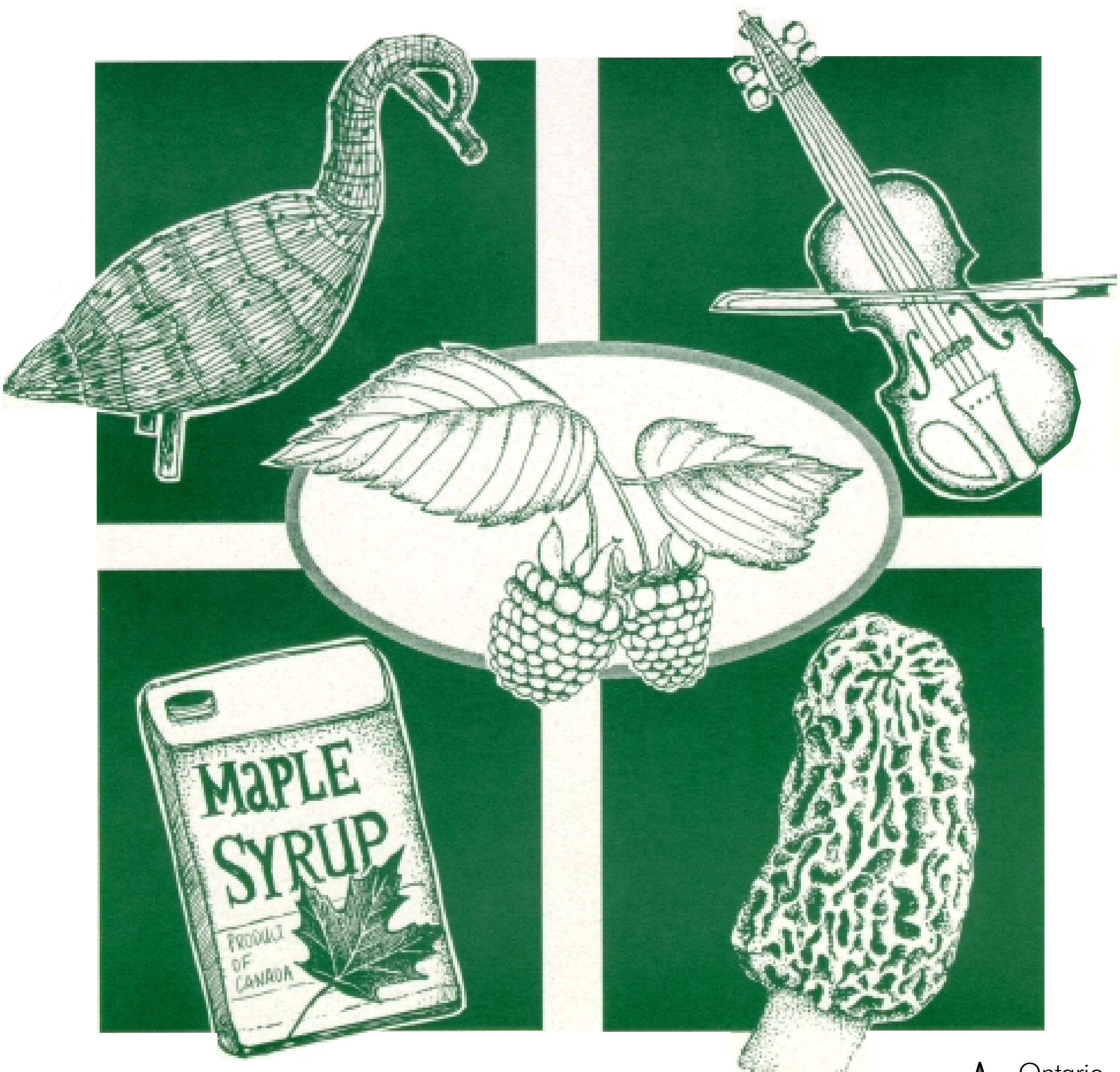
Ontario

Forest Research Information Paper No. 145

Non-Timber Forest Products in Ontario: An Overview



Ministry of Natural Resources

Ontario Forest Research Institute
OFRI • IRFO

Forest Research Information Paper No. 145

Non-Timber Forest Products in Ontario: An Overview

by

Gina H. Mohammed

1999

Ontario Forest Research Institute
Ontario Ministry of Natural Resources
1235 Queen St. E., Sault Ste. Marie, ON
P6A 2E5 Canada
Tel. (705) 946-2981 ext. 214
Fax (705) 946-2030
E-mail: gina.mohammed@mnr.gov.on.ca

Canadian Cataloguing in Publication Data

Main entry under title:
Non-timber forest products in Ontario: an overview

(Forest research information paper, ISSN 1319-9118; no. 145)
Includes Bibliographical references
ISBN 0-7778-8977-3

1. Non-timber forest resources—Ontario.
2. Non-timber forest products industry—Ontario.
3. Sustainable forestry—Ontario.

I. Ontario Forest Research Institute.
II. Title.
III. Series.

SD543.305M63 1999 333.75'09713 C99-964016X

Single copies of this publication
are available from the address
noted below.

Ontario Forest Research Institute
Ministry of Natural Resources
1235 Queen Street East
Sault Ste. Marie, ON
Canada P6A 2E5

Telephone: (705) 946-2981 x271
Fax: (705) 946-2030
E-mail: lisa.buse@mnr.gov.on.ca

Cette publication scientifique n'est
disponible qu'en anglais.

Acknowledgements

I am grateful to many individuals who provided information and helpful discussion – Mamdouh Abou-Zaid, Branka Barl, Bill Baxter, Wayne Bell, Bob Benson, Eric Boysen, Susan Burkholder, Andrew Chapeskie, Linda Commandant, Peter de Groot, Steve Dominy, Luc Duchesne, Michael Dumas, Mary Eaton, Pam Fisher, Charity Frankcom, Diane Gertzen, Nelly de Geus, Gary Grant, Ernie Grimo, Andrea Gunner, Kim Higgins, David Hill, Normand Lafrenière, Todd Leuty, Linda MacDonald, Ken McGregor, Robert Mears, Sue Millson, Peter Neily, Tom Noland, Louise Portelance, Rebecca Richards, Meg Shehad, David Stewart, Brian Swaile, Dean Thompson, Bonnie Turner, and Vic Wearn.

Special thanks go to Steve Banducci and Wayne Bell for reviewing the report.

Line drawings on pages 12 and 45 were done by Trudy Vaittinen. Drawings on pages 22, 36, and 39 are by Shayna LaBelle-Beadman (Chambers et al. 1996)

Disclaimer

Uses of plant species reported here are based on published literature and information contained in company web sites. Their inclusion does not imply endorsement of any product or application by either the author or the Ontario Ministry of Natural Resources. Also, it is recognized that many plant species have toxic properties, and expert advice is strongly recommended before their usage in health and food products.

Executive Summary

Non-timber forest products (NTFPs) are botanical products harvested or originating from forest-based species. They exclude primary timber products, industrial boards and composites, and paper products. This report reviews commercial and non-commercial NTFPs in Ontario, including current and potential NTFPs, issues associated with NTFP use and development, and recommendations for sustainable development of the sector. Information from other jurisdictions is provided where relevant to Ontario.

Non-timber forest products are categorized here as foods, health and personal care products, materials and manufacturing products, environmental products, landscape and garden products, and decorative and aesthetic products. About 50 types of products – such as nuts, essential oils, specialty wood products, dyes, mulches, and biofuels – and hundreds of specific items were identified.

Some of the best known NTFPs in Ontario – and those for which economic statistics are most readily available – are from cultivated sources. Christmas trees, maple products, and ginseng are noteworthy examples. The wholesale value of these 3 products totalled $66.4 million in Ontario in 1998.

A variety of products are available from cultivated, semi-cultivated, or wild sources:

- **Food** items include maple products, nuts, honey, mushrooms, and wild rice.
- **Health and personal care** products include herbal natural health products and drugs from plants.
- **Materials and manufacturing** products encompass a broad range of items, such as specialty wood products, resins, essential oils, and household fragrances.
- **Environmental** products comprise fuels from plant biomass, recycled wood materials, and biological pesticides.
- **Landscape and garden** products encompass over 100 species of trees, shrubs, and wildflowers. These are also used for conservation of rare or endangered species.
- **Decorative and aesthetic** products include florals and craft products, carvings, and natural dyes.

Many opportunities for new products exist, particularly in the value-added products arena. However, much of the development is occurring outside Ontario. This is especially evident in the health products sector. Promising developments in other jurisdictions include the development of health food products from pulp waste, and the use of weed species to produce cosmetic and therapeutic agents.

For some products, such as wild berries, mushrooms, and essential oils, Ontario is a relatively small supplier of both bulk materials and value-added products, compared to some other provinces. There is a strong interest from the private sector in developing these avenues and, particularly, in exploring value-added goods.

Issues relevant to the NTFP sector include sustainability of wild plants, health and safety aspects, and social and economic factors:

- Sustainability of wild plants may be compromised by unrestricted harvest, which can upset ecological balances and effectively curtail future development of that NTFP.
- Health and safety concerns – such as efficacy and potential toxicity of plant medicinals – must be reconciled with timely entry of new products to the marketplace.
- Social and economic aspects – including the frequently low prices paid to harvesters of bulk plant material in the wild, and the need for access to education and information as to emerging product possibilities – must be addressed to develop a truly sustainable NTFP industry.

Recommendations for strengthening the non-timber product industry in Ontario while respecting the need for sound ecological stewardship are:

- Greater emphasis on value-added rather than bulk products
- Utilization of waste materials from forest operations
- Coordination of collection with timber harvest and tending operations
- Emphasis on rural and community-based opportunities
- Cultivation of target species
- Increased coordination within government; and between government, public, and private stakeholders.

Contents

Introduction

Ontario's forest industry generates over $12 billion worth of products and $7 billion in exports (Industry Canada, OMNR 1996[1]). The bulk of this revenue flows from traditional timber-based products such as lumber, wood pulp, and newsprint.

Complementing such goods are a host of non-timber products from forest plants that contribute both to the economy and to a better quality of life for many of us. These include foods, medicines, fuels, and many other functional and esoteric products. Many of these goods and their uses embody longstanding cultural knowledge and heritage values, thereby serving as links among generations. Moreover, they afford impressive commercial prospects – many already developed, and a greater number yet to be explored.

Much of the non-timber products sector in Ontario is not tracked closely, if at all, and is largely unregulated. In this respect, Ontario is similar to many jurisdictions around the world (Langner 1998). While it is well-known that collection of non-timber products for personal use is widespread worldwide, quantification is limited. In Ontario, statistics are kept for products from forest plants that are cultivated and essentially managed as agricultural crops. These include Christmas trees, maple products, and ginseng.

There is more incentive now in Ontario to document non-timber forest products and to encourage growth in this sector. For example, Ontario's Policy Framework for Sustainable Forests requires provision for a sustainable harvest of forest-based food, fur and other renewable goods, while maintaining overall forest sustainability. The Policy also encourages optimum levels and diversity of employment derived from Ontario's forests while being consistent with all other strategic objectives. Another body of guiding principles for forest management and evaluation, that is, the national Criteria and Indicators of Forest Sustainability, identifies the need to monitor and enhance contributions to the economy from the non-timber forest products sector (Canadian Council of Forest Ministers 1995).

This study was undertaken to better understand the kinds of non-timber forest products that are currently obtained from Ontario species and to provide an indication of commercial value or potential where possible. Opportunities for new products are also considered. While it aims to provide a fairly comprehensive overview of the sector, the report is not exhaustive as it does not list every product collected for personal or commercial benefit. The material presented here was obtained from a variety of sources, including published and unpublished reports, and personal interviews with government and industry representatives.

What Are Non-Timber Forest Products?

Non-timber forest products[2] (NTFPs) are botanical products harvested or originating from forest-based species. Excluded from this definition are primary timber products, industrial boards and composites such as plywood, oriented strand board and particle board, or paper and its allied products.

As suggested by Davidson-Hunt (1998), these botanical products may be harvested or extracted from forest lands such as primary

[1] OMNR 1996, Ontario's forest industry, http://www.mnr.gov.on.ca

[2] Some jurisdictions, e.g., the United States, commonly use the term 'Special Forest Products' (SFPs) (Thomas and Schumann 1992). In British Columbia, NTFPs are subdivided into regulated SFPs and unregulated botanical forest products (de Geus 1995).

Non-Timber Forest Products

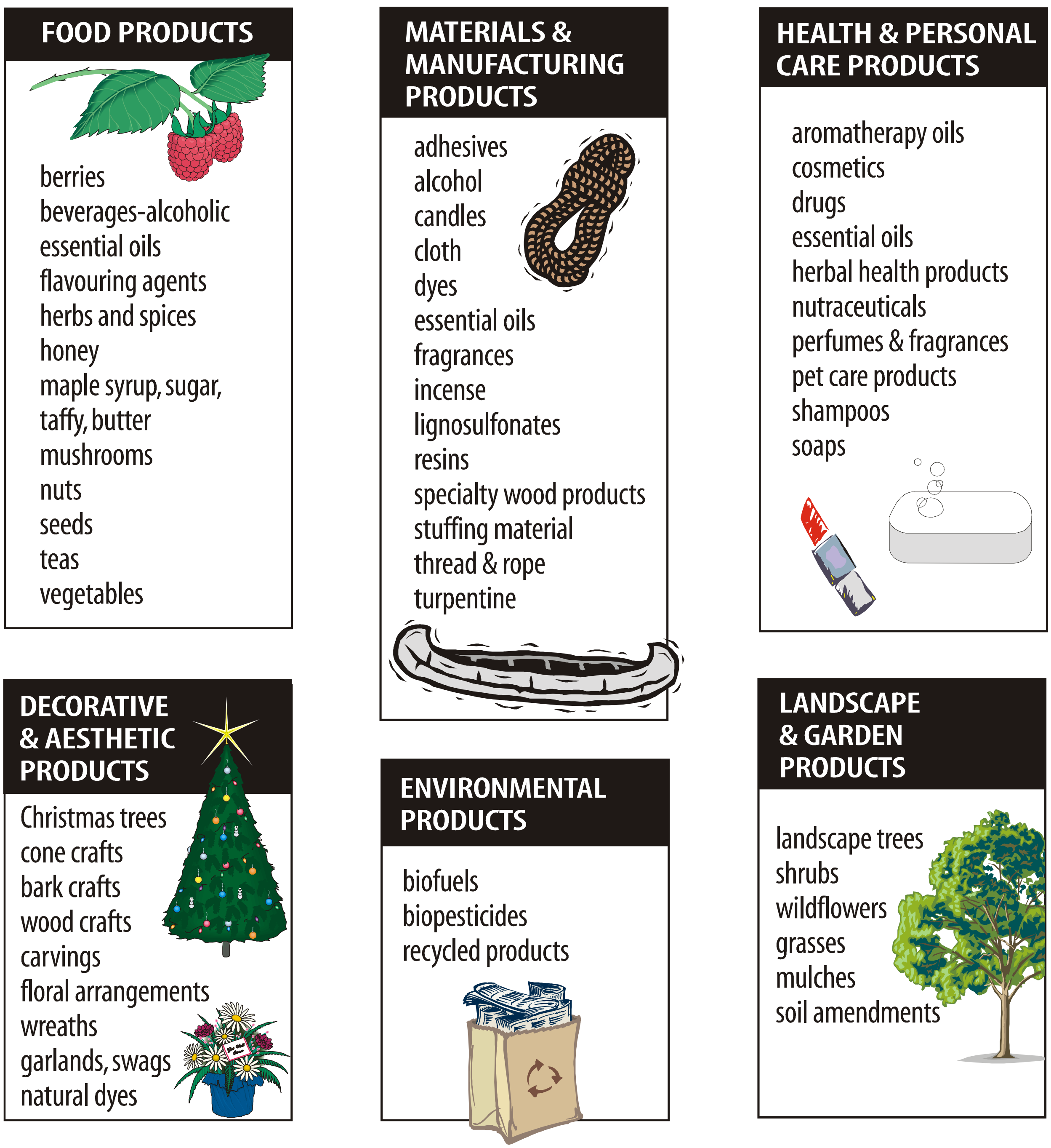


Figure 1. Non-timber forest products in Ontario.

and natural forests, secondary forests, and forest plantations, and may utilize either the whole plant, its parts, or substances derived from these.

Here, products are also included that originate from forest species but are cultivated or propagated in the lab, greenhouse, or 'agricultural' field. This is an important consideration, since the development of commercial opportunities from forest-based plant species is often more ecologically and economically feasible under some form of cultivation, rather than through the harvesting of wild plants.

Altogether, there are about 50 types of NTFPs currently obtained from Ontario forest species. Among these are medicines, foods, essential oils, cosmetics, landscape plants, Christmas trees, floral and craft products, decorative items, and many specialty wood products (Figure 1). The NTFPs may be categorized into 6 major groups: Food Products, Health and Personal Care Products, Materials and Manufacturing Products, Environmental Products, Landscape and Garden Products, and Decorative and Aesthetic Products.

Importance of Non-Timber Forest Products

A study of NTFPs in Canada estimated their value at $241 million in 1997 (Duchesne and Davidson-Hunt 1998). Included were maple syrup products ($120 million), mushrooms ($100 million), and berries ($20 million), with small contributions of less than $1 million each from medicinal plants, ornamentals, and essential oils. This estimate did not include specialty wood products, Christmas trees, cultivated crops such as ginseng, and many other NTFPs discussed here. Hence, the actual value of NTFPs is likely to be much higher.

In other jurisdictions, the economic value of NTFPs is well recognized; for example, in Washington and Oregon alone, Special Forest Products (SFPs) are worth an estimated US$200 million annually (J. Freed, Washington State University Cooperative Extension[3]).

Development of NTFPs may provide several benefits, including local employment, opportunities for better resource stewardship, and fuller use of the forest land base. In a non-commercial sense, their value to individuals and communities is substantial, as they provide a variety of foods, medicinal products, crafts, fuels, and building materials that benefit us directly and enhance our enjoyment of the forest.

Local employment opportunities

Sustainable management of forest products other than traditional timber can provide full or part-time employment opportunities for people living in or near the forest, and spin-off employment elsewhere. Local employment opportunities are particularly important as they allow people to remain in their present setting and maintain a higher quality of life (Arborvitae Environmental Services 1997). This is advantageous in areas such as northern Ontario and many rural regions where economic diversity and stability tend to be limited. Also, development of a wider array of secondary products from the forest will help this sector to advance beyond an historical reliance mainly on primary resource industries.

Ecological stewardship

Using the full spectrum of products from forests, rather than relying primarily on a few goods, can mean less tendency

[3] Reported in the Daily Southtown, February 25, 1998.

for overexploitation of any one species. However, it is essential that extraction of NTFPs not threaten the viability of plant species, particularly those already deemed to be rare, threatened, or endangered. New product exploration can stimulate ecological studies of Ontario species to understand environmental and genetic influences on species establishment, product quantity, and quality (McChesney 1993). Non-timber forest products may also offer alternatives to hazardous chemicals through new biological pesticides. Some products such as recycled materials may help to mitigate declines in regional long-term carbon pools, by serving as carbon reservoirs (Canadian Council of Forest Ministers 1995, 1997).

Utilization of the forest land base

Forest lands can provide timber, pulpwood, and many other products. For example, biochemicals from both tree and non-tree species, floral and greenery products, seed and cuttings for nursery stock, mushrooms, and even weeds can offer new industrial prospects when managed in a sustainable manner. This can enhance the profitability of a site by expanding the diversity of products associated with it.

Non-Timber Forest Products in Ontario

Food Products

Edible products that have been harvested on a commercial or personal scale in Ontario are listed in Table 1. Many species are marketed for culinary purposes such as

flavourings and preservatives, and are sold as seeds, plants, or dried plant parts. For example, the leaves and roots of dandelion, long considered a nuisance weed, are used in salads and beverages, respectively. Dandelion seeds can be purchased for propagation, retailing for about US$1.22 per packet of seed or US$11.20 for 10 g bulk seed, or the dried roots may be purchased for US$60 per kg.[4]

Maple products

Maple products such as syrup, sugar, taffy, and butter, are among the best known foods from Ontario's forest tree species. Ontario is the fourth largest maple syrup producer in the world following Quebec, Vermont and New York State.[5] In Canada, Ontario produces about 6% of maple products, compared to Quebec at about 90%.

There are 7 maple species in Ontario, several of which produce sap that can be used for syrup production (Table 1); but, because of its abundance, sugar maple is the only commercially important species (Chapeskie 1997). The other maples may be used occasionally.

In 1998, Ontario produced 812 kL of maple syrup and sugar, with a wholesale

[4] Richters, Goodwood, ON, 1999 Catalogue prices.
[5] Ontario Maple Syrup Producers Association.

Table 1. Edible commercial and non-commercial products. [6]

Species	Common name	Edible aspect
Acer negundo	Manitoba maple	sap for syrup
Acer nigrum	black maple	sap for syrup
Acer rubrum	red maple	sap for syrup
Acer saccharinum	silver maple	sap for syrup
Acer saccharum	sugar maple	sap for syrup, sugar, taffy, butter; inner bark dried and ground for flour
Acorus calamus	sweetflag	roots used as flavouring agent in candy
Adiantum pedatum	maidenhair fern	fiddleheads
Allium tricoccum	wild leek	bulbs
Amelanchier spp.	serviceberry	fruits
Angelica atropurpurea	Angelica	roots used in condiments
Aralia racemosa	spikenard	roots used in root beer
Arctostaphylos uva-ursi	bearberry	berries
Arisaema triphyllum	Jack-in-the-pulpit	dried roots ground into flour
Asarum canadense	wild ginger	roots used similarly to commercial ginger
Asimina triloba	pawpaw	fruits
Betula alleghaniensis	yellow birch	sap in birch beer and sugar syrup; inner bark pulverized for flour; twigs in wintergreen oil
Betula lenta	cherry birch	sap in birch beer; oil (wintergreen) to flavour chewing gum, dentifrice products, and baked goods
Betula papyrifera	white birch	sap in syrup
Cardamine pensylvanica	Pennsylvania bittercress	young shoots
Carya illinoensis[7]	northern pecan	nuts
Carya laciniosa	big shellbark hickory	nuts
Carya ovata	shagbark hickory	nuts
Castanea dentata	American chestnut	nuts
Castanea pumila	Allegheny chinkapin	nuts
Cercis canadensis	eastern redbud	flowers
Chenopodium album	lamb’s quarters	seeds ground into flour
Chimaphila umbellata	pipsissewa	herb in root beer; berries; dried leaf
Claytonia virginica	spring beauty	tubers
Clinopodium vulgare	wild basil	leaves
Comptonia peregrina	sweetfern	fruits (small elliptoid nuts)
Corylus americana	American hazel	nuts
Corylus cornuta	beaked hazel	nuts
Crataegus monogyna	hawthorn	berries
Crataegus succulenta	long-spined hawthorn	berries in preserves and drinks
Epigaea repens	arbutus	leaves; flowers
Fagus grandifolia	American beech	nuts; young leaves
Fragaria vesca	wild strawberry	berries
Fragaria virginiana	common strawberry	berries
Gaultheria procumbens	wintergreen	berries; leaves; oil in flavouring, chewing gum, candy, and toothpaste
Ginkgo biloba	maiden-hair tree	nuts (female trees); leaves
Heracleum lanatum	cow parsnip	first-year root; young sprouts (cooked)
Juglans ailantifolia var. cordiformis[8]	heartnut	nuts
Juglans cinerea	butternut	nuts; sap in syrup
Juglans nigra	black walnut	nuts; sap in syrup
Juglans regia	English walnut	nuts

[6] Major references: Chambers et al. 1996, Naegele 1996.
[7] Introduced species.
[8] Introduced from its native Japan.

Table 1. *continued*

Species	Common name	Edible aspect
Juniperus communis	common juniper	fruits crushed in alcohol to flavour gin
Lonicera villosa	mountain fly honeysuckle	berries
Mentha spp.	mint	leaves
Mitchella repens	partridge-berry	berries
Monarda fistulosa	wild bergamot	leaves
Monotropa uniflora	Indian pipe	whole plant
Morus rubra	red mulberry	fruits
Osmunda cinnamonea	cinnamon fern	fiddleheads
Picea mariana	black spruce	leaves in spruce beer
Pinus cembra	Swiss stone pine	nuts
Pinus koraiensis[9]	Korean pine	nuts
Pinus strobus	eastern white pine	inner bark; seeds
Plantago major	common plantain	young leaves
Podophyllum peltatum	mayapple	ripe fruits
Polygonatum biflorum	Solomon's seal	young shoots (cooked); roots
Prunus americana	American plum	fruits
Prunus pensylvanica	pin cherry	fruits
Prunus serotina	black cherry	fruits; bark in wild cherry cough syrup
Pteridium aquilinum	bracken fern	rhizome in flour; fiddleheads
Rhus copallina	shining sumac	fruits
Rhus glabra	smooth sumac	young sprouts; fruit
Rhus typhina	staghorn sumac	fruits
Ribes americanum	wild black current	berries
Ribes hirtellum	smooth gooseberry	berries
Rosa acicularis	prickly wild rose	rosehips; petals; leaves
Rubus spp.	raspberry, blackberry, etc.	berries
Salix nigra (or alba)	willow	inner bark
Sambucus canadensis	common elder	berries
Sambucus pubens	red-berried elder	berries in preserves and wine
Sassafras albidum	sassafras	root bark oil in root beer flavouring
Sorbus americana	American mountain ash	ripe berries in juice or ground for flour
Sorbus decora	showy mountain ash	berries
Stellaria media	chickweed	plant
Taraxacum officinale	dandelion	roots roasted and ground as coffee substitute; spring leaves; seeds; entire plant used in brewing beer
Trillium erectum	purple trillium	leaves (boiled)
Urtica dioica	stinging nettle	young plants (cooked)
Vaccinium angustifolium	lowbush blueberry	berries
Vaccinium macrocarpon	large cranberry	berries
Vaccinium ovalifolium	oval-leaved bilbery	berries
Vaccinium oxycoccos	small cranberry	berries
Viburnum cassinoides	Northern wild raisin	berries
Viburnum edule	lowbush cranberry	berries
Viburnum lentago	nannyberry	berries
Viburnum trilobum	highbush cranberry	berries
Viola papilionacea	common blue violet	leaves and flowers
Zizania aquatica	southern wild rice	grain
Zizania palustris	northern wild rice	grain

[9] Introduced species.

value of $8.3 million (Statistics Canada, Agriculture and Agri-Food Canada). This was down from $10.3 million in 1997 mostly because of an early and warm spring and damage caused by the 1998 ice storm in the eastern regions of Canada.

There are an estimated 2000 maple syrup producers in Ontario, mostly located in southern Ontario. Operations range in size from about 200 taps to about 10,000 taps. Many operations are in the range of from 500 to 3000 taps. Typically, the larger producers have built up their production capacity over many years. Profitability of a maple syrup operation depends on many factors including the availability of equipment and the cost of labour. A preliminary economic study conducted for a modern operation in eastern Ontario suggests that at least 1000 taps are required to show a profit.

It takes about 40 L of sugar maple sap to make 1 L of syrup. An averge tree yields 68 to 90 L of sap a year. Sugar maple requires from 20 to 80 years to reach a tappable size of 25 cm diameter measured at 1.3 m above the ground (Chapeskie 1997). Taking sap from a tree does rob it of some nourishment, but because less than one-tenth of a tree's sugar food is removed during tapping, most trees are not harmed. Guidelines for safe tapping are provided by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). In a healthy sugar bush, the number of taps per tree should be based on the diameter of the tree, with a maximum of 4 taps for large trees (at least 62 cm in diameter). Maples that have been tapped for 100 years or more are still productive. These trees can live well over 200 years under favourable conditions.

No licence is required to make maple syrup in Ontario but all syrup offered for sale must be graded in accordance with the Farm Products Grades and Sales Act, and labelled with the name of the product, the amount, the grade and colour class of syrup, and the company that packed the product. Regulations are available from the Ontario Maple Syrup Producers Association[10] or OMAFRA. Maple syrup grades are determined by flavour and colour. There are 2 grades and 4 colour classes sold for consumer use: Canada #1 'extra light', 'light', and 'medium', with increasingly distinct maple flavour; and Canada #2 'amber' with a strong maple flavour. All of these are suitable for table use, with the darker grades recommended for baking or flavouring. Canada #2 'amber' may be labelled Ontario Amber for farm gate sales only.

About 80% of the maple syrup produced in Ontario is sold at sugarbushes or in stores. The remainder is sold wholesale to packers who further process the product. About two-thirds of the maple syrup sold in Ontario is imported from Quebec and other jurisdictions. The price of maple syrup is set by individual maple producers, and current retail prices range between $36 and $52 for a 4-L tin container and from $12-$16 for a 1-L container (Ken McGregor, Ontario Maple Syrup Producers Association, pers. comm.).

Of the total Canadian production of maple products, 90% is exported to more than 25 countries. According to Agriculture and Agri-Food Canada, in 1997/98, Canadian export value reached a record $108.6 million and quantity exported reached a record 23,447 tonnes.[11] Major markets are the United

[10] http://www.ontariomaple.com/rules.html
[11] Metric tonne used throughout report, equal to 1000 kg.
[12] http://www.agr.ca/cb/factsheets/maplee.html

States with 89% of total exports, Europe with 5% and Asia with 5%. Quebec is the major exporter responsible for 89% of total exports. Maple products are mostly exported in retail sizes (60%) and bulk (40%).

Exports of Canadian maple products have been expanding as new trade opportunities emerge in Europe (Germany and France), Asia, and elsewhere. The Canadian maple industry has set a goal of doubling its exports by the year 2002 to $240 million and 48 million kg. Exports have gone from $35 million to over $100 million in less than 10 years. In Canada, this industry is surpassed only by frozen french fries in single commodity exports (Agriculture and Agri-Food Canada).

Berries

A variety of edible berries are native to Ontario, including blueberries, cranberries, raspberries, blackberries, Saskatoons, bearberries, strawberries, partridge-berries, black currants, gooseberries, bilberies, and nannyberries (Table 1).

Canada is the world's largest producer of wild blueberries (primarily lowbush), with 50,292 tonnes produced in 1997, worth almost $66 million at the farm gate. Canadian per capita consumption of blueberries in 1997 was 0.49 kg per year of fresh and 0.22 kg per year of frozen blueberries. In 1997, exports of frozen wild blueberries reached $55.8 million, plus an additional $13.8 million for cultivated blueberries (Agriculture and Agri-Food Canada 1999[12]). Canada is the primary supplier of wild and cultivated blueberries for the United States, and between January and November of 1998, the U.S. imported 7,454 tonnes of wild blueberries from Canada, representing 99.5% of U.S. wild blueberry imports during that period.[13] U.S. imports of Canadian cultivated blueberries was 3,349 tonnes in the same period, equal to 97% of imports.

The majority of wild blueberries commercially harvested in Canada are from Quebec and Nova Scotia, with minimal contributions from Ontario, despite its abundance throughout the province (Bell 1991). In Ontario, picking on a subsistence or casual basis and selling fresh product at roadside for cash is common, especially in the Sault Ste. Marie – Sudbury area, but there is little organized activity. Where wild blueberry operations exist, they are on a small-scale, selling primarily on the fresh market with some limited offering of specialty value-added products. Some product grown in Ontario is sold to Quebec for processing, but again these are small quantities. Export activity is limited.

Wild blueberry production in Canada is frequently done through intensive management of production sites. Although the blueberries are not planted, they are encouraged to proliferate in wild areas where the species occurs naturally. Such sites may be abandoned farm land, where the blueberry plant has become established, or woodlands. The land is carefully tended with tree and stump clearing of woodland areas, fertilization, and weed and pest control (typically with chemicals). The time to achieve a reasonable blueberry crop depends on the degree of land preparation involved and the initial density of the plant, and can range from 4 to 8 years (according to industry sources). Since the harvested crop comes from fields composed of managed, native plants, these blueberries are marketed as 'wild' (Nova Scotia Department of Agriculture and Marketing 1997[14]), in contrast to the usual cultivated blueberry which is

[13] U.S.A. Food Institute Report, February 15, 1999, http://agri.gov.ns.ca/ms/mktinfo/frozblue.htm
[14] http://agri.gov.ns.ca/pt/hort/wildblue/grow.htm

planted and maintained similar to an orchard. Established wild lowbush blueberry fields can produce crop yields of 3,360 to 8,967 kg per ha (3,000 to 8,000 lbs per acre) (Nova Scotia Department of Agriculture and Marketing 1997[14]).

In Ontario, some growers are investigating organically grown blueberries or specialty products from wild berries. Since large-scale blueberry production elsewhere typically involves the use of chemical treatments, a niche opportunity may exist for organically grown wild blueberries and possibly other berry crops. However, growing organic blueberries is very labour intensive. Experiences from a small number of growers in the Ontario Lowbush Blueberry Association proved prohibitively expensive and the growers reverted to chemicals (D. Hill, Ontario Lowbush Blueberry Association, pers. comm.). However, if organic berries could be grown at a reasonable cost, a market could exist for fresh product in urban centres such as Toronto, and that market could be expanded depending on shipping costs (D. Hill, pers. comm.). Further, the demand for lowbush blueberries is expected to remain high due to recent identification of natural health benefits of anthocyanin content.

Opportunities for developing the northern wild blueberry industry are also being explored by a recently formed group of blueberry pickers, the Northern Ontario Wild Blueberry Cooperative. The Coop currently has 60 to 70 members working together to develop avenues for berry cultivation, commercial-scale production, value-added products, and market development (L. Portelance, Northern Ontario Wild Blueberry Cooperative Inc., pers. comm.). The potential value of the industry is captured in their slogan ‘Blue Pearls of the North’.

Developing value-added products can offset declines in demand for bulk crops that may arise because of oversupply. In eastern U.S., for example, cranberry production increased drastically in recent years to supply strong demand both domestically and internationally. That has resulted in an oversupply and a consequent drop in cranberry prices from a high of US$70 to $80 per barrel 3 to 5 years ago, to about US$38 within the last year (K. Higgins, Wyman and Son, pers. comm.). Value-added products such as specialty foods can cater to niche markets that may be more resilient to extreme fluctuations in demand for the bulk form. Specialty food products serve a substantial market. In the U.S., retail sales of specialty/gourmet foods was US$39 billion in 1997, and overall sales are expected to top US$54 billion by 2002 (Kalorama Information 1998b). Specialty items can be marketed in various ways, e.g., by mail order, through gourmet food stores, gift shops, and the delicatessen departments of chain stores.

In Ontario, specialty food products are appearing in some areas. For example, in northern Ontario, indigenous knowledge has been used to develop a prototype snackbar of popped wild rice (manomin) and dried blueberries produced by the Kagiwiosa Manomin cooperative in northern Ontario. These products may soon be marketed in Europe[15] (Taiga Institute for Land, Culture and Economy 1999). Another product is Aneebmeenan (highbush cranberry) Sauce. The Aneebmeenan Sauce may have a niche market in Switzerland (as well as

[15] Reported in the Kenora Enterprise, April 4, 1999.
[16] Pine mushroom formerly also known as *Armillaria ponderosa.*

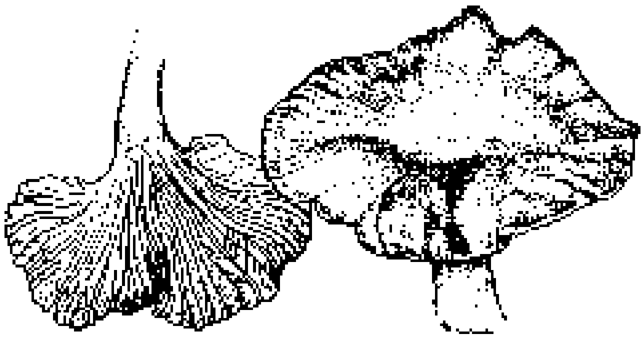
Table 2. Edible forest mushrooms and other fungi. [16]

Species	Common name[17]	Forest type / habitat
Gilled mushrooms		
Agaricus augustus	the prince	woodland clearings
Agaricus bisporus	common cultivated mushroom	under conifers
Agaricus silvaticus	forest mushroom	under pine
Agaricus silvicola	wood mushroom	coniferous woods
*Armillaria caligata**	misty bracelet	under conifers or hardwoods
Armillaria mellea[18]	honey mushroom	at bases of trees or near stumps
Catathelasma imperialis	commander	dense coniferous forests
Clitopilus prunulus	sweetbread mushroom	grass in open woodlands
Hygrophorus niveus		on humus and soil in hardwood and coniferous woods
*Hygrophorus pratensis**	meadow wax cap	open woods
Hygrophorus russula	false russula	under oak and sometimes conifers
Hygrophorus virgineus		in soil or moss in woods
Laccaria ochropurpureus	purple-ochre tallowgill	open grassy woods under oak and other hardwoods
Lactarius hygrophoroides	orange milkcap	hardwood forests
Lactarius volemus	tawny milkcap	mixed hardwood forests
Lentinus edodes	shiitake	fallen hardwood logs
Lentinus lepideus	the train wrecker	decaying wood of conifers, occasionally hardwood
*Lepiota procera**	parasol mushroom	under hardwoods or conifers
Pleurocybella porrigens	angel wings	decaying conifer logs
*Pleurotus ostreatus**	oyster mushroom	hardwood logs, branches, and stumps
*Rozites caperata**	chicken-of-the-woods	coniferous stands
Tricholoma magnivelare[19]	pine mushroom	jack pine stands (often associated with lichen)
Chanterelles		
*Cantharellus cibarius**	golden chanterelle	under hardwoods and conifers
Cantharellus tubaeformis	funnel chanterelle	wet, mossy bogs
*Craterellus cornucopioides**	horn of plenty	under hardwoods
*Craterellus fallax**	black trumpet	under mixed hardwoods
Coral fungi		
Clavicorona pyxidata	crown coral	rotting logs of aspen, poplar, and willow
Boletes		
Boletus badius	bay bolete	mixedwoods, often on decaying tree stumps
Boletus bicolor	two-coloured bolete	under hardwoods, especially oaks
*Boletus edulis**	king bolete	mixedwoods, especially conifers
Boletus strobilaceus		mixed coniferous and hardwood forests
Boletus subglabripes		under mixed hardwoods, sometimes under spruce

Table 2. *continued*

Species	***Common name***[17]	***Forest type / habitat***
Boletus variipes		mixed woodlands, especially beech and oak
Fuscoboletinus aeruginascens	grayish larch bolete	under larch (tamarack)
Gyroporus castaneus[*]	chestnut bolete forests	oak woods and mixed conifer and hardwood
Gyroporus cyanescens	cornflower bolete	exposed or sandy soil among hardwoods
Leccinum aurantiacum	red-cap bolete	under aspen and pines
Leccinum insigne	aspen scaber stalk	under aspen or birch
Leccinum rugosiceps		grassy oak woods
Suillus americanus	Amercian slipperycap	under eastern white pine
Suillus brevipes	stubby-stalk	under conifers
Suillus cavipes[*]	mock oyster	under larch (tamarack)
Suillus granulatus	granulated bolete	under conifers, especially white pine
Suillus grevillei	larch bolete	under larch (tamarack)
Suillus luteus	slippery Jack	under conifers, especially Scots pine
Suillus pictus[*]	painted slipperycap	under eastern white pine
Tylopilus badiceps		oak and mixedwoods
Tylopilus chromapes	chrome-footed bolete	under hardwoods or conifers
Polypores		
Fistulina hepatica	beefsteak fungus	hardwood stumps or base of living oaks or chestnuts
Teeth fungi		
Hericium coralloides	coral hedgehog	logs and livings trees, especially beech and maple
Hydnum repandum[*]	hedgehog mushroom	mixedwoods
Puffballs		
Sparassis herbstii	cauliflower mushroom	base of trees, often pine or oak
True morels[20]		
Morchella conica	black morel	coniferous forests, especially pine; also poplar
Morchella semilibera[*]	half-free morel	mixed hardwoods
Morchella esculenta[*]	yellow morel	various habitats
Other		
Hypomyces lactifluorum[21]	lobster mushroom	in woods on white *Lactarius* and *Russula* mushrooms
[*]Considered choice.		

[16] Miller 1979, Phillips 1991. Note: Mushrooms and other fungi must be cooked thoroughly before eating.
[17] There may be additional common names not listed here.
[18] Must be cooked to be edible; some cases of severe stomach upset have been reported after eating this mushroom (Phillips 1991).
[19] Also called *Armillaria ponderosa*.
[20] This group is probably the best known and most sought after of all the edible fungi. The various species all fruit in spring.
[21] Edible if found on an edible mushroom; toxic if it has parasitized a toxic mushroom.



Canada). Other products are under development.

Value-added cranberry products are sold by the Iroquois Cranberry Growers (located in Bala), which is Ontario's largest cranberry producer at 225 to 550 tonnes of berries annually (Linda Commandant, Iroquois Cranberry Growers, pers. comm.). They sell both cultivated and finished cranberry products under their own label, including pure and blended juices, sauces, and chutneys (a spicy sauce or relish made of fruits, herbs, and peppers). A relatively new product is sweetened dried cranberries – which are dehydrated to a raisin-like appearance and possess a tart flavour. None of the present-day products are from wild berries, but rather from a mix of cultivated vines; however, the marsh areas used for crop production were originally populated by wild cranberry bushes.

Elsewhere, such as in Manitoba, value-added berry products for the commodity food and gift markets have been doing well (Mitchell and Associates 1997). These include jams, jellies, sauces, chutney, and juice. The profit margins are high, for example, some types of preserves can be produced for $0.29 per 57-ml jar and sold for $2.99-$4.10. If a few jars are grouped in a twig basket arrangement, the price more than quadruples for this gift item. Berries can also be used in a wide range of teas, as well as non-food items such as cosmetics and toiletries (see later sections). A liqueur can also be made from blueberries.

Mushrooms

Many wild mushrooms in Ontario are reported to be edible, and the reputedly tastier varieties are listed in Table 2. Popular mushrooms that have commercial value are the chanterelles, morels, and boletes (National Aboriginal Forestry Association 1997, and industry sources). Other wild types collected mainly for personal use in Ontario include lobster, honey, hedgehog, chicken-of-the-woods, oyster, and black trumpet mushrooms. Wild mushrooms, such as chanterelle, lobster, and honey, are sometimes sold to gourmet restaurants and consumer cooperatives by small-scale collectors.

The pine mushroom (*Tricholoma magnivelare*[16]) is of interest to many collectors. This mushroom is an immensely popular product in western Canada and enjoys a high demand from Japan. It is widely known for its aromatic odor, and superior texture and taste. The pine mushroom is related to the matsutake of Japan *(T. matsutake),* which has been a favourite of the Japanese for centuries (de Geus 1995). The North American pine mushroom is also known as the matsutake or white matsutake. However, the variety of *T. magnivelare* that occurs in Ontario is reputed to be inferior in aroma and flavour to that found west of Manitoba, according to Scandia Mat of Canada Ltd., one of Canada's largest collection companies (G. Amnegard, Scandia Mat of Canada Ltd., pers. comm.).

The Scandia Mat company collects 115 to 135 tonnes of wild mushrooms annually, but surprisingly, only about 135 kg of that comes from Ontario. The reasons cited for the small quantities are several-fold (G. Amnegard, pers. comm.). First, access to Ontario forest sites may be restricted following forest fires, which is when morel production would be greatest (see discussion below). Second, in areas where planting and tending of logged stands has not occurred, the regenerating forest is often too wild and thick for mushrooms to thrive. Third, Ontario does not have a strong tradition of picking wild forest plants for food and other products, unlike some other provinces and countries.

About 95% of the mushroom industry in Ontario is through farm production of the common (white) cultivated mushroom *Agaricus bisporus*, with less than 5% of other varieties such as portobello (a brown strain of *A. bisporus)*, shiitake, and oyster mushrooms (K. Potter, Canadian Mushroom Growers Association, pers. comm.). Total production was 36,445 tonnes in 1997, valued at $111 million based on farm cash receipts (Statistics Canada). In 1997, Canadian per capita consumption of fresh mushrooms was 1.74 kg per year and for canned mushrooms was 0.76 kg per year (Statistics Canada, OMAFRA).

For large-scale production, mushrooms may be semi-cultivated using logs inoculated with mushroom spawns. It is recommended that logs of 1.2 to 2.4 cm diameter be cut from living decay-free trees in the dormant season when the wood contains high concentrations of stored carbohydrate. Mushrooms should be ready for picking between 6 and 8 months after inoculation. Commercial production using about 500 logs can cost ~$500 for the spawn and for basic equipment and packaging (National Aboriginal Forestry Association 1997).

Wild mushrooms are in strong demand in some countries, especially Japan, Europe, and the United States. Some sources estimate the world demand for wild mushrooms to be in the order of $900 million (Mitchell and Associates 1997). Demand and prices can vary according to factors such as seasonal availability in other countries, and local productivity. Productivity can vary considerably with moisture conditions and temperature.

In a study of the Lake Abitibi Model Forest (LAMF) in Ontario, Arborvitae Environmental Services (1997) evaluated the economic potential of NTFPs in the area. It identified a wide range of natural forest products that could be marketed, including wild mushrooms, essential aromatic oils, and deciduous twigs, branches, and treetops; however, it was concluded that the greatest potential resided with wild mushrooms because of high demand from European and Japanese markets and little competition. In the LAMF, some of the edible fungal species identified include boletes, puffballs, morels, and pine mushrooms.

In Ontario, a study of mushroom production in Renfrew County found production averaged 1.6 kg per ha for the entire county with a maximum production of 2.8 kg per ha per year in the Round Lake area (Duchesne 1995). Using the average rate of production, and an estimated $50 per kg for the wholesale value of dry mushrooms, the total wholesale value of wild mushrooms was projected to be $36.7 million per year over the

[22] Reported in the Kenora Enterprise, April 4, 1999.
[23] Reported in the Toronto Star, June 20, 1998.

entire productive area of the county. The target markets for these mushrooms (32 species) would include Europe with an annual demand $650 million, and Japan whose annual demand exceeded $75 million at the time of the study. The study also showed that the annual potential for mushroom harvest may exceed that of pulpwood harvest.

In Ontario, some small-scale businesses are marketing specialty dried mushrooms. For example, in northwestern Ontario, a 14-g package of dried mushrooms (expand to 4 times that volume when reconstituted) sells for $3 to $4.[22] According to one market study, however, prices paid to harvesters of dried mushrooms can range from $88-110 per kg for chanterelles and $132 to $176 per kg for some morels and boletes, while fresh mushrooms bring $4 to $11 per kg (Mitchell and Associates 1997). Wild mushrooms are more expensive than common cultivated white varieties, but entrepreneurs are finding niche markets for the products.

Commercial mushroom pickers in Ontario are typically seasonal workers who earn an average of about $2 to $4 per kg of fresh mushrooms. This rate varies considerably depending on mushroom type, and may be as high as $13 to $15 per kg for morels. For good quality chanterelles, pickers are paid about $3 to $5 per kg (one company contacted). Statistics on total earnings from wild mushroom harvesting are scarce for Ontario, but in other areas such as northern Saskatchewan, harvesters earned over $300,000 in 1996 (Farmfacts, Saskatchewan Agriculture and Food). In the Pacific Northwest, up to 3,200 tonnes of mushrooms are annually blanched, chilled, packed in brine and flown to Europe for canning. Fewer than 450 tonnes of matsutake mushrooms were harvested from national forests in all of 1995 but 545 tonnes were harvested during an 8-week period alone in 1997, providing US$366,000 in revenue from permit sales.[23]

In a study of chanterelle production in Washington's Olympic Peninsula (OP), Duncan (1999) reported that prices paid to harvesters were quite volatile, depending on international competition and time of season. The prices paid to harvesters at buying stations in the field differed from US$3 to $11 per kg, depending on intended market, time of season, and international competition. Therefore, while chanterelle harvesting supplements annual income, it is not lucrative for the harvester, and many rely on a diversity of NTFPs to make a living.

Safety and ecological aspects of mushroom harvesting

Collectors should be aware that the practice of mushroom collecting by the general public is a potentially dangerous since many edible fungi closely resemble poisonous species or species of unknown edibility. The likelihood of mistaken identification is further intensified given the many hundreds of fungal species present in Ontario forests.

Uncontrolled harvesting of wild mushrooms can also be damaging to habitat for both fungi and other forest flora and fauna, necessitating the introduction of regulations or legislation to protect species that are being compromised. Thus, from both safety and ecological standpoints, development of this industry may be most prudently accomplished by designing protocols for propagation and culture of desirable species, where feasible, in a nursery environment. Wild collections could then provide the initial source materials

[24] Available from http://www. morelheaven.com
[25] Reported in the Thunder Bay Chronicle – Journal, May 8, 1999.

for establishment of nursery cultures.

Some of the damage to wild mushroom populations is attributable to removing the spores away that would otherwise repopulate wild stocks. This is a particular problem if mushrooms are stored in paper or plastic bags or buckets, which prevent spores from falling to the ground as the mushrooms are carried out. The problem may be avoided by using open mesh bags, made of cheesecloth or other porous fabric that allows spores to pass through. Commercial mushroom bags are now available – one type, called 'The Spore Boy',[24] is a mesh bag with belt loops, handles, and a large pouch.[25] It retails for US$8 with $1 going to Mushrooms for Medicine, a non-profit organization that is developing natural treatments for arthritis and cancer.

The uncertainties associated with wild mushroom harvesting were highlighted in the study of Washington's OP (Duncan 1999). The study found that productivity of chanterelles differs greatly around the OP and across ownerships, ranging from 14 to 478 chanterelles per acre per year (or 35 to 1181 per ha) during 2 years on 11 sites around the OP, including 2 forest types, 3 stand ages, and 5 landowners.

An Ontario study showed that the presence of large populations of some mushrooms may be linked to the occurrence of fire. A study of the black morel in a jack pine forest (Petawawa National Forestry Institute, Chalk River) found that mushroom density was as high as 2860 kg per ha in the year following a prescribed fall burn (Duchesne and Weber 1993). Also, the mushrooms were found within a radius of 2 to 3 m around dead jack pine trees but not near dead red pine or eastern white pine, or in nearby unburned areas. The authors cite that mushroom proliferation following fire has been observed elsewhere in North America, apparently a result of various benefits of heat, including stimulation of spore germination, reduction in soil concentrations of substances inhibitory to fungal growth, destruction of competing microorganisms, and altered soil pH and carbonate concentrations.

Knowing these productivity differences across forest types, stand ages, and management regimes can help land managers design appropriate programs and regulations for mushroom collection.

Nuts

In Ontario, nuts are harvested from at least 16 woody species – mostly deciduous – including walnut, hazelnut, hickory, chestnut, and butternut (Table 1). Popular commercial varieties are black walnut, sweet chestnut, hazelnut, and to a lesser extent English walnut (E. Grimo, Society of Ontario Nut Growers, Grimo Nut Nursery, pers. comm.). Ontario produces most of the sweet chestnuts grown in Canada; British Columbia produces most of the hazelnuts and a small amount of the chestnuts and Persian walnuts. Many species of the genus *Pinus* produce large seeds that are edible and highly nutritious, and about 29 species are used worldwide as local food sources, usually among indigenous tribes. Edible nut producing pines are found in North America, Asia, Europe, and the Near East (Ciesla 1998); in Ontario, the Swiss stone pine is sold commercially for its edible nuts.

Large-scale nut production in Ontario occurs in orchard settings. Production volumes for nut crops are difficult to determine because many growers do not report on their production. Black walnut has been propagated for over a century

[26] Ontario Ministry of Agriculture, Food and Rural Affairs, Statistics Canada – Catalogue No. 23-211 and Statistical Bulletin.

Table 3. Species used in honey production.[27]

Species	Common name
Abies balsamea	balsam fir
Acer spp.	maples
Aesculus hippocastanum	horse chestnut
Alnus rugosa	speckled alder
Amaranthus retroflexus	redroot pigweed
Amelanchier spp.	serviceberry
Arctostaphylos uva-ursi	bearberry
Asclepias syriaca	common milkweed
Aster spp.	asters
Barbarea vulgaris	yellow rocket
Ceanothus americanus	red root
Cephalanthus occidentalis	buttonbush
Epigaea repens	arbutus
Epilobium angustifolium	fireweed
Juglans cinerea	butternut
Juglans nigra	black walnut
Medicago sativa	alfalfa
Melilotus alba	white sweet-clover
Monarda fistulosa	wild bergamot
Nyssa sylvatica	black gum
Prunus serotina	black cherry
Prunus pensylvanica	pin cherry
Ribes americanum	wild black currant
Robinia pseudoacacia	black locust
Rosa spp.	wild rose
Rubus spp.	raspberry, blackberry, etc.
Salix nigra	black willow
Sanguinaria canadensis	bloodroot
Sassafras albidum	sassafras
Solidago spp.	goldenrod
Taraxacum officinale	dandelion
Tilia americana	American basswood
Trifolium repens	white clover
Vaccinium angustifolium	lowbush blueberry
Vaccinium macrocarpon	large cranberry
Viburnum opulus	cramp bark
Viburnum trilobum	highbush cranberry

[27] Naegele 1996, Thomas and Schumann 1992.

and originated from native wild walnuts. Many grafted black walnut cultivars are available today and represent the earliest walnut cultivars to be developed for North America. The annual walnut yield of intensively managed orchards can range from 2.2 to 2.9 tonnes of walnuts per ha, depending on the producer and season. The estimated annual management costs of an established walnut orchard are approximately $3553 per ha ($1438 per acre) including fixed and variable costs (Leuty and Gardner 1999).

A relative of the black walnut, called the heartnut or Japanese walnut, native to Japan, is now being grown in southern regions (E. Grimo, pers. comm.). Ontario produces most of the heartnuts grown in Canada. The Grimo Nut Nursery has about 200 ha planted to heartnuts but only about 20 to 40 ha of improved cultivars. In general, commercial production relies on cultivars rather than seedlings, because the latter do not produce commercial quality product. To be commercial, the nut must crack evenly on the suture and the kernel must fall out of the shell without being pinched or held in by the internal shell structure (E. Grimo, pers. comm.). Nuts from good cultivars can be processed by a commercial nut cracker and sold as nut meats, much as other nuts are sold. Ontario is producing about 18 tonnes of heartnuts with less than 3 tonnes from improved cultivars. The latter figure is growing rapidly as trees are growing larger and are capable of higher production with time (E. Grimo, pers. comm.).

Chestnut production is also expanding with about 40 ha planted and 25 to 30 tonnes of production so far (E. Grimo, pers. comm.). Chestnut blight (a fungal disease) is a problem and resistant cultivars continue to be needed. The native stands of American chestnuts have been wiped out by blight; however the Chinese chestnut and its hybrids are largely blight resistant and are being planted to fill the void.

Hazelnut growers have about 40 ha planted and are likely producing about 9 to 18 tonnes of nuts. Eastern filbert blight is a serious problem for hazels and disease resistant strains will need to be planted to maintain this crop.

According to the industry, there is a strong demand for Ontario-grown nuts (E. Grimo, pers. comm.). Consumers reportedly prefer them to imported nuts, because they are fresher, have less spoilage, and are tastier.

Honey

At least 37 forest species can serve as valuable nectar and pollen sources for bees in the production of honey and related products in Ontario (Table 3). Honey is used as a food product alone or as a sugar substitute in other foods. Honeybees also produce beeswax and other by-products such as bee pollen and royal jelly. Beeswax is sold for candles, polishes, and as a component in cosmetics. Bee pollen is the pollen that bees collect for the hive and enrich with enzymes and nectar. Royal jelly, a secretion from glands of the worker bee, is the queen bee's sole source of nourishment. Bee pollen and royal jelly are marketed as nutrient and energy sources.

In 1997, the total value of honey and wax products in Ontario was $8.2 million.[26] There were 4,000 beekeepers operating in the province in 1997, with a total of 81,000 colonies, and a total production of 4,776 tonnes of honey. The average yield per colony was 59 kg, and the average price was $2.48 per kg. Capital cost estimates for a 1,000 colony

[28] http://www.greyowlfoods.com/goricestuff.html.

operation have been calculated at about \$272,000 (summarized in Mitchell and Associates 1997, citing Manitoba Department of Agriculture). This size of operation would require a minimum of 3,000 hours of labour to maintain. An efficient hive houses a colony of 80,000-100,000 bees and can produce 23 to 45 kg (50 to 100 lbs) of honey per year. Someone aiming for \$1,600 to \$2,000 per year in supplemental income might keep under 100 hives. Currently, honey generates above average profits with gross margins approaching 125% (Mitchell and Associates 1997).

According to Agriculture and Agri-Food Canada, Canadian beekeepers have one of the highest honey yields in the world, partly a result of a northern climate with long days. Average production in Canada is about 60 kg per hive, twice the world's average. Canada is the fifth largest producer of honey in the world behind China, the U.S., Mexico, and Argentina. It is produced in all 10 provinces and the territories and is valued at approximately \$82 million in farm gate receipts per year. In 1997, Canadian honey production was 30,020 tonnes, of which 7,109 tonnes were exported, mainly to the U.S. and Germany, but also to Great Britain, Japan, and many other countries. Alberta was the largest producing province, followed by Saskatchewan and Manitoba. Those provinces successfully exploit vast expanses of canola, clover, and alfalfa for honey production.

Bees require nectar and pollen over a long period to produce substantial quantities of honey crops. Therefore a polyculture of species with a succession of flowering periods is best for honey production. Early season sources of nectar include cranberry, maple, willows, alder, pin cherry, and dandelion (Mitchell and Associates 1997). Other sources can provide good mid-and late-season sources (Thomas and Schumann 1992). Southern Ontario beekeepers tend to rely more on cultivated farm fields as sources of pollen, whereas in the north, honey products utilize many natural forest stands in the vicinity of the hives. In fact, a continuous supply of honey would not otherwise be possible in the north without wild sources of pollen; alder is used very early in spring, followed by poplar, maple, birch, berry bushes, and apple trees.

Producers of honey from wild plants have not yet explored broader markets for this particular product, mainly because they do not produce large quantities of product. Beekeeping is usually a secondary source of income. For example, the largest producers in the Algoma region produce about 500 to 1600 kg annually and the smaller ones less than 100 kg (M. Eaton, Algoma Beekeepers Association, pers. comm.). The product can generally be sold locally, e.g., at farmers' markets, local retail outlets, and through casual sales. However, markets outside Ontario for such products would be of interest to the beekeepers.

Many of the very desirable forage trees of bees have higher value for other uses so that honey production is a secondary product of their growth. Timber production, for example, can be combined with grazing by bees. This has been suggested for basswood, among other species, in southern Ontario. Thomas and Schumann (1992) have suggested such routes as worthy of consideration in rural development strategies.

[29] Bridgehead Catalogue, Spring 1999.

[30] Capital Brewery, Middleton, Wisconsin. http://www.capital-brewery.com/limited.htm.

Table 4. Species used commercially in medicinal or health products.[31]

Species	*Common name*	*Commercial use*
Abies balsamea	balsam fir	resin in aromatherapy
Achillea millefolium	yarrow	oil in aromatherapy
Arctostaphylos uva-ursi	bearberry	leaf extract in *Doans Pills*
Betula papyrifera	white birch	wood and bark oil in aromatherapy
Fagus grandifolia	American beech	nut oil used in aromatherapy carriers
Ginkgo biloba	maiden-hair tree	leaves in herbal medicines
Hamamelis virginiana	witch hazel	topical astringent and toilet water
Hydrastis canadensis	goldenseal	alkaloids hydrastine and berberine in *Murine* eye drops
Hypericum perforatum	St. John's-wort	herbal antidepressant; oil in aromatherapy
Juniperus communis	common juniper	flower oil in aromatherapy
Juniperus virginiana	eastern redcedar	wood oil in aromatherapy
Ledum groenlandicum	Labrador tea	oil from aerial parts in aromatherapy
Mentha x *piperata*	peppermint	oil from aerial parts in aromatherapy
Mentha spicata	spearmint	oil from flowering tops in aromatherapy
Panax quinquefolius	American ginseng	roots in herbal preparations and medicines
Picea spp.	spruce	oil from needles and twigs in aromatherapy
Pinus strobus	eastern white pine	volatile oil in inhalants; inner bark in cough syrup; extract in analgesic *Prunicodeine*
Pinus sylvestris	Scots pine	oil from needles, twigs and cones in aromatherapy
Prunus serotina	black cherry	bark in wild cherry cough syrup
Rubus spp.	raspberry	fruit in pharmaceutical syrup
Salix nigra (or alba)	willow	bark salicin previously used in aspirin
Sanguinaria canadensis	bloodroot	root in analgesic *Prunicodeine*
Sassafras albidum	sassafras	root bark oil in perfumed soaps and root beer flavouring
Solidago canadensis	Canada goldenrod	oil in aromatherapy
Thuja occidentalis	eastern white cedar	leaf oil in various products, e.g., men's cologne, pharmaceuticals, incense, aromatherapy
Tsuga spp.	hemlock	oil from needles and twigs in aromatherapy
Viola odorata	sweet violet	leaf oil in aromatherapy
Xanthoxylum americanum	prickly-ash	oil from berries in aromatherapy

[31] Naegele 1996, and various commercial sources.

Table 5. Herbs sold commercially for medicinal purposes.[32]

Species	Common name	Species	Common name
Achillea millefolium	yarrow	*Melilotus officinalis*	yellow sweet-clover
Agrimonia eupatoria	agrimony	*Mentha spp.*	mint
Allium tricoccum	wild leek	*Monarda fistulosa*	wild bergamot
Aralia nudicaulis	wild sarsaparilla	*Myrica pensylvanica*	bayberry
Aralia racemosa	spikenard	*Oenothera biennis*	evening primrose
Asarum canadense	wild ginger	*Panax quinquefolius*	American ginseng
Aster novae-angliae	New England aster	*Pinus strobus*	eastern white pine
Caulophyllum thalictroides	blue cohosh	*Plantago major*	common plantain
Chrysanthemum leucanthemum	ox-eye daisy	*Polygonatum biflorum*	Solomon's seal
Cimicifuga racemosa	black cohosh	*Populus balsamifera*	balsam poplar
Clinopodium vulgare	wild basil	*Populus tremuloides*	trembling aspen
Conium maculatum	poison hemlock	*Potentilla recta*	sulphur cinquefoil
Convallaria majalis	lily-of-the-valley	*Pulmonaria officinalis*	lungwort
Coptis trifolia	goldthread	*Quercus alba*	white oak
Crataegus monogyna	hawthorn	*Rhamnus cathartica*	buckthorn
Echinacea spp.	coneflower	*Rubus idaeus*	red raspberry
Equisetum arvense	field horsetail	*Salix alba*	white willow
Eupatorium purpureum	purple Joe-pye-weed	*Sambucus nigra*	European elderberry
Fragaria vesca	wild strawberry	*Sanguinaria canadensis*	bloodroot
Galium verum	yellow bedstraw	*Sassafras albidum*	sassafras
Gaultheria procumbens	wintergreen	*Stellaria media*	chickweed
Geranium maculatum	wild cranesbill	*Taraxacum officinale*	dandelion
Geranium robertianum	herb-robert	*Thuja occidentalis*	eastern white cedar
Geum urbanum	avens	*Trifolium pratense*	red clover
Hepatica acutiloba	liverwort	*Tussilago farfara*	coltsfoot
Hypericum spp.	St. John's-wort	*Ulmus rubra*	slippery elm
Juglans nigra	black walnut	*Urtica dioica*	stinging nettle
Juniperus communis	common juniper	*Vaccinium angustifolium*	lowbush blueberry
Lactuca virosa	wild lettuce	*Veronica officinalis*	speedwell
Lythrum salicaria[33]	purple loosestrife	*Viola odorata*	sweet violet

[32] Assembled from retail outlets in Ontario. Seeds, plants, or dried plant parts may be sold.
[33] Sales are restricted to outside North America because purple loosestrife is displacing native wetland species.

The Canadian Food Inspection Agency (CFIA) monitors the safety and quality of honey and ensures producers and importers meet federal standards. The CFIA regulates the production and packing of domestic and exported honey, through the Honey Regulations of the Canada Agricultural Products Act. Producers and packagers must conform to very specific labelling regulations, and these are enforced by CFIA inspectors.

Canada is monitoring the Africanized honeybee found in Central and South America, and now entering the United States. This breed is known to be very aggressive and potentially harmful for beekeepers and the public.

Wild rice

Wild rice is a robust, annual, aquatic grass that is found in shallow lakes and quiet streams with loose organic bottoms (Newmaster et al. 1997). It is the only cereal grain native to North America. Since its wetland habitats are often associated with forest ecosystems, wild rice is included here as an NTFP. Annual production of organic wild rice from Canadian lakes is estimated to be 1.1 million kg (Grey Owl Foods, Saskatchewan: Wild Rice Industry Reference Book[28]).

There are 2 types of wild rice in Ontario: northern wild rice (also called marsh rice) and southern wild rice (also called water oats). Northern wild rice is a traditional, sacred food as well as an economically important crop to indigenous peoples such as the Ojibway (Stevenson 1986, Chapeskie 1990).

The grain is gathered from both wild and cultivated stands, processed to remove the hull, and is sold by the package or as an ingredient in specialty food products such as the fruit bars discussed earlier from the Kagiwiosa Manomin Coop. A 125-g package of certified organic wild rice from Kagiwiosa retails by mail order for $3.95.[29] Whole or cracked grains are sold, the latter suitable for soups, stuffings, salads, and breads. In the U.S., wild rice has even been used by one company to brew an award-winning beer.[30] The beer has a nutty flavour and is advertised as 'one of the most unique beers brewed in the United States'.

The collection of wild rice on Crown Land is regulated in Ontario under the Wild Rice Harvesting Act.

Other food products

Essential oils are another product obtained from forest species for use in a variety of edible products such as flavourings and preservatives (Table 1). Essential oils are concentrated aromatic oils of plant leaves, flowers, seeds, bark, roots, and fruits. The oils may be obtained from cultivated or wild plants including peppermint, spearmint, basil, and others in Ontario (National Aboriginal Forestry Association 1997). Other products from essential oils are discussed in later sections.

Many other food products are collected from Ontario's forest plants, but collection tends not to be well-organized. In the spring, fiddleheads (ostrich fern) are picked in small quantities by individuals and companies. One or two of the larger companies gather about 200 to 500 kg per week during the spring peak periods. To sellers serving the Toronto area, fiddleheads are more a retail product

[34] Source cited in Winslow and Kroll: The right stuff: Drug Store News picks the categories taking off in '94. Drug Store News 1994, 16: 15.
[35] For organizations and contacts for ginseng, see Schooley (1999b).

than a restaurant item. In the U.S., fiddleheads are plentiful and cheap, hence that is not a major future market for Canadian suppliers. Abroad, markets are improving somewhat, e.g., in Europe, but purchasers will require further education in fiddlehead cuisine before those markets can really expand. In Ontario, other products such as wild leeks are collected on a small scale and used personally.

Health and Personal Care Products

Herbal medicinals

Plant and fungal species frequently synthesize chemical compounds that can be used in pharmaceutical and natural health products. These chemicals include terpenes, aromatics, proteins, and alkaloids (Kaufman et al. 1998). Several hundred of Ontario's plant species have been used medicinally, mainly by indigenous peoples. Four hundred and sixty-six of these species are identified in the Ontario Plant List (Newmaster et al. 1998). While there are too many forest species to list here, commercial examples are listed in Table 4. Also, a variety of plants are sold as seeds, whole plants, or dried plant parts for medicinal uses (Table 5).

Many of the plants in Table 5 are used in herbal teas. These include ginseng, wild ginger, strawberry, raspberry, blueberry, mint, and dandelion. Teas can also be made from the labrador tea plant, stinging nettle, fireweed, juniper, bergamot, sassafras, and rose petals (Mitchell and Associates 1997). The Canadian tea market has been estimated to be worth over $390 million, of which herbal teas make up between 5% and 25%. The world tea market has been projected to have an annual growth rate of 20% through the year 2000, and herbal teas have been suggested as one of the most promising value added items currently on the market (Mitchell and Associates 1997 and references cited therein).

As an alternative to conventional drugs, natural products are part of new alternative health programs and new commercial ventures. This is a lucrative market, with the current estimated global market for nutraceuticals expected to rise to US$8.2 billion by 2002 (Freedonia Group 1998e). The herbal extracts sector is expected to grow the fastest. In 1997, Canadian consumers spent approximately $340 million on herbal plant preparations (Saxena et al. 1999). Sales of herbal health products are growing by 20% a year, and herbs are the largest growth area in retail pharmacy, far exceeding increases in the conventional drug category (Winslow and Kroll 1998[34]).

Ginseng[35]

North American ginseng was originally found growing wild in southern Ontario, Quebec, and the northeastern United States, and is now grown commercially in some areas, particularly Ontario, Wisconsin, and British Columbia.

There are several ways to grow ginseng commercially, including cultivated and wild-grown methods, however, most of the North American production is cultivated. Cultivation of ginseng in Ontario began in earnest

[36] Statistics Canada, International Trade Division.

[37] A weed is considered here to be any plant that can occur on forest sites and can compete with forest crops for light, water, and/or nutrients.

Table 6. Forest weed species that have been used medicinally.[38]

Scientific name	*Common name*	*Plant part*	*Usage*
Acer pensylvanicum	striped maple	bark, leaf	emetic, gonorrhea, kidney infections, skin eruptions
Acer rubrum	red maple	bark	eyewash
Acer spicatum	mountain maple	bark, twig	eyewash, diarrhea, intestinal problems
Agropyron repens	quack grass	various	kidney stones, urinary incontinence
Alnus rugosa	speckled alder	bark, leaf	eye infections, inflammation, ulcers, skin diseases
Amaranthus hybridus	smooth pigweed	leaf	diarrhea, inflammation, ulcers
Amaranthus retroflexus	redroot pigweed	various	canker sores, hemorrhage, inflammation of mouth and throat
*Ambrosia artemisiifolia**	common ragweed	leaf, root	insect bites, nausea, skin eruptions, stroke
*Ambrosia trifida**	giant ragweed	leaf	fever, diarrhea, insect bites, mouth sores
Amelanchier spp.*	serviceberry	fruit, root	blood remedy for pain and hemorrhage after childbirth
*Asclepias syriaca**	common milkweed	latex, root	congestive heart failure, kidney stones, laxative, rheumatism, syphilis, warts
*Barbarea vulgaris**	yellow rocket	leaf	wounds
Betula alleghaniensis	yellow birch	bark, twig	antiseptic, diuretic, local stimulant
Chamaedaphne calyculata	leatherleaf	leaf	fever, inflammation
*Chenopodium album**	lamb's-quarters	various	burns, gout
Cirsium arvense	Canada thistle	leaf, root	diarrhea, diuretic, tuberculosis, skin eruptions
Comptonia peregrina	sweetfern	various	colic, diarrhea, toothache, rheumatism, sores, toxic effects of poisons
Convolvulus arvensis	field bindweed	various	laxative, fever, spider bites, wounds
Cornus alternifolia	alternate-leaved dogwood	root	eye soreness
Cornus rugosa	round-leaved dogwood	bark	tonic
Corylus cornuta	beaked hazel	bark, stem	convulsions, lung hemorrhage, rheumatism, ulcers, teething pain, tumours
*Crataegus chryscarpa**	golden-fruited hawthorn	flower, fruit	angina pectoris, arteriosclerosis, heart tonic
*Crataegus douglasii**	black hawthorn	flower, fruit	angina pectoris, arteriosclerosis, heart tonic
*Crataegus succulenta**	long-spined hawthorn	flower, fruit	angina pectoris, arteriosclerosis, heart tonic, neuro-vascular sedative
Diervilla lonicera	bush honeysuckle	various	diuretic, gonorrhea, senility
Epilobium angustifolium	fireweed	leaf, root	burns, inflammation, ulcerous sores
*Hypericum perforatum**	St. John's-wort	various	inflammation, Sciatica, sores, urinary disorders, wounds, ulcers
*Kalmia polifolia**	bog laurel	leaf	herpes, sores, ulcers
Lonicera canadensis	Canada fly honeysuckle	bark, root, vine	gonorrhea, lung disorders, urinary disorders

Table 6. *continued*

Scientific name	*Common name*	*Plant part*	*Usage*
Lythrum salicaria	purple loosestrife	entire flowering plant	antiseptic, diarrhea, sore throat, wounds
*Medicago sativa**	alfalfa	leaf	inflammation from arthritis, rheumatism, lupus, gout, vitality augmenter
Pastinaca sativa	wild parsnip	root	inflammation, pain, sores
*Plantago major**	common plantain	leaf, root, seed mucilage	cough, high cholesterol, sores, wounds
*Populus balsamifera**	balsam poplar	bark, bud, resin, root	colds, kidney disorders, lung disorders, muscle pain, rheumatism, tumours
Populus tremuloides	trembling aspen	bark, bud	arthritis, colds, fever, urinary disorders, venereal disease
Potentilla recta	sulphur cinquefoil	root	diarrhea
Prunus pensylvanica	pin cherry	inner bark, root	bowel disorders, jaundice
*Prunus virginiana**	choke cherry	root bark	bowel disorders, lung disorders, wounds
Pteridium aquilinum	bracken fern	root	burns, headache, promote hair regrowth, sores
Rubus idaeus	red raspberry	various	colds, conjunctivitis, diabetes, diarrhea, alleviates labour pains, sores
Salix bebbiana	beaked willow	bark	diarrhea, fever, inflammation
Salix discolor	pussy willow	root bark	fever, hemorrhage, inflammation, sore throat
Salix humilis	upland willow	root	colic, fever, hemorrhage, inflammation
Salix petiolaris	slender willow	root bark throat	fever, hemorrhage, inflammation, sore
*Sambucus canadensis**	common elder	bark, flower, fruit, leaf	burns, laxative, migraine, wounds
Sambucus pubens	red-berried elder	various	burns, laxative, migraine, wounds
*Solidago canadensis**	Canada goldenrod	flower, root	burns, fever, snakebites, sore throat
*Sorbus americana**	American mountain ash	various	antiseptic, colds, colic, pneumonia
Sorbus decora	showy mountain ash	various	antiseptic, colds, colic, pneumonia
Spiraea latifolia	broad-leaved meadowsweet	leaf	diuretic, nausea
Vaccinium angustifolium	lowbush blueberry	leaf, root	bowel diseases, congestive heart failure, diarrhea, sore throat and mouth, uterus inflammation
Vaccinium myrtilloides	velvet leaf or downy blueberry	fruit, leaf, root	bowel diseases, congestive heart failure, cystitis, diabetes, diarrhea, sore throat and mouth, uterus inflammation
Viburnum acerifolium	maple-leaved viburnum	inner bark	cramps, emetic
Viburnum alnifolium	hobblebush	leaf	migraine
Viburnum cassinoides	Northern wild raisin	bark	inflammation
Viburnum lentago	nannyberry	inner bark	diuretic
Viburnum trilobum	highbush cranberry	inner bark	colic, cramps, emetic
Xanthoxylum (Zanthoxylum) americanum	prickly-ash	bark, fruit	colic, congestive heart failure, expectorant, kidney disorders, lung disorders, rheumatism, sores, topical stimulant, ulcers, venereal diseases

[38] Erichsen-Brown 1979, Mowrey 1986, Foster and Duke 1990, Naegele 1996, Duke 1998. *Indicates species that are potentially toxic.

Table 7. Pharmacological activities of chemicals extracted from weed species.[39]

Scientific name	Plant part	Chemical	Biological activity
Alnus rugosa	bark, fruit, leaf	betulin	antiinflammatory, antitumour
Amaranthus hybridus	various	rutin	anticataract, antiinflammatory, antitumour
Amaranthus retroflexus	various	rutin	anticataract, antiinflammatory, antitumour
Ambrosia artemisiifolia	various	artemisiifolin	antitumour
Asclepias syriaca	sprout seedling	alpha-amyrin	antitumour
		beta-amyrin-acetate	anticonvulsant
		desglucouzarin/uzarigenin	antitumour
		cinnamic acid	antiinflammatory, anesthetic, cancer preventive
Betula alleghaniensis	bark	betulin	antiinflammatory, antitumour
Chenopodium album	various	ascaridole	analgesic, sedative
		imperatorin	anticonvulsant, antiinflammatory
		oleanolic acid	cancer preventive, diuretic
		scopoletin/xanthotoxin	antiinflammatory, antiseptic, antitumour
		trigonelline	anticancer, antimigraine, antiseptic
	fruit	vanillic acid	antifatigue, antiinflammatory
		ferulic acid	antiinflammatory, antiviral, cancer preventive
Comptonia peregrina	various	betulin	antiinflammatory, antitumour
Hypericum perforatum	various	(-)-epicatechin	antidiabetic, antihyperglycemic, antihepatitic, antileukemic, antiviral
		hyperforin	antibiotic, sedative
		hyperin	antiinflammatory, antiviral, hepatoprotective
		hyperoside	cancer preventive
	essential oil	caryophyllene	antiasthmatic, antiinflammatory, antitumour
Lythrum salicaria	leaf	chlorogenic acid	antiHIV, cancer preventive, immunostimulant
		ellagic acid	antiHIV, anticataract, antiinflammatory, cancer preventive
		orientin	antiinflammatory, cancer preventive
Medicago sativa	various	biochanin-A	cancer preventive
		cycloartenol	antiinflammatory, antirheumatic
		daidzen	antianginal, antimigraine
		daphnoretin	antitumour
		octacosanol	antiParkinsonian, antiviral
	leaf	genistein	antileukemic, cancer preventive
	essential oil	limonene	anticancer, antitumour, antiviral, sedative
Pastinaca sativa	root	5-methoxypsoralen	cancer preventive
		alpha-linolenic acid	antiinflammatory, antiprostatic, cancer preventive
		angelicin	anticonvulsant, antiflu, antiviral, sedative
		bergapten	antiinflammatory, antitumour, cancer preventive
		beta-bisabolene	antiulcer, antiviral
		myristicin	anesthetic, antidepressant, antistress, sedative
	leaf	quercetin	antiCrohn's, antiasthmatic, anticataract, antiflu

Table 7. *continued*

Scientific name	*Plant part*	*Chemical*	*Biological activity*
	various	rutin	anticataract, antiinflammation, antitumour
		xanthotoxol	anti-nicotinic, cancer preventive
	seed	isopimpinellin	antiinflammatory, antitubercular, diuretic
Plantago major	various	allantoin	antidandruff, antiinflammatory, sunscreen
		baicalin	antiHIV, antiallergic, tranquilizer
		caffeic acid	anticarcinogenic, antiflu, antiinflammatory, antiviral
		chlorogenic acid	analgesic, antiseptic, antitumour, antiulcer
		salicyclic acid	analgesic, antidandruff, antiinflammatory
		syringin	antistress, immunostimulant
		ursolic acid	antidiabetic, antileukemic, antiobesity
	leaf	apigenin	AntiHIV, antitumour, antiviral, cancer preventive
		baicalein	antiHIV, antiacne, antiarthritic
		benzoic acid	antiseptic, expectorant
Populus balsamifera	bark, leaf	salicortin, salicin	analgesic
	various	ar-curcumene	antiulcer, antiviral
		caryophyllene	antiasthmatic, antiinflammatory, antitumour
Prunus pensylvanica	bark, leaf	betulin	antiinflammatory, antitumour
Pteridium aquilinum	various	benzoic acid	antiseptic, expectorant
		caffeic acid	anticarcinogenic, antiflu, antiinflammatory, antiviral
		ferulic acid	analgesic, antiinflammatory, antiviral, cancer preventive
		procyanidin	antiHIV
	various, leaf	p-coumaric acid	antitumour, cancer preventive
Rubus idaeus	various	benzaldehyde/beta-ionone	antiseptic, antispasmodic, antitumour
		farnesol	anticancer (pancreas), sedative
	fruit	caffeic acid	anticarcinogenic, antiflu, antiinflammatory, antiviral
		ferulic acid	analgesic, antiinflammatory, antiviral, cancer preventive
		geraniol	antiseptic, antitumour, cancer preventive
		maltol	antifatigue
		salicyclic acid	analgesic, antidandruff, antiinflammatory
	leaf	gallic acid	antiHIV, antibacterial, antiflu, antitumour, cancer preventive
Sambucus canadensis	various	alpha-amyrin-palmitate	antianemic, antiarthritic, antiinflammatory
		beta-amyrin-palmitate	antidepressant, sedative
	seed	mucilage	cancer preventive
	flower, leaf	rutin	anticataract, antiinflammation, antitumour
Sorbus americana	bark, leaf	betulin	antiinflammatory, antitumour
Viburnum cassinoides	bark	betulin	antiinflammatory, antitumour

[39] Duke 1998.

Table 8. Patents on products from forest weed species.[40]

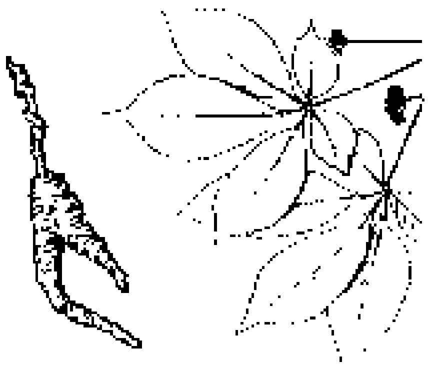
Species	Application	Patent document #	Country
Agropyron repens	acne treatment	4803069	USA
Amaranthus retroflexus	fat substitute for processed foods	5651828	USA
Ambrosia artemisiifolia	allergy diagnosis and treatment	2117779	Canada
	antifungal activity	5648354	USA
Ambrosia trifida	antifungal activity	5648354	USA
Betula spp.	inducing immunologic tolerance	2164326	Canada
Chamaedaphne calyculata	eczema treatment	2137109	Canada
Comptonia peregrina	method of stabilizing food	4110483	USA
Crataegus spp.	cardiac arrest and cardiovascular lesions	2168246	Canada
	anti-pollution cosmetic composition	5571503	USA
Epilobium angustifolium	inflammation inhibitor	3900023	Germany*
Hypericum perforatum	Herpes treatment	2211802	Canada
	antiviral compositions	4898891	USA
Lythrum salicaria	Herpes treatment	2211802	Canada
Medicago sativa	hair re-growth; hair loss prevention	2106097	Canada
	wound treatment	4318906	USA
Plantago major	transdermal patch for tobacco or nicotine habit	5716635	USA
Populus tremuloides	diabetes treatment	2204384	Canada
Prunus virginiana	leukemia treatment (mice)	3932628	USA
Pteridium aquilinum	treatment of cognitive and/or neuroimmune disorders	5601829	USA
Rubus idaeus	Herpes treatment	2211802	Canada
Vaccinium spp.	oral antibacterial agent	2193583	Canada
Xanthoxylum americanum	treatment of vascular disorders, e.g., hemorrhoids	5562906	USA

[40]Canadian Patent Database http://patents1.ic.gc.ca; U.S. Patent and Trademark Office; *Hetherington and Steck 1997. Note: patents either filed or issued.

within the last decade, in response to strong demand for this medicinal herb in South East Asia and the Pacific Rim countries.

In 1998, farm cash receipts from the sales of ginseng in Ontario were $46.6 million (Statistics Canada), and the value of exports was $36.9 million (OMAFRA). The main commercial market for Canadian ginseng is China; other markets include Taiwan and Malaysia. The majority of Canadian-grown ginseng is sent to Hong Kong for processing before distribution to final markets.

Ginseng root is usually sold dried (Schooley 1999c), which is done in kilns modified to provide appropriate air flow and temperature. Shallow trays are rotated several times during the drying process to ensure even drying of a mixture of root sizes and shapes. Dryness is determined by how quickly and easily the dried root breaks and by surface texture and resilience. Dried root is packed in cardboard barrels lined with plastic bags in 45-kg (100-lb) lots. The barrels are then sealed and shipped.



Ginseng root is not usually graded on the farm, other than to provide a consistent mixture of 'pencil root' and 'chunky root' in all barrels, which buyers prefer. Further grading of the root takes place in warehouses at the shipping destinations. Custom refrigeration and drying is offered by experienced growers with large facilities.

Some growers prepare and market ginseng products in North America (Schooley 1999d). Capsules, teas, candies, soaps, and other products are available from various grower retail outlets. These growers also offer custom services to others interested in producing value-added products.

The cost of producing 1 ha of ginseng is about $138,857 ($56,195 per acre) for a 3-year root (Schooley 1999a). This includes land preparation costs (e.g., seedbed preparation, seeding, chemicals, soil tests, labour, wooden lath shades), annual cash costs (e.g., fertilizers, fungicides, shade maintenance, labour), harvest costs, and post-harvest costs (e.g., drying, refrigeration, shipping). Specialized machinery necessary for ginseng production is about $105,000.

There are no cultivars of ginseng (Schooley 1999c). Field cultivation was begun by moving wild roots into protected gardens. Further expansion of acreage was achieved using seeds originating from domesticated wild roots. There is essentially free movement of seed both inter-provincially within Canada and internationally within North America. Selection of superior strains has not been achieved.

American ginseng is listed under the Convention on International Trade in Endangered Species (C.I.T.E.S.) as an endangered species (Schooley 1999d). C.I.T.E.S. is an agreement among many nations to protect wild plant and animal life from extinction. While this does not limit international trade, it does require that trade be documented. This means that before importing or exporting American ginseng, a permit from the exporting country is required.

An important issue for the ginseng industry is whether Chinese demand for North American ginseng will keep pace with increased production from Canada, China, the U.S. and other countries. Market volatility has been a concern for growers (Schooley 1999d). For example, while the quantity of ginseng exports almost tripled in Ontario between 1994 and 1998, from 325,571 kg in 1994 to 892,051 kg in 1998, the price declined considerably, from $72.31 per kg in 1994 to $41.22 per kg in 1998.[36] Ontario enterprises may need to consider developing their own value-added ginseng products for domestic and export markets rather than emphasizing bulk shipments.

Medicinal products from weed species

Many weed[37] species common to forest sites have been used medicinally (Table 6). These species are often considered as nuisance competition for forest crops, to be controlled by burning, chemical, or manual methods. However,

[41] Forbes website: www.forbesmedi-tech.com

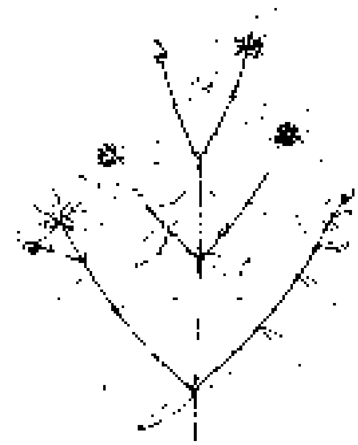
[42] Reported in USA Today, July 22, 1998.

there are studies that show pharmacological activities from chemical extracts of many of these species (Table 7), which may yield new health products in the future. Products from a number of these species have already been patented (Table 8).

St. John's-wort

St. John's-wort is a common weed that has become a popular herbal remedy for a variety of ailments, including depression, bedwetting in children, hepatitis, HIV, AIDS, cancer, inflammations of the digestive tract, shingles, headaches, sciatica, and trigeminal neuralgia (McQuarie 1998). Products made from St. John's-wort include oils, pills, dried foliage and flowers, tinctures, and flower essences, which are available commercially in health food stores in Ontario. Patented products from the plant have also been developed as antiviral agents (Table 8).

In an effort to develop standardized medicinal products, researchers at the



University of Guelph have been developing technologies for micropropagating St. John's-wort under controlled laboratory conditions (Saxena et al. 1999). Plant cells or tissues are used to regenerate whole plants that are free from bacterial, fungal or insect contamination. Individual plants are then screened for uniquely high levels of active medicinal compounds, and successful clones are mass produced using tissue culture techniques. St. John's-wort is one of several medicinal species that has been micropropagated

Table 9. Herbs used commercially in cosmetic and toiletry products.

Species	Common name
*Achillea millefolium**	yarrow
*Convallaria majalis**	lily-of-the-valley
*Equisetum arvense**	field horsetail
*Gaultheria procumbens**	wintergreen
Juniperus virginiana	eastern red cedar
*Myrica pensylvanica**	bayberry
*Oenothera biennis**	evening primrose
Thuja occidentalis	eastern white cedar
*Viola odorata**	sweet violet

*Herbal products sold commercially as seeds, plant, dried plant parts (Source: supplier catalogues).

[43] Includes markets for food, cosmetic and toilettries, soaps and detergents, beverages, polishes and sanitation goods, etc.
[44] Article on Pet health products market overview, in the International Market Insights Series, August 17, 1995.

successfully.

Fireweed

Fireweed is widespread throughout the boreal forest and aspen parkland, particularly in areas disturbed by fire. A western Canadian company, Fytokem, has been developing new health products from fireweed and other species, some of which are common in Ontario (Hetherington and Steck 1997, Canadian Agricultural New Uses Council 1998). For example, an aqueous extract of fireweed (*Epilobium angustifolium* L.) has shown considerable promise as a functional ingredient for cosmetic and therapeutic end uses. Fireweed extract was non-irritating and reduced skin redness from inflammation by as much as 41% in 24 h. The extract was shown to have microbial inhibitory properties. This supports traditional uses of the plant by local people in northern Canada and northern Europe for many centuries. The plant extract also demonstrated some properties as a protectant against ultraviolet solar radiation (SPF 4). The active compounds are currently being identified and isolated for other potential applications.

Development of natural health products from pulp waste in other jurisdictions

Some new health products use industrial by-products from forest species. For example, a Vancouver company, Forbes Medi-Tech,[41] has developed health products from tall oil 'soap', the frothy substance that floats to the top of the vat during the pulping process. This soap is rich in plant sterols that have potential commercial applications in the cholesterol-lowering

Table 10. Prices from companies that purchase plant biomass.[45]

Species name	*Common name*	*Plant part*	*Price (CDN $/kg)*
Agropyron repens	Quack grass	rhizome - fresh	36.96
Hypericum perforatum	St. John's-wort	flowers - dried aerial - powder aerial - dried	30.80-36.96 100.8 14.75
Medicago sativa	Alfalfa	aerial - dried	5.55-12.32
Plantago major	common plantain	leaves - fresh leaves - dried	27.72 9.24
Populus tremuloides	trembling aspen	buds - fresh	61.60
Prunus virginiana	choke cherry	bark (young branches) - dried	30.80
Rubus idaeus	red raspberry	leaves - dried	20.02-46.20
Sambucus canadensis	common elder	flowers - fresh fruit - fresh	23.16-43.12 17.06-18.48
Xanthoxylum americanum	prickly ash	bark - dried	25.10-33.88

[45] Prices assembled from various companies.

and pharmaceutical steroid markets. Plant sterols are naturally occurring compounds found in all oil-producing plants and are chemically similar to cholesterol. Balsam fir and most of the pines can be used, and apparently, northern mills are favoured suppliers of raw material (D. Stewart, Forbes Medi-Tech, pers. comm.).

In Finland, a margarine is made using sitostanol from pine, which reportedly helps to reduce cholesterol.[42] Benecol margarine, a product of the Raisio Company, is apparently very popular in Finland, reportedly selling out even at prices 6 times those of regular margarine. The product is also being introduced to the United States. Scientific studies show it prevents absorption of dietary cholesterol and inhibits the liver's own production of cholesterol. The manufacturers may also create other cholesterol-lowering foods containing sitostanol, such as salad dressings and ice cream.

Future drugs from plants

Worldwide, about 50% of all drugs in clinical use derive from natural products, and at least 25% of all prescription drugs contain ingredients extracted from higher plants (Carr et al. 1993). A well-known example from the forest is Taxol[R], the anti-cancer drug derived originally from the Pacific yew *Taxus brevifolia* – and later other species such as *T. canadensis* – which is now available in semi-synthesized form (Balandrin et al. 1993, Cragg 1998). Such products can be very profitable; for example, each new drug is estimated to be worth an average of US$94 million to a private drug company and US$449 million to society as a whole (Mendelsohn and Balick 1995). In the U.S., pharmaceutical chemicals constitute a US$11.4 billion market (Freedonia Group 1998c). In Europe, the industry is worth about US$9.3 billion (Freedonia Group 1998b). Pharmaceutical chemicals in these estimates includes conventional drugs and medicinals, as well as vitamins, minerals, and herbal extracts.

However, new drug development is a lengthy process and the time lag between discovery and marketing can range from 10 to 20 years (Couzinier and Mamatas 1986, Cragg 1998).

Where a species is being evaluated for drug development, considerable quantities of plant biomass are needed for preclinical and clinical investigation (Cragg 1988). An initial sample of raw material (0.3 to 1.0 kg) is used to yield about 10 to 40 g for isolation of the pure, active constituent and elucidation of its chemical structure. Subsequent secondary testing and preclinical development might require gram or even kilogram quantities, depending on the degree of activity and toxicity of the active agent. For early preclinical development, recollections of 5 to 50 kg of the raw material, preferably from the original collection location, might be necessary. Should the preclinical studies justify initiation of clinical trials, considerably larger amounts of material would be required. While total synthesis may be a desirable route for bulk production of the active agent, it is worth noting that the structures of most bioactive natural products are extremely complex, and bench-scale syntheses often are not readily adapted to large-scale economic production. Isolation from the natural source, therefore, often provides the most economically viable method of production. This can place significant pressure on wild populations.

[46] Reported in the Sault Star, April 17, 1999.

[47] http://www.tembec.ca

Table 11. Specialty wood products.[48]

Species name	Common name	Use
Abies balsamea	balsam fir	craft wood
Acer rubrum	red maple	clothes hangers; clothespins; kitchenware; spinning wheels; spools
Acer saccharinum	silver maple	range of products where strength not required
Acer saccharum	sugar maple	utensils; crafts; toys; bowling pins; musical instruments; smokewood; carving
Aesculus glabra	Ohio buckeye	artificial limbs; troughs; cradles; hats from shavings
Aralia elata	sarsaparilla	button boxes; photograph frames; pen racks; stools; rocking chair arms
Asimina triloba	pawpaw	inner bark woven into cloth
Betula alleghaniensis	yellow birch	snow sled frames; wheel hubs
Betula lenta	cherry birch	baskets; woodenware
Betula papyrifera	white birch	canoes; spoons; dishes; arts and crafts; ice cream sticks; toothpicks; bobbins; clothespins; spools; broom handles; toys; carving; moose calling horns; snowshoe frames; teepee or lodge coverings
Carpinus caroliniana	American hornbeam	tool handles; small wooden articles e.g., dishes
Carya cordiformis	butternut hickory	handles; sporting goods; fuel; smokewood; bark in chair backs or seats;
Carya glabra	pignut hickory	tool handles; skis; race wagon parts; textile looms
Carya ovata	shagbark hickory	fuelwood; smokewood for hams; gun ramrods
Carya tomentosa	mockernut hickory	smokewood for hams; firewood; charcoal
Castanea dentata	American chestnut	barrel staves; fuelwood
Celtis occidentalis	hackberry	athletic goods
Cornus florida	flowering dogwood	weaving shuttles; spools; small pulleys; mallet heads; jeweller's blocks; golf club heads; chisel handles; wedges; knitting needles; sledge runners; hay forks; barrel hoops; wheel hubs; machinery bearings; rake teeth
Crataegus succulenta	long-spined hawthorn	carving
Fagus grandifolia	American beech	decorative containers; handles; woodenware; fuelwood; shoes; clothespins
Fraxinus americana	white ash	canoes; snowshoes; baskets; sporting goods; agricultural implements; playground equipment; garden implements; oars and keels of small boats; butter tub staves
Fraxinus nigra	black ash	baskets; washboards
Fraxinus pennsylvanica	green ash	agricultural implements; sporting goods; fuelwood
Fraxinus quadrangulata	blue ash	tool handles
Juglans cinerea	butternut	carving
Juglans nigra	black walnut	gunstocks; cradles
Juniperus communis	common juniper	vine stakes; incense; crafts
Juniperus virginiana	eastern red cedar	mothproof chests; carving; pencils
Larix laricina	tamarack	roots used to sew birchbark canoes; knees/stringers/keels of boats
Liriondendron tulipifera	tulip tree	canoes; well linings
Magnolia acuminata	cucumber tree	slats for venetian blinds
Morus rubra	red mulberry	agricultural implements; bark in cloaks; bark ropes; boat building
Nyssa sylvatica	black gum	tool handles; gunstocks and pistol grips; chopping bowls; agricultural machinery parts
Ostrya virginiana	ironwood	tool handles; small wooden articles

Table 11. *continued*

Species name	*Common name*	*Use*
Picea glauca	white spruce	musical instruments e.g., guitars and violins; piano sounding boards; carving; paddles; containers; fuelwood; roots for lashing canoes and baskets
Picea mariana	black spruce	roots as binding material
Picea rubens	red spruce	musical instruments e.g., guitars and violins; piano sounding boards
Pinus banksiana	jack pine	canoe frames; fuelwood
Pinus rigida	pitch pine	light torches
Pinus strobus	eastern white pine	carving; matches; heddles of looms; craft wood
Platanus occidentalis	sycamore	butcher blocks; wheels; chests and trunks; piano and organ cases
Populus deltoides	eastern cottonwood boards; trunks	woodenware; matches; cigar box linings; barrel staves; ironing
Populus grandidentata	largetooth aspen	veneer; matches
Populus tremuloides	trembling aspen	matches; chopsticks; carving
Prunus serotina	black cherry	professional and scientific instruments; handles; toys; carving; hairbrush backs; musical instruments; weighing apparatus; spirit levels
Quercus alba	white oak	barrels for liquid; fuelwood
Quercus macrocarpa	bur oak	barrels for liquid soap
Quercus rubra	red oak	craft wood
Quercus velutina	black oak	fuelwood
Robinia pseudoacacia	black locust	rake teeth; tool handles; ladder rungs; wheel hubs; policemen's clubs
Salix spp.	willow	carving
Salix discolor	pussy willow	decorative twig products
Salix nigra	black willow	barrels; toys; wicker baskets
Sassafras albidum	sassafras	small boats
Thuja occidentalis	eastern white cedar	canoes; chests; carving
Tilia americana	American basswood	carving; modelling; food boxes; yardsticks; ropes; woven mats; musical instruments; picture puzzle backs; heavy-duty thread; masks
Ulmus americana	white elm	barrels; boats
Ulmus thomasii	rock elm	axe handles; wheel hubs and spokes; flour barrels

[48]Peattie 1966, Chambers et al. 1996, Newmaster et al. 1997, Catling and Porebski 1998.

Personal care products

Some plants produce essential oils (Table 9) and other chemicals that may be used in perfumes, shampoos, deodorants, cosmetics, and other personal care items. Essential oils are concentrated aromatic oils of plant leaves, flowers, seeds, bark, roots and fruits. Oils found in trees are used in products such as talcs, insect repellants, and room deodorizers (National Aboriginal Forestry Association 1997, see also Materials and Manufacturing Products section below). Cedar leaf oil, for example, is used in men's cologne and Vick's Vaporub.

Overall, the cosmetic and fragrance market is estimated at US$8 billion, with an annual growth rate of 10% (National Aboriginal Forestry Association 1997). For the U.S., the flavours and fragrances market[43] is worth about US$3.5 billion (Freedonia Group 1998a). Demand for flavours and fragrances is expected to rise at least 7% annually in the U.S. Similarly, European markets are expected to remain strong for fine fragrances, cosmetics, toiletries, soaps, and detergents

Table 12. Species used commercially in materials and manufacturing.[49]

Species name	Common name	Commercial use
Abies balsamea	balsam fir is	resin used in mounting medium for microscopic lenses; sap oleoresin known as Canada turpentine; oil used to scent detergents, room fresheners, household cleaners, disinfectants
Acer spp.	maple	wood chemicals in lignosulfonates
Asclepias syriaca	common milkweed	fibres used in cloth or thread; silky hairs on seeds used for stuffing and as substitute for kapok in life preserver industry
Betula lenta	cherry birch	bark oil used in tanning of Russian leather
Dicranum scoparium	broom moss	bedding, mattresses, cushions, pillows in alpine Himalayas because insect-repellant and rot-resistant
Hylocomium splendens	mountain fern moss	used as chinking for log cabins in Alaska
Hypnum cupressiforme	cypress-leaved feather moss	bedding, mattresses, cushions, pillows in alpine highlands of Himalayas because insect-repellant and rot-resistant
Juniperus communis	common juniper	gin
Juniperus virginiana	eastern redcedar	wood oil in room sprays, household insect repellants
Larix laricina	tamarack	bark used to tan leather and make turpentine
Ledum groenlandicum	Labrador tea	insect repellant from crushed leaves, alcohol and glycerine
Myrica pensylvanica	bayberry	candles, soaps, dyes
Picea spp.	spruce	wood chemicals in lignosulfonates and alcohol
Picea glauca	white spruce	oil to scent detergents, disinfectants, soaps
Picea mariana	black spruce	sap used as glue substitute; twig and needle oil to scent detergents, disinfectants, soaps
Pinus spp.	pine	wood chemicals in lignosulfonates and alcohol
Pinus sylvestris	Scots pine	oil to scent room fresheners, disinfectants, soaps, detergents, and vaporizer liquids
Polytrichum commune	common hairy cap moss	household bedding, brooms, stuffing
Populus balsamifera	balsam poplar	buds in incense
Quercus alba	white oak	bark in tanning of leather
Quercus velutina	black oak	bark in tanning of leather
Rhus typhina	staghorn sumac	tanning of leather
Sphagnum spp.	peat moss	woven with wool into cloth; inner soles of hiking boots to cushion foot and absorb moisture and odours; footmats; binders in construction; insulation
Thuja occidentalis	eastern white cedar	leaf oil to scent closets, drawers and wood furniture, hardwood floor cleaning products, and natural fly repellants; incense
Tsuga canadensis	eastern hemlock	oil to scent disinfectants, detergents, soaps; wood chemicals in lignosulfonates and alcohol; tanning of leather
Urtica dioica var. gracilis	slender nettle	fibres of older plants used to make thread, rope, and fishing nets
Vaccinium macrocarpon	large cranberry	pulp waste in anthocyanic dyes

[49]Naegele 1996, Chambers et al. 1996, and commercial retail sources.

Table 13. Wholesale and retail prices for essential oils.[50]

Species	*Common name - plant part*	*Price (US$) (WS - wholesale; RT - retail)*
Abies balsamea	balsam fir – needle oil	10-ml: $ 3.45 WS, $5.74 RT 60-ml: $10.64 WS 120-ml: $19.28 WS
Betula lenta	cherry birch – bark oil	10-ml: $ 2.84 WS, $4.74 RT 60-ml: $ 7.04 WS 120-ml: $12.08 WS
Picea mariana	black spruce – twig and needle oil	10-ml: $ 5.95 WS, $9.92 RT 60-ml: $31.21 WS 120-ml: $53.97 WS
Thuja occidentalis	eastern white cedar – leaf oil	10-ml: $ 4.72 WS, $7.86 RT 60-ml: $18.26 WS 120-ml: $34.52 WS
Tsuga canadensis	eastern hemlock	10-ml: $ 3.25 WS, $5.41 RT 60-ml: $ 9.44 WS 120-ml: $16.88 WS

[50] Gritman Corporation, prices as of May 1999.

(Kalorama Information 1999). The LAMF study by Arborvitae Environmental Services (1997) reported that new suppliers of certain essential oils may face stiff competition, e.g., from China, which is a well-established provider of competitively priced material.

Pet care products

A relatively new area of commercial enterprise is the use of herbals, including medicinals, in pet care products. Pet supplies is an expanding market, with U.S. retail sales in 1997 of US$4 billion, and projected to grow to US$5.3 billion by 2002 (Kalorama Information 1998c). Another growing market is Japan at US$178 million in 1994 and growing at a rate of 10 to 20% per year.[44]

Ontario species used in herbal pet care products include cedar oil in flea collars, deodorants, shampoos, and hair detangling products; horsetail in wound-healing products; poplar buds in pain relievers; stinging nettle in dandruff control products; white oak bark and dandelion in intestinal cleansers; and goldenseal in products to control indigestion and gas. Most of these products are produced and distributed by U.S. companies.

Prices paid to harvesters of herbs

Collectors of wild plant biomass often do not share in the substantial revenues that their products eventually generate (Andrea Gunner, AG Consulting, B.C., pers. comm.). Low prices are paid to pickers and wildcrafters, e.g. US$0.90 to $3.00 per kg. In tracing the commercial path of 6 medicinal plants from the field to the market in Mexico, it was noted that only 6.17% of the consumer price, on average, was returned to the plant collectors (Hersch-Martinez 1995).

In Ontario, the prices paid by companies to individual harvesters is typical of such low revenues, despite the initial processing of the plant material necessary for shipments. Table 10 lists the prices paid for biomass of some ‘weed’ species mentioned earlier. Material from these species is used in a variety of natural health products and herbal teas produced by the purchasing companies.

Demand is strong from buyers but not in a sustainable fashion because they often are not willing to pay a high price for the raw materials. Also, there is no satisfactorily organized system of marketing wildcrafted herbs. Growers generally have to phone buyers, which is a tedious process involving up to 30 to 40 calls to arrange a sale.

Materials and Manufacturing Products

Specialty wood products

A wide assortment of products is refined from the wood of trees and produced from the biomass and extracts of tree and non-tree species in Ontario. Specialty wood products include practical items such as tool handles, canoes, smokewood, matches, and barrels; and more esoteric products such as musical instruments, carving wood, and craft wood (Table 11).

Specialty wood products constitute an important industry with excellent opportunity for growth. Major markets exist within Canada, the U.S., the European Union, and in Pacific-rim countries – especially Japan. A study of the value-added sector, which included specialty wood products, identified it as a growth area for groups investigating new business opportunities, e.g., Aboriginal companies (National Aboriginal Forestry Association 1997). Many specialty products are compatible with small-scale businesses.

Some of the specialty wood products listed in Table 11 were mainly in historical usage in Ontario, but in certain cases these items are becoming popular again and may represent niche industries. For example, canoes made of birch bark – an historical craft – have been re-introduced recently by a craftperson in northern Ontario, using traditional construction methods. The canoes have reportedly been selling for $9,000 to $11,000, mostly to U.S. customers.[46]

A growing trend is the recycling of used specialty wood items in a variety of products, thereby enhancing value-added and environmental benefits. Recycled wood products are discussed in more detail later (see Environmental Products).

Silvichemicals

Silvichemicals (chemicals from wood) are produced as byproducts of wood processing (Table 12) and have important industrial applications. These chemicals include alcohol and lignosulfonates. Alcohol (ethanol) can be produced from the fermentation of spent sulfite liquor. Lignosulfonates are made during the acid-bisulfite pulping of wood and are left over after the pulping process removes the cellulosic material from the wood.

Ethanol is used in cosmetics, foods, detergents and other industrial products.

[51] Ontario Ministry of the Environment.
[52] Environmental Building News, Vol.1, No. 1, July-August 1992, published by West River Communications, Inc.
[53] Reported in Northern Ontario Business, August 1998.
[54] Reported in the Sault Star, November 3, 1998.

Lignosulfonates are used as industrial binders, dispersants, and emulsifiers, for products such as animal feed, carbon black, concrete additives, ceramic and brick manufacturing, fertilizer pellets, oil well drilling muds, pesticides, soil stabilization, and tanning. Lignosulfonates may also be used as an ingredient in phenol formaldehyde resins, which are used in the production of oriented strand board.

Tembec Inc. is the leading supplier of lignosulfonates in Canada and the dominant supplier of 95% of the alcohol in Eastern Canada. Tembec's annual sales of silvichemicals – including alcohol, lignin, and resin products – is approaching $50 million and is growing at a rate of 20% a year for the last 5 years.[47] The company uses a variety of softwood and hardwood species, including jack pine, red pine, spruce, white pine, hemlock, and maple, for lignin products. Softwood species are preferred for alcohol production because of the high content of easily fermentable sugar (e.g., glucose, mannose) compared to hardwoods, which contain a lot of xylose. Current research is focussed on developing effective methods for xylose fermentation (B. Benson, Tembec Inc., pers. comm.).

Essential oils

Other commercial uses for forest products in materials and manufacturing include the use of forest plant oils in a variety of products (Table 12). Oils obtained from trees are generally produced by a lengthy steam distillation process using either the chopped wood or leaves and branch ends of the tree. There are other methods of production from fruits, flowers, and herbs as well (Thomas and Schumann 1992).

Canada is a major supplier of certain wild-harvested essential oils such as cedar leaf oil, fir needle oil, birch bark oil, black spruce twig and needle oil, and eastern hemlock oil. For other types of oils, cheaper and abundant supplies are provided by countries such as the U.S., China, and Russia. Sample wholesale and retail oil prices are shown in Table 13. Ontario supplies small quantities of essential oils, and collections are made by individuals or small companies. Quebec is, by far, the largest supplier of essential oils in Canada.

Cedar leaf oil, the main component of which is the terpene thujone, comes from the foliage of eastern white cedar. Boughs are harvested typically from the end of April to November in Ontario, and harvesters typically make about $110 per tonne, representing a secondary source of income for most (E. Boysen, Ontario Ministry of Natural Resources, pers. comm.). Among the many uses of cedar leaf oil are scents for closets and drawers, cleaning products for hardwood floors and wood furniture, and natural fly repellants.

The main areas of production of cedar leaf oil have been southeastern Ontario, New York, and eastern Quebec (National Aboriginal Forestry Association 1997). In Ontario, the distilleries tend to be small. Canadian commercial production of cedar leaf oil is greatest in Quebec, and one of the largest operations produces about 27 tonnes annually (R. Marcott, Cèdres Recyclés de l'Outaouais, pers. comm.). Most of this product is exported. The market value for cedar leaf oil is estimated at US$44 per kg according to one broker, and the market is expanding (B. Turner, David Cookson and Co., pers. comm.).

Table 14. Research at Canadian Forest Service (Great Lakes Forestry Centre) on plant-derived natural products.[55]

Subject	Contact
• Natural plant products from maple, pine, fir that act against forest tent caterpillar, European gypsy moth, and budworm (respectively) • Novel fungal isolates of pathogens to fireweed • Medicinal plant use by northern Ontario First Nations peoples as guide to new bioactive natural products	Mamdouh Abou-Zaid
• Plant produced chemicals – host acceptance and resistance to insects; semiochemical-based pest management systems	Peter de Groot
• Biological control of decay fungi and weeds, and modes of action	Michael Dumas
• Plant-produced chemicals involved in host acceptance and resistance to insects – identification and application to pest management systems, e.g., for spruce budworm, pine coneworm	Gary Grant
• Chemical structures of natural and synthetic compounds involved in plant-insect interactions (e.g., feeding deterrence)	Linda MacDonald
• Fate and environmental impacts of pest control products	Dean Thompson

[55] Contact: Great Lakes Forestry Centre, 1219 Queen St. East, P.O. Box 490, Sault Ste. Marie, Ontario, Canada P6A 5M7, Telephone (705) 949-9461

There is also some cedarwood oil shipped from Canada, but cheaper sources exist in the U.S. and elsewhere. Cedarwood oils can be produced from eastern redcedar and other species of the Cupressa family. The chief constituents of these oils are the terpene cedrene and cedral (cedar camphor). The essential oil is distilled from the sawdust and other by-products of the milling and furniture-making processes. It tends to be about 5 to 10 times cheaper than cedar leaf oil. Cedarwood oils are used in products such as room sprays, household insect repellants, leather dressings and preservatives, and wood-restoration solutions.

Balsam fir oil has a pleasant, fresh, turpentine-like odour and is highly volatile. Two of the terpenes contained in this oil are fenchone and thujone. It is used in fragrance formulations for air fresheners, detergents, household cleaners, and disinfectants. Small quantities come from Ontario, unlike Quebec where substantial amounts of this oil are produced. Ciesla (1998) reported that production of balsam fir oil by Huiles Essentialles Branchex Ltd. of Quebec was about 4.5 tonnes annually. The U.S. market for the product has been estimated to be about 18 to 36 tonnes annually, valued at about US$325,000 to $650,000 (Arborvitae Environmental Services 1997).

[56] http://www.recycle.net/exchange

[57] Reported in Northern Ontario Business, September 1998.

Environmental Products

It is expected that the Canadian market for environmental products and services will grow to $12 billion by the year 2000.[51] This sector is also a key one since recent provincial and federal frameworks for supporting the sustainability of forests rely in part on successes in developing these types of products. Recycled wood materials, and bioenergy and biofuels are examples of products that may be consistent with national and international efforts to curb carbon dioxide emissions, although scientific and economic debates continue as to the overall merits of various approaches. In North America, buildings and the building industry reportedly account for about 30% of carbon dioxide emission and 35 to 40% of ozone depletion.[52]

Bioenergy

National statistics indicate that biomass provides approximately 7% of Canada's total energy use, and it is estimated that almost all of the biomass originates from the forest (Canadian Council of Forest Ministers 1997). The forest sector itself uses the largest share of the bioenergy for space heating, steam and electricity – primarily in pulp and paper mills. Lignosulfonates from the pulping process are frequently used as fuel products, as well as in many other industrial applications discussed earlier (see Materials and Manufacturing – silvichemicals).

In Ontario, fuelwood is available to the public following timber harvest on Crown land. This is intended to ensure maximum utilization of unmerchantable and unmarketable timber. The locations where fuelwood is available must be advertised, and a license is required to collect personal use fuelwood, the price of which is determined under sections 31 and 48 of the Crown Forest Sustainability Act. There is only one stumpage rate for fuelwood for all species, currently set at $3.23 per m^3.

Emptied seed cones can also serve as a fuel source. For example, cones from the seed processing operation of Millson Forestry Service in Timmins are often used to serve some of the plant's energy needs (S. Millson, pers. comm.). Also, public purchasers of cones sometimes coat them with copper before resale, as the copper produces colourful flames when burnt in home fireplaces.

Bioenergy products may be supplied to other users. For example, Superior Wood Pellets (Broland Enterprises, Inc.) produces pellets for wood stoves using waste materials.[53] Also, Domtar is adding a co-generation plant to its White River operation to consume the estimated 6 ha of wood waste that borders their site, and to generate steam for Domtar and additional power to feed the Ontario Hydro grid.[54] The plant has the capacity to produce 7 ½ megawatts of power which is enough to run the Domtar mill,

[58] Agriculture and Agri-Food Canada.
[59] http://www.carolinian.org
[60] CFS website: http://www.nrcan.gc.ca/cfs

Table 15. Landscape tree and shrub species.[61]

Species	Common name
Abies balsamea	balsam fir
Acer pensylvanicum	striped maple
Acer rubrum	red maple
Acer saccharinum	silver maple
Acer saccharum	sugar maple
Alnus rugosa	speckled alder
Amelanchier spp.	serviceberry
Andromeda polifolia	bog rosemary
Aronia melanocarpa	black chokeberry
Betula papyrifera	white birch
Celastrus scandens	American bittersweet
Celtis occidentalis	hackberry
Cephalanthus occidentalis	buttonbush
Cercis canadensis	eastern redbud
Clematis virginiana	clematis
Comptonia peregrina	sweetfern
Cornus alternifolia	alternate-leaved dogwood
Cornus obliqua	silky dogwood
Cornus racemosa	gray dogwood
Cornus stolonifera	red-osier dogwood
Crataegus crus-galli	cockspur hawthorn
Crataegus succulenta	long-spined hawthorn
Diervilla lonicera	bush honeysuckle
Elaeagnus commutata	silverberry
Fagus grandifolia	American beech
Fraxinus americana	white ash
Fraxinus nigra	black ash
Fraxinus pennsylvanica	green ash
Gymnocarpium dryopteris	oak fern
Hepatica americana	round-lobed hepatica
Hypericum kalmianum	Kalm's St. John's-wort
Hypericum perforatum	St. John's-wort
Juglans nigra	black walnut
Larix laricina	tamarack
Lonicera dioica	honeysuckle
Nyssa sylvatica	black gum
Ostrya virginiana	ironwood
Parthenocissus quinquefolia	Virginia creeper
Picea abies	Norway spruce
Picea glauca	white spruce
Picea mariana	black spruce

Species	Common name
Picea rubens	red spruce
Pinus banksiana	jack pine
Pinus resinosa	red pine
Pinus strobus	eastern white pine
Platanus occidentalis	sycamore
Populus balsamifera	balsam poplar
Populus x *canadensis*	Carolina poplar
Populus deltoides	eastern cottonwood
Populus tremuloides	trembling aspen
Potentilla spp.	cinquefoil
Prunus pumila	sandcherry
Prunus serotina	black cherry
Prunus virginiana	choke cherry
Rhus copallina	shining sumac
Rhus typhina	staghorn sumac
Robinia pseudoacacia	black locust
Rosa spp.	wild rose
Quercus alba	white oak
Quercus macrocarpa	bur oak
Quercus palustris	pin oak
Quercus prinus	chestnut oak
Quercus rubra	red oak
Rhus spp.	sumac
Salix spp.	willow
Sambucus spp.	elder
Sorbus americana	American mountain ash
Sorbus decora	showy mountain ash
Spirea alba	meadowsweet
Symphoricarpos albus	snowberry
Thuja occidentalis	eastern white cedar
Tilia americana	American basswood
Tsuga canadensis	eastern hemlock
Ulmus americana	white elm
Viburnum acerifolium	maple-leaved viburnum
Viburnum alnifolium	hobblebush
Viburnum cassinoides	northern wild raisin
Viburnum dentatum	arrow wood
Viburnum lentago	nannyberry
Viburnum rafinesquianum	downy arrow-wood
Viburnum trilobum	highbush cranberry

[61] Assembled from various retail sources.

Table 16. Cultivated ornamental woodland wildflowers and grasses.[62]

Species	Common name
Aquilegia canadensis	wild columbine
Arisaema triphyllum	Jack-in-the-pulpit
Asclepias syriaca	common milkweed
Campanula rotundifolia	harebell
Chamaelirium luteum	devil's bit
Epilobium angustifolium	fireweed
Eupatorium maculatum	Joe-pye-weed
Eupatorium purpureum	purple Joe-pye-weed
Glyceria striata	fowl meadow grass
Helianthus strumosus	woodland sunflower
Monarda fistulosa	wild bergamot
Oenothera biennis	evening primrose
Rosa blanda	meadow rose
Scirpus cyperinus	woolgrass
Smilacina racemosa	Solomon's plume
Thalictrum dasycarpum	meadowrue
Trillium grandiflorum	white trillium
Viola pedata	birdsfoot violet

[62] Sutton and Sutton (1986) and retail sources.

the town of White River and the plant itself. This apparently makes the Domtar mill 100% energy efficient. They use the whole log – by producing lumber, chips, sawdust, selling dry shavings from the planer to use as bedding, and using the rest as fuel to produce electricity and steam.

Biological pesticides

Biological pesticides can offer ecologically attractive alternatives to chemicals. Some herbs are sold commercially as insecticides. For example, poison hemlock (*Conium maculatum*) contains coniine, an insecticide effective against aphids and blowflies. Stinging nettle (*Urtica dioica*) also serves as a natural insecticide. According to Chambers et al. (1996), crushed Labrador tea (*Ledum groenlandicum*) leaves make a good insect repellant.

Biological insecticides have been with us for some years since the introduction of the commercial microbial insecticide *Bacillus thuringiensis* (*Bt*) – effective against forest Lepidoptera pests such as spruce budworm. The Canadian Forest Service (CFS), which developed *Bt* as a biological insecticide, has an intensive research program in biopesticides, and also makes new products available for licensing and commercialization.

Part of the research focus of the CFS is to study naturally derived products from plants for management of pests. Many plants synthesize chemicals that are toxic to insect pests, regulate their growth, or discourage them from feeding on host plants. Similarly, competing vegetation may be discouraged through the use of biological herbicides derived from fungi. These mycoherbicides include one that is isolated from the

[63] National Forestry Database Program, Canadian Council of Forest Ministers, http://nrcan.gc.ca/cfs/prog/iepb/nfdp/.

fungus *Chondrostereum purpureum* and is specific to hardwoods. It is also harmless to the environment. Another research focus is mycoviruses – viruses that act against pathogenic fungi.

To safeguard against possible risks to the environment, the CFS has test sites to assess environmental impact of biopesticides and herbicides. Both aquatic and soil microcosms are studied for effects of pest control products on the habitat and resident organisms and microbes.

A major objective of the CFS is to transfer pest control product technology to the commercial sector for use in forest protection. By consulting the CFS website, a potential user or commercial developer can view the CFS technologies currently available for licensing and commercialization. Technologies of specific interest in Ontario may include the use of fungal isolates against grass and alder competition.

Research on biological pest control methods is conducted at 5 CFS centres in Canada. Table 14 identifies some of the activities underway at the Ontario-based Great Lakes Forestry Centre that are relevant to NTFPs.

Bioherbicide for *Calamogrostis* (Patent US5472690)

Developed by the CFS in British Columbia, this mycoherbicide controls *Calamagrostis canadensis* and related grasses. The mycoherbicide is produced from one or both of the fungi *Fusarium nivalis* and *Colletotrichum calamagrostidis,* isolated from a diseased plant of *C. canadensis* var. *canadensis.* A method of treatment includes the application of endophytes of reduced virulence to grass bordering a target area to prevent either natural or inoculative infection. The technology is available for licensing and commercialization.

Bioherbicide for *Alnus* (Patent US5340578)

The CFS in B.C. have also developed a method for controlling red alder using the fungus *Nectria ditissima.* The method involves injecting a wooden charge containing a fungus capable of killing weed trees. Preferably the fungus is indigenous to the area where the trees are being treated. This technology is also available for licensing and commercialization.

Recycled wood materials

Waste wood has been defined as ‘all wood, wood fibre, and bark that is discarded, unused or unwanted by manufacturing, construction or demolition operation, municipality, government agency or other organization’ (Ontario Ministry of Environment 1991). It may include sawdust, shavings, bark, end-cuts, chips, pallets, skids, damaged guard rails, and used Christmas trees; however materials such as sawdust, shavings, and chips are now routinely used in secondary products in Ontario and many other jurisdictions.

Wood waste can often be diverted from landfills through refurbishing and reprocessing to yield many wood-based products such as landscaping materials, drying agents for composting, and energy products.

For suppliers of wood waste products, on-line services, e.g., the Recycler’s Exchange[56] are available to access current market prices for wood waste materials including sawdust and fuel chips.

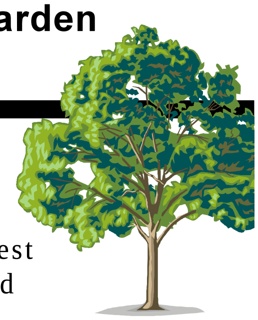
Table 17. Plants used commercially in the floral and craft industries.[64]

Species	*Common name*	*Plant part*
Abies balsamea	balsam fir	branches
Achillea millefolium	yarrow	flowers
Adiantum pedatum	maidenhair fern	fronds
Amaranthus spp.	pigweed	flowers
Anaphalis margaritacea	pearly everlasting	flowers
Betula spp.	birch	branches and bark peels
Cladina rangiferina	reindeer lichen	foliage
Dicranum scoparium	broom moss	foliage
Equisetum spp.	horsetail	foliage (with stem)
Dirca palustris	leatherwood	foliage
Hylocomium splendens	mountain fern moss	foliage
Hypericum perforatum	St. John's-wort	flowers
Hypnum cupressiforme	cypress-leaved feather moss	foliage
Juniperus spp.	juniper	foliage with berries
Lonicera dioica	honeysuckle	branches
Lycopodium annotinum	interrupted club-moss	foliage
Picea spp.	spruce	branches
Pinus strobus	eastern white pine	branches
Polytrichum commune	common hairy cap moss	foliage
Quercus spp.	oak	foliage
Salix discolor	pussy willow	branches with catkins
Sphagnum spp.	peat moss	foliage
Trientalis borealis	starflower	flowers
Typha latifolia	cattail	flower spikes

[64] Based on information obtained from supplier catalogues and retail outlet displays.

Forest companies are interested in developing alternative products, and in some instances these may help them to solve other problems in their operations. For example, MacMillan Bloedel's plywood mill near Nipigon, in seeking to find a cost-effective method to safely dispose of a pile of more than 76,000 m^3 of waste bark, have developed a bark composting plan.[57] They are testing the use of nitrogen from fish parts or sludge from nearby waste ponds to activate the composting process. They are also looking for commercial uses for the compost material, such as in the production of top soil and sand box sand.

Landscape and Garden Products



Landscape plants

Trees, shrubs, and flowering plant species that originate in the forest are popular in home and commercial gardens in Ontario. About 100 examples of these species are listed in Tables 15 and 16. Many are propagated at nurseries. Farm cash receipts of the floriculture and nursery industry in Canada were worth \$1.1 billion in 1997, representing a rate of growth of 12.3% in the last decade.[58] This is the third largest farm cash receipts crop after wheat and canola.

[66] New Brunswick Department of Natural Resources and Energy.
[67] Reported in the Daily Southtown, Washington, February 25, 1998.

Table 18. Plants used as dyes.[65]

Species	Common name
Acer rubrum	red maple
Achillea millefolium	yarrow
Acroptilon repens	Russian knapweed
Agrimonia eupatoria	agrimony
Amaranthus retroflexus	redroot pigweed
Ambrosia spp.	ragweed
Apocynum cannabinum	Indian hemp
Arceuthobium spp.	mistletoe
Arctium minus	burdock
Arctostaphylos uva-ursi	bearberry
Artemesia frigida	prairie sagewort
Aster spp.	aster
Campanula rapunculoides	creeping bellflower
Carduus nutans	musk thistle
Carex spp.	sedge
Carya ovata	shagbark hickory
Castilleja miniata	minute painted-cup
Chenopodium spp.	goosefoot
Cichorium intybus	chicory
Cirsium arvense	Canada thistle
Convallaria majalis	lily-of-the-valley
Convolvulus arvensis	field bindweed
Conyza canadensis	horseweed
Cornus florida	flowering dogwood
Coronilla varia	variable crown-vetch
Cuscuta spp.	dodder
Dipsacus fullonum	wild teasel
Echinochloa crusgalli	common barnyard grass
Epilobium angustifolium	fireweed
Equisetum arvense	field horsetail
Erodium cicutarium	stork's-bill
Euphorbia esula	leafy spurge
Euphorbia marginata	snow-on-the-mountain spurge
Fraxinus quadrangulata	blue ash
Gaillardia aristata	blanket-flower
Galium boreale	northern bedstraw
Galium verum	yellow bedstraw
Glycyrrhiza lepidota	wild licorice
Grindelia squarrosa	broad-leaved gum-plant
Heracleum lanatum	cow parsnip
Heterotheca villosa	camphorweed
Hypericum perforatum	St. John's-wort
Iva xanthifolia	burweed marsh-elder
Juglans cinerea	butternut
Juglans nigra	black walnut
Juncus balticus	baltic rush
Juniperus virginiana	eastern redcedar
Kochia scoparia	summer cypress
Lactuca serriola	prickly lettuce
Laportea canadensis	wood nettle
Lathyrus spp.	pea
Lupinus spp.	lupine
Lysimachia spp.	loosestrife
Maclura pomifera	osage-orange
Mahonia spp.	Oregon-grape
Malva neglecta	cheeses
Marrubium vulgare	common horehound
Melilotus officinalis	yellow sweet-clover
Mentha x *piperita*	peppermint
Monarda fistulosa	wild bergamot
Oxalis stricta	upright yellow wood-sorrel
Plantago spp.	plantain
Polygonum aviculare	prostrate knotweed
Polygonum cuspidatum	Japanese knotweed
Populus deltoides	eastern cottonwood
Populus tremuloides	trembling aspen
Portulaca oleracea	purslane
Potentilla spp.	cinquefoil
Pteridium aquilinum	bracken fern
Quercus velutina	black oak
Ranunculus acris	tall buttercup
Rhamnus cathartica	buckthorn
Rhus spp.	sumac
Ribes spp.	currant
Rosa spp.	wild rose
Rudbeckia hirta	black-eyed Susan
Rumex crispus	curly-leaf dock
Salix spp.	willow
Salsola kali	Russian thistle
Sambucus canadensis	common elder
Sanguinaria canadensis	bloodroot
Saponaria officinalis	bouncing-bet
Scirpus acutus	hard-stemmed bulrush
Senecio jacobaea	tansy grounsel
Sisymbrium altissimum	tall tumble-mustard
Solidago spp.	goldenrod
Sonchus oleraceus	common sow-thistle
Tanacetum vulgare	common tansy
Taraxacum officinale	dandelion
Tragopogon pratensis	meadow goat's-beard
Trifolium spp.	clover
Tsuga canadensis	eastern hemlock
Tussilago farfara	coltsfoot
Typha latifolia	cattail
Urtica dioica	stinging nettle
Vaccinium spp.	blueberry
Verbascum thapsus	common mullein
Xanthium strumarium	tumor-curing cocklebur

[65]Thomas and Schumann 1992, Chambers et al. 1996.

Some of these species – such as eastern redbud – are no longer abundant in natural stands because of urbanization and clearing of forest lands, particularly in ecologically treasured pockets such as the Carolinian forest of southwestern Ontario. The Carolinian Canada Coalition, which is a partnership of public and private agencies working cooperatively to conserve biodiversity in the Carolinian region, lists sources of native plant materials in Ontario.[59]

A critical aspect of restoration is the use of native tree, shrub, and herbaceous plant species that are naturally adapted to their local area. The use of native plants encourages the conservation of the diversity of species that originally evolved in the Carolinian region. The Carolinian Canada web site lists 19 nurseries and other sources of native, genetically appropriate, plant species in Ontario. Varieties include forest, grassland, and wetland seeds and plants – both herbaceous and woody.

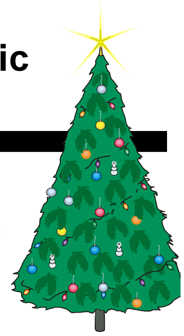
Of increasing popularity nowadays are cultivated native ornamental woodland wildflowers and grasses (Table 16) that can be purchased from various suppliers in the province. Propagation of wild woodland flora through nurseries is really the only acceptable route to obtaining these species, as wild collections on a large scale would not be ecologically supportable for many species. Wildflower plants should only be used to provide source material for propagation, which should be carried out to avoid compromising the source and its habitat.

Occasionally, new ornamentals are developed through research. For example, the Petawawa National Forestry Institute, CFS, produced a new variety of ornamental white spruce, which has bright yellow (instead of the normal green) spring foliage and a slower than normal growth rate. The CFS has made this product available for licensing and commercialization.[60]

Mulches and soil amendments

Mulch materials and soil amendments from forest trees species are abundant, and include bark and sawdust mulches from wood processing waste, peat moss, and mulches made from recycled Christmas trees and crushed cones. For example, at the Ontario Tree Seed Plant, emptied, broken cones are frequently made available to the local public for use as mulches on driveways and garden plots. Mulches in general are used to keep weeds under control, reduce moisture evaporation and need for irrigation, and maintain aeration in the soil. The Seed Plant also provides cone material to a local commercial rose grower, for use as an amendment in the peat:sand growing mix.

Decorative and aesthetic Products



Christmas trees

Ontario currently produces approximately 580,000 Christmas trees annually, worth about $11.5 million (T. Leuty, OMAFRA, pers. comm.). This is an estimate of farm production, since Ontario has not updated actual statistics for several years. Quebec is Canada's largest producer, with 1,887,000 trees reported for 1997 (S. Gailloux, National Forestry Database Program, pers. comm.). Nova Scotia and New Brunswick are the other main producers.

There are approximately 3500 ha of farmed Christmas trees in Ontario, of which 440 ha are harvested annually. Each ha produces about 1320 trees (T. Leuty, OMAFRA, pers. comm.).

The majority of Christmas trees are used locally, with exports accounting for only 2.6% of the total value for Ontario.[63] Ontario exports fewer Christmas trees than some other provinces. In 1998, Ontario exported 47,717 trees valued at $597,835, only 1.8% of total Canadian exports and 1.65% of the total Canadian value of $36.2 million (Canadian Christmas Tree Growers Association 1999). In contrast, Quebec, Nova Scotia, and New Brunswick were responsible for 51.4%, 29.5%, and 12.7%, respectively, of Canadian tree exports. The largest markets for Canadian Christmas trees are the U.S., Puerto Rico, and Mexico.

In Ontario, both domestic and export markets are dominated by Scots pine (*Pinus sylvestris)*, followed by white spruce (*Picea glauca)* and, more recently, balsam fir (*Abies balsamea)* and Fraser fir (*Abies fraseri*) have become popular. Eastern white pine (*Pinus strobus*) is a traditional favourite. Average selling price for Christmas trees is about $20, but high quality Fraser and balsam fir often sell for $30 to $40 (T. Leuty, OMAFRA, pers. comm.).

Christmas trees are marketed in several ways, depending on volume of production and farm location relative to urban centres (Leuty 1999). Large producers usually establish wholesale outlets or buyers. Producers close to urban centres may retail directly to the customer or use a cut-your-own system. Except in the cut-your-own system, spruce and fir are cut from mid-November into December if snow conditions allow access to plantations. Scots pine is typically cut earlier to avoid foliar yellowing from early frost.

Christmas trees are graded following regulations under the Farm Products Grades and Sales Act for the province of Ontario. Grading is based on several features including branch spacing and quality, foliage colour and density, tree shape, stem straightness, mechanical damage, presence of lichens or other foreign material, and any other defects (Leuty 1999). Although grading is not mandatory, a knowledge of grading standards can help growers to produce a more valuable product.

Arts and crafts

Woody and herbaceous species provide a variety of materials for the floral and craft industries. These include branches and twigs, foliage, bark peels, cones, flowers, and berries (Table 17), and can be from fresh, dried, or preserved specimens. Many Ontario tree species also provide aesthetic wood products such as carvings, toys, jewellery boxes, and musical instruments (Table 11). Another common use is in the production of natural dyes for cloth and crafts (Table 18). In the U.S., dyes and organic pigments comprise a US$6 billion industry (Freedonia Group 1998d).

Floral, foliage, and branch products

Floral, foliage, and branch products are sold either in bulk quantities or crafted into finished items such as wreaths, hanging swags, table decorations, woven baskets, potpourris, sachets, herb pillows, trivets, and air fresheners.

In general, value-added craft products are the most profitable, supplying a lucrative giftware market (Arborvitae Environmental Services 1997). In the U.S., giftware retail sales were valued at US$21 billion in 1998, of which $3.6 billion were from seasonal decorative items. This market is projected to reach US$28 billion by 2003 (Kalorama Information 1998a). Examples of typical prices for finished products from one mail order company are US$16 for a 24-inch (61-cm) wreath of balsam fir (decorated with berries, pine cones, moss, apples and bow); US$15 for an 18-inch (46-cm) Christmas swag of balsam fir, cedar and pine; US$16 for centerpieces made of balsam fir, cedar and pine, and decorated with pine cones, candles, berries, and a bow.

Potpourri is a homogenous mixture of dried sweet scented flowers and leaves with aromatic spices and stabilizing agents or fixatives (e.g., common salt). The market for potpourris is about $500 million to $1 billion, but has been relatively stagnant with respect to the bulk potpourri segment (Mitchell and Associates 1997). Bulk markets are depressed with Asian and Latin American products providing low cost ingredients, usually wood chip based. The main opportunity is in value added or specialty potpourris, where the container or image is as important as the product ingredients. Pillows, sachets, jewellery boxes, and ornamental potpourri containers command a higher price. There is some appreciation of theme potpourris bases representing certain species for forest types. Mitchell and Associates (1997) suggested that a Boreal Forest potpourri with a unique look, containing nuts, acorns, alder cones, dyed wood chips, birch strips, and pine needles could have a market niche.

Florals and greenery constitute a substantial industry with significant opportunities for further development (e.g., Arborvitae Environmental Services 1997, Mitchell and Associates 1997, Mater Engineering 1993). In New Brunswick, the Christmas tree and wreath industry had a wholesale value of $14 million in 1996, in which over $8 million was attributed to wreath sales – mostly of balsam fir.[66] In Minnesota, which is the largest supplier of bough and wreath products in the U.S., wreath sales are worth at least US$10 million annually, based on industry interviews in 1994 (Preece 1999). Considering prices for bulk quantities, a survey of the U.S. market reported that the wholesale value

[68] Current lists can be obtained from the COSEWIC website: http://www.cosewic.gc.ca.

Extirpated: no longer known to exist in the wild in Canada, but occurring elsewhere. Endangered: threatened with imminent extinction or extirpation throughout all or a significant portion of its Canadian range. Threatened: likely to become endangered in Canada if the factors affecting its vulnerability are not reversed. Vulnerable: at risk because of low or declining numbers, occurrence at the fringe of its range or in restricted areas, or for some other reason, but is not yet threatened.

[69] Source: Saskatchewan Agriculture and Food.

Table 19. Issues related to NTFP development.

Issue	*Recommendation*
Sustainability	
overharvesting of wild plant sources	• establish inventory of locations and abundance of species of interest • develop methods for agroforestry, nursery production, and tissue culture production • control unrestricted collection • protect rare, vulnerable, threatened, and endangered species • use plant material that would normally be burned or treated with herbicide/manual controls, e.g., weeds • survey related species that may produce similar benefits • avoid collections of sensitive species during periods of climatic stress
loss of genetic diversity in target species	• collect in different areas • harvest non-destructively, e.g., cuttings/prunings rather than whole plant • understand ecological requirements for reproduction, survival, growth • develop propagation methods, using wild sources for donor material only
variability in active chemical ingredients of collections	• understand influence of genetic source, and effects of diurnal, seasonal, site, and environmental factors • develop appropriate methods for harvesting, storage, transport, and chemical extraction • develop laboratory methods for synthesis or semi-synthesis of active ingredients
conflicts among multiple resource uses, e.g., timber harvest	• coordinate collections with harvesting operations, e.g., removal of weed biomass • coordinate access to site with all user groups • minimize site damage resulting from soil compaction and disturbance, e.g. restrict periods of collection, avoid sensitive areas • emphasize non-destructive collections of branches, cuttings, prunings • stagger timing of collection to minimize interference with peaks in other activities, e.g., off-season collections • avoid buildup of waste materials on site that can increase risk of fire
Health and safety	
risk of toxicity in wild populations	• disseminate resource information, implement training and education for potential collectors and developers • limit unrestricted collection of certain wild-grown products • develop methods for controlled propagation of target species • develop appropriate methods and guidelines for collection, storage, and processing to minimize risk

Table 19. *continued*

Issue	*Recommendation*
unsubstantiated product claims	• ensure adherence to relevant legislation, policies, and guidelines for product testing • distribute information and provide access to impartial advice
variability in quality of health products	• ensure detailed product labelling • develop appropriate methods for collection, storage, and processing • understand the influence of genetic source, environment, season, etc. on product quality • develop propagation systems
conflicts between collectors in the field	• coordinate collection activities among all users
Social and economic concerns	
lack of awareness of NTFP opportunities	• provide information, training, education, and access to expert advice for potential developers • increase government interagency cooperation and awareness of potential opportunities; coordinate services to developers
low profitability to individual collectors of plant biomass	• develop final products for retail rather than providing source material to large developers
uncertain profitability for developers of new NTFPs	• provide access to information, training, education, and expert advice • provide access to research, feasibility, and marketing resources • provide funding programs for development of new products
loss of revenue to government	• combine revenue generation with resource stewardship, e.g., permits for NTFP collection • consider NTFP opportunities on lands where removal of timber is not permitted and where removal of plant materials would have no adverse effects.

for dried flowers and foliage is $295.7 million annually, and for preserved foliage is $177.6 (Mitchell and Associates 1997).

Even plants considered nuisance weeds can become valuable decorative items, based on experiences in other jurisdictions. For example, in the Pacific Northwest, the salal plant – historically a notorious weed on forest sites – now enjoys new popularity as a result of its decorative, long-lived foliage. Salal is used in various types of floral and greenery arrangements, and generates millions of dollars in annual revenues (de Geus 1995). In Ontario, packets of about 15 preserved salal leaves from the west coast currently retail for $3.99 at one large craft supply chain. Unfortunately, along with the burgeoning demand, some serious issues have arisen regarding competition for harvest of these products, sometimes resulting in violent confrontations among pickers on sites in the Pacific Northwest.[67]

Cones

Craft materials may be turned out as by-products of normal forest processing operations. For example, manufacturers of cone products often obtain their cones from seed cleaning plants after the seed has been removed (Thomas and Schumann 1992). In Ontario, there are 2 seed cone processing plants – Millson Forestry Service in Timmins and the Ontario Tree Seed Plant in Angus. Both plants sell extracted cones to bulk purchasers and the general public, although the public is not a big market for the Timmins plant (S. Millson, Millson Forestry Service, pers. comm.).

The total quantity of cones marketed is in the order of 300 tonnes, mainly black spruce and jack pine. Red pine cones are a popular item when available. Bulk purchasers of cones tend to be located outside Ontario, such as in the U.S. and Alberta. Cones are sold by the pound at Millson for $.30 per lb ($.66 per kg), or by the bag at the Ontario Tree Seed Plant. Bags range in weight from 3.9 kg (white pine) to 19 kg (black spruce) per filled bag, at a cost ranging from $7.50 per bag for black spruce to $15 for white cedar and larch (C. Frankcom, pers. comm.). Open extracted cones are sold at Angus from 16 species of spruce, pine, hemlock, cedar, and larch.

Some cones are too fragile to withstand the seed extraction process intact. These include Norway spruce, white spruce, and, often, white pine. However, damaged cones can be used for other purposes, such as in landscaping or as fuels.

The majority of cones are destined for the craft market, especially Christmas craft items. Final products include decorated individual cones (fancied up with flowers, ribbon, figurines, and other trinkets), wreaths and swags, garlands, and potpourris. The peak period for cone sales is early to mid summer, which allows craft products to be ready for retail by late summer and autumn. In the floral market, large cones are generally more marketable. In the potpourri market, small, midsized, and large cones may all be used. Hemlock is considered a premium cone for potpourris because it is light and has a good shape. Small pine cones are generally more valued for wreath-making.

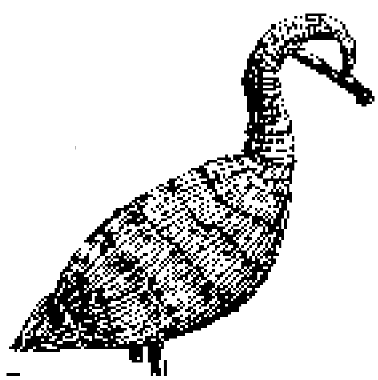
Carvings and native crafts

Many woody species can be used for carving, and popular species include black cherry, butternut, basswood, white birch, maple, willow, trembling aspen, white spruce, eastern white cedar, and

[70] http://www.fda.gov.

[71] http://www.herbs.org.

hawthorn (Table 11). Often, scrap and residual wood can be carved; one carver in southern Ontario uses fallen cedar trees to fashion nursery rhyme figures and to depict fairy tales. The variety of carved creations is virtually unlimited, and includes decorative wildfowl (waterfowl, shorebirds, songbirds, birds of prey); miniatures; aquatic figures; caricatures; human figures; animals/ wildlife; abstracts; carousel animals and rocking horses; woodburnings; intarsia (wood inlays); chip carvings; paddles and canes; working decoys; and architectural, nautical, and landscape scenes. Prices for carvings vary widely, from a few dollars for small items to thousands of dollars for larger and intricate pieces. The U.S. and Europe are the best markets.



Traditional crafts from Ontario's native community are sold in markets in the U.S., and especially Germany. The bark and wood of white birch, American elm, ash, red-osier dogwood, white spruce, alder, poplar, cedar, and other species, are fashioned into a variety of ornamental and functional pieces such as lampshades, lamp bases, wastebaskets, miniature decorative canoes, teepee ornaments, plant pots, baskets, quill-decorated boxes, tamarack geese, dream-catchers, trivets and Christmas tree ornaments. Sweetgrass is also commonly worked into these items.

According to one company specializing in native arts and crafts in the Algoma area, best selling items include lampshades and wastebaskets. Retail prices vary widely, for example, a 52-cm wide birch bark wastebasket can sell for about US$50, a 10-cm wide quill-decorated box for US$250, a table-top lampshade and base for US$160, and small – less than 25-cm long – ornaments such as teepee villages and birch bark canoes sell in the US$20 to $30 range (V. Wearn, Polar One, pers. comm.). Many of these items are authentic, that is, only natural products are used in their construction; spruce roots and sinew are typically used for joinery. Tamarack geese are popular items in craft shops in Canada, and a given supplier may market between 2,000 and 3,000 annually.

The market for native craft items has not been quantified, but is likely in the order of US$ millions (V. Wearn, pers. comm.). At present, demand exceeds supply. Many of these crafts are painstakingly constructed, and it is often difficult to find sufficient numbers of artisans to meet the demand for many types of products. For example, decorative miniature canoes of elm bark are prized for their beauty; however, only one family in the Algoma area makes them. Quill-decorated boxes require much artistic skill as well as the time to prepare the quills (cleaning, sorting, dyeing) prior to use, requiring several days to craft a small box. The need for more sources of such items is a major factor limiting the expansion of this industry.

Some markets prefer certain types of products. For instance, birch bark items are considered too rustic for New York or Philadelphia tastes, but sweetgrass and ash items may be fine. For the more rustic products, ready markets are Wisconsin, Michigan, and Minnesota, and also Colorado, North Carolina, Florida, and Alaska (V. Wearn, pers. comm.). Many of these products are sold through agents and wholesalers who serve the local retail market in a given area.

Issues

There are a number of issues associated with the development of NTFPs and they must be addressed for development of these products to be successful in the long term. For example, commercial development of a plant-derived natural product must be economic, sustainable, reliable, and not adversely affect the environment (McChesney 1993). De Geus (1995) suggested that a number of issues need to be addressed, including sustainability, multiple forest resource use, revenue to government, social and economic factors, health and safety, and interagency coordination. Here, issues are discussed in the context of sustainability, health and safety, and social and economic concerns (Table 19). In addition, possible approaches to their resolution are presented. Addressing such issues requires coordination and planning by government, resource managers, and product developers.

Government can help to address the issues by becoming involved in:

- awareness – providing information on opportunities, risks, funding programs, expertise
- facilitation – coordinating partners, research support, information on ecological aspects, and removing unnecessary barriers to development
- stewardship – providing incentives for responsible management, compliance monitoring, quality control, habitat protection
- promotion – increasing awareness of successes of Ontario companies, and expanding markets outside Ontario
- research – enhancing resource quality and productivity, supporting research for new product development, and testing new products
- conflict – resolving among various users
- access – facilitating for product developers

Sustainability

Sustainability is an issue because of the dangers of overharvesting a species in the wild or depleting wild gene pools. Also, maintaining a sustainable, reliable source of chemical active ingredients in some products can be a problem, owing to natural and man-induced variability in phytochemical contents. Conflicts among users of the various forest resources can further endanger sustained supplies of botanical material. Identifying species requiring protection is aided by the availability of published lists of high priority species; e.g., Ontario's rare plants (Newmaster et al. 1998); the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists of endangered, threatened, or vulnerable species;[68] and a recent list of rare wild plants of potential or current economic importance in Canada (Appendix I – Catling and Porebski 1998).

Ontario has not generally regulated the harvest of NTFPs on forest sites, but it does protect flora threatened with extinction, through the Endangered Species Act. The Ministry of Natural Resources also regulates wetland harvests of wild rice with the Wild Rice Harvesting Act. Provincially, there are 51 legal Acts that govern and regulate the use of natural resources in Ontario. Also, federal legislation is relevant to many novel uses of forest-based species in the food, health, and biotechnology industries. Examples that may have direct bearing on the development or extraction of NTFPs are listed in Appendix II.

In contrast to Ontario, Saskatchewan requires a permit for all Special Forest Products (SFPs) harvested for commercial purposes.[69] The Saskatchewan government states that improper harvesting techniques can cause severe environmental damage or greatly affect the regeneration of the product harvested; and the government can imposes penalties or prosecute for improper practices. Additional regulations for special forest products harvested in the Provincial Forest are currently under consideration in Saskatchewan. Often, timber and special forest product harvesting operations can occur concurrently. Communication with the timber harvesting companies to discuss SFP harvesting are recommended to avoid potential conflicts.

In the United States, commercial harvest of special forest products from federal forested land requires strict adherence to regulations. The harvester must obtain a permit from local federal agency offices, such as the U.S. Department of Agriculture Forest Service and U.S. Department of the Interior Bureau of Land Management (BLM). Permits generate revenue for government, while allowing it to manage and regulate harvest, thus providing an opportunity to protect the resource and reduce possible adverse environmental impacts. Permit rates are subject to change, and can be issued for 3 days, 7 days, seasonally or annually (Thomas and Schumann 1992). Individual states also regulate the commercial harvest of SFPs from state lands. For example, harvest may be limited to certain seasons, amount, and species (itemized by weight per person per calendar year). Harvesting may be restricted by area. For example, in the Eugene District BLM, the SFP program does not allow harvest in Botanically Sensitive Areas, Areas of Critical Environmental Concern, or Riparian Reserves.

An important route to maintaining sustainable sources of NTFPs is to ensure that collectors have access to reliable information on the ecology and management needs of the species of interest as well as associated species in the ecosystem. In British Columbia, the Chilliwack Forest District puts out a Botanical Forest Products (BFP) Bulletin to increase awareness and knowledge in that sector. Intended for direct distribution to all known BFP harvesters and buyers within the Chilliwack Forest District, the bulletin contains information on issues and concerns, current district policy, harvesting guidelines to safeguard the resource, and business development training courses.

One of the first steps in planning for Ontario's NTFP resources should be to create an inventory of specific locations and abundance of these resources in the province, which could be useful in identifying opportunities as well as potentially sensitive situations.

Health and safety

The federal Food and Drugs Act provides authority to Health Canada for assessment and control of the nutrition, quality, and safety of food, and the safety and effectiveness of human and veterinary drugs. Federal legislation also governs many novel products in the biotechnology industry. These acts are intended to help ensure that new products are tested adequately and that health claims for new drugs are substantiated with appropriate clinical trials.

Primary concerns with health products include product safety, toxicity, and efficacy. Drew and Myers (1997) classified the adverse effects of herbal medicines as *Intrinsic* – due to the herb itself – and *Extrinsic* – due to misidentification, lack of standardization, contamination, substitution, adulteration, incorrect preparation or dosage, or inappropriate labelling and/or advertising.

Users and developers of herbal medicinal products can consult various sources that provide toxicity information, and some of these have been summarized in a report by Winslow and Kroll (1998). Sources include the FDA 'MEDWATCH',[70] and the Herb Research Foundation.[71]

The subject of natural health products has historically been a grey area in Canada as far as regulations are concerned. Herbal medicines have been classified either as foods – in which case one cannot make health claims – or drugs, which must go through costly testing. However, recent changes to the regulatory framework will probably serve to expedite the introduction of natural health products to the market, in response to increasing public demand for these items.

The federal government has accepted recommendations from the Federal Standing Committee on Health and is taking steps to make alternative medicines more available (Health Canada 1999). The government will spend $7 million over 3 years to establish a new Office of Natural Health Products (ONHP) within Health Canada that will be responsible for providing access to natural health products. The ONHP will also design protocols for ensuring safety, quality, and consistent labelling of products. Labels will be required to describe product contents, their use, and the health claims associated with them. The ONHP will also be responsible for guiding the development of appropriate manufacturing standards for manufacturers and importers of natural health products. Eventually, the Office will also be responsible for issuing a product licence. The government will also allocate $3 million over 3 years for research.

These new procedures will be developed in consultation with stakeholders, such as industry, physicians, herbalists, natural health practitioners, and consumer groups. Compliance will be enforced by Health Canada inspectors already operating across the country.

Social and economic aspects

Given the low prices paid to harvesters of plant biomass, it may be advisable for harvesters to develop a finished product for retail, if possible, rather than supplying raw material to a company. However, this route may not be feasible for some medicinally related applications where the resources of a large company are required for production, testing, and marketing. Aside from such instances, though, it may be advisable for individual collectors of NTFPs to try to develop niche markets for certain products. This avenue would also help to develop local economic opportunities.

In deciding which species to collect for sale to companies or directly to market, it is interesting to note that where health-related herbs are involved, the market is focusing increasingly on certified organic herbs (Letchworth 1998). Even so, an herb such as the purple coneflower is produced by so many now that even the certified organic herb is selling for very low prices and some growers have not been able to sell their harvest. St. John's-wort is another herb that may be on the verge of oversupply. However, there are several herbs that are on the 'hard to find top quality', let alone the 'certified' organic list, including milk thistle seed, hawthorn leaf and flower, and hawthorn berries.

There is also a need to bring over-harvested indigenous species, e.g., black cohosh, bloodroot, blue cohosh, goldenseal, slippery elm bark, and trillium, into cultivation (Letchworth 1998).

A requirement for any system producing a plant-derived natural product is the availability of a superior source of the natural product that contains a consistently high yield of the target substance(s) (McChesney 1993). However, productivity in wild sources may vary depending on factors such as genetic source, site quality, time of day, season, and weather. For medicines and other health care products, this variability can make quality control of final products very difficult, and can reduce the effectiveness or even possibly increase toxic effects of these plants. In some cases, more plant material may have to be collected to compensate for uncertainties in concentrations of active ingredients, which can affect not only the profitability of the enterprise but also the sustainability of the wild resource.

An alternative may be production from a cultivated plant source. Two strategies may be taken to accomplish this (McChesney 1993) – bring into cultivation the currently recognized source of a particular product, or evaluate and select currently cultivated varieties for products or their chemical precursors.

The first strategy may be hampered by difficulties with introducing a new plant into cultivation, a process that has succeeded in cultivating only about 3,000 species of the 300,000 to 500,000 plant species in the world. Even with success, a period of several years may be needed for this strategy to work.

In contrast, the second strategy may have many advantages. A proven cultural system is in place. An additional advantage is the known genetic origin and uniformity of cultivated plants. Finally, cultivation can provide high plant densities in localized areas, which will significantly reduce collection and transportation costs. This strategy may also permit greater flexibility and responsiveness to demand.

A refinement of the cultivation approach is to use biotechnological routes such as tissue culture to produce large quantities of product-yielding cells, tissues, or whole plants. But this route may require considerable research depending on the species and cultural requirements for satisfactory product yields. This investment is worthwhile if the final products generate sufficient revenues. Commercial production of plant natural products via cell and tissue culture systems becomes viable when the product commands a price exceeding about $1,000 per kg (DiCosmo and Misawa 1995).

An important need in pursuing NTFP opportunities is access to information resources dealing with such matters as research, market feasibility, and product promotion. A variety of such avenues is available from provincial and federal government agencies, education institutions, and private sector cooperatives and associations (Appendices III and IV).

Another enabling tool is access to information about product opportunities and education relevant to NTFPs. For instance, several Canadian educational institutions offer programs that address the subject of herbal products. McCutcheon (1998) summarized programs from the following institutions:

- Canadian College of Naturopathic Medicine (Toronto, ON) – 4-year Naturopathic Doctor (N.D.) diploma
- Dominion Herbal College (Burnaby, B.C.)
- Douglas College (New Westminster, B.C.)
- International College of Traditional Chinese Medicine (Vancouver, B.C.)
- Toronto School of Traditional Chinese Medicine
- University of Manitoba, University of Saskatchewan, and Olds College (Alberta) – Prairie Horticulture Certificate Program (jointly established distance education)
- University of Saskatchewan – Saskatchewan Herb Research Program

Finally, funding programs and tax incentives for the development of new products can help advance the NTFP sector in Ontario. Some provincial and federal programs are listed in Appendix V.

Conclusions and Recommendations

Ontario plant species provide a range of valuable commercial and non-commercial goods. Altogether, about 50 product types – e.g., nuts, essential oils, specialty wood products, dyes, mulches, biofuels – and hundreds of specific goods have been identified here, and there are opportunities for many new and value-added items.

Important issues exist with respect to NTFP collection and commercial development. These include the risk of undermining sustainability of wild plants; health and safety, particularly for medicinal products; and social and economic concerns, such as profitability to collectors and entrepreneurs. These issues must be considered carefully in balancing commercial development with responsible stewardship of the forest and safety for users.

Several recommendations that may help to advance this sector in a sustainable manner are suggested:

Recommendation #1.

Emphasize value-added products

Income levels for collectors of bulk NTFP materials are typically low, and the demand for the products can fluctuate widely. By concentrating on value-added products, which command a higher price, developers may be able to earn more with less plant biomass, and further, there may be greater buffering against sharp decreases in demand for bulk supplies. Also, there is less competition for bulk markets already dominated by other provinces with better organized large-scale collection. Importantly, there may be less risk of overharvesting wild plant stocks.

Recommendation #2.

Use waste materials for new products

Materials such as emptied seed cones, pulp waste materials, and various byproducts of wood processing can serve as valuable sources of new products. Collection costs are low because the material is already being harvested for other purposes.

Recommendation #3.

Coordinate NTFP collection with timber harvest and tending operations

Although forest lands can provide a wealth of products, Ontario has traditionally emphasized timber and pulpwood. Fuller use of the forest's productive capacity through NTFP development could mean a greater flow of benefits to various users. For instance, collection of weed materials that would otherwise be burned or chemically controlled could provide biomass for other products. (Some biomass and debris should remain on site for ecological benefits such as maintaining wildlife habitat and soil nutrient balance.)

Collection of weeds and other products such as birch bark, boughs, etc. can be coordinated with normal forest operations so as to minimize interference with those activities, and possibly assist in achieving some objectives. For example, in British Columbia, where the Ministry of Forests began pruning operations in 1978 to treat white pine blister rust, public harvesters were permitted to remove the pruned boughs and, upon receipt of an authorization letter, were able to conduct some of the pruning activities themselves (de Geus 1995). This type of activity may be worth considering on some Crown lands in Ontario.

Recommendation #4.

Emphasize rural and community-based NTFP opportunities

Development of niche products with a local character can be a profitable venture for many communities. A good example is the range of manomin and wild berry products being created by the Wabigoon Lake First Nation, where traditional knowledge is being applied to produce interesting new specialty foods. Such products are novel and may be more successful in a competitive marketplace.

Recommendation #5.

Develop methods for cultivating NTFP species

Unrestricted harvesting of wild plants can severely compromise the viability of natural populations and eventually endanger important species. Instances of these occurrences are common in many jurisdictions. Further, product quality of some medicinals can be too variable when taken from wild sources because of the considerable influence of environmental factors, genetic source, and site conditions on the quality and consistency of extracts. Damage to habitat is also a major concern. There are many instances where wild plants have been brought into cultivation successfully, using either agroforestry, nursery, or laboratory mass propagation methods. It is now possible to synthesize a variety of chemicals that serve the pharmaceutical industry. Controlled production methods, wherever feasible, should be explored. This approach also avoids some issues around territorial rights to lands.

Recommendation #6.

Increase coordination within government and between government, public, and private stakeholders

NTFP development needs to occur in an atmosphere that is conducive to innovation and free of unnecessary administrative controls. Entrepreneurs will benefit from access to ecological information, education programs, start-up funding or tax incentives, market assistance, and research support. Government agencies can help to foster this climate. In Ontario, a number of the provincial ministries have an interest in industrial uses for renewable resources. This is true federally as well (e.g., Ashmead Economic Research and Serecon Management Consulting 1997 – study of non-food/non-feed opportunities for the agricultural sector). Government agencies will need to work together to provide the support needed to develop this sector. In Ontario, some steps are being taken in this direction, but only on an *ad hoc* basis. Commercial development should occur in partnership with the private sector and with non-governmental groups such as First Nations peoples, who have been instrumental in stimulating ideas for NTFPs through the sharing of traditional knowledge.

References

Arborvitae Environmental Services (J. Williams). 1997. Commercialization of special forest products in the LAMF and region: Assessment of commercialization potential of wild mushrooms, aromatic oils, and decorative twigs and branches. Toronto, ON. 59 p. + append.

Ashmead Economic Research and Serecon Management Consulting. 1997. Non-food/non-feed industrial uses of agricultural products in Canada: An assessment of market potential, development issues and a strategy for industrial market commercialization. Report prepared for Agriculture and Agri-Food Canada, Market and Industry Services Branch. Calgary and Edmonton, AB. 111 p.

Balandrin, M., A.D. Kinghorn and N.R. Farnsworth. 1993. Plant-derived natural products in drug discovery and development. Pp. 2-12 in Balandrin, M. and A.D. Kinghorn (eds.) Human Medicinal Agents From Plants. American Chemical Society, Washington, DC.

Bell, F.W. 1991. Critical silvics of conifer crop species and selected competitive vegetation in northwestern Ontario. For. Can., Ont. Region, Sault Ste. Marie, ON Ont. Min. Nat. Resour., N.W. Ont. For. Technol. Dev. Unit, Thunder Bay, ON, COFRDA Rep. 3310 / NWOFTDU Tech. Rep. 19. 177 p.

Canadian Agricultural New Uses Council. 1998. Functional foods, pharmaceuticals, and skin care products: Fytokem finds new uses for northern plants. BIOinnovations 4: 5-6.

Canadian Christmas Tree Growers Association. 1999. Canadian Christmas Tree Growers Association update. Nova Scotia Christmas Tree Journal, Spring 1999: 4.

Canadian Council of Forest Ministers. 1997. Criteria and indicators of sustainable forest management in Canada. Nat. Resour. Can., Can. For. Serv., Ottawa, ON. Tech. Rep. 137 p.

Canadian Council of Forest Ministers. 1995. The Canadian approach: Criteria and indicators of sustainable forest management. Hull, QC.

Carr, T., H. Pedersen and S. Ramaswamy. 1993. Rain forest entrepreneurs - cashing in on conservation. Environment 35: 14-15 and 33-38.

Catling, P.M. and S. Porebski. 1998. Rare wild plants of potential or current economic importance in Canada - a list of priorities. Can. J. Plant Sci. 78: 653-658.

Chambers, B., K. Legasy, S. LaBelle-Beadman and E. Thurley. 1996. Forest Plants of Central Ontario. Lone Pine Publishing, Edmonton, AB; Ont. Min. Nat. Resour., Central Region Sci. Technol., North Bay, ON. 448 p.

Chapeskie, A.J. 1990. Indigenous law, state law and the management of natural resources: Wild rice and the Wabigoon Lake Ojibway Nation. Pp. 129-166 in Law and Anthropology. Verlag Verband der Wissenschaftlichen Gesellschaften Österreichs. Wien, Austria.

Chapeskie, D. 1997. The maple syrup industry in Ontario. Ont. Min. Agric. , Food Rural Aff. – Agroforesty. http://www.gov.on.ca/OMAFRA/english/crops/facts/maple.htm.

Ciesla, W.M. 1998. Non-wood forest products from conifers. Food and Agriculture Organization of the United Nations (Rome), Tech. Pap. No. 12. 124 p.

Couzinier, J.P. and S. Mamatas. 1986. Basic and applied research in the pharmaceutical industry into natural substances. Pp. 57-61 in Barton, D. and W.D. Ossis (eds.) Advances in Medicinal Phytochemistry. John Libbey, London, UK.

Cragg, GM. 1998. Paclitaxel (Taxol[R]): A success story with valuable lessons for natural product drug discovery and development. Med. Res. Rev. 18: 315-331.

Davidson-Hunt, I. 1998. Non-timber forest products -- definitions and meanings. Taiga Institute, Kenora, ON. Boreal Culturescapes Newsletter 1:2-3.

De Geus, P.M.J. 1995. Botanical forest products in British Columbia: An overview. B.C. Min. For., Integrated Resour. Pol. Br., Victoria, B.C. 51 p.

DiCosmo, F. and M. Misawa. 1995. Plant cell and tissue culture: Alternatives for metabolite production. Biotechnol. Adv. 13: 425-453.

Drew, A.K. and S.P. Myers. 1997. Safety issues in herbal medicine: Implications for the health professions. Med. J. Aust. 166: 538-541.

Duchesne, L.C. 1995. Commercial potential of wild mushroom harvest in Renfrew County. Unpubl. Rep. 10 p.

Duchesne, L.C. and I. Davidson-Hunt. 1998. Non timber forest product exploitation in Canada. Proceedings North American Forestry Association (NAFA) Annual Meeting, Merida, Mexico, June 21-24, 1998.

Duchesne, L.D. and M.G. Weber. 1993. High incidence of the edible morel *Morchella conica* in a jack pine, *Pinus banksiana*, forest following prescribed burning. Can. Field-Nat. 107: 114-116.

Duke, J.A. 1998. Phytochemical and ethnobotanical databases. Agricultural Research Service. http://www.ars-grin.gov/cgi-bin/duke/

Duncan, S. 1999. Mushrooms in the mist: stalking the wild chanterelle. USDA For. Serv., Pac. Northw. Res. Sta., Corvallis, OR, Science Findings, Issue #12. 5 p.

Erichsen-Brown, C. 1979. Medicinal and Other Uses of North American Plants: A Historical Survey with Special Reference to the Eastern Indian Tribes. Dover Publications Inc., New York, NY. 512 p.

Foster, S. and J.A. Duke. 1990. A Field Guide to Medicinal Plants: Eastern and Central North America. Houghton Mifflin Co., New York, NY. 366 p.

Freedonia Group. 1998a. Flavors and fragrances to 2002. Cleveland, OH. http://freedoniagroup.imrmall.com.

Freedonia Group. 1998b. Pharmaceutical chemicals in Europe to 2002. Cleveland, OH. http://freedoniagroup.imrmall.com.

Freedonia Group. 1998c. Pharmaceutical chemicals to 2002. Cleveland, OH. http://freedoniagroup.imrmall.com.

Freedonia Group. 1998d. Private dye and pigment companies. Cleveland, OH. http://freedoniagroup.imrmall.com.

Freedonia Group. 1998e. World nutraceuticals to 2002. Cleveland, OH. http://freedoniagroup.imrmall.com.

Health Canada. 1999. News releases: (1) Natural health products – recent chronology; (2) Facts about the Office of Natural Health Products and the Expert Advisory Committee on Natural Health Products. http://www.hc-sc.gc.ca/main/hc/web/english/archives/releases/9946ebk2.htm.

Hersch-Martinez, P. 1995. Commercialization of the wild medicinal plants from southwest Puebla, Mexico. Econ. Bot. 49: 197-206.

Hetherington, M. and W. Steck. 1997. Natural chemicals from northern prairie plants. Ag-West Biotech Inc., Saskatoon, SK. 277 p.

Kalorama Information. 1999. European fragrance markets. Bethesda, MD. http://www.findexonline.com.

Kalorama Information. 1998a. The U.S. giftware market. Bethesda, MD. http://www.findexonline.com.

Kalorama Information. 1998b. The U.S. gourmet/specialty foods market. Bethesda, MD. http://www.findexonline.com.

Kalorama Information. 1998c. The U.S. pet supplies market. Bethesda, MD. http://www.findexonline.com.

Kaufman, P.B., L.J. Cseke, S. Warber, J.A. Duke and H.L. Brielmann. 1998. Natural Products From Plants. CRC Press, New York, NY. 343 p.

Langner, L. 1998. Non-wood goods and services of the forest. Report of the United Nations Economic Commission for Europe / Food and Agriculture Organization of the United Nations. Geneva Timber and Forest Study Papers, No. 15. Geneva, Switzerland: United Nations Timber Section, UN/ECE Trade Division. 44 p.

Letchworth, B. 1998. Market report. Canadian Herb Society Journal – Herbal Times 3: 6.

Leuty, T. 1999. Christmas tree production. Ontario Ministry of Agriculture, Food and Rural Affairs Infosheet. http://www.gov.on.ca/OMAFRA/english/crops/facts/info_xmastreeprod.htm.

Leuty, T. and J. Gardner. 1999. Commercial production of walnut tree crops in Ontario. Ontario Ministry of Agriculture, Food and Rural Affairs Infosheet. http://www.gov.on.ca/OMAFRA/english/crops/facts/info_walnutcost.htm.

Mater Engineering Limited. 1993. Special forest products market analysis (for Saskatchewan Timberlands Division, Weyerhaeuser Canada Ltd.). Prince Albert, SK. Can. For. Serv., Proj. No. 3017.

McChesney, J.D. 1993. Biological and chemical diversity and the search for new pharmaceuticals and other bioactive natural products. Pp. 38-47 in Kinghorn, A.D. and M.F. Balandrin (eds.) Human Medicinal Agents From Plants. American Chemical Society, Washington, D.C.

McCutcheon, A.R. 1998. Herb education. Canadian Herb Society Journal - Herbal Times 4: 7-9 and 16-17.

McQuarie, J. 1998. Harvesting sun herbs: St. John's wort and Arnica. Canadian Herb Society Journal – Herbal Times 3: 9.

Mendelsohn, R. and M.J. Balick. 1995. The value of undiscovered pharmaceuticals in tropical forests. Econ. Bot. 49: 223-228.

Miller, O.K. Jr. 1979. Mushrooms of North America. E.P. Dutton, New York, NY. 368 p.

Mitchell, M. and Associates. 1997. The harvest, market and availability of special forest products in the Manitoba Model Forest. Nat. Resour. Can., Can. For. Serv., Manitoba Model Forest, Pine Falls, MB. 81 p. + append.

Mowrey, D.B. 1986. The Scientific Validation of Herbal Medicine. Keats Publ. Inc. New Canaan. 316 p.

Naegele, T.A. 1996. Edible and Medicinal Plants of the Great Lakes Region. Wilderness Adventure Books, Davidburg. 423 p.

National Aboriginal Forestry Association. 1997. Value-added forestry and aboriginal communities: The perfect fit. National Aboriginal Forestry Association, Ottawa, ON. 114 p.

Newmaster, S.G., A. Lehela, P.W.C. Uhlig, S. McMurray and M.J. Oldham. 1998. Ontario plant list. Ont. Min. Nat. Resour., Ont. For. Res. Inst, Sault Ste. Marie, ON. For. Res. Info. Pap. No. 123.

Newmaster, S.G., A.G. Harris and L.J. Kershaw. 1997. Wetland Plants of Ontario. Lone Pine Publishing, Edmonton, AB/ Ont. Min. Nat. Resour., Toronto, ON. 240 p.

Ontario Ministry of the Environment. 1991. Wood waste generation and management in Ontario Toronto, ON..

Peattie, D.C. 1966. A Natural History of Trees of Eastern and Central North America. 2nd ed. Houghton Mifflin Co., Boston, MA. 606 p.

Phillips, R. 1991. Mushrooms of North America. Little, Brown and Co, Toronto, ON. 319 p.

Preece, K. 1999. Taking a bough. Taiga Inst., Kenora, ON. Boreal Culturescapes Newsletter, Spring 1999: 4.

Saxena, P., S. Murch and K. Choffe. 1999. Standardizing the beneficial components in herbal medicines. Agri-food research in Ontario, Winter 1998-'99. 22(1): 4-5.

Schooley, J. 1999a. Cost of production of 1 acre of ginseng in Ontario. Ontario Ministry of Agriculture, Food and Rural Affairs Ginseng Series. http://www.gov.on.ca/OMAFRA/english/crops/facts/gincop.htm.

Schooley, J. 1999b. General information and contacts for ginseng. Ontario Ministry of Agriculture, Food and Rural Affairs Ginseng Series. http://www.gov.on.ca/OMAFRA/english/crops/facts/infcngin.htm.

Schooley, J. 1999c. Ginseng production in Ontario. Ontario Ministry of Agriculture, Food and Rural Affairs Ginseng Series. http://www.gov.on.ca/OMAFRA/english/crops/facts/gpak.htm.

Schooley, J. 1999d. Marketing and export of ginseng. Ontario Ministry of Agriculture, Food and Rural Affairs Ginseng Series. http://www.gov.on.ca/OMAFRA/english/crops/facts/ginmkexp.htm.

Stevenson, S. 1986. Wild rice report: Northwestern region of Ontario. Ont. Min. Nat. Resour., Toronto, ON.

Sutton, A. and M. Sutton. 1986. Eastern Forests. Random House, Toronto, ON. 638 p.

Taiga Institute for Land, Culture and Economy. 1999. Boreal landscapes/northern culturescapes: Linking biodiversity and community economic well being. Taiga Institute, Kenora, ON. Boreal Culturescapes Newsletter Spring 1999: 2.

Thomas M.G. and D.R. Schumann. 1992. Seeing the forest instead of the trees: Income opportunities in special forest products. Midw. Res. Inst., Kansas City, KS.

Winslow, L.C. and D.J. Kroll. 1998. Herbs as medicines. Arch. Intern. Med. 158: 2192-2199.