Appendix 10

Forest and Forest Products Research in Canada

Canada's forests, unlike those of the United States, are largely owned by the federal government and managed by the provinces; relatively little forestland is privately owned. Canada is the world's largest exporter of forest products, including softwood lumber, paper, wood pulp, wood panels, and value-added products. For more information on Canada's forest area and extent, forest types, forest management, and forest industry, see Appendix 2 of this report and two summaries available online:

- *The Canadian Encyclopedia* (http://www.thecanadianencyclopedia.ca/en/article/forestry/); and
- Natural Resources Canada (http://www.nrcan.gc.ca/forests/industry/overview/13311).

The forest sector research landscape of Canada comprises federal, university, and partnership programs, discussed below.

Federal forest research programs

Federal government activities regarding forests and forest research in Canada unfolded on much the same timeline as they did in the United States, starting in the late 1800s into the early 1900s. In 1909, Parliament established the Commission on Conservation with responsibility over natural resources, opening the way for creation of forest laboratories and stations to study timber and wood preservation. This was the beginning of federal research in the forest sector. In 1930, the federal government transferred jurisdiction over western forestland to the provinces, leaving federal forestry programs to concentrate on scientific research in silviculture, forest protection and products, and collecting information on forest resources.

Today, the Science and Technology program of the Canadian Forest Service (CFS) promotes sustainable forest management and a competitive Canadian forest sector through the development and implementation of knowledge, databases, and technology. The program tackles strategic, fundamental national and international issues that the forest community faces. Activities to accomplish these goals are undertaken through a system of five national science and technology research networks administered by five research centers and headquarters. Each of the centers serves as the administrative and operational lead for its respective network. Activities undertaken by each network have operating components in each of the national centers in addition to the lead center with which a given network is identified.

Atlantic Forestry Centre. The Fredericton, New Brunswick, site includes state-of-the-art research laboratories, a comprehensive insect and disease collection facility, and a sophisticated climate-controlled greenhouse and nursery complex. Researchers here are investigating, among other things, new methods of integrated pest management, forest health, gene conservation to preserve biodiversity, somatic embryogenesis and gene manipulation to improve timber production, climate change impacts and adaptation, and computer-based management planning tools.

The center's Corner Brook, Newfoundland, site focuses on disturbance in boreal ecosystems, such as carbon and nutrient cycling, climate change, issues of scale in ecology, biodiversity, as well as risk analyses to advance forest ecosystem sustainability. Research

infrastructure includes computing facilities to address remote sensing, GIS, and knowledge management.

The Atlantic Forestry Centre is also responsible for the 10,000-hectare Acadia Research Forest, just east of Fredericton. Situated in the heart of the Acadian forest region, the research forest was officially founded in 1933. It is the site of some of the oldest documented forest research studies in Canada, including direct seeding experiments that were conducted in the early 1920s. The forest is also part of the Burpee Wildlife Management Area.

Laurentian Forestry Centre. This facility, in Sainte-Foy, Quebec, conducts research in the following areas:

- general forest health (insects and diseases) and forest biodiversity;
- biological control of forest insect pests (spruce budworm, gypsy moth, and hemlock looper) and diseases (annosus root rot, white pine blister rust, and Scleroderris canker), using environmentally friendly controls such as *Bacillus thuringiensis* (B.t.) and other nonchemical methods;
- effects of natural disturbances (forest fires, insect epidemics, wind throw, and ice storms) to develop appropriate ecosystem management strategies;
- ecosystem productivity (e.g., the effects of current techniques for forest management on forest productivity), and improvement of forestry practices;
- tree improvement to obtain better yields and preserve the forest (insect and disease resistance, increased forest biomass, wood quality, biotechnology, and genetics);
- tree functioning;
- development of decisionmaking tools (remote sensing and geomatics); and
- evaluation of the effects of climate change on forests and development of adaptation strategies.

Great Lakes Forestry Centre. This center, in Sault Ste. Marie, Ontario, has the following research interests:

- how fundamental ecological processes affect the productivity and resilience of forest ecosystems;
- sustainable productivity;
- forest succession; and
- population dynamics and the development of ecologically acceptable methods for managing forest pests, including biological controls, microbial control agents, pest management biotechnology, natural products and semiochemicals, environmental research and assessment, and pest management applications.

Northern Forestry Centre. This Edmonton, Alberta, facility is responsible for research and operational programs in Alberta, Saskatchewan, Manitoba, the Northwest Territories, and Nunavut. The work is focused on three main areas:

- *Aboriginal and rural communities.* This issue involves increasing our understanding of the economic, social and environmental effects of forests and the forest sector on communities.
- *Climate change.* Research is concerned with the potential effects of climate change on forests and forest ecosystems, and the development and implementation of appropriate policies and adaptation strategies.
- *Sustainability of Canada's forests.* Researchers seek to improve understanding about the health of forests, identify threats and develop strategies to manage these threats, and raise the economic and social value of forests.

The Northern Forestry Centre also leads national initiatives relating to wildland fire strategy and the boreal forest, and it coordinates regional delivery of Canada's Model Forest Program and the First Nations Forestry Program. In addition, it hosts CFS staff working with the Fibre Centre, a national virtual organization dedicated to improving the value of wood fiber resources in Canada.

Pacific Forestry Centre. Located in Victoria, British Columbia, this center works within a national science and policy project framework to coordinate and deliver information and knowledge about climate change, forest protection, forest ecosystems, landscape disturbance, invasive species, forest health and biodiversity, and synthesis of knowledge and information.

National programs led by the Pacific Forestry Centre, in collaboration with provincial and territorial partners, include the Earth Observation of Sustainable Development of Forests, Forest Carbon Measurement and Monitoring Framework, National Forest Pest Strategy, National Forest Inventory, and the National Forest Information System. Over the next five years, these programs will develop and deliver integrated national forest information methods and products. They will also develop infrastructure to provide clients with web-based access to information held by federal, provincial, territorial, and other government and nongovernment agencies. Researchers also contribute to CFS priority analyses on industry, trade and economic issues. Finally, to meet the diverse needs of the forest sector, the Pacific Forestry Centre assists with the delivery of the First Nations Forestry Program, the Mountain Pine Beetle Initiative, and the Forest Communities Program.

Canadian Wood Fibre Centre. This is a "virtual center" whose employees are located across the country. Part of its mandate is to provide wood fiber research expertise to FPInnovations, a not-for-profit public-private membership organization in the forest research sector. Linking the three organizations—Canadian Wood Fibre Centre, CFS research centers, and FPInnovations—brings the federal government's priorities together with the Canadian forest sector's research needs. Within this structure, the center's goal is to develop targeted and environmentally responsible solutions to challenges faced by Canada's forest sector industries.

A major focus for staff is work identified by FPInnovations under the Resource Assessment Program, in two areas:

- *Resource characterization.* Researchers are working to enhance forest inventory systems and evaluation tools and techniques. This research, conducted in collaboration with provincial governments, academia, consultants, and forest companies, is aimed at finding practical ways to enable the semi-automated identification of tree species,

improve the resolution of forest inventories, develop predictive productivity models, improve understanding of wood fiber characteristics, and characterize woody residuals for economical harvest, conversion, and utilization.

- *Resource production.* Research in this area emphasizes innovative technologies for producing wood fiber with desirable attributes. Researchers are developing forest genomics tools to identify genetic markers, developing and refining conifer somatic embryogenesis systems and their use in multivarietal forestry, and developing tools and management regimes for short-rotation woody crops.

The center collaborates with provincial governments and the industrial sector to ensure effective and rapid uptake of innovations. Its work is directly supported by the Forest Innovation Program (FIP), which was established to advance research, development and technology transfer activities in Canada's forest sector. Together, these activities are intended to help transform the sector by adopting and commercializing new technologies.

The Canadian Wood Fibre Centre is also responsible for the 10,000-hectare Petawawa Research Forest, located in Chalk River, Ontario. Since its creation in 1918, it has been bringing together federal, provincial, and industry researchers whose work has contributed to the protection and sustainable use of Canada's vast forest resources. Many long-term research studies have been carried out at the Petawawa Research Forest, addressing silviculture, forest fire research, forest ecology, and tree genetics. These studies have resulted in the creation of about 2,000 experimental research areas and continue to influence regional, national, and global forest management practices. The Petawawa Research Forest is playing an important role in charting Canada's future forest health and management practices and the prospects for forest-based industries. Among the notable forest research studies now underway in emerging areas of scientific research are those addressing next-generation enhanced forest inventory, climate change, innovative silviculture techniques, bioindicators, and forest-based bioenergy.

University forest research programs

Canada's universities offer a variety of forestry programs. The following list groups the universities by forestry program accreditation. The eight universities with programs accredited by the Canadian Forestry Accreditation Board are members of the Association of University Forestry Schools of Canada (AUFSC)(http://www.aefuc-aufsc.ca/home/).

Board-accredited programs

University of Alberta. The Department of Renewable Resources, within the Agriculture program, offers BSc programs in environmental and conservation sciences and forestry, as well as land resources (soil science). Students taking forestry may major in either forest management or forest resources. Research in the School of Forest Science and Management within the department often involves local, provincial, national, and international partnerships.

The university has three groups related to forestry:

- *Biodiversity Monitoring Institute.* The institute monitors more than 2,000 species and habitats to support decision making about provincial biodiversity.
- *Alberta Innovates Technology Futures.* This group helps build sustainable resource management capacity through research, development, and deployment of scientifically valid ecosystem management tools. Work includes biodiversity monitoring, ecological conservation, and water management.
- *Centre for Enhanced Forest Management.* This group provides opportunities for collaborative research in developing and testing innovative forestry practices that link genetics, silviculture, protection, growth and yield, and management for enhancing wood production and other values (including watersheds, recreation, wildlife, and biodiversity).

University of British Columbia. UBC's forest education seeks to keep pace with changing social values and an increasingly knowledge-based forest sector. The biology of trees, innovative wood products, forest engineering, and ecological and cultural issues related to the forest are among the topics that students address. Four departments offer degrees and conduct research:

Forest and Conservation Sciences, Wood Science, Forest Resources Management, and the UBC Pulp and Paper Centre and Centre for Advanced Wood Processing.

Lakehead University. Lakehead's Faculty of Natural Resource Management is committed to enhancing the management of Canada's forested ecosystems and advancing forest science through scientific research.

Université Laval. Laval's Faculty of Forestry and Geomatics takes a global perspective designed to connect students with future issues. The faculty of 32 includes staff at the University of Quebec in Montreal. Laval's Forest Research Centre, in Quebec, applies scientific expertise to working in the forest and links understanding of forest ecosystems with alternative designs for forest management (planning strategies and silvicultural practices).

Université de Moncton. The university's Faculty of Forestry offers a bachelor's program designed to give forestry students the knowledge, skill, and abilities to manage forest environments in the context of sustainable development process. The Research Forest's mission has three main components: education, research, and demonstration.

University of New Brunswick. The university's Forest Engineering program, the only accredited program of its kind in Canada, enjoys an international reputation. The Forestry program has been a leader in educating managers of the forest landscape. It pioneered computer applications in forestry and trains students in simulation modeling, ecological management, GIS, and wildlife management. The Environment and Natural Resources program educates managers of the forest landscape. The Faculty of Forestry also offers master's and doctoral programs.

University of Northern British Columbia. The Ecosystem Science and Management Program offers a BSc in forest ecology and management. The university offers a master of engineering in integrated wood design, cooperating with the Canadian Wood Council, plus master of arts programs in biology, environmental science, forestry, geography, and outdoor recreation and tourism management. It also has a doctoral degree program in natural resources and environment.

The 9,000-ha Aleza Lake Research Forest is a university-based outdoor research and working forest. Its mandate is to provide research and educational facilities and opportunities to government agencies, private sector researchers, and universities and other educational groups.

University of Toronto. The Faculty of Forestry is an interdisciplinary group of natural, engineering, and social scientists engaged in research in forest conservation science, forest ecosystem management, forest governance and policy, and biomass utilization for sustainable bio-based materials and chemical products.

Other forestry or related science education programs

Although the forestry programs at these schools are not accredited by the Canadian Forestry Accreditation Board, the engineering programs may be accredited by other organizations.

Royal Roads University, British Columbia. The School of Environment and Sustainability undertakes research to advance capacity building, collaboration, and organizational effectiveness, dialogue, environmental protection, pollution mitigation, and resource stewardship. It offers master's degrees in environment and management, environmental practice, and environment education and communication.

Simon Fraser University, British Columbia. The School of Resource and Environmental Management has a program in environmental science with specialization in biology, chemistry, envirometrics, physical geography, pollutant transport, and quantitative techniques for resource management. Both master's and doctoral degrees are offered. The PhD program in resource and environmental management provides an opportunity for students to pursue research and interdisciplinary education in natural resources and environmental management, including environmental science, ecological economics, and environmental policy. Simon Fraser also has a graduate engineering studies and research program, including research in nanotechnology.

Thompson River University, British Columbia. The two main programs of study are the Natural Resource Science Degree Program and the Forestry Transfer Program. It offers an

honors program, co-operative education opportunities, courses needed for professional accreditation by the Association of British Columbia Forest Professionals, and a master's program in environmental science.

University of Victoria, British Columbia. Restoration of Natural Systems is an accredited program in the field of environmental restoration that provides practical background knowledge, training, and skills for those working in areas related to the restoration of natural systems. The university offers master's and doctoral degrees in environmental studies. The Department of Mechanical Engineering offers graduate-level degrees that can include work on clean energy and nanotechnology.

Vancouver Island University, British Columbia. Through classroom lectures and discussion, hands-on laboratories, and outdoor activities and field trips, this university's programs provide an overview of forestry that recognizes economic, social, and environmental values. Options include a two-year forest resources technology diploma, a postdiploma bridging year to university degrees, and an upgrading program for diploma program entry. The university also offers a master's degree in sustainable leisure management.

University of Manitoba. The Clayton H. Riddell Faculty of Environment, Earth, and Resources offers seven undergraduate degree programs. A cooperative education option is available to facilitate professional development in several of these programs. The university offers master's programs in environmental management and natural resources management and a PhD program in natural resources management. The Department of Engineering offers graduate studies in biofuels and biotechnology.

Queens University. The university's School of Environmental Studies emphasizes the diverse contributions of technology, the natural sciences, humanities, and social sciences. It provides an interdisciplinary approach to problem solving and education. It offers both graduate degrees in environmental studies and engineering and applied physics, including nanotechnology.

University of Waterloo. The Department of Environment and Resource Studies offers programs that focus on sustainability and the ethics of solving environmental and resource

problems, using techniques and ideas from ecology, environmental governance, energy, water, waste management, media, and environmental assessment. Its graduate degrees include master's programs in biology, environmental studies (including both business aspects and resource management aspects), engineering (nanotechnology), and recreation and leisure management. Doctoral programs include biology, engineering, and environmental studies.

Not-for-profit, member-based research partnerships

Three not-for-profit partnerships were in existence in 2000: the Forest Engineering Research Institute of Canada, the Pulp and Paper Research Institute of Canada, and Forintek Canada Corp. In 2007, the three became divisions of a new research organization, FPInnovations (see Appendix 11).

Forest Engineering Research Institute of Canada (FERIC). The initial mandate of this institute, established jointly by Canada's forest industry and the federal government in 1975, was to conduct research and develop machine concepts that would improve the efficiency of wood harvesting operations. FERIC's mandate was expanded several times: in 1981, to include mechanized silvicultural operations (e.g., tree-planting and precommercial thinning machinery, herbicide application equipment); in 1984, to address the specific problems associated with managing and harvesting small woodlots; and in 1999, to deal with the operational aspects of fighting forest fires. FERIC had eastern and western divisions, with a head office in Pointe-Claire, Quebec, covering the Maritimes to Manitoba, and a western office in Vancouver, covering British Columbia, Alberta, and Saskatchewan.

Pulp and Paper Research Institute of Canada (PAPRICAN). This nonprofit, membership-based research and education organization began in 1925 and operated both research laboratories and educational programs. The educational programs provided graduate and postgraduate programs and continuing education for the pulp and paper industry on the campuses of the University of British Columbia, McGill University, and École Polytechnique de Université de Montréal. Paprican had approximately 340 scientists, engineers, and technical and administrative support staff. Its operating budgets were provided largely by member companies.

Forintek Canada Corporation. This organization was Canada's wood products research institute. In 1979, when the Eastern and Western Wood Products Laboratories of CFS were privatized, the federal government invited the provinces and the private sector to help underwrite a new, not-for-profit organization, Forintek Canada Corporation, to carry on the research that CFS had done in-house. Based on priorities identified by the forest industry and the federal and provincial governments, Forintek delivered technological solutions in such areas as production of lumber, panels, and other value-added wood products, manufacturing processes or attributes (e.g., strength of products, service life of wood products), wood drying and protection (e.g., preservative treatments), building systems, product durability, structural performance, environmental impact, fire resistance, and related topics. Forintek also conducted market and economic studies and helped write building codes and standards, both nationally and internationally. It had a staff of 130 scientists, engineers, and technologists, operating from research centers in Vancouver and in Sainte-Foy, Quebec, with satellite centers in Edmonton, Alberta, and in Carleton University in Ottawa.

Other research facilities and programs

Boreal Ecosystem-Atmosphere Study (BOREAS). The goal of this large, international, interdisciplinary experiment in the northern boreal forests of Canada is to improve our understanding of the boreal forests—how they interact with the atmosphere, how much carbon dioxide they can store, and how climate change will affect them.

Canadian Journal of Forest Research. Published in English and French by a private, not-for-profit company, this journal has been ranked as one of the top three publications in its field. It offers research articles in silviculture, ecophysiology, forest ecology, biotechnology, forest genetics and tree improvement, tree physiology, forest entomology and pathology, and other forest-related topics.

FORAC. The Consortium for Research on e-business in the forest products industry, FORAC offers forest products industry companies multidisciplinary research expertise of

international caliber in developing concepts, methodologies and management tools leveraging the potential of Internet technologies.

Foothills Research Institute. This community of partners is dedicated to providing practical solutions for stewardship and sustainability of forestland. It has three principal partners, which represent the agencies with vested land management authority for the land base covered by the Model Forest Network (see below).

International Development Research Centre–Forests. This is a Canadian crown agency committed to building a sustainable and equitable world. It funds research in the developing world that enables the people of the global South to find solutions to pressing development problems.

International Model Forest Network. At each site in this network, local partnerships are created among groups representing industry, environmentalists, community associations, indigenous peoples, and other relevant interests, who then work together to define and implement a shared vision of sustainable forest management.

John Prince Research Forest. This forest encompasses 13,032 ha of crown land in north-central British Columbia, 50 km north of Fort St. James and between Tezzeron (Chuzghun) and Pinchi (Tesgha) lakes in the traditional territory of the Tl'azt'en First Nation.

Ontario Forest Research Institute. A branch of the Ontario Ministry of Natural Resources and Forestry, this institute employs scientists and monitoring specialists to study forests and how they respond to natural disturbances and management activities.

Sustainable Forest Management Network. This is one of Canada's networks of centers of excellence. It conducts interdisciplinary research on the management of Canadian forests, focusing on integrated and directed research in developing new planning and management tools for industry, as well as policy insights and improved institutions for government.

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