints, each group should be able to take into consideration all of the important aspects of the forest and its uses, and to develop agreed-upon solutions.

WESTERN NEWFOUNDLAND MODEL FOREST
Location: Western Newfoundland
Forest Region: Boreal
707 060 hectares

FUNDY MODEL FOREST, MARITIMES
Location: Southern New Brunswick
Forest Region: Acadian
419 266 hectares

AN INHABITED FOREST, QUEBEC
Location: Temiscouata-Restigouche in the central-eastern part of Quebec
Forest Region: Great Lakes - St. Lawrence
112 634 hectares

EASTERN ONTARIO MODEL FOREST
Location: Eastern Ontario, north of the St. Lawrence River
Forest Region: Great Lakes - St. Lawrence
1 534 115 hectares

LAKE ABITIBI MODEL FOREST, ONTARIO
Location: Northeastern Ontario
Forest Region: Boreal
1 094 690 hectares

MANITOU ABI MODEL FOREST, MANITOBA
Location: North of Winnipeg, southeast of Lake Winnipeg
Forest Region: Boreal
1 047 069 hectares

PRINCE ALBERT MODEL FOREST, SASKATCHEWAN
Location: Central Saskatchewan, 70 km north of Prince Albert
Forest Region: Boreal
314 649 hectares

HOW MODEL FORESTS SUPPORT CANADA'S BROADER FOREST MANAGEMENT OBJECTIVES

Model forests are an important initiative of the new National Forest Strategy and were developed under the auspices of the Canadian Council of Forest Ministers. Although the lands involved in the model forest projects fall into different categories — national parks, private lands, or First Nation lands — as owners of the majority of Canada's forests, the provinces are critical partners in the model forests network.

The model forests will look at ways of resolving many important issues, including: managing the forest areas surrounding national parks; examining how forests with different owners can be managed for common goals; trying to integrate First Nations' philosophies into forestry programs; and developing recovery plans for threatened or endangered species. Although these projects will be implemented in different provinces and different ecological regions, the results can be applied across Canada.

WHAT MODEL FORESTS WILL DO

Sustainable development initiatives undertaken in each of the model forests will reflect the context and issues in the particular region. The goals and activities of An Inhabited Forest of Quebec, for example, which includes a lot of small, privately owned forests, are very different from those in the McGregor Model Forest in north-central British Columbia, which has a large portion of provincial Crown land. A strong and distinct philosophy can also be found where Canada's Aboriginal people are heavily involved. For example, the Prince Albert Model Forest proposal included the following vision statement: "The Great Spirit has created all living things to exist in harmony with each other. The forest is our home. We live here and remain here. We must continue to share with each other for the sake of our children's children."

In many ways, the model forests reflect concrete examples of the issues facing all Canadian forest management programs. Critical wildlife concerns are being addressed in several projects. For example, the Western Newfoundland Model Forest includes a recovery plan for the threatened Newfoundland pine marten. This mammal has lost much of its habitat due to a series of destructive insect epidemics and decades of forest harvesting. The remaining mature forest habitat of the pine marten must now be conserved and protected by carefully designed forest management programs. Similar situations are found in the Foothills and Manitou Abi Model Forests, where the fate of the woodland caribou is an important concern.

Social values like employment, rural stability, and access to hunting and fishing are emphasized in many model forest projects. In An Inhabited Forest of Quebec, for example, an innovative approach has been developed to give rural people a stake in, and responsibility for, the hands-on management of forest land owned by Abitibi-Price Inc. This initiative provides a long-term opportunity for local residents not only to be employed in the forest, but also to have a role in its ongoing management. In Ontario, the Lake Abitibi Model Forest will expand and improve efforts to develop the tourist industry, particularly outfitting and fly-in fishing camps. A new public information centre will also be built.

In coastal British Columbia, the Long Beach Model Forest will focus on developing better scientific research and planning systems that will ensure the conservation and understanding of coastal rain forest ecosystems. A broad group of stakeholders will work together to define these research programs, the results of which will be made available to local communities, environmental groups, industry and government agencies.

Despite their differences, all 10 sites are working forests. Proposed ideas and practices must not only stand the test of the real world, but must also be implemented across the entire forest.

SUPPORT FOR GLOBAL SUSTAINABLE FOREST DEVELOPMENT

At the "Earth Summit" in Brazil, Prime Minister Mulroney announced Canada's intention to expand the concept of model forests by seeking partners around the globe. An international network of model forest projects will provide Canadian forest managers with an opportunity to share experiences and technology with other forest managers around the world.

FOOTHILLS FOREST, ALBERTA
Location: Eastern slopes of the Rocky Mountains, east of Jasper National Park in west-central Alberta
Forest Region: Boreal, Subalpine and Montane
1 218 014 hectares

McGREGOR MODEL FOREST, BRITISH COLUMBIA
Location: North-central British Columbia, northeast of Prince George
Forest Region: Montane and Subalpine
181 000 hectares

LONG BEACH MODEL FOREST, BRITISH COLUMBIA
Location: West coast of Vancouver Island
Forest Region: Coastal
400 000 hectares

All participants in the Model Forests Program will have an opportunity to benefit from the experience gained from using different techniques in each model forest.

CHAPTER THREE

RECYCLING

ITS IMPACT ON THE CANADIAN NEWSPRINT INDUSTRY

REDUCE, REUSE, RECYCLE: THESE ARE THE CATCHWORDS OF THE '90S. PRODUCERS AND CONSUMERS ARE RESPONDING TO THE CHALLENGES OF ENVIRONMENTAL AWARENESS. MANY CONSUMERS HAVE BECOME MORE AWARE OF THE ENVIRONMENTAL IMPACT OF THEIR CHOICES AND ACTIONS, AND ARE TRYING TO ALTER THEIR CONSUMPTION PATTERNS. MUNICIPALITIES HAVE RESPONDED TO ENVIRONMENTAL CONCERNS BY CREATING BLUE BOX COLLECTION PROGRAMS. NEWSPAPERS, READ DAILY BY MILLIONS OF CANADIANS, CONSTITUTE A VISIBLE AND BULKY PROPORTION OF COLLECTED WASTE. RECYCLING IS CHANGING THE ECONOMICS OF THE NORTH AMERICAN NEWSPRINT INDUSTRY, AND WILL HAVE AN IMPACT ON THE COMPETITIVENESS OF CANADA'S INDUSTRY. PULP AND PAPER MANUFACTURING PLAYS A VERY IMPORTANT ROLE IN THE NATION'S ECONOMY, AND IS ONE OF THE MAJOR INDUSTRIES AFFECTED BY RECYCLING. IN THE PAST THREE YEARS, THERE HAS BEEN A DRAMATIC INCREASE IN INVESTMENT IN NEW FACILITIES TO RECYCLE OLD NEWSPAPERS INTO PULP AND PAPER.

Recycling is creating a challenge for Canada's newsprint industry as it competes to maintain its share of North American markets.

RECOVERY RATES FOR WASTEPAPER (1991)

	% of total wastepaper
Canada	26
USA	37
Sweden	46
Japan	50
Switzerland	51
Germany	47
Finland	35
UK	34
France	34
EC	38
World	37

Source: Pulp and Paper Research Institute of Canada

PAPER RECYCLING IN CANADA

Each year, Canada generates about 30 million tonnes of waste; approximately 33% is considered "municipal." Roughly 35% of the municipal waste consists of paper and paperboard products. In Ontario, the high level of participation (a rate of 70 to 80%) in the Blue Box Program diverted more than 200 000 tonnes of waste from landfill sites in 1989. Under the federal government's Papersave Program in the National Capital Region, more than 10 000 tonnes of office paper are recycled annually, which saves on waste disposal charges and removes paper from the waste stream.

Canada collects approximately 26% of the paper it consumes. This recovery rate is below the European Community (EC) average of about 38%. High population densities in many countries make collection programs easier and cheaper, and high costs of disposal encourage alternate uses of waste. Maximum feasible collection is generally thought to be about 60 to 65%, although higher rates in particular grades of paper have been achieved. The higher the recovery rate, the more wastepaper is diverted from landfill sites and incineration. Recovery rates for newspapers tend to be higher than those for wastepaper in general, because of well-organized collection programs. Japan has achieved 98% recovery for old newspapers, the USA has achieved 53%, and Canada has achieved 31%.

THE CANADIAN NEWSPRINT INDUSTRY (1992)

Annual production	8.9 million tonnes
Annual consumption	1 million tonnes
Annual exports to USA	5.9 million tonnes
Number of mills	44

CHALLENGES FACING CANADA'S NEWSPRINT INDUSTRY

Newsprint is the most important segment of the Canadian pulp and paper industry, representing 43% of its exports. Canada ships 66% of its newsprint production to the USA. Although its market share has declined as more mills are built south of the border, Canada continues to supply over half of American needs.

In recent years, the Canadian industry has been faced with low profits, overcapacity, changing consumer demands, and increased competition from American producers. Recycling is also having a profound impact on the industry. To retain their most important market, Canadian producers have recently had to respond to U.S. laws requiring a minimum amount of recycled fibre in their newsprint.

U.S. LAWS INCREASE DEMAND FOR WASTEPAPER

In the USA, more than half the states are estimated to have less than 10 years of landfill capacity remaining. In the mid-1980s, many states responded to the landfill crisis by passing laws that called for community recycling programs. These programs have been so successful that there is now a temporary glut of old newspapers. Some municipalities have had to pay mills between $5 and $20 per tonne to take away old newspapers.

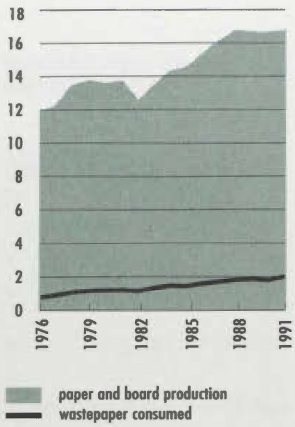
To stimulate markets for the wastepaper and other items collected through recycling programs, some states passed legislation with mandatory recycled-content requirements (also called "minimum-content laws"). These laws require newspaper publishers to use a minimum percentage of recycled fibre in their newspapers. This creates demand for old newspapers, and provides the stable market that firms need to invest in facilities that use wastepaper. However, in the long term, these laws may create a shortage of recyclable fibre.

Since 1988, 13 states have set mandatory recycled-content laws and 14 have set voluntary recycled-content agreements. These 27 states represent over 77% of total newsprint consumption in the USA. A few more states are expected to pass minimum-content laws for newsprint by 1995. The American regulations generally require the recycled content of newspapers to increase to roughly 40% before the turn of the century, although this varies from state to state.

The U.S. legislation alters the economic structure of the pulp and paper industry. Producers of paperboard, who have traditionally used much of the available wastepaper, must now compete with other users, such as newsprint producers. The source of fibre for newsprint manufacturers is shifting from the forest to urban centres, which gives a competitive advantage to mills that are close to areas with large populations.

Canada has taken a non-legislative approach to the landfill crisis by exploring policies to reduce the amount of wastepaper going into landfill sites. Options include more efficient collection systems, higher dumping fees, or per-bag garbage collection fees.

USE OF WASTEPAPER IN PAPER AND BOARD PRODUCTION IN CANADA



Source: Canadian Pulp and Paper Association

WASTEPAPER RECYCLED IN CANADA (1991)

grade	tonnes	%
Old newspaper	407 000	20.2
Container grades	948 000	47.0
Mixed papers	104 000	5.2
Boxboard cuttings	98 000	4.9
Other grades	458 000	22.7
Total	**2 014 000**	**100**

Source: Canadian Pulp and Paper Association

WHAT IS WASTEPAPER?

Wastepaper recycling in Canada has been underway for a number of years. Wastepaper, collected in municipal and industrial recycling programs, includes old newspapers, corrugated cardboard, photocopying paper, and magazine paper. Half of the wastepaper currently collected is cardboard. In 1991, 2 million tonnes of wastepaper were used in paper and board products in Canada, three times the amount used in 1975.

Wastepaper of all kinds has been an inexpensive source of fibre for the corrugated board and boxboard from which folding cartons and boxes are made. In 1990, approximately 52 of Canada's 110 pulp and paper mills used wastepaper to produce tissue and sanitary products, paperboard and cartons, modest amounts of newsprint, and printing and writing papers.

The amount of wastepaper used in the production process varies according to the product. For example, every 100 tonnes of boxboard produced in Canada contains approximately 93 tonnes of wastepaper, mostly used corrugated cardboard. Every 100 tonnes of sanitary tissue paper contains almost 40 tonnes of wastepaper.

In the past, much of the recycled wastepaper was "pre-consumer" waste, i.e., the cuttings and trimmings collected at paper mills that are a by-product of the papermaking process. Increasingly, attention is being turned to the use of "post-consumer" waste, i.e., fine papers, magazines and newspapers collected through Blue Box and other recycling programs.

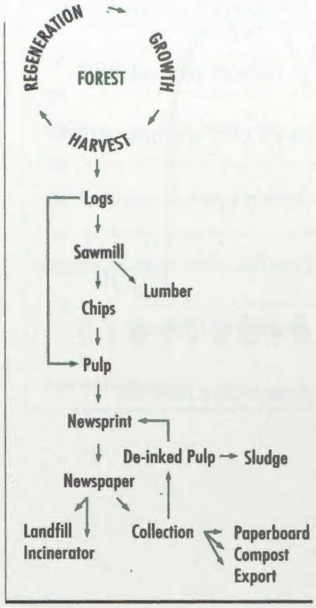
There is no provincial or federal legislation in place in Canada to regulate recycled content. Several Metro Toronto municipalities, however, have passed by-laws requiring newspapers sold from vending boxes on municipal property to contain a certain percentage of recycled content. In April 1989, the Canadian Council of Ministers of the Environment set as a target a 50% reduction in waste generation by the year 2000.

CANADIAN RECYCLED-NEWSPRINT PRODUCTION EXPANDING

The capacity of Canadian mills to produce recycled newsprint is expanding dramatically. As part of the pre-production process, the wastepaper collected through recycling programs is first taken to mills where the ink is removed. The pulp from these de-inking plants is combined with pulp derived from trees. Recycled-content newsprint can be comprised of varying proportions of wastepaper. The main component is old newspapers, but up to 30% can be magazines. Wastepaper can be recycled approximately seven times before the individual fibres become too short to make good newsprint, so there will always be a need to add fibres from wood.

Canada currently recovers 31% of its newspaper consumption. For several reasons, this amount is not expected to increase above 60% in the near future. Most of Canada's newsprint is exported to the USA. Of the newsprint sold within Canada's borders, not all can be collected economically, because of the high costs of recovering paper from a small population scattered over a large area. As well, some newspapers are used in ways that make recycling impossible. For example, some newspapers are used for animal bedding or to make fibre insulation, and some end up in public trash bins, which are generally not sorted.

By 1993, the demand in Canada for old newspapers and magazine papers is expected to reach 1.3 million tonnes, but only approximately 400 000 tonnes of old newspapers will be available in Canada for use by the newsprint industry. This means that Canada will likely need to import more than 900 000 tonnes of wastepaper annually to supply its recycled-content newsprint mills. This may result in higher production costs. Even if Canada could collect and reprocess all of its annual newsprint consumption (approximately 1 million tonnes), it could not satisfy the demand for old newspapers from both the recycled-content newsprint mills, and the other paper and board producers who use this type of wastepaper.



PRODUCERS OF RECYCLED-CONTENT NEWSPRINT IN CANADA

	1990	1993 (PROJECTED)
Number of mills	1	15
Recycled-content capacity (1 000 tonnes)	310	4 000
Percentage of total newsprint capacity	3%	40%

In 1992, Canada's newsprint industry had to import almost half (445 000 tonnes) of the wastepaper it needed to produce recycled-content newsprint for the American market.

IMPACT OF U.S. RECYCLING LAWS

The possible environmental benefits from the increasing public trend toward recycling and from U.S. newsprint recycling laws may seem obvious. They include, for example, reducing the quantity of waste disposed of in landfill sites, and reducing the number of trees and amount of energy required to produce paper. There are other broader environmental and economic impacts, both positive and negative.

IS CANADA'S COMPETITIVENESS THREATENED?

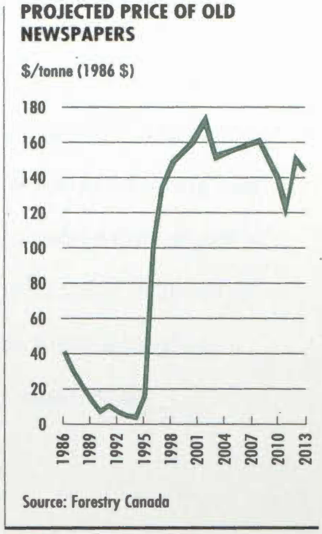
The implications of recycling on Canadian competitiveness are not clear. The U.S. legislation has resulted in billions of dollars of investment in Canadian de-inking plants. These investments were not always made because it was more profitable to produce recycled-content newsprint than virgin newsprint, but because U.S. legislation forced Canadian producers to make the investment to maintain their access to markets.

Some Canadian de-inking plants are in remote locations such as Kapuskasing, Ontario, and Whitecourt, Alberta. This means that they are far away from the most plentiful sources of wastepaper, i.e., large U.S. cities. Although recycled-content newsprint is generally cheaper to produce than newsprint made from wood pulp — mainly because of lower energy requirements and the lower price of wastepaper compared to wood fibre — this will only be true if old newspapers continue to be available at a reasonable price. Some mills will be able to use old Canadian newspapers from nearby centres, and others are close enough to inexpensively import wastepaper from major U.S. cities. However, if wastepaper must be imported from distant urban centres, the added transportation cost may offset any savings.

WILL THE PRICE OF OLD NEWSPAPERS INCREASE?

The mounting demand for old newspapers from both Canadian and U.S. producers is likely to increase the price of wastepaper. In 1991, the USA used almost 3 million tonnes of old newspapers to produce other paper and paperboard products. It also exported about 1.2 million tonnes to offshore markets, primarily Korea, Mexico and Taiwan. Demand for American wastepaper will likely continue to grow because of its high quality, and because collection rates in many regions of the world are reaching their practical limits.

Prices are still at an all-time low because mills have not used up the current oversupply. However, once all of the recycled-content newsprint mills that are under construction become fully operational, prices will likely begin to rise. These higher prices will probably continue, because the supply of wastepaper will only increase if collection rates are improved. However, it is not known how quickly higher wastepaper prices will result in increased collection.



HOW MUCH LANDFILL SPACE IS SAVED?

Increased demand for Canadian wastepaper should reduce the amount of waste going into landfill sites. On the other hand, for every tonne of wastepaper de-inked, 0.3 tonne of wet sludge is produced. Sludge can be used as an organic soil conditioner for vineyards and orchards, or to produce asphalt, cement, bricks, roof tiles, and moulded pulp products such as egg cartons. It can also be incinerated or burned to generate energy. However, most sludge is dumped into landfill sites. Further research is underway to find other uses, and to determine whether the inks or de-inking process contain or produce harmful substances.

In 1988, old newspapers constituted approximately 7% of the volume of municipal solid waste in Canada. Thus, if all of Canada's newspapers and sludge could be recycled, a maximum of 7% of landfill space would be freed. However, because Canada will be recycling both Canadian and American wastepaper, some of the sludge from imported newspapers will end up in Canadian landfill sites. The de-inking of that wastepaper (at least 900 000 tonnes) will produce more than 260 000 tonnes of sludge annually, equivalent to about 600 000 m³ of landfill space.

If all of the sludge from imported newspapers is disposed of in Canada, it may more than offset any landfill space saved by recycling Canadian newspapers.

DOES RECYCLING REALLY SAVE TREES?

Wastepaper replaces wood fibre in newsprint production. In Canada, approximately 45% of the wood used to produce newsprint is in the form of chips, a by-product of the sawmilling process. Chips are made from parts of the log that cannot be sawn into lumber. The use of chips in newsprint manufacturing has been increasing over time because of changes in production technology, and because of favourable economics for the pulp and paper producer and the sawmill. Historically, the chips were discarded or burned. Sawmills earn roughly a quarter of their total revenues from the sale of wood chips to pulp and paper mills. If wastepaper is substituted for chips to produce newsprint, the demand for chips will decline. The subsequent loss of income could have a significant impact on the ability of some sawmills to survive.

It is more likely that wastepaper would replace some of the solid wood currently used to produce newsprint. Approximately 24 million m^3 of pulpwood, or 55% of the wood used to produce newsprint, is in the form of logs. In 1993, approximately 1.3 million tonnes of wastepaper will be required to produce recycled-content newsprint. If this wastepaper replaced logs, there would be a savings of roughly 3.4 million m^3, or 14%. This represents approximately 2% of Canada's total softwood harvest.

Each tonne of old newspapers can replace between 11 and 24 trees, depending upon the size and species.

Current limits on harvesting levels in some regions mean that firms cannot expand their production of forest products without some alternative fibre source. By using wastepaper, some producers will be able to expand their production of newsprint (or other forest products) without cutting more trees.

There is a great deal of uncertainty about the future cost of wood compared to wastepaper. Increased land use and environmental pressures on public forests in both Canada and the USA are reducing the timber supply. This reduction may increase wood prices and affect the economics of producing recycled-content newsprint in Canada.

CONCLUSIONS

Recycling removes paper from the waste stream, lowers the demand for wood, and reduces the energy required to produce paper. In the case of the Canadian newsprint industry, however, this is not the entire story.

Recycled-content regulations in the USA were aimed at reducing the amount of waste going into landfill sites, but they have also changed the economic structure of the North American newsprint industry, and the comparative advantages that determine trade flows. The amount of domestically consumed wastepaper going into landfill sites in Canada is being reduced, but thousands of tonnes of U.S. newspapers will need to be shipped into Canada to produce recycled-content paper for the U.S. market. The sludge from those U.S. newspapers must be disposed of in Canada, which will offset some, if not all, of the landfill reductions realized by recycling domestic newspapers.

The competitiveness of the Canadian mills that are producing recycled-content newsprint varies by location, and depends on whether they can obtain wastepaper at a reasonable price. The transportation costs for hauling old newspapers from U.S. cities, combined with the projected increases in wastepaper prices as a result of growing demand, could make it difficult for some mills to compete in the recycled-content market.

Recycling allows some substitution of wastepaper for solid wood in newsprint production. However, despite the size of Canada's newsprint industry, only about 15% of the softwood harvest is used to produce newsprint. A substantial amount of chips from the sawmilling industry are also used. The projected use of wastepaper in Canadian newsprint mills could reduce wood requirements by about 3.4 million m^3 or 2% of Canada's softwood harvest.

Recycling is an important component of Canada's efforts to use its resources wisely and to reduce the amount of solid waste disposed of in North American landfill sites.

Canada and the Global Forest

BEYOND NATIONAL BOUNDARIES

Concern over the Earth's shrinking forest cover, the loss of biodiversity, and the damage to forests from air pollution have brought forest issues to the forefront of the international policy agenda.

The growing recognition of the importance of forests in maintaining the global environment and in meeting many basic human needs, including economic development, has initiated an urgent international dialogue on the future of the world's forests.

In recent years, the world community has become aware of the global importance of forests. Forests play a key role in sustaining ecological cycles, supporting the quality of the Earth's environment, preserving a large portion of the planet's biological diversity, and meeting basic human needs for food, fodder, fuel and fibre.

Much of the international dialogue on the world's forests took place during the two-year process of preparing for the United Nations Conference on Environment and Development (UNCED) held in June 1992, in Rio de Janeiro, Brazil. The Canadian delegation played a lead role in structuring the debate and engaging the world forestry community in the deliberations.

One of Canada's priorities was to establish an internationally accepted definition and measurement of sustainable forest development. Environmental considerations are becoming more important to international trade. Scientifically based international criteria for sustainable forest development would create a level playing field for competitors in the forest products market. They would also encourage more producers to practice sustainable forest management.

At the beginning of the UNCED process, Canada's goal was to develop criteria for the sustainable development of forests within a legally binding international agreement. Such an agreement proved elusive because of the many different perspectives that nations have regarding the social, economic and environmental importance of forests around the world. The UNCED process did lead, however, to a concensus on a set of forest principles, entitled *The Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests,* commonly referred to as the "UNCED Forest Principles."

UNCED FOREST PRINCIPLES

- *Establish national guidelines and scientifically based international criteria for the conservation, management and sustainable development of forests.*
- *Perceive forests as integrated ecosystems with a whole range of diverse values (such as timber, culture, wildlife and soil conservation).*
- *Promote public participation in decision making and, in particular, ensure the participation of women and Aboriginal peoples.*
- *Develop the skills, education, knowledge and institutions needed to support forest conservation and sustainable development.*
- *Strengthen international cooperation and assistance for forests in developing countries.*
- *Identify and deal with pressures placed on forest ecosystems from outside the forest sector.*
- *Develop policies to ensure the conservation and sustainable development of forests.*
- *Encourage fair international trade in forest products.*

The Forest Principles are significant because they leave the door open to further progress toward Canada's goal of a legally binding international agreement.

From a Canadian perspective, there is some disappointment that a legally binding agreement was not reached. However, these new principles represent an important breakthrough. Before the Rio summit, there was no international consensus on what constitutes sound forest management. Nevertheless, Canada will not wait before acting; rather it will implement the UNCED Principles through the action plans being established under Canada's National Forest Strategy.

AGENDA 21

Agenda 21 is one of the main documents negotiated at UNCED. It details an international agenda for development and the environment in the 21st century, but focusses primarily on the needs of developing nations. The forestry chapter is a useful international action plan and a good point of departure to promote the sustainable development of forests. It will also be the basis for Canada's cooperation with, and assistance to, developing countries.

Canadian funding of research programs for developing countries will be provided by the International Development Research Centre. Since its creation in 1970, IDRC has supported some 4 000 projects in more than 100 countries. More than 300 of those projects are forestry related.

Canada will implement Agenda 21 through its Official Development Assistance Program, managed primarily by the Canadian International Development Agency. Canada is one of the largest donors of development assistance in forestry, currently providing nearly $115 million per year to projects in developing countries.

GLOBAL CONVENTIONS

Canada will also implement the conventions on biodiversity and climate change that were signed by heads of state at UNCED. At this early stage, the biodiversity and climate change agreements are regarded as "framework" conventions. Much work will be done in the coming years to negotiate the more detailed aspects of those conventions.

BIODIVERSITY CONVENTION

The biodiversity convention is designed to protect the variety of life on Earth, and to ensure that the management and economic use of natural resources are undertaken in an appropriate manner. As such, the convention is largely consistent with Canada's National Forest Strategy. The legally binding convention requires Canada to prepare and adhere to a national biodiversity strategy, which will outline how we will meet the convention commitments. This strategy, to be developed over the next few years, will ensure that a representative sample of Canada's forests are protected, that research and education on biodiversity are supported, and that Canadian forest management does not adversely affect biodiversity.

CLIMATE CHANGE CONVENTION

The framework convention on climate change seeks to stabilize greenhouse gases in the atmosphere (primarily carbon dioxide) to prevent further threats to the climate. Developed countries that signed the convention are required to adopt national policies and measures on climate change, to limit emissions of greenhouse gases, and to report regularly on their progress in maintaining emissions at early-1990 levels until the end of the decade. To help developing countries meet their commitments, the convention provides for the transfer of technology and financial resources.

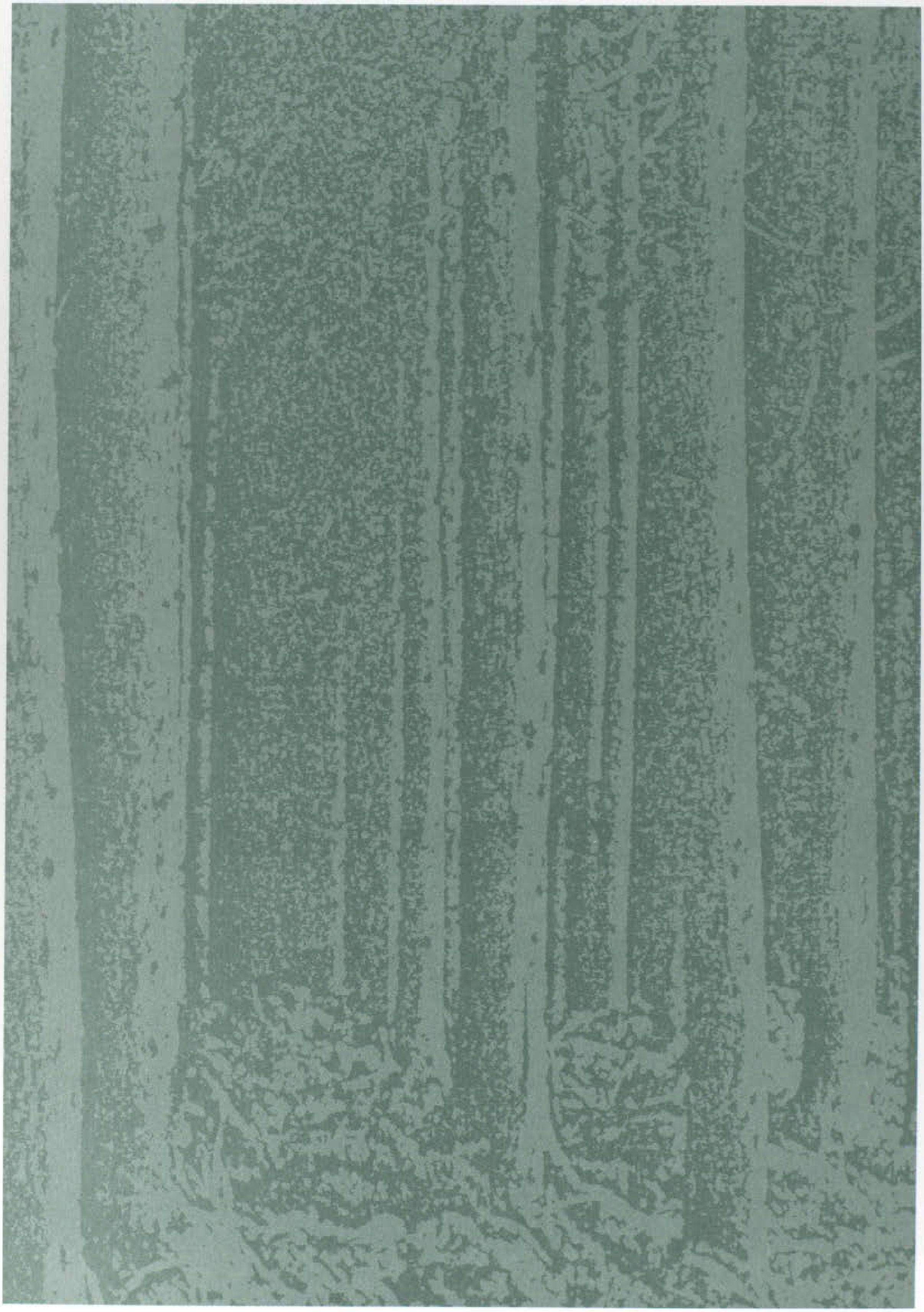
FUTURE WORK

It is crucial to come to an international agreement on the future of the world's forests. Canada will, therefore, participate in a variety of international forums in which global forest issues will be discussed, including the new UN Commission on Sustainable Development, the UN Food and Agriculture Organization (FAO), the International Tropical Timber Organization, the UN Environment Program, and the UNESCO (UN Educational, Scientific and Cultural Organization).

As well, Canada has started two important initiatives to promote the management, conservation and sustainable development of all types of forests. In September 1993, Canada will host a major international symposium on the sustainable development of temperate and Boreal forests, sponsored by the Conference on Security and Cooperation in Europe. The second initiative, international model forests, will be linked to the Model Forests Program recently started in Canada *(see page 54)*. The objective of the program is to demonstrate effective and sustainable forest management practices and standards.

To further promote sustainable development in less developed nations, Canada is moving quickly to implement the commitment made by Prime Minister Mulroney at UNCED — to establish international model forests.

Canada recognizes that by working in partnership with other nations, it can more successfully meet the challenges of sustainable forest development, worldwide.



CHAPTER FOUR

ENVIRONMENTAL, ECONOMIC AND SOCIAL INDICATORS

MEASURES OF SUSTAINABLE DEVELOPMENT

Many of the issues regarding Canada's forests relate to the search for a balance among the preservation of environmental quality, the enhancement of economic wealth, and the development of social benefits. None of these objectives can be met in isolation. Canada, like other nations, is striving to manage its forests for a combination of environmental, economic and social values.

In *The State of Canada's Forests 1991*, we introduced 12 preliminary indicators to track Canada's progress in achieving environmental, economic and social objectives. The indicators were developed following consultations with a broad range of forest stakeholders. Given the complexity of the issues and the number of government agencies involved, research and data collection are on-going for many indicators.

1

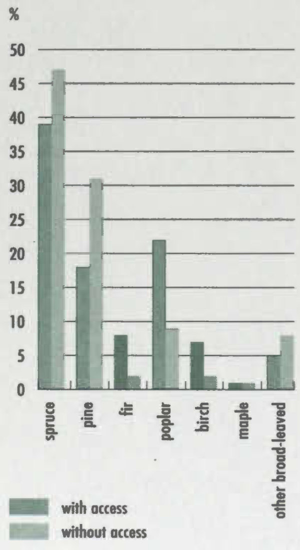
THE DIVERSITY OF CANADA'S FORESTS

"Has human intervention changed the fundamental nature of Canada's forests?"

Canada is one of the few developed nations still richly endowed with large areas of natural forests. These ecosystems reflect years of evolution, as well as adaptation to such changes as forest fires and fluctuations in climate. Canadians are concerned about whether human activities are changing the fundamental nature of these forest ecosystems.

In addressing this question, it is important to assess the impact of human activities and nature on the biological diversity of forests. "Biodiversity" includes the variety of different species, the genetic variability of each species, and the variety of different forest ecosystems.

SPECIES COMPOSITION OF THE BOREAL FOREST



Source: Forestry Canada

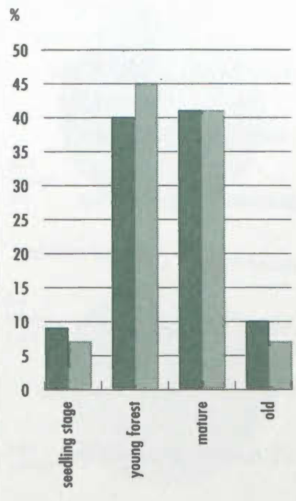
The National Forest Strategy commits Canada to establishing a national reporting system for forest biodiversity. The scope and complexity of the concept of biodiversity make it very difficult to derive a simple indicator. One interim means of assessing the extent to which human intervention has changed the biodiversity of forests can be broadly estimated by comparing the characteristics of forests in areas with access to those without. This assumes that the areas without access are indicative of what might be called the "natural" state of the forest.

The first graph depicts the species composition of most of the commercial forest in the Boreal region. It compares forests with access to those without. However, it does not give a complete picture of the changes in species composition, because changes in less common tree, shrub and herb species, or animal and bird species are not reflected. *(The graphs use the most recent data from the 1991 Canada Forest Inventory. Only data for the Boreal forest is available at this time.)*

If areas without access are used as an indicator of Boreal forests in their natural state, human intervention is shown to have increased the proportion of poplar, birch and fir, and lowered the proportion of pine and spruce. This change largely reflects the impact of harvesting, which only occurs in the accessed forest, compared to fire, which is the dominant type of disturbance in the non-accessed forest. Fire in a pine forest is usually followed by regrowth of pine trees, whereas harvesting results in a greater frequency of poplar and birch. The lower proportion of spruce and the increased amount of fir in accessed forests could reflect geographic differences. The accessed forest is located primarily in the southern and eastern areas of the Boreal forest, where stands of fir are more common.

The graph that deals with age composition indicates only very small differences in the age structure between the accessed and non-accessed forest. The proportion of old forests is lower in the Boreal forest than in other forest regions. This is because fire, which plays an important role in the ecology of the non-accessed Boreal forest, continually replaces large areas of old forest with young forests. In the accessed area, harvesting and fire play the same role in renewing the forest.

AGE COMPOSITION OF THE BOREAL FOREST



Source: Forestry Canada

2

THE PRESERVATION OF WILDERNESS AREAS

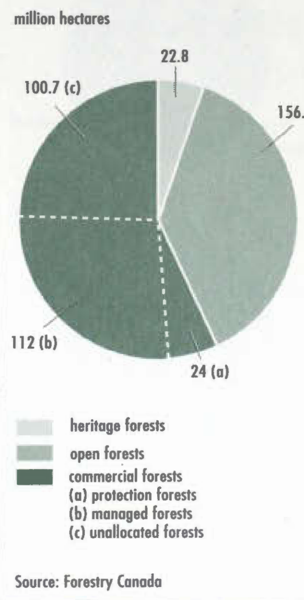
"Are representative areas of Canada's major ecoregions being preserved for future generations?"

In the Brundtland report published in 1987, the World Commission on Environment and Development suggested that nations try to triple the world total of protected areas to 12%. Furthermore, the 1992 UN Conference on Environment and Development (commonly referred to as the "Earth Summit") gave an added boost to protected areas. The countries that signed the biodiversity convention at the conference agreed to cooperate in developing systems of protected areas to conserve biodiversity at the gene, species and ecosystem levels.

Data on protected sites around the world have been kept since 1961 in the United Nations List of Parks and Protected Areas, which is maintained by the UN Environment Program, the Worldwide Fund for Nature, and the World Conservation Union. Canada's version of the UN List is the National Conservation Areas Database, maintained by Environment Canada.

Five categories of protected areas are recognized in the UN List: scientific reserves/strict nature reserves; national parks; natural monuments/natural landmarks; nature conservation reserves, managed nature reserves and wildlife sanctuaries; and protected landscapes or seascapes. The 1990 UN List contains almost 7 000 areas and represents roughly 600 million hectares, or 4% of the world's total landmass.

CANADA'S FORESTS



Source: Forestry Canada

The first national park was created in Banff, Alberta, in 1885; eight years later, the first provincial park was established in the Algonquin region of Ontario. There are now 35 national parks in Canada covering a total of 19.3 million hectares, and more than a thousand provincial parks, with a total area of roughly 22.9 million hectares.

Canada's Green Plan also advocates a target of 12%. In addition, the federal, provincial and territorial governments, through Canada's National Forest Strategy, are committed to completing a network of protected areas that are representative of Canada's forests by the year 2000. Other nations are adopting similar objectives.

Protected areas in Canada have tripled over the past three decades (from 25 million hectares in 1960, to the current figure of 74 million hectares). Protected areas now account for more than 7% of our total land and freshwater, or approximately 12.5% of the world total.

Not all protected areas are forested. Forestry Canada is currently working with Environment Canada and the provinces to determine the exact number of protected areas that are forested. Based on the National Conservation Areas Database and the 1991 Canada Forest Inventory, there are an estimated 22.8 million hectares of land within the forested regions of Canada where, by law, no timber harvesting is permitted.

In addition, the forests found on shallow or rocky soil, on steep slopes, or along lakes and waterways may be too sensitive for harvesting. Although sensitive forests lack the formal status of parks or protected reserves, according to provincial policy, they are excluded from harvesting. Forestry Canada estimates that the total area of these "protection forests" within Canada's commercial forests is 24 million hectares.

In summary, more than 11% of the forest land in Canada, or 46 million hectares, is protected by either policy or legislation. In addition, there are no large-scale harvesting operations in more than 157 million hectares of open forests located primarily in northern Canada.

3

SUSTAINING FOREST PRODUCTIVITY

"To what extent are human activities changing the natural dynamics of Canada's forest lands?"

The principal causes of disturbances in Canada's forests are insects, disease, fire and harvesting. Forest ecosystems adapt to these periodic disturbances; the Boreal forest depends on them. Although the cause of disturbances varies considerably by region, human activities are becoming increasingly important agents of change in Canada's forests.

The graphs show the average annual disturbances between 1980 and 1991 in the major forest regions in Canada. They deal with commercial forest lands only. Every effort was made to reconcile the statistics reported by different sources. Pest- and fire-killed stands of trees are harvested if the timber is accessible and of acceptable quality. To avoid double-accounting, the estimated area salvaged was subtracted from the area killed by pests and the area burned. Pest losses were limited to those attributed to the spruce budworm, mountain pine beetle, jack pine budworm and hemlock looper.

The Eastern and Western Boreal forest regions cover the largest proportion of the land base in Canada, and therefore contain the largest commercial forest areas disturbed. In the wetter Eastern Boreal region, insect defoliation was the major disturbance (35%); 9% of defoliated trees were harvested. Fires were the primary type of disturbance (78%) in the drier Western Boreal region.

In the Acadian region, more than half of the harvest was carried out to salvage pest-killed trees; only 3% of the area was affected by fire.

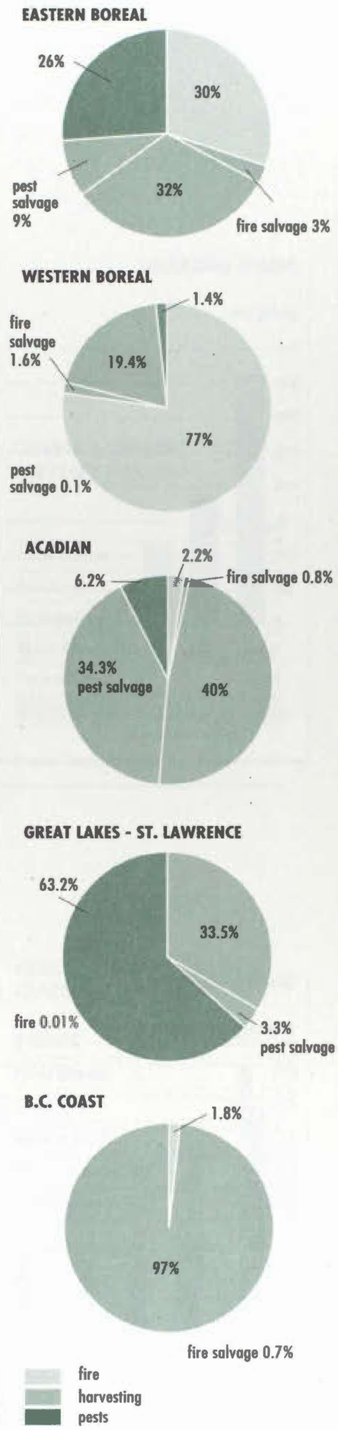
In the Great Lakes-St. Lawrence region, more than 66% of the area disturbed was depleted by pests; however, only 3% of the pest-damaged area needed to be harvested. Less than 1% of the Great Lakes-St. Lawrence region was disturbed by fire.

In the B.C. Coast region, harvesting was the major disturbance. Less than 2% of the commercial forest area was affected by fire.

During the past decade, there has been an overall decline in insect defoliation in the Great Lakes-St. Lawrence and Acadian regions. In 1989, there was a large increase in the areas burned, due almost entirely to the major forest fires in the Boreal region. The largest 10-year average of area burned occurred between 1980 and 1990. One explanation for this record may be the higher-than-average temperatures experienced during that decade.

Harvesting has been increasing steadily over the past 70 years, albeit with some annual fluctuations. The highest level of harvesting was recorded between 1980 and 1990. However, there has been a slight decrease in harvesting in the past two years.

DISTURBANCES

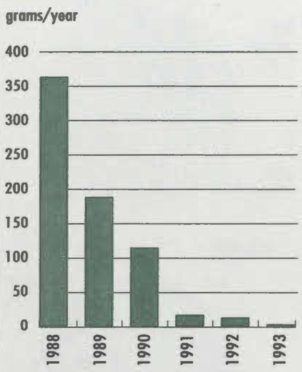


Source: Forestry Canada

ENVIRONMENTAL QUALITY

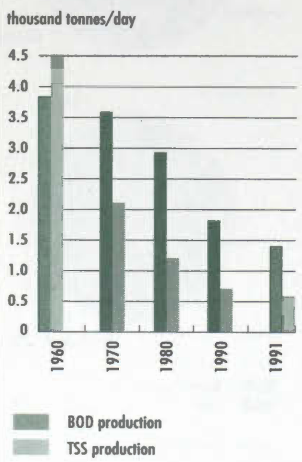
"What steps are Canadians taking in forest management and manufacturing activities to protect the environment?"

DIOXIN EMISSIONS



Source: Pulp and Paper Research Institute of Canada

DISCHARGE LEVELS



Source: Canadian Pulp and Paper Association

Many Canadians have expressed concern over the use of pesticides in the forest, and over pulp and paper mill pollution.

Pesticides are applied to control insect epidemics ("insecticides") and competing vegetation ("herbicides"). Less than 3% of all pesticides are used in forest management. The federal government tests and approves pesticides, and the provinces regulate their use. During the past decade, the area of forest treated with insecticides decreased by 80%. Despite a 10% increase in planting between 1988 and 1991, herbicide use was reduced by 13.6%.

Public concern has prompted changes in pulp mill production processes to reduce unwanted organic chemicals, such as dioxins and furans. Under new federal regulations, paper mills using chlorine bleach that were in operation prior to 1990 must implement process changes by January 1994 to prevent the formation of dioxins and furans. Several mills now use chlorine dioxide instead of chlorine to bleach their pulp; other mills have switched to chlorine dioxide in more than 50% of their production operations. In 1992, two Canadian mills were producing totally chlorine-free (TCF) kraft pulp. By 1992, 90% of dioxins and furans had already been eliminated.

Research to find environmentally safe bleaching agents is on-going. Pilot programs are underway to replace chlorine with ozone. Several other chemicals, such as peroxide and oxygen, are being investigated. The use of enzymes, which help brighten pulp prior to bleaching, could reduce the need for chemicals. Several mills are also looking at ways to break down the rigid cell walls in wood — a process called "delignification." By removing these tough substances, less bleaching is required.

In addition, amendments to the federal *Fisheries Act* set new limits on pulp mill effluent discharges. To ensure sufficient oxygen to sustain aquatic life, Canada has substantially reduced the level of BOD (Biochemical Oxygen Demand) in the water, as well as the level of TSS (Total Suspended Solids), which may deposit on the bottom of rivers or lakes. On a per tonne basis, TSS discharges were reduced by 93%, and BOD discharges were cut by 81% between 1960 and 1991.

All mills had to comply with the new BOD and TSS regulations by December 1992. Mills may apply to the ministers of Environment, and Fisheries and Oceans for an extension to December 1993. Under extraordinary circumstances, mills established prior to 1971 may apply for a second extension to 1995. To date, 86 mills have been granted a one-year extension.

5

THE ROLE OF FORESTS IN ENVIRONMENTAL QUALITY

"What contribution do Canada's forests make to the global environment?"

Forests contribute significantly to the health of the global environment. They moderate climate, prevent soil erosion, help regulate stream flow, and improve air and water quality. Trees and plants absorb carbon dioxide from the atmosphere, and return oxygen to the air. The carbon is stored for decades or even centuries in tree trunks, branches, roots and forest soils (*see carbon cycle on page 26*).

Carbon storage is extremely important in the context of global warming. Predictions are that increased concentrations of carbon dioxide and other greenhouse gases in the atmosphere will cause average temperatures around the world to rise.

Worldwide, the amount of carbon currently released into the atmosphere (primarily through the burning of fossil fuels) has increased dramatically over the past 50 years, and is now estimated at between 5 and 6 billion tonnes per year. Of this, as many as 2 billion tonnes are released annually when tropical forests are cleared and burned for agricultural or other purposes.

Sound forest management can help regulate carbon dioxide levels, and as steward of almost 10% of the world's forests, our nation can play a positive role in confronting this global problem. Canada is contributing to carbon storage through tree planting programs, forest products recycling, and silvicultural practices that increase forest growth. Canadian scientists are also improving their ability to measure and assess the nation's carbon balance.

The estimates of carbon accumulation and release presented in last year's report have been further refined. Forestry Canada now estimates that in 1986, the total carbon accumulation in forest biomass, forest soils, forest products and peat soils was 72 million tonnes greater than the total carbon released into the atmosphere.

CANADA'S CURRENT CARBON INVENTORY

	billion tonnes
Forest biomass	12.0
Forest soils	76.4
Forest products	0.6
Total forest sector	**89.0**
Peatlands	135.0
TOTAL ACCUMULATION	**224.0**

Source: Forestry Canada

CANADA'S FOREST SECTOR CARBON BUDGET (1986)

RELEASE	million tonnes
Forest biomass	119.9
Forest soils	15.2
Forest products	23.1
Fossil fuel energy use[a]	4.8
Total release	**163.0**
ACCUMULATION	
Forest biomass	92.0
Forest soils	72.7
Forest products	44.2
Peatlands	26.2
Total accumulation	**235.1**
NET SINK	**72.1**

[a] Does not include energy derived from bio-energy (biomass)

Source: Forestry Canada

This is after allowing for the losses from decomposition and burning, including the fossil fuel energy used by the forest sector. The figures show that by maintaining our forest lands as healthy and productive ecosystems, the forest sector plays an important role in reducing Canada's net carbon dioxide emissions.

The forest sector can also improve global atmospheric carbon dioxide levels by replacing fossil fuels with bioenergy. Like fossil fuels, biomass releases carbon into the air when burned. However, growing forests reabsorb this carbon from the air, effectively recycling it. Forest biomass can be converted into various forms of energy, either directly through burning, or indirectly through conversion to such fuels as ethanol and methanol.

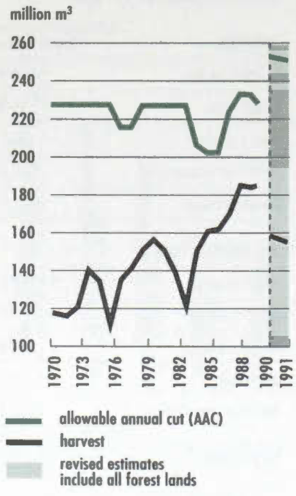
In terms of energy use, bioenergy plays a significant role in forest sector activities. In 1988, total energy use by the sector was approximately 12 million tonnes. Biomass fuels (including mill wastes) accounted for about 66% of the total energy used by Canada's forest industries. Fossil fuels and electricity made up the remainder. Over the past 10 years, the pulp and paper industry has increasingly turned to biomass fuels for energy.

6

SUSTAINABLE ECONOMIC BENEFIT

"Are Canada's forests being managed to supply sufficient fibre to sustain the long-term economic needs of Canadians?"

AAC AND HARVEST



Sources: National Forestry Database/ Statistics Canada

The provinces own the majority of forest lands and control the rate of timber harvesting. The level of harvest is set through an "allowable annual cut" (AAC), which is based on biological, economic and social considerations. The AAC is a prescribed rate of harvesting over a certain length of time in a specified area of forest. It takes into account such factors as species, age, natural disturbances, conservation needs and forest renewal rates. There is no one correct harvest rate for a forest. Rather, the rate is determined by the age and growth of the forest, the level of management activities such as tree planting, and the demand for other uses of the forest, such as parks.

The sustainability of the economic benefits that Canadians derive from their forests may be indicated by comparing the AAC to the annual harvest rate. The AAC for Canada is calculated by totalling the individual AACs for each region and province.

In this year's report, improved data from the new National Forestry Database enables us to better compare AACs and harvest rates. These most recent estimates of AACs account for all forest lands in Canada. For the first time, they also include all private lands. The graphs reflect the new data and estimates starting in 1990. The drop in harvest levels in 1990 and 1991 are the result of both improvements in data and the poor economic conditions experienced by the forest sector.

On a national basis, the AAC has remained stable over the past two decades, averaging approximately 225 to 230 million m³. Harvesting, however, has increased from about 120 million m³ per year in the early 1970s, to a peak of an estimated 185 million m³ in 1990.

Softwood species account for more than 90% of Canada's harvest. The 1991 national estimate for the softwood AAC is approximately 190 million m³, compared to an estimated harvest of 138 million m³. Since the early 1980s, the data had indicated that the softwood harvest was approximately equal to the softwood AAC.

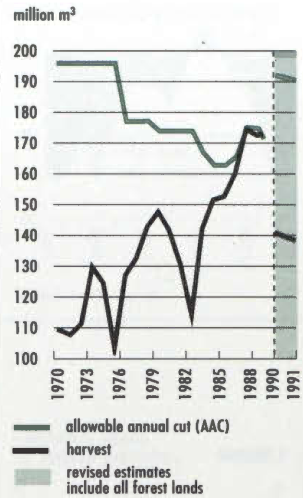
The situation for hardwoods in Canada is quite different. The hardwood AAC continues to be significantly higher than the harvest. The development of new products, such as waferboard from poplar, has increased the amount of hardwood harvested in recent years, but the harvest is still well below the allowable level.

Comparing current AACs to harvests indicates that provincially prescribed rates are being adhered to. In recent years, a number of provinces have reduced their AACs. Changes in AACs often result from revisions to the basic inventory, withdrawals of land for non-timber uses, and a gradual switch to harvesting "second-growth" forests.

When all commercial forests are considered, irrespective of their economic accessibility, harvest levels are still well below the biological growth of the forest (estimated at more than 350 million m³ per year). And, as noted in the Commercial Forest Account on page 89, volume growth is still greater than total depletions, including fire, insects and harvesting.

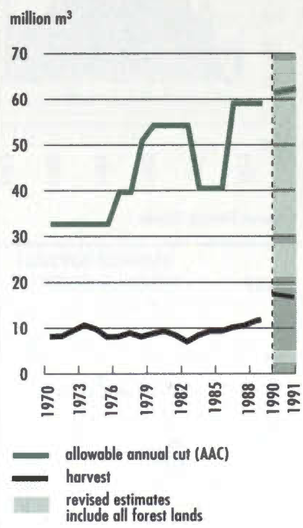
In some regions of the country, the supply of timber is adequate to sustain harvest levels in the short to medium term. However, in other parts of Canada, the harvest has reached the allowable cut level, particularly for softwood species. The quality of the resource is also changing as large softwood sawlogs become increasingly

SOFTWOOD AAC AND HARVEST



Sources: National Forestry Database/ Statistics Canada

HARDWOOD AAC AND HARVEST

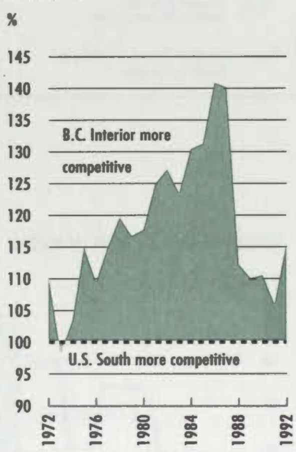


Sources: National Forestry Database/ Statistics Canada difficult to find, as the species mix changes, and as the age of harvested trees declines. In addition, the future supply of timber will be affected by the increasing demands on Canada's forests for other values, such as recreation, wilderness and aesthetics, which may lead to reductions in the AAC. British Columbia, for example, is recalculating its AAC and expects to further reduce harvest levels over the next few years. Other provinces are heavily dependent on continued silvicultural investment to maintain current harvest levels.

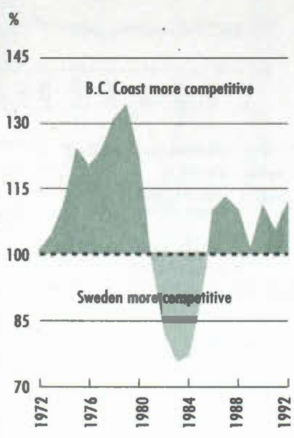
7

THE COMPETITIVENESS OF THE FOREST INDUSTRIES

"Can Canada's forest industries compete in the global marketplace?"



Source: Forestry Canada



Source: Forestry Canada

Canadian forest products companies continue to face difficult times as their profit margins are squeezed by mounting international competition, and by increasing costs for wood and for environmental protection.

It is difficult to isolate a single measure or indicator of competitiveness for Canada's forest products industries. Competitiveness depends on a number of factors, including relative costs and/or productivity levels, and the ability to adapt to a changing marketplace. Exchange rates also play an important role in determining the competitiveness and profitability of an industry.

One way to measure the cost-competitive position of an industry is to look at its production costs compared to those of foreign producers. Canada exports almost 50% of its production and must compete with other producers in foreign markets. Especially in commodity industries such as newsprint, lumber and pulp, where quality does not vary markedly between producers, purchasing decisions are based primarily on price. Production costs are therefore major determinants of competitiveness and profitability.

In the following graphs, Canada's production costs for three major forest products are compared to those of competitors. Competitors' costs are given as a percentage of Canadian costs. For example, in 1991, the cost of producing lumber in the U.S. South was 110% of Canadian costs, or 10% higher than in Canada. Thus, Canada was more competitive in that particular product. On the other hand, newsprint costs in the U.S. South were only 90% of costs in eastern Canada, indicating that Canadian producers' costs were 10% higher. The competitiveness of producers changes over time, reflecting fluctuations in input prices, productivity, and exchange rates.

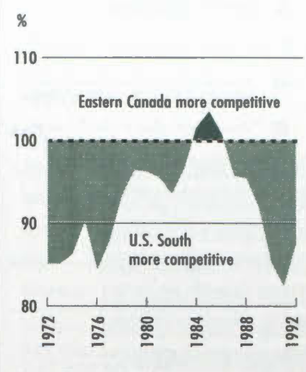
On the basis of relative costs, these graphs show that Canada's primary forest products have become less competitive since the mid-1980s as a result of the appreciation in the Canadian dollar, and the rising costs of wood and energy. This decline in competitiveness has led to considerable restructuring within the forest industries, forcing older mills to modernize, change their product mix, or cease operations. This adjustment process is ongoing, but the long-term result should be an overall improvement in the industries' competitive position, and a subsequent return to profitability.

Investments in new technology and equipment will affect competitiveness through product cost and quality. The ability of an industry to develop, adapt and market new products in a changing marketplace is difficult to measure, but can serve as a significant long-term indicator of competitiveness.

A further indicator of competitiveness is the share of world markets for forest products. Canada is one of the world's major suppliers of forest products, accounting for between 18 and 23% of the global market during the past 20 years. Canada's exports in 1991 were worth more than $20 billion.

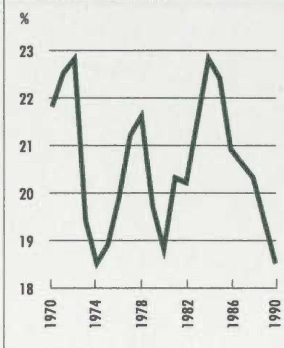
In general, Canada's overall competitive strengths in the international marketplace include high-quality wood fibre and low-cost energy. To maintain its share of trade products, Canada must continue to develop and adopt new technology, adapt to a marketplace that fosters innovation and competition, and respond to consumer demands for environmentally sound products.

NEWSPRINT



Source: Forestry Canada

CANADA'S SHARE OF WORLD EXPORTS



Source: Food and Agriculture Organization

8

EFFICIENT USE OF WOOD

"Is Canada's timber efficiently harvested and processed?"

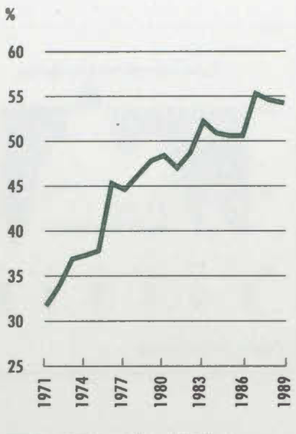
Canadians want to ensure that the maximum value is produced from each cubic metre of wood harvested and that less waste is left on logging sites.

Various factors influence the amount of fibre left in the forest after harvesting operations. Leaving some waste on the logging site can be beneficial because it protects the soil from the wind, sun and rain, and shelters a variety of plant and animal species. Later,

SAWLOGS REQUIRED TO PRODUCE LUMBER

Source: Forestry Canada

USE OF WOOD RESIDUES IN PULP PRODUCTION



Source: Forestry Canada

as the waste decomposes, it provides valuable nutrients to the soil. On the other hand, if more timber can be removed and used from an area, fewer hectares will need to be logged to obtain the same volume of wood.

Provincial governments have balanced these ecological and economic tradeoffs by establishing standards to govern the recovery of wood harvested on Crown lands. Companies that leave excessive merchantable timber on a harvested site are fined or required to pay a stumpage fee for the material.

Improvements in technology have helped improve the efficiency of manufacturing processes. Larger amounts of lumber are being obtained from smaller-sized logs. In addition, more waste from lumber manufacturing is now used in the pulping process. The graphs show a decrease in the volume of sawlogs required to produce one cubic metre of lumber, which indicates an improved efficiency of wood use.

The volume of pulplogs required to produce a tonne of pulp has also declined over time, as more and more wood waste from the sawmilling industry is used as raw material. This waste was formerly discarded or burned; now it replaces some of the trees cut to produce pulp. Increasingly, wastepaper is being used to make recycled-content papers such as newsprint.

9

CONTROL OF CANADA'S FOREST RESOURCES

"Who owns and controls the forests and forest industries in Canada?"

Canadians want to know who owns and controls Canada's forests and the industries that manufacture Canadian forest products. Last year's report indicated that overall, Canadian companies controlled 74% of forest industry assets. This year, we look at who owns and controls Canada's forests.

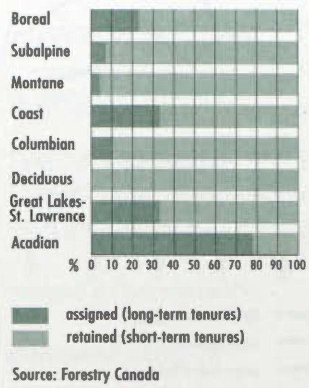
The Canadian public, through provincial and federal governments, owns 94% of Canada's forests. Roughly another 6% is owned by more than 425 000 private landowners.

The provincial governments, who own most of Canada's forests, confer harvesting rights to industry under a variety of short- and long-term licencing arrangements. The provinces retain public ownership of the land, but sell timber-harvesting rights to private industry. Longer-term arrangements are used to provide the incentive and stability required for industry to make large investments in mills. Generally, these contracts also transfer certain forest management responsibilities to the company, such as the costs of road building and regeneration. The provincial government regulates and inspects the company's performance at regular intervals. Short-term permits, tenders and licences are used to sell cutting rights, providing smaller companies with flexibility and opportunities, while the government retains responsibility for managing the forest.

The graph provides a breakdown of provincial forest lands in the eight principal forest regions where management responsibility has been "assigned" to a private agency, or "retained" by the government. In all cases, the provinces retain ownership of the forest lands. The data represent all of the provincial forest land (commercial and open) that has not been set aside in parks.

On average, in these eight forest regions, the provincial governments have retained direct management responsibility for about 77% of the total provincial forest land. In the remaining 23%, the provinces have assigned management responsibility to the industry under longer-term lease arrangements. In general, the industry has accepted this forest management responsibility and related cost in exchange for longer-term tenures. The percentage of land assigned to industry varies considerably by forest region, from 0% in the deciduous forest, to 80% in the Acadian forest.

PROVINCIAL FOREST LANDS



Source: Forestry Canada

10

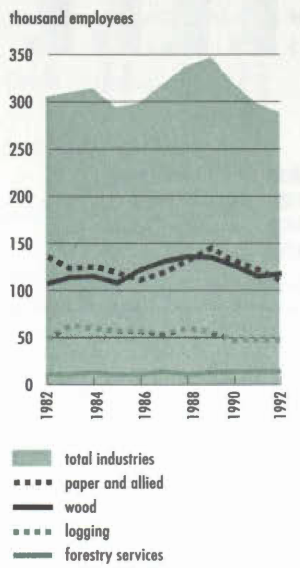
EMPLOYMENT AND COMMUNITY STABILITY

"Will the forest sector continue to provide quality employment and community stability?"

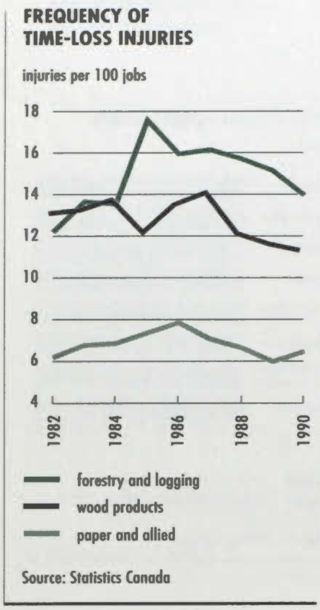
In 1992, Canada's forest industries provided 289 000 direct jobs and 440 000 indirect jobs. Historically, the forest sector has provided well-paying employment. However, the number and type of positions have been affected by changes in equipment and technology.

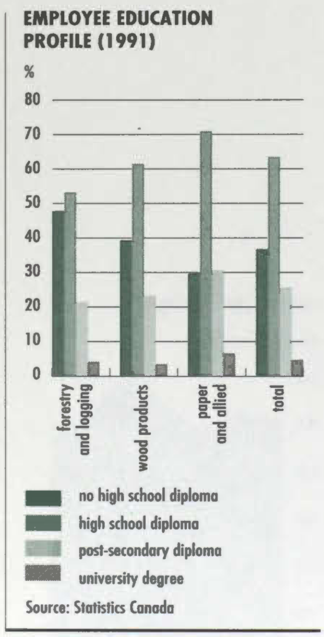
Direct jobs are those in logging, in the wood industries, forestry services, and paper and allied industries. Examples include operating a feller-buncher in logging operations or a trim saw in the wood industries, planting trees in the forestry services, or

DIRECT EMPLOYMENT



Source: Statistics Canada





tending a paper machine in the paper and allied industries. Indirect jobs are those created by the purchase of goods and services by the forest industries.

Direct employment levels have remained relatively flat for the past decade, despite growth in individual forest industries — from about 2.75% to slightly more than 4% annually. By investing in labour-saving technologies, the forest industries have increased their production while maintaining constant levels of employment. Over the past decade, the average annual income for employees in the forest sector has remained at roughly $30 000.

Another measure of the quality of employment is the amount of time lost because of injuries. Last year's report presented the total time-loss injuries for each industry. A better measure of comparison between different industries is the number of injuries per 100 employees. In this case, the forest industries have nearly the same level of time-loss injuries as other natural-resource-based industries. The overall frequency of injuries in the forest sector has not changed significantly in the past decade. Although the frequency of injuries in the wood products industries has risen somewhat (from 12 to 13.9%), it has declined in the forestry services and logging industry (from 13.2 to 11.4%).

A large percentage of forest-sector workers (37%) have not completed high school. Between 1990 and 1991, workers without post-secondary training lost the largest number of jobs; however, preliminary estimates show that those holding university degrees had the highest proportion of job losses.

11

PUBLIC INVOLVEMENT IN DECISION MAKING

"Does the public have the opportunity to determine how Canada's forests are managed?"

Canadians want to have a say in how their forests are managed. Governments, decision-makers and resource managers are all trying to improve and increase the public's opportunities to participate.

Last year's report identified the four levels at which public involvement could take place. The following examples describe public involvement in Canada in 1992, which varied from reviewing broad policies, to participating in land-use decisions.

BROAD POLICY REVIEWS

Canada-wide public consultations led to the National Forest Strategy unveiled in 1992. The values and vision of a wide range of Canadians are presented in this Strategy, which is intended to guide the policies and actions of Canada's forestry community. Implementation of the Strategy is strengthened by several policy initiatives that have been introduced at the provincial level. For example, an independent forest policy panel was established to consult with the people of Ontario in developing a comprehensive forest policy framework aimed at ensuring forest sustainability.

REVIEW OF FOREST MANAGEMENT PLANS

Forest management plans indicate how a specific area of forest is to be managed, usually over a 20- or 25-year period. For example, in New Brunswick, companies are required to prepare 25-year forest management plans under the *Crown Lands and Forests Act*. Every five years, the public is invited to participate in revising the management plans. In Saskatchewan, several co-management boards involving local residents are helping a forest company plan its future forestry activities. The Model Forests Program is another example of public involvement in forest management planning. Under this national initiative, different groups with an interest in the forest were brought together to develop a consensus on the objectives for managing a specific forest *(see page 54)*.

REVIEW OF OPERATIONAL PLANS

Operational plans outline in more detail the specific forestry operations proposed for an area, usually for a five-year period. In most cases, the company carries out public consultations at the local level.

LAND-USE PLANNING

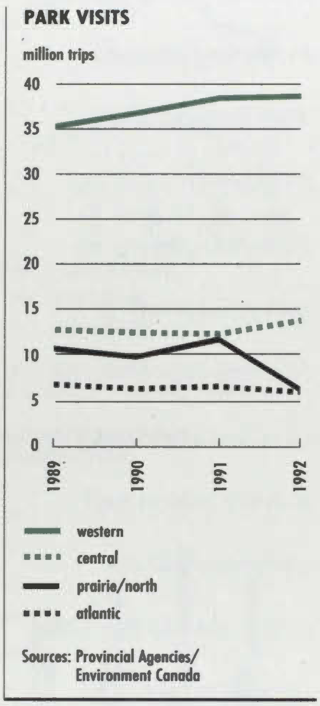
In British Columbia, the newly created Commission on Resources and Environment has been given the challenge to develop a comprehensive land-use strategy. The goal is to strike a balance between the use and conservation of resources in British Columbia, while maintaining high environmental standards.

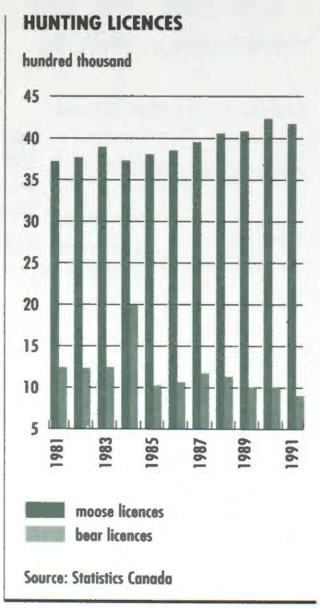
It is estimated that at any one time, there are upwards of 300 public processes taking place in British Columbia. They range in scope from provincial policy reviews to community watershed plans. In New Brunswick, several companies are trying to better inform staff, customers and the public alike by providing more information on company operations. One company conducts public tours that attract more than 2 000 people annually.

12

ACCESS TO NATURE

"What roles do forests play in satisfying the recreational needs of Canadians?"





For many citizens and visitors, Canada's forests have unique qualities that make them a pleasing and desirable place to be.

Forest recreation includes such activities as snowmobiling, camping, hiking, cross-country skiing, snow-shoeing, canoeing, bird watching, photography, painting, hunting and fishing. Given this diverse range of activities, assessing the use of forests for recreational purposes can be difficult.

Outdoor recreational activities are defined according to their effects on the environment. When a resource is removed or depleted because of a recreational activity, e.g. hunting, the activity is said to be "consumptive." Activities such as bird-watching and canoeing are deemed "non-consumptive." In some cases, the difference between consumptive and non-consumptive is not as clear as it once seemed. The cumulative practices of hikers or campers (considered non-consumptive) may degrade forest areas to the point where they need to be closed off and rehabilitated.

One measure of the use of forests for outdoor recreation is the number of trips to parks. Last year's state of the forests report presented the number of trips to national, provincial and regional parks between 1986 and 1990. That picture was based on a biennial Statistics Canada survey that only includes trips longer than 80 km. This year we show the total number of visits to Canada's national and provincial parks. Visits to national parks increased between 1989 and 1992, whereas visits to provincial parks decreased slightly. Total park visits increased by 0.2%.

Over the past decade, there has been an increase in the number of naturalist organizations and other conservation groups affiliated with the Canadian Nature Federation. In 1992, there were approximately 150 affiliates, compared with 90 in 1982. This increase provides some indication of the growing interest in nature.

Since 1987, there has been a distinct downward trend in the popularity of bear hunting in Canada. Licences have decreased by 23%. On the other hand, the overall national demand for moose hunting has increased by 10%. Some provinces, however, have experienced a decline in licence sales.

Commercial Forest Account

The Commercial Forest Account presents some of the changes that occurred in Canada's commercial forests over a 10-year period (1982 - 1991).

HIGHLIGHTS

- There was a net increase of 554 million m^3 in the volume of commercial species. More than 17 million hectares were regenerated.
- Forests classified as old or mixed aged decreased by 0.5% or 500 000 hectares, and forests in the seedling stage increased by 5.7% or 1.64 million hectares.
- In this account, the area not growing commercial species (part of "non-stocked" in previous accounts) includes only the land that has not regenerated to commercial species 10 or more years after harvesting. This area increased by 1.29 million hectares to 4.37 million hectares, and now represents less than 2% of the commercial forest.

	Area (million ha)	Volume (million m^3)
COMMERCIAL FOREST – 1981*	**234.50**	**25 031**
Seedling stage	28.44	412
Young forest	89.71	7 316
Mature, old and mixed aged	103.30	17 303
Area regenerating	10.27	—
Area not growing commercial species 10 years after harvesting	3.08	—
CHANGES – 1982 - 1991		
Depletions:		
Harvesting	9.29	1 693
Fire	7.56	763
Insects and disease	4.58	631
Total depletions	21.43	3 087
Additions:		
Natural regeneration	13.59	113
Planting and seeding	3.77	68
Growth in standing forest	—	3 460
Total additions	17.36	3 641
COMMERCIAL FOREST – 1991*	**234.50**	**25 585**
Seedling stage	30.08	423
Young forest	84.51	6 988
Mature, old and mixed aged	102.79	18 173
Area regenerating following:		
fire or insects	10.82	—
recent harvesting	2.23	—
Area not growing commercial species 10 years after harvesting	4.37	—
Net increase in area not growing commercial species 10 years after harvesting	**1.29**	**—**
Net increase in volume of commercial species	**—**	**554**

* Does not include 2.2 million hectares of forest for which the age class has not yet been determined. May not add up due to rounding.

Source: Forestry Canada

Depletions to the commercial forest result from insects, disease, fire or harvesting. Over the 10-year period, depletions occurred on 9% of Canada's commercial forest land. Natural forces were the major cause, accounting for 57% of depletions. Harvesting accounted for the balance.

Additions to the forest result from natural regeneration, from planting and seeding, and from annual growth in the forest. More than 17 million hectares regenerated with commercial species between 1982 and 1991. Forest growth added more than 3.6 billion m^3 of wood to Canada's forest, an increase of almost 15%. Most of this increase occurred in older and mature forests. They grow more slowly than younger forests, but because older forests make up almost half of the commercial forest, they account for most of the forest growth.

The net effect of these changes was that Canada's commercial forest grew more wood than was depleted between 1982 and 1991, resulting in a net increase of 554 million m^3 or 2.2%. This net increase is equal to more than three years' harvest.

In assessing the impact of these changes on the forest land base, the account distinguishes between natural and human-caused disturbances. Fire, insects and disease are all part of the natural cycle of change and renewal in the forest. In Canada's forests, areas depleted by nature tend to regenerate naturally over time. In 1991, almost 11 million hectares of forest were classified as regenerating following depletion by fire, insects and disease.

Of concern is the harvested area that has failed to regenerate within an acceptable time frame. The account distinguishes between forest lands that were recently harvested and those harvested more than 10 years ago. Some 2 million hectares of recently harvested forest are considered to be regenerating.

In 1991, the total area that had not regenerated with commercial species within an acceptable period of time (10 years) increased from 3 million hectares to slightly over 4 million hectares — an average increase of 129 000 hectares per year. This increase is equivalent to approximately 14% of the average area harvested annually. It should be noted that most of these areas are not barren, but have regenerated with a variety of bushes and plants (such as alder, willow and hazel). However, they do not contain sufficient quantities of commercial tree species to be considered successfully regenerated for commercial purposes. In addition, some areas may have regenerated, but have not been surveyed recently.

These older harvested areas will likely require some form of silvicultural treatment to successfully reestablish commercial species within the near future. However, the total area that has not regenerated to commercial species within 10 years represents less than 2% of the commercial forest land base.

NOTES

SOURCE — The forest account is based on the most up-to-date information derived from the 1991 Canada Forest Inventory. Data on annual change is from the National Forestry Database and from published statistics.

LAND BASE — The account covers the commercial forest land base only. There are 2.2 million hectares of forest for which the age class has not yet been determined. Lands that may have changed status, i.e, from forests to farm lands, or from farm lands to forest lands, are not included in this account.

DISTURBANCES — Fire, insects, disease and harvesting are the only disturbances recorded within the commercial forest land base.

DEFINITIONS *(Last year's terms are indicated in brackets.)*

COMMERCIAL FOREST *(timber-productive forest)* — Forest land that is able to grow commercial timber within an acceptable time frame.

SEEDLING STAGE *(regeneration)* — Trees less than 1.3 m high.

YOUNG FOREST *(immature)* — Trees more than 1.3 m high.

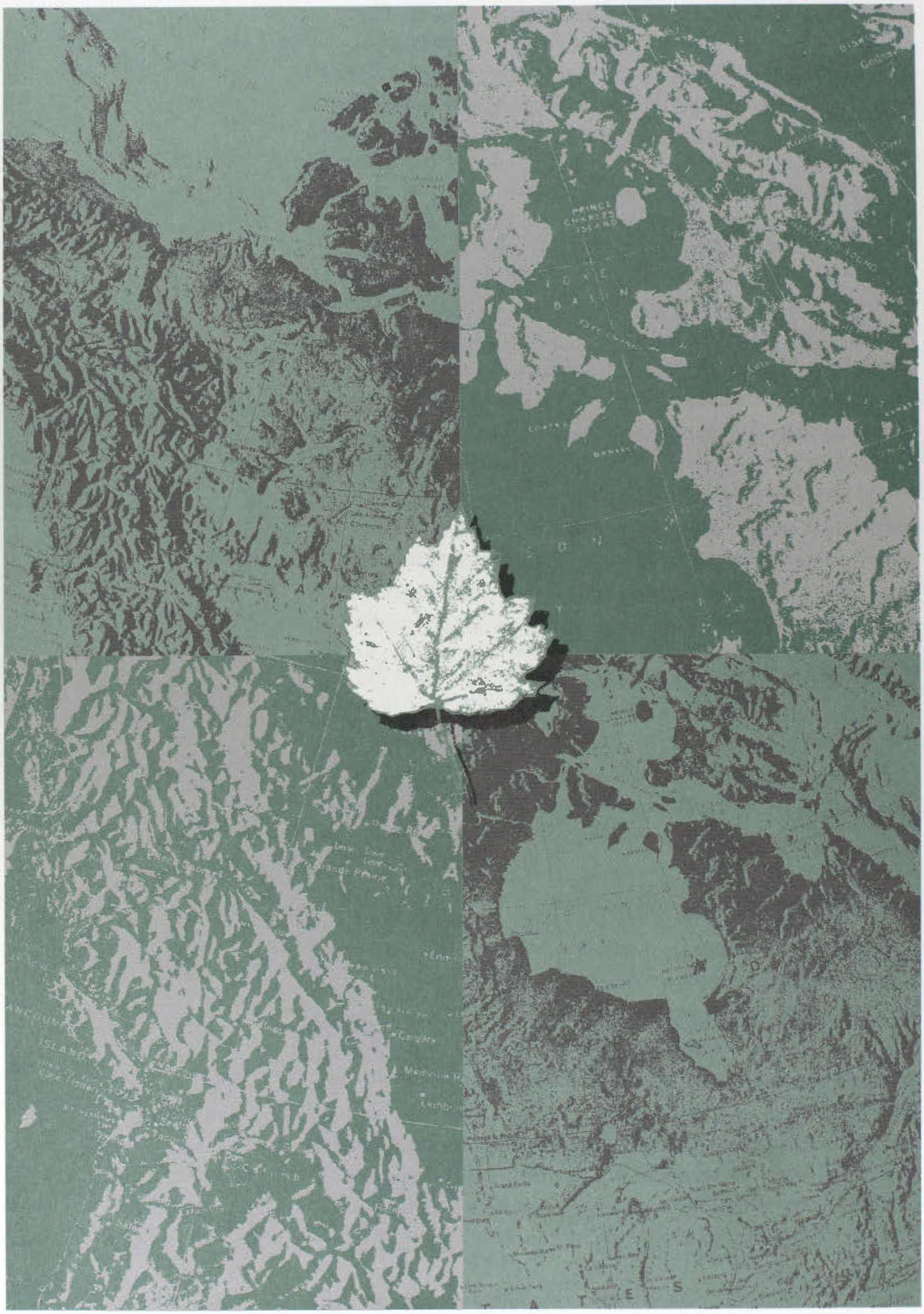
MATURE *(mature)* — Timber ready to be harvested.

OLD *(overmature)* — Trees that have grown past the mature stage. The age of maturity varies for each species, from 80 years for jack pine, to 200 years for subalpine fir.

MIXED-AGED *(uneven-aged)* — Forests in which trees differ markedly in age (usually greater than 20 years).

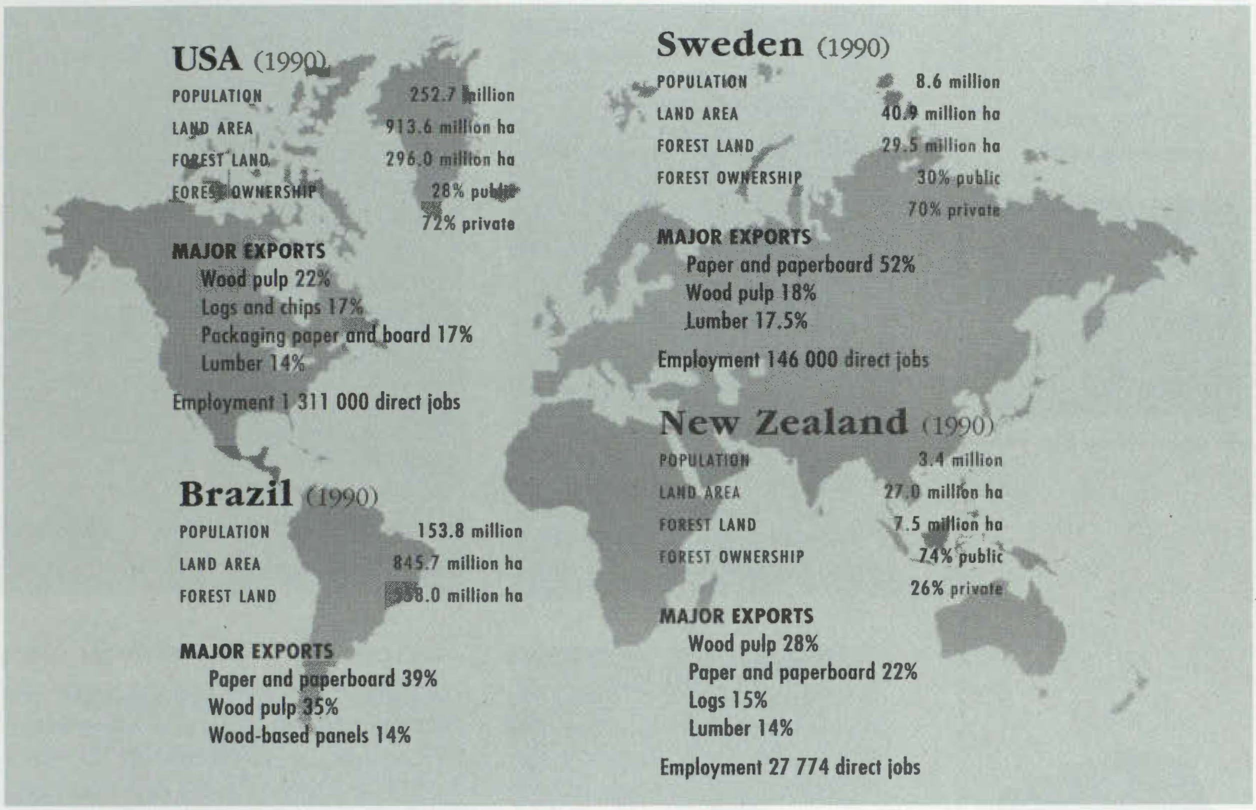
AREA REGENERATING *(part of last year's non-stocked total)* — Includes areas that have been harvested recently (less than 10 years ago), and areas depleted by natural disturbances such as fire, insects and disease.

AREA NOT GROWING COMMERCIAL SPECIES 10 YEARS AFTER HARVESTING *(part of last year's non-stocked total)* — Areas that were harvested more than 10 years ago and have not yet regenerated to commercial species.


PRINCE CHARLES ISLAND

FORESTRY PROFILES

DIFFERENT PERSPECTIVES



USA (1990)

POPULATION 252.7 million
LAND AREA 913.6 million ha
FOREST LAND 296.0 million ha
FOREST OWNERSHIP 28% public
72% private

MAJOR EXPORTS
- Wood pulp 22%
- Logs and chips 17%
- Packaging paper and board 17%
- Lumber 14%

Employment 1 311 000 direct jobs

Brazil (1990)

POPULATION 153.8 million
LAND AREA 845.7 million ha
FOREST LAND 558.0 million ha

MAJOR EXPORTS
- Paper and paperboard 39%
- Wood pulp 35%
- Wood-based panels 14%

Sweden (1990)

POPULATION 8.6 million
LAND AREA 40.9 million ha
FOREST LAND 29.5 million ha
FOREST OWNERSHIP 30% public
70% private

MAJOR EXPORTS
- Paper and paperboard 52%
- Wood pulp 18%
- Lumber 17.5%

Employment 146 000 direct jobs

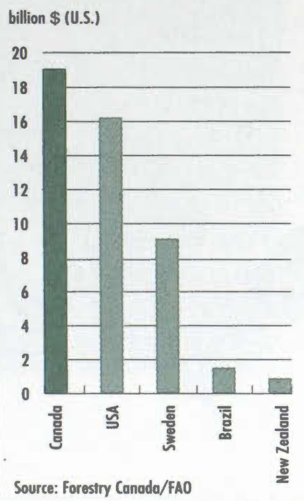
New Zealand (1990)

POPULATION 3.4 million
LAND AREA 27.0 million ha
FOREST LAND 7.5 million ha
FOREST OWNERSHIP 74% public
26% private

MAJOR EXPORTS
- Wood pulp 28%
- Paper and paperboard 22%
- Logs 15%
- Lumber 14%

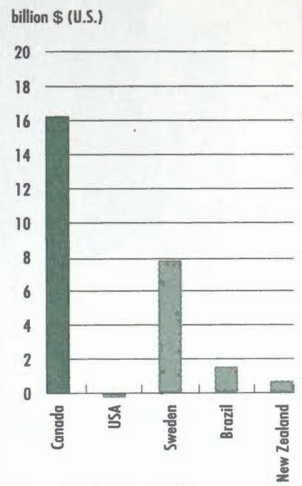
Employment 27 774 direct jobs

VALUE OF EXPORTS (1990)



Source: Forestry Canada/FAO

BALANCE OF TRADE (1990)



Source: Statistics Canada/FAO

Canada

POPULATION	26.6 million
TOTAL AREA	997.0 million ha
LAND AREA	921.5 million ha
FOREST LAND	416.2 million ha
NATIONAL PARKS	19.3 million ha
PROVINCIAL PARKS	22.9 million ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	71%
Federal	23%
Private	6%
FOREST TYPE	
Softwood	64%
Hardwood	15%
Mixedwood	21%
DISTURBANCES	
Insects	33.8 million ha
Fire	1.6 million ha
Harvesting	859 362 ha
Regeneration method	
Natural	61%
Planting or seeding	39%

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$20.6 billion
Wood pulp	24%
Newsprint	28%
Softwood lumber	24%
MAJOR EXPORT MARKETS (1991)	
United States	66%
EC	15%
Japan	9%
Others	10%
BALANCE OF TRADE (1991)	$ +17.3 billion
CONTRIBUTION TO GDP (1991)	$ +17.5 billion
VALUE OF SHIPMENTS (1990)	$46.9 billion
Sold domestically	53%
Exported	47%
NUMBER OF ESTABLISHMENTS (1990)	12 587
Logging industries	8 447
Wood industries	3 409
Paper and allied industries	731
EMPLOYMENT (1992)	729 000
289 000 direct jobs	
440 000 indirect jobs	
1 job in 17	
WAGES AND SALARIES (1990)	$9.9 billion
NEW INVESTMENTS (1991)	$6.5 billion

Newfoundland

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$439 million
Newsprint	83%
Book and writing paper	17%
MAJOR EXPORT MARKETS (1991)	
United States	31%
EC	42%
South and Central America	19%
BALANCE OF TRADE (1991)	$+433 million
VALUE OF SHIPMENTS (1990)	not available
NUMBER OF ESTABLISHMENTS (1990)	154
Logging industries	100
Wood industries	47
Paper and allied industries	7
EMPLOYMENT (1992)	8 000
5 000 direct jobs	
3 000 indirect jobs	
1 job in 24	
WAGES AND SALARIES (1990)	not available
NEW INVESTMENTS (1991)	not available

POPULATION	573 400
TOTAL AREA	40.6 million ha
LAND AREA	37.2 million ha
FOREST LAND	22.5 million ha
PROVINCIAL PARKS	439 400 ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	99%
Private	1%
FOREST TYPE	
Softwood	94%
Hardwood	1%
Mixedwood	5%
DISTURBANCES	
Insects	26 360 ha
Fire	65 374 ha
Harvesting	20 584 ha
Regeneration method	
Natural	87%
Planting or seeding	13%

Black spruce
(Picea mariana)

Prince Edward Island

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$2.6 million
Wood pulp	40%
Book and writing paper	17%
MAJOR EXPORT MARKETS (1991)	
United States	47%
EC	43%
BALANCE OF TRADE (1991)	$ +2.6 million
VALUE OF SHIPMENTS (1990)	not available
NUMBER OF ESTABLISHMENTS (1990)	34
Logging industries	15
Wood industries	18
Paper and allied industries	1
EMPLOYMENT (1992)	not available *
WAGES AND SALARIES (1990)	not available
NEW INVESTMENTS (1991)	not available
*see page 102	

POPULATION	130 300
TOTAL AREA	0.57 million ha
LAND AREA	0.57 million ha
FOREST LAND	0.29 million ha
PROVINCIAL PARKS	1 500 ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	7%
Private	92%
Federal	1%
FOREST TYPE	
Softwood	37%
Hardwood	28%
Mixedwood	35%
DISTURBANCES	
Insects	150 ha
Fire	119 ha
Harvesting	2 091 ha
Regeneration method	
Natural	51%
Planting or seeding	49%

Red oak
(Quercus rubra)

Nova Scotia

Red spruce
(Picea rubens)

POPULATION	894 000
TOTAL AREA	5.6 million ha
LAND AREA	5.3 million ha
FOREST LAND	3.9 million ha
PROVINCIAL PARKS	21 800 ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	28%
Federal	3%
Private	69%
FOREST TYPE	
Softwood	46%
Hardwood	31%
Mixedwood	23%
DISTURBANCES	
Insects	4 650 ha
Fire	1 776 ha
Harvesting	37 566 ha
Regeneration method	
Natural	70%
Planting or seeding	30%

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$513 million
Newsprint	47%
Wood pulp	44%
MAJOR EXPORT MARKETS (1991)	
United States	69%
EC	21%
BALANCE OF TRADE (1991)	$ +494 million
VALUE OF SHIPMENTS (1990)	$973 million
NUMBER OF ESTABLISHMENTS (1990)	412
Logging industries	305
Wood industries	93
Paper and allied industries	14
EMPLOYMENT (1992)	13 000
8 000 direct jobs	
5 000 indirect jobs	
1 job in 28	
WAGES AND SALARIES (1990)	$204 million
NEW INVESTMENTS (1991)	not available

New Brunswick

Balsam fir
(Abies balsamea)

POPULATION	723 000
TOTAL AREA	7.3 million ha
LAND AREA	7.2 million ha
FOREST LAND	6.1 million ha
PROVINCIAL PARKS	24 900 ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	48%
Federal	1%
Private	51%
FOREST TYPE	
Softwood	45%
Hardwood	27%
Mixedwood	28%
DISTURBANCES	
Insects	274 100 ha
Fire	3 325 ha
Harvesting	91 916 ha
Regeneration method	
Natural	82%
Planting or seeding	18%

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$1.3 billion
Wood pulp	39%
Newsprint	27%
Other paper and paperboard	23%
MAJOR EXPORT MARKETS (1991)	
United States	56%
EC	29%
Japan	9%
BALANCE OF TRADE (1991)	$ +1.2 billion
VALUE OF SHIPMENTS (1990)	$2.5 billion
NUMBER OF ESTABLISHMENTS (1990)	952
Logging industries	787
Wood industries	142
Paper and allied industries	23
EMPLOYMENT (1992)	18 000
11 000 direct jobs	
7 000 indirect jobs	
1 job in 16	
WAGES AND SALARIES (1990)	$479 million
NEW INVESTMENTS (1991)	not available

Quebec

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$5.1 billion
Newsprint	48%
Wood pulp	11%
Other paper and paperboard	21%
MAJOR EXPORT MARKETS (1991)	
United States	81%
EC	11%
BALANCE OF TRADE (1991)	$+4.3 billion
VALUE OF SHIPMENTS (1990)	$12.6 billion
NUMBER OF ESTABLISHMENTS (1990)	3 531
Logging industries	2 070
Wood industries	1 237
Paper and allied industries	224
EMPLOYMENT (1992)	151 000
80 000 direct jobs	
71 000 indirect jobs	
1 job in 20	
WAGES AND SALARIES (1990)	$2.8 billion
NEW INVESTMENTS (1991)	$1.7 billion

POPULATION	6 769 000
TOTAL AREA	154.1 million ha
LAND AREA	135.7 million ha
FOREST LAND	82.5 million ha
PROVINCIAL PARKS	7.1 million ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	92%
Private	8%
FOREST TYPE	
Softwood	67%
Hardwood	14%
Mixedwood	19%
DISTURBANCES	
Insects	297 899 ha
Fire	438 328 ha
Harvesting	236 815 ha
Regeneration method	
Natural	70%
Planting or seeding	30%

Quebec has not officially adopted a tree.

Ontario

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$3.8 billion
Newsprint	37%
Wood pulp	15%
Other paper and paperboard	20%
MAJOR EXPORT MARKETS (1991)	
United States	94%
BALANCE OF TRADE (1991)	$+1.9 billion
VALUE OF SHIPMENTS (1990)	$11.5 billion
NUMBER OF ESTABLISHMENTS (1990)	2 535
Logging industries	1 367
Wood industries	836
Paper and allied industries	332
EMPLOYMENT (1992)	135 000
69 000 direct jobs	
66 000 indirect jobs	
1 job in 35	
WAGES AND SALARIES (1990)	$2.5 billion
NEW INVESTMENTS (1991)	$1.2 billion

POPULATION	9 743 000
TOTAL AREA	106.9 million ha
LAND AREA	89.1 million ha
FOREST LAND	58.0 million ha
PROVINCIAL PARKS	6.3 million ha

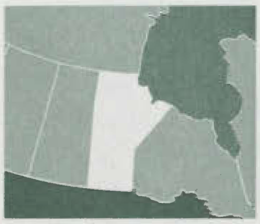
FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	88%
Federal	1%
Private	11%
FOREST TYPE	
Softwood	56%
Hardwood	18%
Mixedwood	26%
DISTURBANCES	
Insects	31.75 million ha
Fire	318 883 ha
Harvesting	199 719 ha
Regeneration method	
Natural	55%
Planting or seeding	45%

Eastern white pine
(Pinus strobus)

Manitoba

White spruce
(Picea glauca)



POPULATION	1 091 000
TOTAL AREA	65.0 million ha
LAND AREA	54.8 million ha
FOREST LAND	26.3 million ha
PROVINCIAL PARKS	1.5 million ha

FOREST RESOURCE (1991)

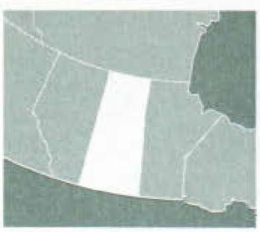
OWNERSHIP	
Provincial	94%
Federal	1%
Private	5%
FOREST TYPE	
Softwood	67%
Hardwood	19%
Mixedwood	14%
DISTURBANCES	
Insects	101 273 ha
Fire	114 182 ha
Harvesting	8 518 ha
Regeneration method	
Natural	55%
Planting or seeding	45%

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$165 million
Wrapping paper	36%
Softwood lumber	30%
Newsprint	14%
MAJOR EXPORT MARKETS (1991)	
United States	93%
BALANCE OF TRADE (1991)	$ +44 million
VALUE OF SHIPMENTS (1990)	$594 million
NUMBER OF ESTABLISHMENTS (1990)	248
Logging industries	137
Wood industries	83
Paper and allied industries	28
EMPLOYMENT (1992)	10 000
6 000 direct jobs	
4 000 indirect jobs	
1 job in 48	
WAGES AND SALARIES (1990)	$130 million
NEW INVESTMENTS (1991)	not available

Saskatchewan

White birch
(Betula papyrifera)



POPULATION	999 500
TOTAL AREA	62.2 million ha
LAND AREA	57.1 million ha
FOREST LAND	28.8 million ha
PROVINCIAL PARKS	908 000 ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	97%
Federal	2%
Private	1%
FOREST TYPE	
Softwood	56%
Hardwood	24%
Mixedwood	20%
DISTURBANCES	
Insects	15 600 ha
Fire	239 374 ha
Harvesting	17 522 ha
Regeneration method	
Natural	63%
Planting or seeding	37%

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$198 million
Wood pulp	50%
Other paper and paperboard	26%
MAJOR EXPORT MARKETS (1991)	
United States	72%
Japan	10%
BALANCE OF TRADE (1991)	$ +178 million
VALUE OF SHIPMENTS (1990)	not available
NUMBER OF ESTABLISHMENTS (1990)	201
Logging industries	131
Wood industries	64
Paper and allied industries	6
EMPLOYMENT (1992)	8 000
5 000 direct jobs	
3 000 indirect jobs	
1 job in 55	
WAGES AND SALARIES (1990)	not available
NEW INVESTMENTS (1991)	not available

Alberta

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$709 million
Wood pulp	64%
Softwood lumber	21%
MAJOR EXPORT MARKETS (1991)	
United States	68%
BALANCE OF TRADE (1991)	$+631 million
VALUE OF SHIPMENTS (1990)	$1.9 billion
NUMBER OF ESTABLISHMENTS (1990)	513
Logging industries	276
Wood industries	208
Paper and allied industries	29
EMPLOYMENT (1992)	29 000
17 000 direct jobs	
12 000 indirect jobs	
1 job in 43	
WAGES AND SALARIES (1990)	$386 million
NEW INVESTMENTS (1991)	not available

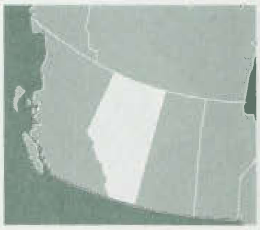
POPULATION	2 471 000
TOTAL AREA	66.1 million ha
LAND AREA	64.4 million ha
FOREST LAND	38.2 million ha
PROVINCIAL PARKS	1.25 million ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	87%
Federal	9%
Private	4%
FOREST TYPE	
Softwood	43%
Hardwood	37%
Mixedwood	20%
DISTURBANCES	
Insects	270 200 ha
Fire	6 172 ha
Harvesting	50 160 ha
Regeneration method	
Natural	27%
Planting or seeding *	73%

*see page 102

Lodgepole pine
(Pinus contorta)



British Columbia

FOREST INDUSTRY

VALUE OF EXPORTS (1991)	$8.4 billion
Softwood lumber	43%
Wood pulp	29%
Newsprint	12%
MAJOR EXPORT MARKETS (1991)	
United States	48%
EC	20%
Japan	20%
BALANCE OF TRADE (1991)	$ +7.9 billion
VALUE OF SHIPMENTS (1990)	$15.7 billion
NUMBER OF ESTABLISHMENTS (1990)	3 999
Logging industries	3 251
Wood industries	681
Paper and allied industries	67
EMPLOYMENT (1992)	170 000
87 000 direct jobs	
83 000 indirect jobs	
1 job in 9	
WAGES AND SALARIES (1990)	$3.2 billion
NEW INVESTMENTS (1991)	$2.4 billion

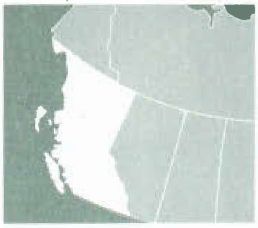
POPULATION	3 126 000
TOTAL AREA	94.8 million ha
LAND AREA	93.0 million ha
FOREST LAND	60.6 million ha
PROVINCIAL PARKS	5.33 million ha

FOREST RESOURCE (1991)

OWNERSHIP	
Provincial	95%
Federal	1%
Private	4%
FOREST TYPE	
Softwood	83%
Hardwood	5%
Mixedwood	12%
DISTURBANCES	
Insects *	957 302 ha
Fire	30 912 ha
Harvesting	193 654 ha
Regeneration method	
Natural	51%
Planting *	49%

*see page 101 and 102

Western red cedar
(Thuya plicata)



Yukon Territory

The Yukon Territory has not officially adopted a tree.

POPULATION	26 100
TOTAL AREA	48.3 million ha
LAND AREA	47.9 million ha
FOREST LAND	27.5 million ha

FOREST RESOURCE (1991)

OWNERSHIP	
Federal	100%
FOREST TYPE	
Softwood	75%
Hardwood	2%
Mixedwood	23%
DISTURBANCES	
Insects *	
Fire	129 370 ha
Harvesting	350 ha
Regeneration method	
Natural	100%

*see page 101

Northwest Territories

Jack pine
(Pinus banksiana)

POPULATION	53 800
TOTAL AREA	342.6 million ha
LAND AREA	329.4 million ha
FOREST LAND	61.4 million ha

FOREST RESOURCE (1991)

OWNERSHIP	
Federal	100%
FOREST TYPE	
Softwood	29%
Hardwood	5%
Mixedwood	66%
DISTURBANCES	
Insects	130 000 ha
Fire	225 470 ha
Harvesting	467 ha
Regeneration method	
Natural	100%

Notes

PROVINCIAL TREES

An illustration of the tree species that has been designated or officially adopted as the arboreal emblem of each province is included in the profiles on the preceding pages.

FOREST LAND

The data regarding Canada's forest land have been revised and are based on the 1991 Canada Forest Inventory. For the first time, the Inventory covers all of Canada's forest land. Previously uninventoried areas in northern Ontario, Manitoba and Alberta are now included in the total forest area (416.2 million ha). It seems that two-thirds of the previously uninventoried land (55.4 million ha) do not include significant areas that are classified as "forest land" in the new Inventory. This explains the difference between the 1986 Inventory figure and the 1991 Inventory figure for total forest land. The map on page 94 shows the new forest land boundary.

FOREST RESOURCE

Last year's report to Parliament provided ownership figures for timber-productive forests only. In this year's report, ownership data are provided for the total forest land.

The data relating to insects were provided by provincial and territorial agencies, and include moderate-to-severe defoliation only.

* *The limited amount of defoliation that occurs in the Yukon Territory is included in the figures for British Columbia.*

Areas harvested are regenerated naturally, or by planting or seeding. Various silvicultural activities (e.g., surveys, site preparation, spacing and weeding) are undertaken to ensure the success of both regeneration methods. In most cases, the percentages shown for regeneration methods are average or target figures.

* *The data provided by Alberta for planting and seeding may also include site preparation or a combination of treatments.*
* *In British Columbia, all artificial regeneration was carried out by planting.*

Forestry Canada is working with the provinces to develop conventions for measuring, analyzing and reporting national forest regeneration statistics.

FOREST INDUSTRY

The national employment figure includes both direct and indirect jobs in the forest sector. The total indirect jobs provided for each province will not add up to the national total, because the provincial figures do not include the indirect jobs created outside the province. Forestry Canada has revised its method of calculating indirect employment; refinement of the data for indirect employment is on-going. Therefore, the reader should not compare the employment data in this report with last year's report.

Some of the provincial data for wages, salaries and new investments are considered confidential and are therefore not available.

* *The limited number of forestry jobs in Prince Edward Island is not reported by Statistics Canada.*

DATA SOURCES

The main sources for the data are Statistics Canada, Environment Canada, the Canadian Pulp and Paper Association and Forestry Canada. Most of the information was collected by provincial and territorial forestry agencies.

Statistical Highlights

FORESTRY AT A GLANCE

PLANTING AND SEEDING (1991)
505 117 ha

SITE PREPARATION AND STAND TENDING (1991)
801 470 ha

HARVESTING (1991)
859 362 ha

FIRE (1991)
1.57 million ha

EMPLOYMENT (1992)
729 000

WAGES AND SALARIES (1990)
$9.9 billion

VALUE OF SHIPMENTS (1990)
$46.9 billion

EXPORTS (1991)
$20.6 billion

BALANCE OF TRADE (1991)
$17.3 billion

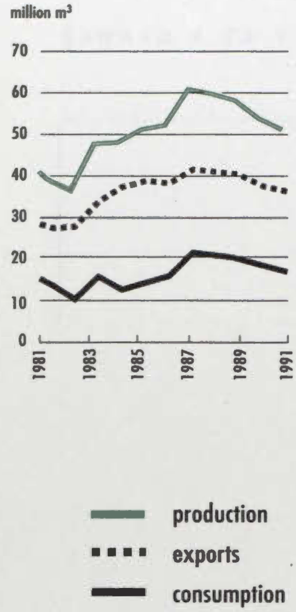
FOREST MANAGEMENT EXPENDITURES (1990)
$2.6 billion

CAPITAL AND REPAIR EXPENDITURES (1991)
$6.5 billion

R & D EXPENDITURES (1990)
$343 million

Note: Some of these statistics are detailed in the following pages.

LUMBER (1991)



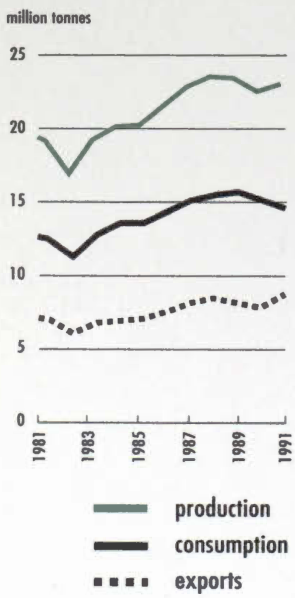
Canada consumes 33% of the lumber it produces. Domestic consumption decreased significantly between 1990 and 1991.

The global recession and a slowdown in housing starts in both Canada and the USA also affected the production and export levels of lumber, which decreased steadily between 1988 and 1991. However, there have been some signs of recovery in 1992, with moderate increases in the number of housing starts. In addition, lumber prices increased to record levels in late 1992.

million m³	annual % change 1 year	10 years
52.1	– 5.0	+ 3.2
36.4	– 2.9	+ 3.2
17.0	– 9.9	+ 4.1

Source: Statistics Canada

PULP (1991)

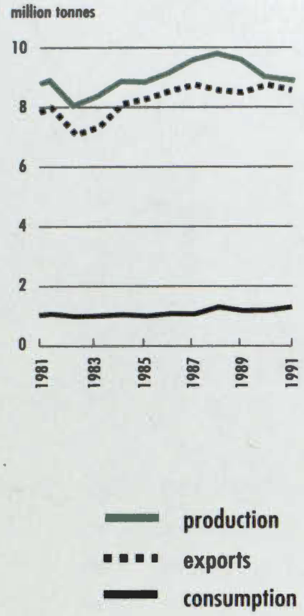


Canada is still the largest exporter of wood pulp. Following a few years of decline, exports of pulp increased by 11% in 1991. Production also increased slightly, while consumption decreased by 4%. Pulp prices remained low throughout 1992.

million tonnes	annual % change 1 year	10 years
23.3	+ 2.2	+ 2.1
14.6	– 4.1	+ 1.7
8.8	+11.3	+ 2.6

Source: Statistics Canada

NEWSPRINT (1991)



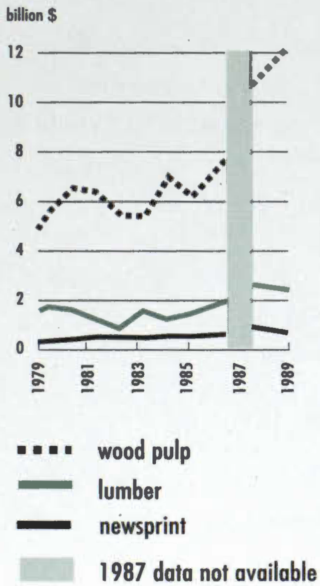
Although both the production and export of newsprint decreased, domestic consumption increased significantly between 1990 and 1991.

Canada exports 78% of its production to the USA and about 11% to western Europe. Canada's share of the U.S. market has been declining in the past few years, and dropped to 50% in 1991. Exports to the USA fell to their lowest level since 1982.

million tonnes	annual % change 1 year	10 years
9.0	– 1.0	+ 0.1
8.6	– 2.1	+ 0.8
1.3	+ 17.3	+ 2.2

Sources: Canadian Pulp and Paper Association/Forestry Canada

DOMESTIC SALES (1989)

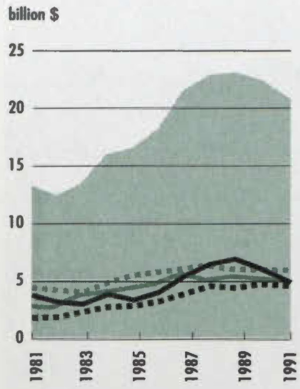


Domestic sales for both lumber and newsprint have been relatively stable over the past decade. The value of domestic sales for pulp, however, has been steadily increasing since 1983. In 1989, Canada's domestic sales of its three main commodity products were worth $15.3 billion.

billion $	annual % change 1 year	10 years
12.2	+ 9.7	+ 8.6
2.4	– 5.0	– 7.5
0.7	– 18.0	+ 7.0

Sources: Canadian Pulp and Paper Association/Statistics Canada

EXPORTS (1991)

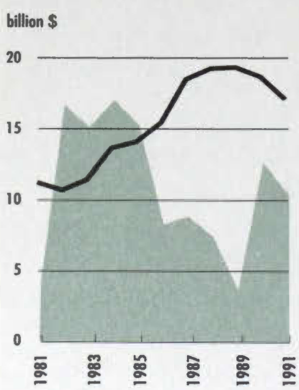


Total exports of forest products have been declining since 1989. The high Canadian dollar, recycling and new competitors are some of the factors that have contributed to this decline. In the future, a lower dollar combined with the expected growth in global economies and a relatively low inflation rate should improve the competitiveness of Canadian exporters.

billion $	annual % change 1 year	10 years
20.6	– 7.0	+ 5.1
4.9	– 19.5	+ 4.3
5.8	– 0.7	+ 3.4
5.1	– 4.1	+ 6.5
4.7	– 1.8	+ 9.8

Source: Statistics Canada

BALANCE OF TRADE (1991)

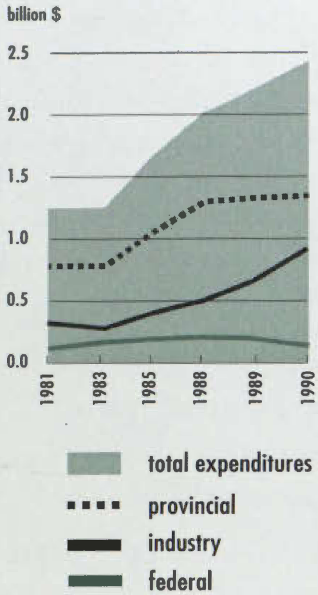


The export of forest products contributes significantly to Canada's high standard of living. Forest products continue to be the single largest contributor to Canada's positive balance of trade. In 1991, forest industries contributed $17.3 billion to Canada's balance of trade.

billion $	annual % change 1 year	10 years
10.3	– 18.7	+ 41.3
17.3	– 8.4	+ 4.6

Source: Statistics Canada

FOREST MANAGEMENT EXPENDITURES (1991)

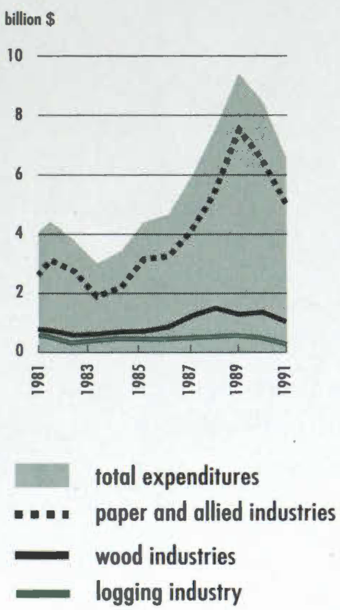


During the past decade, more of the responsibility for regenerating and managing Canada's forests has been assigned to the forest companies doing the harvesting. Forest management expenditures by Canadian forest industries increased by 11.2% between 1990 and 1991. Total expenditures increased by 7.8% to $2.6 billion.

billion $	annual % change 1 year	10 years
2.6	+ 7.8	+ 7.6
1.4	+ 5.8	+ 6.2
1.0	+ 11.2	+ 12.1
0.2	+ 5.6	+ 2.0

Sources: Canadian Pulp and Paper Association/Forestry Canada

CAPITAL AND REPAIR EXPENDITURES (1991)

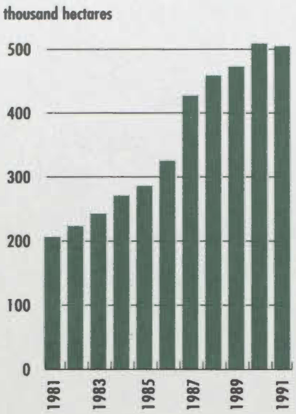


Canadian pulp and paper industries continued to direct their expenditures toward environmental projects, such as reducing dioxin emissions, installing secondary treatment facilities, controlling the odor at kraft pulp mills, and installing new recycling and de-inking facilities. However, the global recession and record losses by all forest industries contributed to a decrease in capital and repair expenditures in 1991.

billion $	annual % change 1 year	10 years
6.5	– 22.8	+ 5.9
5.0	– 21.5	+ 8.2
1.0	– 24.1	+ 5.5
0.4	– 33.3	– 2.7

Source: Statistics Canada

PLANTING AND SEEDING (1991)



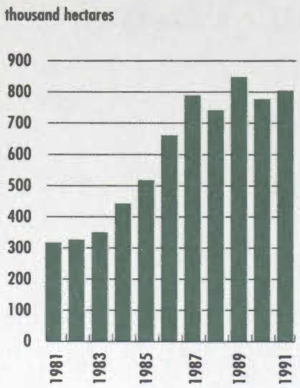
total area planted and seeded

Over the past decade, federal-provincial forest resource development agreements have resulted in large gains in regeneration efforts in Canada. Roughly 2 billion trees were planted under the first round of agreements. In addition, millions of seedlings are planted each year by the provinces and private woodlot owners. Between 1981 and 1991, the areas planted and seeded increased by 182 and 12% respectively, for an overall annual average increase of close to 10%.

hectares	annual % change	
	1 year	10 years
505 117	– 1.0	+ 9.89

Source: Forestry Canada

SITE PREPARATION AND STAND TENDING (1991)



site preparation and stand tending

Forest renewal activities, including site preparation and stand tending, are the focus of many of the second-round agreements between the federal, provincial and territorial governments. Thinning, fertilizing and pruning newly planted forests improves the growth and quality of young trees. Silvicultural activities have increased steadily over the past decade.

hectares	annual % change	
	1 year	10 years
801 470	+ 2.9	+ 10.3

Source: Forestry Canada

Glossary

TERMS OF THE TRADE

ALLOWABLE ANNUAL CUT (AAC) — The amount of timber that is permitted to be cut annually from a specified area. The AAC is used to regulate the harvest level to ensure a long-term supply of timber.

BACTERIA — One-celled microorganisms found in soil, water and air, and within other living organisms.

BLISTER — A type of tree disease characterized by the discharge of resin and/or fungal spores from the blister-type cankers on the surface of a stem or branch.

BOD (BIOCHEMICAL OXYGEN DEMAND) — A measure of the oxygen consumption of organic material in effluent.

CELLULOSE — A carbohydrate that is the principal constituent of wood. It forms the framework of wood cells.

CFCS (CHLOROFLUOROCARBONS) — Gaseous synthetic substances composed of chlorine, fluorine and carbon. They have been used as refrigerants, aerosol propellants, and cleaning solvents, and are used in the manufacture of plastic foam. CFCs are suspected of causing ozone depletion in the stratosphere.

CHEMI-THERMOMECHANICAL PULPING (CTMP) PROCESS — A process by which wood chips are separated into fibres using heat, pressure and chemicals.

COMMERCIAL FORESTS — Forest land capable of producing merchantable species of timber, as well as a variety of non-timber benefits.

CORKY ROOT — A root-damage disease caused by a microscopic worm called a "nematode."

COUNTERVAILING DUTY — A duty levied on imports to offset a subsidy in the exporting country.

CRYOGENICS — The study and application of behaviour of matter and materials at extremely low temperatures.

DDT (DICHLORODIPHENYLTRICHLOROETHANE) — A synthetic insecticide introduced for widespread use just after World War II to control malaria. Because this chlorinated organic compound is persistent and tends to bioaccumulate, and is known to induce cancer, most uses of DDT have been banned since 1974.

DECIDUOUS FOREST — Trees that lose their leaves in autumn; usually broad-leaved and usually classified as hardwoods.

DESERTIFICATION — The transformation of once-productive arid and semi-arid areas into deserts through prolonged drought or continued mismanagement of land and water resources.

DIOXIN — A chlorinated hydrocarbon that may be highly toxic.

ECOSYSTEMS — An integrated and harmonious association of living and nonliving resources functioning within a defined physical location. The term may be applied to a unit as large as the entire Ecosphere. More often it is applied to a smaller division.

ENDEMIC — Something regularly found in a population or locality.

ENTOMOPOXVIRUS — A virus that attacks some insects and is used as an expression vector for foreign proteins.

ENZYMES — Proteinaceous substances that are produced in living cells. Can incite or modify biochemical actions or changes in living cells or tissues without being changed themselves.

ETHANOL — A type of alcohol often distilled from plants, sugar cane, cereals or root crops. Can be used as a fuel.

FELLER-BUNCHER — A self-propelled machine used to fell trees by shearing them off near the ground using a hydraulic apparatus. Some models also strip limbs and "bunch" the logs for later pickup.

FENITROTHION — A synthetic pesticide occasionally sprayed on forests to control a wide range of insects such as budworms.

FOREST BIOMASS — The mass of the above-ground portion of woody plants in a forest.

FOSSIL FUELS — Fuels, such as oil, gas and coal, that were formed under the Earth's surface from the fossilized remains of plants and tiny animals that lived millions of years ago.

FURAN — A chlorinated compound that is an unwanted by-product of certain manufacturing processes.

GYPSY MOTHS — *Lymantria dispar.* A moth, native to Europe, that was introduced into North America and is now considered a major danger to leafy plants. The larvae of the gypsy moth feed on the leaves of trees, defoliating them. Several successive attacks are enough to weaken the trees, making them vulnerable to drought or disease, or to other insect attack.

KRAFT PAPER — A heavy paper or paperboard made from wood pulp by boiling wood chips in a sodium sulfate solution. Typically used for corrugated paper or grocery bags.

LAND RECLAMATION — Bringing the land, damaged from natural or human causes, back into use for growing trees or agricultural crops.

LIGNIN — The thin, cementing layer between wood cells, located principally in the secondary wall and the middle lamella. Lignin is the second most abundant constituent of wood.

METHANE — This colourless, odorless, flammable gas is formed naturally in marshes, petroleum wells, volcanoes and coal mines.

METHANOL — A colourless, poisonous, volatile and flammable liquid that can be manufactured from wood, as well as from coal, oil, natural gas or municipal waste. Can be used as a fuel.

MICROORGANISMS — Microscopic one- or multi-celled organisms such as bacteria, viruses, yeasts, algae, fungi and protozoans.

MYCOHERBICIDES — A group of fungi or fungal products used to control unwanted competing vegetation in a forest stand or plantation.

NITROUS OXIDE — A colourless nonflammable gas that is often used as a dental anaesthetic.

PAPERBOARD — A general term describing sheets made of fibrous material 0.3 mm or more in thickness. Compared with paper, paperboard is heavier per unit area, thicker, and more rigid. Paperboard is the term used to describe a variety or group of varieties of board materials used in the production of boxes, folding cartons, and solid fibre and corrugated shipping containers.

PAPRIFORMER — One of many types of machines that form sheets of paper during the papermaking process. This machine was designed by the Pulp and Paper Research Institute of Canada.

PARASITES — Animals or plants that live and sustain themselves on, with or inside another organism, and may or may not cause damage or a disease.

PATHOGENIC FUNGI — Fungi that attack and cause disease or damage to other organisms.

ROOT FLARES — Parts of a tree where the roots emerge from the main stem.

SECONDARY TREATMENTS — The biological treatment of wastewater in which a bacterial or biochemical action is used or intensified to stabilize, oxidize and nitrify the unstable organic matter that is present.

SHIPMENTS — Includes all shipping of goods within or outside Canada. Excludes product inventories.

SITE PREPARATION — Disturbance of an area's topsoil and ground vegetation to create conditions favourable or more suitable for stand establishment.

SLUDGE — A soft, thick mixture, deposit or sediment. Often a by-product of sewage treatment processes.

SOIL STABILIZATION — Techniques used to protect soil areas at risk from erosion, flooding or wind, e.g., planting grass or other vegetation on bare hillsides or sandy deserts. Such plants are also known as "soil binders."

SOMATIC EMBRYOGENESIS — A biotechnological technique that uses a plant embryo from a seed to propagate plants.

SPRUCE BUDWORM — An insect that damages spruces and firs. Eggs of the spruce budworm are laid on tree branches by the adult moth. Young budworms primarily feed on the new growth of the tree branch, but also eat older needles. Defoliation results, killing the tree.

STAND TENDING — Maintenance operations on groupings of forest trees. Includes weeding, thinning, improvement cuttings of trees, and the removal of undesired competing vegetation.

STUMPAGE FEE — The fee paid by companies or individuals for the right to harvest timber on Crown land.

SUMMER FALLOWING — Land left unsown, usually for a season, to conserve moisture in the soil and to allow accumulation of nitrogen.

TEMPERATE FOREST — One of three main forest types in the world, mainly composed of deciduous trees. The other two types are the equatorial evergreen forest and the northern coniferous forest.

TIMBER LICENCES — A licence to cut and remove Crown timber.

TISSUE-CULTURE TECHNIQUES — A general term for the cultivation of plant or animal tissues in a controlled artificial environment on defined media under aseptic conditions.

TRIM SAWS — A set of saws, usually circular, used to cut lumber to various lengths. The individual blades are lowered to contact the lumber as it passes beneath on a moving chain.

TSS (TOTAL SUSPENDED SOLIDS) — The total amount of fibres or particles found in effluent.

TWIN WIRE TECHNOLOGY — A process whereby a mixture of wood pulp and water runs between two wire screens so that the cellulose fibres clump together and the water drains off, allowing the mixture to form a continuous wet paper sheet.

VALUE-ADDED PRODUCTION — Manufacturing that adds value to a primary product as it passes through various processing stages. Measures profits against wages.

WAFERBOARD OR ORIENTED STRAND BOARD — A type of particleboard composed of wafers cut from roundwood bolts (mostly poplar) of uniform length and thickness that resemble small pieces of veneer. The wafers are bonded together with resin binder, under heat and pressure, by a process similar to that by which particleboard is made.

WHITE-PINE BLISTER RUST INFECTION — A fungi-caused disease affecting needles, branches and stems. Stem rust diseases can cause cankers and malform trees.