Forest Patches and Non-timber Forest Products in the Boreal Forest: A Case Study from the Shoal Lake Watershed, Northwestern Ontario

By

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A Thesis Submitted
In Partial Fulfillment of the
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Abstract

The purpose of this study was to explore the feasibility of utilizing the Ontario Ecological Land Classification system to examine the composition and abundance of plant non-timber forest products (NTFPs) in culturally important birch *(Betula papyrifera)* forest patches. The research objectives were 1) to describe the flora of the culturally important birch forest patches, particularly flora selected based on importance to the First Nation people of the Shoal Lake watershed, and to compare the floral composition and abundance across ecosites (10-100 ha mapable landscape units); 2) to describe birch growth and bark quality across ecosites; and 3) to assess whether ecosites are useful units for incorporating information about NTFPs into ecosystem-based forest management planning.

Fieldwork took place within the Shoal Lake watershed during the summers of 2000 and 2001. The vegetation of birch forest patches was sampled in four different forested ecosite types. This was done using a methodology that combined a Forest Growth and Yield plot to gather stand-level data on trees and a Forest Ecosystem Classification plot to gather data on understory plants and environmental variables.

The rapid NTFP inventory in this study gained information about plant species composition and abundance and related environmental variables beyond what is available in current ecosite type descriptions. The rapid NTFP inventory revealed that some plant species, such as the shrub Canada yew, were unique to birch forest patches of one ecosite type. Most plant species, however, were present in two or more ecosite types. In general, it was not composition, but abundance that differed across ecosite

types. For example, velvet-leaved blueberry shrubs were not absent from any ecosite types but their percent cover was considerably higher in two specific ecosite types. It was also discovered that because ecosites are large and variable in habitat, certain NTFP plant species have specific habitat niches where they are most abundant across and within ecosite types.

Regarding birch specifically, the rapid NTFP inventory showed that the abundance and size of mature birch trees and snags was significantly different across ecosite types. This study indicated that groups of ecosite types similar in environmental conditions could be used to identify how birch is growing across the landscape. Birch bark quality generally did not differ across ecosite types indicating that ecosite types were not useful units to relate to birch bark quality. However, it was discovered that tree age was an important factor in determining bark quality.

Overall, the study found that the Ecological Land Classification system of ecosite types currently in use by forest managers in Ontario is not useful for identifying the composition and abundance of plant NTFPs. Rapid NTFP inventories, such as conducted in this study, are necessary in order to gain reliable information about what kind of NTFP plant species are occurring and where they are most abundant on the land. This information would allow local forest managers, such as First Nations, and provincial forest managers, such as the OMNR, to make decisions about how best to manage NTFP resources. For example, the type of data gathered in this study would help to identify potential NTFP harvesting areas where plants are abundant, or areas where it is crucial to protect valuable NTFP plant species.

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Chapter 1 - Introduction

Background

Ecological Land Classification Systems

The forestry industry in Canada has its foundation in intensive forest management for the purpose of timber extraction. There is a need for the maintenance of ecologically healthy landscapes that can provide not only timber, but other valued forest products as well (Freedman et al. 1994). The concept of ecosystem-based forest management, which has its origins in the USDA Forest Service, emerged from the desire to meet both the economic and environmental needs of society (Brand et al. 1996). The objective of this type of management is maintaining biodiversity and ecosystem integrity at the landscape level (Grumbine 1994).

To aid in putting this concept into practice Ecological Land Classification (ELC) systems were developed (Host et al. 1996). These ELC systems identify, name, and describe different types of ecosystems for the purposes of forest management planning. For example, the goal of the Ontario Ecological Land Classification program is to have a system of describing ecosystems that is comprehensive and consistent across the province (Harris et al. 1999). These ELC systems still tend, however, to focus on the management of forest stands in different ecological land classes for the purpose of timber harvesting. It may be possible to use these ELC systems to locate and describe other forest values that would vary with ecological conditions across the forested landscape, such as non-timber forest products.

Non-timber Forest Products

Currently many aboriginal and other rural communities in Canada continue to make use of a diverse array of species from forests (Duchesne, Zasada, and Davidson-Hunt 2000). Such species are termed non-timber forest products (NTFPs), and are defined as those biological organisms, excluding timber, valued by humans for both consumptive and non-consumptive purposes found in various forms of forested landscapes (Davidson-Hunt, Duchesne, and Zasada 2001).

Sustainable development of non-timber forest products is an idea that is drawing attention at a national scale as a way to include local people in forest management and sharing of benefits derived from the forest (Bodeker 1997, Wong 2000). In Canada, because government and forest managers still lack knowledge about species used locally, NTFPs have generally not been included in ecosystem-based forest management planning (Duchesne, Zasada, and Davidson-Hunt 2000). If NTFPs are to be developed in a sustainable manner more information about their ecology, biology, and uses will need to be gathered (Duchesne, Zasada, and Davidson Hunt 2000; 2001). Gathering information not only about species of known NTFP value, but also about other plant species that may have potential value, is important. Comparing the kind and amount of plant species among different forest site types may provide useful information about species distribution and abundance. For example, forest managers may want to know the location of NTFPs in order to include these areas when planning for timber harvesting.

As more information about NTFPs is gained, incorporating this information into ecosystem-based inventories already in use by forest managers, such as the ELC system currently in use in Ontario, may be desirable. Using a familiar system of classification could ease the transition to including NTFPs as a forest management priority.

Birch as an Important NTFP

Traditionally, birch has been a spiritually significant and highly useful tree to many northern Native groups (Johnson et al. 1995; Turner 1998). In contemporary use, the sap may be used as food or in drinks (Ganns et al. 1982), and the bark or leaves for medicinal tea (Johnson et al. 1995). Artisans use the papery outer bark to make baskets and other artwork (Turner 1998) and there is a significant tourist and gallery market for birch bark art (Marles et al. 2000). The wood and bark are also still used to make canoes or canoe parts (Gidmark 1989).

Although softwoods (i.e. conifers) are usually the main focus in timber harvesting, forestry companies may desire white birch as a raw material. Its wood has a smooth grain and texture and may be used for wood and veneer products as well as for pulp, oriented strandboard, and fibreboard (Peterson et al. 1997). Recently, in Northwestern Ontario, a manufactured lumber mill has been approved for start up which will be harvesting poplar and birch in the near future. Birch will need to be carefully managed, as it is not only valuable as wood or pulp, but also as an NTFP.

There is a lack of baseline information on birch (Wang et al. 1998). Despite this, it is known that birch holds high spiritual and cultural significance in aboriginal culture (Buhner 1996, Gottesfeld 1992) and specifically, to the Shoal Lake First

Nation people (Greene, personal communication 2000). More information is also needed about other plant NTFPs that can be harvested from birch forest patches.

Purpose and Objectives

The purpose of this research was to explore the feasibility of utilizing the Ontario Ecological Land Classification system to examine the composition and abundance of plant species, and potential non-timber forest products, in birch (*Betula papyrifera*) forest patches.

The objectives were:

1. To describe the flora of the culturally important birch forest patches found in the Shoal Lake watershed, particularly flora selected based on importance to the First Nation people of the Shoal Lake watershed, and to compare floral composition and abundance across ecosites.

2. To describe birch growth and bark quality across ecosites in the Shoal Lake watershed.

3. To assess whether ecosites are useful units for incorporating non-timber forest product information into forest management planning.

Methods

Field Sampling

Fieldwork took place within the Shoal Lake watershed in Northwestern Ontario during the summers of 2000 and 2001. Four different forested ecosite types (11, 12, 19, and 29) were chosen for this study (see Chapter 3). Vegetation in 36 forest patches within the various ecosite types was sampled. A methodology was used that combined a square100 m^2 Forest Ecosystem Classification plot to gather detailed shrub and herb data within a circular 400 m^2 Forest Growth and Yield plot to gather stand-level data on trees.

It was important that the vegetation inventory methods used for this study were the same as those already in use by forest managers in Ontario. The reason being to demonstrate how NTFP data such as species composition and abundance could be incorporated into established inventory methods. Also, so that data gathered in this study could potentially be linked to existing data already gathered using the same sampling methods.

First Nation and Scientific Researcher Cooperation

Cooperation between a First Nation community and scientific researchers was integral to this project. There are some basic barriers to communication such as different world views. Indigenous people possess a knowledge-practice-belief system in which the spiritual and material world is inseparable and humans are a part of nature (Berkes 1999; Gadgil et al. 1993). Western science holds a reductionistic view and sees the spiritual world and humans as separate from nature (Kimmerer 2000). However, a more holistic view is espoused by ecosystem-based management that seeks to work with nature (Grumbine 1994). Barriers can begin to be overcome for the benefit of both people and ecosystems when local people are included in resource management and their beliefs are respected (Berkes and Davidson-Hunt 2001).

In this research the First Nation community and university researchers were able to learn from one another. A First Nation community researcher worked on the collection of NTFP plant species data in the different ecosite types and learned botanical field research methods. In turn, First Nation community members had the opportunity to share knowledge regarding current and traditional harvesting of NTFPs in the area.

The Larger Research Project

This research, undertaken as a Masters of Natural Resource Management thesis project, is part of a larger research project funded by the Sustainable Forest Management Network entitled: Combining Scientific and First Nation Knowledge for the Management and Harvest of Traditional and Commercial Non-timber Forest Products. The larger research project occurred through a partnership between the Natural Resources Institute, University of Manitoba and Iskatewizaagegan No. 39 Independent First Nation.

The purpose of the larger research was to develop a model for cooperative research between First Nation harvesters and scientific researchers in order to build sustainable rural livelihoods through the traditional and commercial harvesting of non-timber forest products (Berkes and Davidson-Hunt 2000). Overall, the larger research project consists of two parts: a) an ecological research component using western scientific methods to examine the feasibility of using an Ecological Land Classification system to study non-timber forest products and b) a traditional ecological knowledge research component using qualitative interview methodologies to investigate the linkages between ecosystems, institutions, and local knowledge of plant harvesters. The traditional ecological knowledge component is being undertaken as a Ph.D. research project. The ecological research component is the focus of this project.

Organization

This thesis is organized into 6 chapters. Following this Introduction Chapter, Chapter 2 provides a review of the literature. Chapter 3 describes the methods used in the research. Chapter 4 describes the plants and environment of the birch forest patches studied and how plant composition and abundance varies with ecosite type. Chapter 5 describes birch growth and bark quality in the forest patches and differences across ecosite types. Chapter 6 makes conclusions about the study and suggestions for management of NTFPs in northwestern Ontario.

Chapter 2 - Literature Review

Non-Timber Forest Products in Canada

The value of NTFPs in Canada is currently 241 million dollars per year. This estimate does not include cultivated NTFPs such as Christmas trees or ginseng (Duchesne, Zasada, Davidson-Hunt 2000). Duchesne, Zasada, and Davidson-Hunt (2000) predict that this value may be doubled or tripled in the future due to a growing demand for non-timber products and increased access to international markets.

The most valuable NTFPs in Canada today are maple sap products, wild mushrooms, and berries (Duchesne and Davidson-Hunt 1998 cited by Mohammed 1999). NTFPs are the most developed on the west coast, in British Columbia. However, other provinces are prominent in commercial production of NTFPs. For example, Canada is the world's largest producer of wild blueberries, with commercial harvesting done mainly in Quebec and Nova Scotia. In Ontario, there are 50 types of NTFPs currently derived from forest plant species. Such products include foods like wild berries, flavorings, and teas, medicines, essential oils, cosmetics, landscape plants, and floral and craft products (Mohammed 1999). Brubacher (1999), in a study of NTFPs in the Great Lakes-St. Lawrence and Eastern Boreal forests of Ontario, found that many plant species have the potential to be developed, or to be developed further, as NTFPs. For example, some of the plants that have immediate market demand in Ontario are: wild blueberries, cranberries, and lingonberries for specialty products like jams; Ostrich fern fiddleheads as edible greens; the boughs of eastern white cedar for floral greenery; and many such as wild ginger, Canada yew, and white pine for seed collection to sell to nurseries or seed houses. Others plants that have good potential for economic development include Labrador tea for essential oil extraction, birch bark as a medicinal, and red osier dogwood branches as a decorative item (Brubacher 1999).

Many opportunities may exist for further development in Canada but whether or not development is sustainable should also be considered. The technology exists to extract NTFPs at a rapid rate that can deplete natural populations. For example, over-harvesting of American ginseng has caused this herb to become endangered in Canada (Duchesne, Zasada, and Davidson-Hunt 2000).

NTFPs and First Nations

Plant species are particularly valuable as NTFPs to First Nation people because they have been for thousands of years, and continue to be, a source of medicines, foods, and materials for tools and artwork (Turner 1998, Kuhnlein and Turner 1991, Marles et al. 2000). Also, the practical, cultural, and spiritual value of NTFPs may intermingle. For example, medicinal plants like seneca root and echinacea are harvested and prepared accompanied by special songs and prayers in cultures such as Ojibwa and Sioux (Buhner 1996).

The value of these traditionally harvested plant species often has the potential to extend beyond First Nation communities. Many of the medicinal plants traditionally harvested by First Nation groups have been proven effective according to western science. A study by Arnason, Hebda, and Johns 1981 found that of some 400 plant species used in First Nation medicines in eastern Canada (Ontario, Quebec, and the eastern provinces) at least 150 were effective due to their phytochemical properties. Food plants from the forest such as root vegetables, the sap and inner bark of some tree species, and many kinds of berries have been traditionally and are currently harvested by First Nation people (Kuhnlein and Turner 1991). Many of the traditionally harvested food plants exceed conventional plant sources in vitamin and mineral content (Arnason et al. 1981). Turner's 1981 study lists 100 species of traditionally harvested plants that have the potential to be incorporated more fully into the modern North American diet. The benefits of developing such non-timber forest products is of particular importance to First Nation communities as a means of improving health, heightening cultural pride, and providing a valuable source of income (Turner 1981). However, with increasing interest in developing NTFPs for their commercial value, First Nation communities will need to ensure that NTFP resources on their traditional lands are not exploited (Marles et al. 2000).

Ecosystem-Based Forest Management and NTFP Inventories

The harvest of non-timber forest products is beginning to be included as a goal for ecosystem-based forest management. For example, ecosite classification for the Province of Manitoba has recently begun and one of the goals of this project is to describe ecosites in association with NTFPs for forest management planning (Baydack, personal communication 2001). The sustainable management of Ontario's NTFP resources is a goal of the Ontario Ministry of Natural Resources, but it is one that has not been reached yet. The harvest of NTFPs from forested areas in Ontario is currently unregulated, aside from the Wild Rice Harvesting Act (Mohammed 1999).

A special forest products market analysis done in the Saskatchewan Forest Management License Agreement area of Weyerhaeuser Canada was the first effort of its kind to gather data in preparation for inventorying NTFPs (Mater Engineering 1993). Mater Engineering (1993) conducted a survey of Canadian provincial governments and National Forest Systems and found that, aside from the project in Saskatchewan, no identification or inventory work was being done on NTFPs specific to Canadian forests. Currently, there are still no standardized methodologies developed for inventorying NTFPs in Canada (Ehlers 2001). There is, however, some progress on a local scale. A methodology to inventory NTFPs on North Vancouver Island is currently being developed with the goal to integrate data into the B.C. Ministry of Forests ecological databases (Ehlers 2001). Mohammed (1999) suggests that an important first step for the management of Ontario's NTFP resources needs to be a provincial inventory of locations and abundance of NTFPs. Inventories will help in recognizing opportunities for development of new NTFPs and in managing NTFPs in a sustainable manner.

The Forests of Northwestern Ontario

The boreal forest in northern North America covers land from Alaska and the Rocky Mountains eastward to the Atlantic Ocean. In Canada and Alaska the boreal forest makes up over 60 % of the total forested area (Johnson et al. 1995). Northwestern Ontario is defined as the large area of land to the north and northwest of Lake Superior and most of this area is boreal forest (Baldwin and Sims 1997).

The forests of northwestern Ontario are composed primarily of black spruce, jack pine and balsam fir stands as well as mixed or pure stands of deciduous species such as trembling aspen and paper birch (Zoladeski and Maycock 1990). The Shoal Lake watershed falls within the Great Lakes-St. Lawrence Forest Region. The forests in this area are made up of the characteristic boreal tree species mentioned, along with other tree species, such as white pine, eastern white cedar, and black ash occurring in suitable habitats (Rowe 1972 cited by Sims et al. 1997).

In general, boreal forest areas are exposed to a climate that is characterized by long, cold winters and short, warm summers (Rowe 1956). Temperature and humidity are the two main climatic gradients that stratify the northwestern Ontario area. Mean annual temperatures are cooler in the northern part of northwestern Ontario and are also moderated by Lake Superior. Also, humidity and precipitation are higher in the east relative to the west. For example, mean annual precipitation is less than 550 mm west of Kenora and is over 800 mm in the Marathon/Manitouwadge area near Lake Superior. (Chapman and Thomas 1968 cited by Baldwin and Sims 1997).

Various soil types and moisture regimes occur across the boreal forest. These soil-related factors affect the distribution and abundance of boreal forest species (Bonan and Shugart 1989). For example, moist, poorly drained organic soil sites are normally dominated by black spruce and drier sandy sites are normally dominated by jack pine (Shafi and Yarranton 1973). The forests of northwestern Ontario are depicted by a diverse array of forest site conditions such as parent material, soil types, and topography (Sims et al. 1997). The bedrock of the Canadian Shield is often close to the soil surface or is exposed, particularly near Lake of the Woods and Rainy Lake.

This creates acidic often nutrient poor sites with little soil development. However, there are also more nutrient rich sites with deeper fine sandy soils, loamy soils, or clayey soils throughout the area (Watson 1998).

Disturbances such as recurring forest fires are an important part of boreal forest ecology (Heinselman 1981, Bonan and Shugart 1989). Fire interacts with landscape features such as topography and soils and the effects of fire may vary according to site conditions (Foster and King 1986). Also, fire intensity is a factor determining how vegetation will be affected. Fires that are not very severe may only remove understory vegetation. However, high intensity crown fires, which are common in the boreal forest, may kill most trees in a stand and initiate regeneration of a new stand (i.e. secondary succession) (Heinselman 1981, Bergeron and Dansereau 1993). Fire can expose mineral soil, which is important for the establishment of tree seedlings, especially pioneer species such as aspen and birch (Heinselman 1981).

Outbreaks of defoliating insects such as spruce budworm (*Choristoneura fumiferana*) are another common boreal forest disturbance that can affect stand structure and composition by creating gaps in the tree canopy (Bonan and Shugart 1989). In Ontario, forest tent caterpillars (*Malacosoma disstria*) have caused widespread defoliation of deciduous trees during outbreaks that last for approximately 3 years, but have been known to persist for up to 6 years. Defoliation may weaken trees and make them susceptible to other insects or disease that can ultimately kill trees (Natural Resources Canada, 2002).

Zoldaski and Maycock (1990) studied forest stand establishment and succession in northwestern Ontario and found that a short fire cycle generally maintains young forest communities and prevents stand deterioration. However, in the southern portion of northwestern Ontario, where much of the timber harvesting occurs, it has been difficult to determine whether fire suppression affects stand dynamics. Regeneration patterns usually continue with the same initial tree composition that had established following fire. Dix and Swan (1971), in a study boreal forest stands in central Saskatchewan, found that on an individual basis each forest stand may be dominated by one or two tree species and appear quite uniform. However, at the landscape scale, the boreal forest is not uniform but characterized by a patchwork of tree stands of various ages and species composition.

Birch Ecology

Paper birch or *Betula papyrifera* is a tree that is small to medium in size (averaging 16 m high, but can reach 28 m) with distinct white papery bark (Bell 1991). Paper birch is a widely distributed tree in northern regions, being one of the few trees that grows in all provinces and territories of Canada (Blouin 2001). In Ontario, paper birch is widespread and occurs in most regions of the province (Bell 1991).

Paper birch generally tolerates a wide range of moisture and soil conditions (Wang et al. 1998). For example, in the boreal forest of Manitoba and Saskatchewan Rowe (1956) found that birch occurred with jack pine on dry, sandy sites and also with eastern larch and black spruce on wet, peaty sites. In northwestern Ontario, paper birch stands are mainly found growing on deep, coarse sandy, fine sandy and coarse loamy soils. In regards to moisture conditions, paper birch occurs most frequently on dry to fresh soils. Optimal growth occurs on fresh, well-drained sandy loams or silty soils (Bell 1991).

Fire plays a vital role in the establishment of many birch stands. (Rowe 1956, Foster and King 1986). Birch regeneration is more prevalent in burned versus unburned areas and birch readily regenerates from seeds or sprouts following disturbance by fire. Broken boles from other disturbances such as high winds will also resprout (Rowe 1956).

Paper birch is normally classified as an early successional tree species due to its longevity and shade intolerance. It rapidly colonizes open areas and grows best in full sun (Rowe 1956). Birch and other pioneer species, such as aspen, usually overtop the more shade tolerant and slower growing spruce and fir species (Bergeron and Dubuc 1989, Zoladeski and Maycock 1990). Birch can be an aggressive competitor with conifers in the understory if not too shaded by tall shrubs (Peterson et al. 1997). Birch may also establish later in succession. For example, Zoladeski and Maycock (1990) in a study of boreal forest dynamics in northwestern Ontario, found that paper birch established for 40-50 years of succession in trembling aspen stands and for 60 years in balsam fir stands. However, if disturbance by fire does not occur in forest stands for long periods of time, birch may be replaced by more shade-tolerant and long-lived species such as conifers (Bergeron and Dubuc 1989). Peterson et al. (1997) notes that birch may be able to tolerate more shade on more fertile sites versus sites with nutrient poor soil conditions. Wang et al. (1998) found that birch is also better adapted to drier conditions than conditions of low soil nutrient availability.

Paper birch grows quickly in its juvenile stage but is relatively short-lived and matures at 60-70 years, after which growth begins to slow. Birch may begin to deteriorate as early as 70 years depending on site conditions. However, it may reach ages of approximately 150 years (Rowe 1956).

Birch as an NTFP

Not only is paper birch important to overall ecosystem health in the boreal forest, it is also viewed by many humans as an economically valuable tree species. Although softwoods (i.e. conifers) are usually the main focus in timber harvesting, forestry companies may desire paper birch as a raw material. Its wood has a smooth grain and texture and may be used for wood and veneer products as well as for pulp, oriented strandboard, and fibreboard (Peterson et al. 1997).

Paper birch is a tree species with high NTFP value. Traditionally, birch has been a spiritually significant and highly useful tree to many northern First Nation groups (Johnson et al. 1995, Turner 1998). For example, birch sap, rich in vitamins, was used as a syrup on fish and bannock. The young leaves and inner bark were used as food and the bark and leaves were made into tea, salve, or oil and used for medicinal purposes. Birch wood was used to make sleds, snowshoes, canoes, and paddles and birch bark was used to make baskets and for art work (Johnson et al. 1995).

Today, the NTFP value of birch is still high. Marketable products may be made from the wood, bark, and sap of the paper birch. There is a small birch sap industry in Alaska and parts of Canada in which sap is used to make syrup, wine, and other drinks (Ganns 1982). The wood and bark are still used to make canoes or canoe parts (Gidmark 1989). The bark of the birch tree is especially valuable as an NTFP. Artisans use the papery outer bark to make baskets and other artwork (Turner 1998) and there is a significant tourist and gallery market for birch bark art (Marles et al. 2000). In British Columbia, for example, birch bark basketry is being revived as a way to earn extra income and keep traditions alive (Gottesfeld 1992). There is a demand for sheets of birch bark for use in decorative items such as lamp bases, bird feeders, and flower pots (Marles et al. 2000). Birch bark may also have important medicinal properties. For example, betulinic acid derived from birch bark has been found to be active against certain brain tumors (Fulda et al. 1999 cited by Marles et al. 2000).

Peterson et al. (1997), in a paper birch management handbook for B.C., mention that adequate information does not yet exist to manage birch for harvesting of NTFP materials through silvicultural practices. For example, how the quality of bark for basketry or canoe making changes with age of the tree is not well documented. However, it may be possible in the future to manage birch for desirable bark qualities, such as maintaining stands of large trees so that bark can be harvested in large strips. Zasada of the U.S. Forest Service in Minnesota also points out that there is very little quantitative data available about birch bark quality and how it varies from site to site (Zasada, personal communication 2002).

Birch Forest Patches and NTFPs

Within the boreal forest, birch stands contribute to ecosystem functioning by creating habitat diversity. Birch forest patches are normally shrub and herb rich. These characteristics distinguish birch communities from conifer communities that are generally shrub and herb poor, although rich in moss and lichen species (Foster and King 1986, Bell 1991). Watson (1998), in a comparative study of different forest stands in northwestern Ontario, also described birch mixed wood and birch-trembling aspen stands as being particularly species-rich. The richness of the understory vegetation in birch patches may be due in part to the seasonal deciduous canopy which means open conditions in spring resulting in increased light and higher soil temperatures than closed canopy conifer patches. This creates favorable growth conditions for a variety of understory plant species (Carlton and Maycock 1981, Foster and King 1986). Also, the deterioration of birch litter, rich in nutrients such as phosphorus, potassium, calcium, and magnesium, can enrich the soil. In pure stands or mixed with conifers birch increases surface soil nitrogen availability for other plant species as well (Pare and Bergeron 1996).

The literature did not reveal any studies on plant NTFPs specifically associated with birch forest patches, aside from birch itself. However, it was clear from the studies mentioned above that birch stands are important for providing habitat for a variety of plant species. These plant species may be culturally and economically valuable as NTFPs. In fact, First Nation groups have long recognized birch forest patches as an important source of culturally important NTFPs (Greene, personal communication 2000).

Summary

As this chapter establishes, much of the research already done in Canada has focused on describing the uses of non-timber products (Turner 1998, Marles et al. 2000). In general, past studies of non-timber forest products have focused on the production of NTFPs rather than on including NTFPs in the management of healthy ecosystems. Further research on non-timber forest products that brings together ecosystem-based forest management with ecology, traditional ecological knowledge, and production is needed (Berkes and Davidson-Hunt 2001). There is a particular research need for ways to include information about non-timber products in ecosystem-based forest management plans already in use by forest managers. There is also a need for more research on distribution and abundance of certain NTFPs. The quality of NTFP sources should also be considered, as one site may not be as desirable for harvesting as another (Duchesne, Zasada, and Davidson-Hunt 2000). Research concerning sustainable management of NTFPs that involves First Nation groups will be particularly important (Freed 1997, Turner 1998, Marles et al. 2000). Such research is of interest to both forest managers and First Nation communities for the purpose of revealing new priorities for sustainable forest management and helping to preserve the wealth of knowledge that First Nations, particularly elders, possess in regards to NTFPs (Marles et al. 2000).

Chapter 3 - Methods

Site Information and Selection

Study sites were located in northwestern Ontario, within the Shoal Lake Watershed (Fig. 1). Shoal Lake falls within the Great Lakes – St. Lawrence Forest Region (Fig. 2). The area surrounding Shoal Lake consists of a diverse mix of conifer and hardwood tree species. Tree species characteristic of the Boreal Forest Region such as black spruce, jack pine, balsam fir, trembling aspen, and white birch occur along with others typical of the Great Lakes – St. Lawrence Forest Region such as white pine and black ash (Rowe 1972 cited by Sims et al. 1997).

Ecosites are site types defined by abiotic factors (soil depth and texture, nutrient regime, moisture regime, and hydrology) as well as biotic factors (plant community structure and composition). The Ontario Ministry of Natural Resources (OMNR) uses ecosites as mapable landscape units, usually 10-100 hectares in size, at a 1:10,000 to 1:20,000 map scale. Ecosites are used in Ontario's Forest Ecosystem Classification System to describe the forest land base and to achieve an ecosystem-based approach to forest management planning. Ecosites are used for management applications such as silvicultural planning, determining stand productivity, and planning for wildlife habitat (Racey et al. 1996).

Ecosites are made up of ecoelements that are smaller units (100-100,000 m2), normally too difficult to map for forest management planning purposes, but used for applications such as stand-level succession studies or looking at soil/vegetation interactions. Ecoelements are defined by Vegetation Types (V-types) and Soil Types

(S-types). V-types and S-types were developed using data from over 2200 10 x 10 m vegetation plots and corresponding soil samples. Ecosite types were then developed using knowledge of ecoelement composition and where these ecoelements occur across the landscape (Racey et al. 1996).

Four different forested ecosite types were chosen for comparison of plant species composition and abundance, as well as birch growth and bark quality across ecosites. Over the course of the summer field seasons of 2000 and 2001 twelve study sites representing the four ecosite types were sampled. This included three ecosite type 11 forest stands, three ecosite type 12 forest stands, three ecosite type 19 forest stands, and three ecosite type 29 forest stands. As described below, ecosite types 11, 12, 19, and 29 were chosen on the basis that each ecosite had a different nutrient and moisture regime and/or dominant tree species than the other three ecosites according to Terrestrial and Wetland Ecosites of Northwestern Ontario NWST Field Guide FG-02 (Racey et al. 1996) (Appendix 1).

Ecosite 11 is Red Pine – White Pine – Jack Pine: Very Shallow Soil. This ecosite is described as being dominated by red, white or jack pine. Aspen, white birch or white spruce also occur and white cedar can be locally abundant. It is generally shrub and herb-poor. Shallow soils (< 20 cm) and bedrock outcrops are characteristic, although pockets of deeper soils may occur. Bedrock, needle litter, lichen, and feathermoss make up the ground cover (Racey et al. 1996) (Appendix 1).

Ecosite 12 is Black Spruce – Jack Pine: Very Shallow Soil. This ecosite is described as dominated by black spruce, jack pine, as well as patches of balsam fir and trembling aspen. It is generally shrub and herb-poor on shallow soils (< 20 cm).

Bedrock may be exposed or only covered by a shallow litter layer. Bedrock, needle litter, lichen, and feathermoss make up the ground cover (Racey et al. 1996) (Appendix 1).

Ecosite 19 is Hardwood – Fir – Spruce Mixedwood: Fresh, Sandy-Coarse Loamy Soil. This ecosite is described as being dominated by trembling aspen, white birch, and balsam fir, with some occurrences of black and white spruce. Deciduous trees make up > 50 % of the canopy. This ecosite is generally shrub and herb-rich. The soils are fresh, well drained, coarse loamy to fine sandy; parent materials mainly glaciofluvial when soil is deep and morainal when soil is shallow. Broadleaf and conifer litter, wood and feathermoss make up the ground cover (Racey et al. 1996) (Appendix 1).

Ecosite 29 is Hardwood – Fir – Spruce Mixedwood: Fresh, Fine Loamy-Clayey Soil. This ecosite is described as being dominated by trembling aspen or sometimes white birch, with a mix of conifers consisting of balsam fir, white spruce, black spruce and sometimes jack pine. Deciduous trees make up > 50 % of the canopy. This ecosite is shrub and herb-rich. The soils are fresh, moderately well to well drained, fine loamy-clayey; mainly on lacustrine parent material. Broadleaf and conifer litter, feathermoss, and wood make up the ground cover (Racey et al. 1996) (Appendix 1).

The forest stands studied, three per ecosite type, were chosen from the OMNR's 1999 Forest Resource Inventory (FRI) data for the Shoal Lake Watershed of the Kenora Crown Unit. The FRI data includes location and size of forest stands, age-class, ecosite type, as well as fire occurrence data.

Selection of forest stands was based on the following criteria:

a) *Presence of birch (Betula papyrifera)*: defined by stands classed as Birch Working Group according to OMNR's 1999 FRI data. Working Group is defined by the OMNR as stands that have the same dominant species and are managed under the same broad silvicultural system.

b) *Stand maturity*: mature stands that were $\geq$ 50 years and $\leq$ 80 years according to OMNR's 1999 FRI data were chosen. The OMNR defines stands 50 years of age and over as mature (Sims et al. 1997).

c) *Stand origin*: all stands originating from natural disturbance (i.e. fire).

The particular forest stand study sites were chosen by process of elimination. FRI data in the form of Geographic Information System (GIS) maps were examined and the 127 stands that were Birch Working Group were chosen. Of these, all stands that were of ecosite type 11, 12, 19, and 29 and that met the above criteria were selected. From this set, 38 forest stands that were reasonably accessible by road or by lake were identified. From this final set, three study sites of each ecosite type were chosen at random.

Sampling Design

Sampling of trees and associated flora was done using a combination of the Ontario Forest Ecosystem Classification (FEC) plot design and the Ontario Forest Growth and Yield (G & Y) plot design. At the center of each of the circular G & Y plots, a 10 x 10 m square FEC plot was placed (Fig. 3). The plot combinations were placed at random distances along a transect line in each forest stand. Vegetation in 36 forest patches, 9 patches (i.e. sites) per each of the 4 ecosite types, was sampled.

The designs were combined in order to capture greater stand-level information with the larger 400 m^2 (11.2 m radius) circular G & Y plot as well as more detailed data on tree regeneration, shrubs and herbs provided by the 100 m^2 square FEC plot. Both the FEC plot design and the G & Y plot design are currently in use by the Ontario Ministry of Natural Resources as a means of helping to classify the forested land base and to predict future changes. Using established methodologies for a rapid NTFP inventory is important in order to make the transition to including NTFP data into management plans easier and to allow for linking newly gathered data with previously gathered data.

FEC Plot Sampling

The Forest Ecosystem Classification (FEC) plots in this study were used to gather information about the composition and abundance of plant species in the birch forest patches in each of the different ecosite types. Information about soils and other environmental variables was also collected in the FEC plots.

At the center of each of the 400 m2 (11.2 m radius) circular Growth and Yield (G & Y) plot, a 10 x 10 m square FEC plot was placed (Fig. 3). Each FEC plot was laid out using a tape measure and compass to mark out the four corners of the plot from the center point. The tape measure was then laid out from corner to corner to form the square and make it more visible.

Within each 10 x 10 m FEC plot, information about trees, tree saplings, tree seedlings, shrubs, dwarf shrubs, and herbaceous plant species was recorded according to Describing Ontario's Ecosystems: Data Collection Standards for Ecological Land Classification (Harris et al. 1999). Most vascular plants were identified to species, although some, due to lack of identifying features (e.g. plants not in flower) were only identified to genus. Non-vascular plants were categorized as either mosses or lichens. Cover is a standard measure of abundance that is a visual estimate of what percentage of the study plot area is covered by a plant species. In this study each plant taxon and their percent cover were recorded. To make the task more manageable and to ensure the data was compatible with other FEC plot data collected in Ontario, percent cover was recorded in layers of position and height (Appendix 2).

A soil sample in the form of a soil core was taken near the center of each FEC plot using a soil auger. The soil sample was then keyed to a Soil Type and a Moisture Regime using the Field Guide to the Forest Ecosystem Classification for Northwestern Ontario NWST Field Guide FG-03 (Sims et al. 1997). The process of keying out soil included obtaining a soil core from up to 100 cm in depth or up to the contact point with bedrock. The C-horizon of a soil profile is the relatively unweathered material beneath the surface A and subsurface B soil horizons (Sims et al. 1997). To determine the Soil Type, texture of the C-horizon was keyed out using taste, feel, shine, ribbon, and moist cast tests according to the FEC field guide. If C-horizon was not present such as in shallow soils over bedrock, then the texture of the mineral soil present was determined using the above tests. Moisture Regime was then determined from the texture, pore pattern, and depth of mineral or organic soils. Other characteristics of the soil core such as the presence and depth of mottling as well as the topographic position of the particular site were considered in determining Moisture Regime.

Environmental variables of slope position, bare ground, overall tree canopy cover, fire evidence, and evidence of human activity were recorded for each FEC plot. The slope position was recorded according to Harris et al. 1999 (Appendix 3). Bare ground was recorded as the percent cover of ground or exposed bedrock that was not covered by vegetation. This described how sparsely or fully vegetated the site was. The percent cover of all tree (> 10 m in height) species combined was recorded to describe how shaded or open the site was. Fire evidence in the form of charcoal pieces in the soil or charred tree trunks or stumps was recorded as either present or not present. Evidence of human activity which showed up in the form of litter, walking paths, cut tree stumps, or culturally modified trees (i.e. birch trees from which bark has previously been cut) was recorded when present. In total the 7 environmental variables included: 1) slope position, 2) bare ground, 3) tree canopy cover, 4) fire evidence, and 5) evidence of human activity as well as 6) Soil Type and 7) Moisture Regime.

G & Y Plot Sampling

The Ontario Forest Growth and Yield Program establishes plots to monitor the growth and dynamics of Ontario's forests (Hayden et al. 1995). Presently there are over 4,000 permanent sample plots set up for this purpose. G & Y permanent sample plots were originally developed to measure the growth and yield of timber in different stand types in Ontario. G &Y monitoring has since been extended into an ecosystem-based approach as data on forest communities and wildlife habitat are collected along with data on growth and yield of timber (Hayden et al. 1995).

The growth and yield (G & Y) plots in this study were used to get a sense of how birch was growing in each of the different ecosite types. Percent cover, number of trees, and diameter at breast height (DBH) were used as measures of growth.

The $400m^2$ (11.2 m radius) circular G & Y plots were placed at random distances along the transect line in each site. Each G & Y plot was laid out by using a tape measure and compass to mark out distances of 11.2 m radiating out from the center point until a full circle was formed.

Within the larger G & Y plot (including the smaller FEC plot area) information about trees was recorded according to the Ontario Forest Growth and Yield Program Field Manual (Hayden et al. 1995). For the purposes of this study, a tree was defined as a living woody species with a height of at least 10 m. A snag was defined as a dead woody species with a height of at least 1.3 m. The percent cover of birch and the percent cover of each other tree species was recorded. The DBH of live birch trees and snags was measured at 1.3 m above ground level. The number of live birch trees and snags was counted.

Birch Bark Sampling

Birch bark was sampled as it is a raw material for use in non-timber forest products (Turner 1998, Marles et al. 2000). Specifically, as it is used by Shoal Lake First Nation people for making birch bark baskets. Birch bark samples were taken from each of the sites and examined in order to detect if any differences in bark thickness, lenticel length, or number of lenticels existed across ecosites. These measures were developed in the field as to my knowledge no other comparative study has been done on birch bark quality across different site types for non-timber forest product use.

The basis of these measures lies in birch bark characteristics required for basket-making or other bark artwork. Bark thickness was used as a measure of quality because thickness is considered when making a basket. The bark should not be too thick or rough or it won't be flexible enough to make a basket (Green, personal communication 2001). Lenticels are the horizontal pores used for gas exchange in the outer bark (Fahn 1982) of the birch tree. Lenticels were measured because they are also considered when deciding which piece of bark to use for basket-making. Relatively long lenticels are undesirable when basket-making because they may cause the bark to split apart more easily (Turner 1998). Too many lenticels make it difficult to sew a basket without hitting one with a sewing tool such as an awl and causing the basket to split (Greene, personal communication 2001).

A 15 x 15 cm sample of birch bark was cut from a sample tree (i.e. the closest mature tree to plot center) at each plot. Out of 9 plots per ecosite type there were 33 bark samples in total: 8 from ecosite 11 sites, 8 from ecosite 12 sites, 9 from ecosite type 19 sites, and 8 from ecosite type 29 sites. Three plots did not have a mature birch tree within plot boundaries. The bark was cut using a pocket knife and the outer birch bark was peeled off including the papery dead outer layer and cork, but not including the whitish living layer of inner bark. This was according to the technique used for basket-making by the Shoal Lake First Nation people (Wapioke, personal communication 2000). A 15 x 15 cm sample was used as it was a large enough size to make a small birch bark basket, yet small enough to manageably measure and count lenticels and easy enough to carry out of the field.

Thickness of the papery outer layer plus the cork was measured in millimeters using calipers. The measurement was taken 8 times for each bark sample, 2 measurements per edge, then averaged per sample. For each birch bark sample, the length of each individual lenticel was measured in centimeters, then averaged per sample. Also the number of individual lenticels per sample was counted. Age of the sample tree was also measured using an increment borer to retrieve a core and counting the number of growth rings. Height of the sample tree was taken using a clinometer. DBH of the sample tree was recorded as part of the G & Y plot data.

Data Analysis

For the purpose of data analysis, the 7 vegetation layers described in Appendix 2 were reduced into 3 layers. The layers became: 1) Trees (includes Layer 1 dominant > 10 m and Layer 2 subdominant > 10 m); 2) Shrubs and Saplings (includes Layer 3 shrubs and saplings 2 – 10 m and Layer 4 low shrubs and regeneration 0.5 – 2 m); and 3) Herbs, Dwarf Shrubs, and Seedlings (include Layer 5 shrubs and seedlings 0 – 0.5 m, as well as Layer 6 forbs and graminoids and Layer 7 mosses and lichens, any size). The percent cover values from each site were averaged to give a mean percent cover value for each plant taxon in the 3 layers for each ecosite type. This was calculated using a spreadsheet program (Microsoft Excel) in order to compare presence/absence and abundance across ecosites.

The 7 environmental variables were also quantified for the purpose of data analysis. Slope position was quantified as 1 = level, 2 = lower slope, 3 = mid slope, 4 = upper slope to 5 = crest (Appendix 3). Soil Type was quantified from 1 = shallower sandy soils on bedrock to 8 = deeper soils with increasing clay content, and 9 was a deep organic soil type (Appendix 4). Moisture Regime was quantified from 1 = dry, 2 = fresh, 3 = moist to 4 = wet. Tree canopy cover indicating shade/light was quantified as percent cover. Bare ground indicating full/sparse vegetation was also quantified as percent cover. Fire evidence was quantified as 1 = present or 2 = absent. Evidence of human activity was also described and quantified as 1 = present or 2 = absent.

Data was analyzed with Canonical Correspondence Analysis (CCA) using the statistical package Canoco (Ter Braak 1990). CCA is a multivariate ordination technique that uses the environmental data to "constrain" the plant species data along axes. In this study ecosite types 11, 12, 19, and 29 were classified as categorical variables and used to constrain the plant species data to get an overall picture of plant species composition of the different ecosite types. CCA was also used to examine plant species composition of the birch forest patches in relationship to the 7 environmental variables.

The basic principle in interpreting a CCA is that data points that are the closest in proximity to each other are the most similar, and the data points that are the farthest away from each other are the least similar. A Redundancy Value (sum of canonical eigenvalues/sum of unconstrained eigenvalues) was used to represent the total variation explained in constrained ordination. Normally, this value is only 20 to

50 %, with the rest of the "unexplained variation" due to such factors as noise, complex spatial relationships, or unmeasured environmental variables (Okland 1999).

When analyzing data particular attention was paid to 12 plant species selected because they are utilized, or otherwise recognized as important, by the people of Shoal Lake First Nation. The species selected were four tree species: paper birch (*Betula papyrifera*), black spruce (*Picea mariana*), white pine (*Pinus strobus*), and eastern white cedar (*Thuja occidentalis*); four shrub species: Labrador tea (*Ledum groenlandicum*), sand cherry (*Prunus pumila*), Canada yew (*Taxus canadensis*) and velvet-leaved blueberry (*Vaccinium myrtilloides*); and four herbaceous species: wild ginger (*Asarum canadense*), woodland strawberry (*Fragaria vesca*), sweet cicely (*Osmorhiza longistylis*), and dewberry or dwarf raspberry (*Rubus pubescens*).

A literature review of current periodicals, texts, and internet websites was conducted on these twelve species to identify their current or potential commercial uses. This was done to create awareness of markets for NTFP plant species and which ones may be sought after for their commercial value, particularly those found in birch forest patches, as they are areas of importance to the community of Shoal Lake First Nation.

For these twelve selected plant species histograms were created to compare presence/absence and abundance (i.e. percent cover) across ecosite types. One-way analysis of variance (ANOVA) (SAS institute 1996) was used to determine if mean percent cover was significantly different across ecosite types. Significance was determined by a p-value with an alpha level set at 0.01 ($\alpha = 0.01$). A P-value less than 0.01 indicated means to be significantly different. An R^2 value was also used to indicate the amount of variation that was explained by the ANOVA. Multiple regression was run to determine whether any of these twelve plants were significantly related to any of the 7 environmental variables that were measured.

To analyze birch growth in the different ecosite types, the number of birch trees and snags and the diameter at breast height (DBH) of birch trees and snags was averaged across sites to give mean values per ecosite type. The bark quality measures of bark thickness, lenticel length, and lenticel count were first averaged per birch bark sample, and then mean values per ecosite type were calculated. ANOVA was used to test for significance of differences in birch growth and bark quality values across ecosite types. Multiple regression was also run to determine whether the bark quality measures were significantly related to the sample tree characteristics of age, DBH, and height.

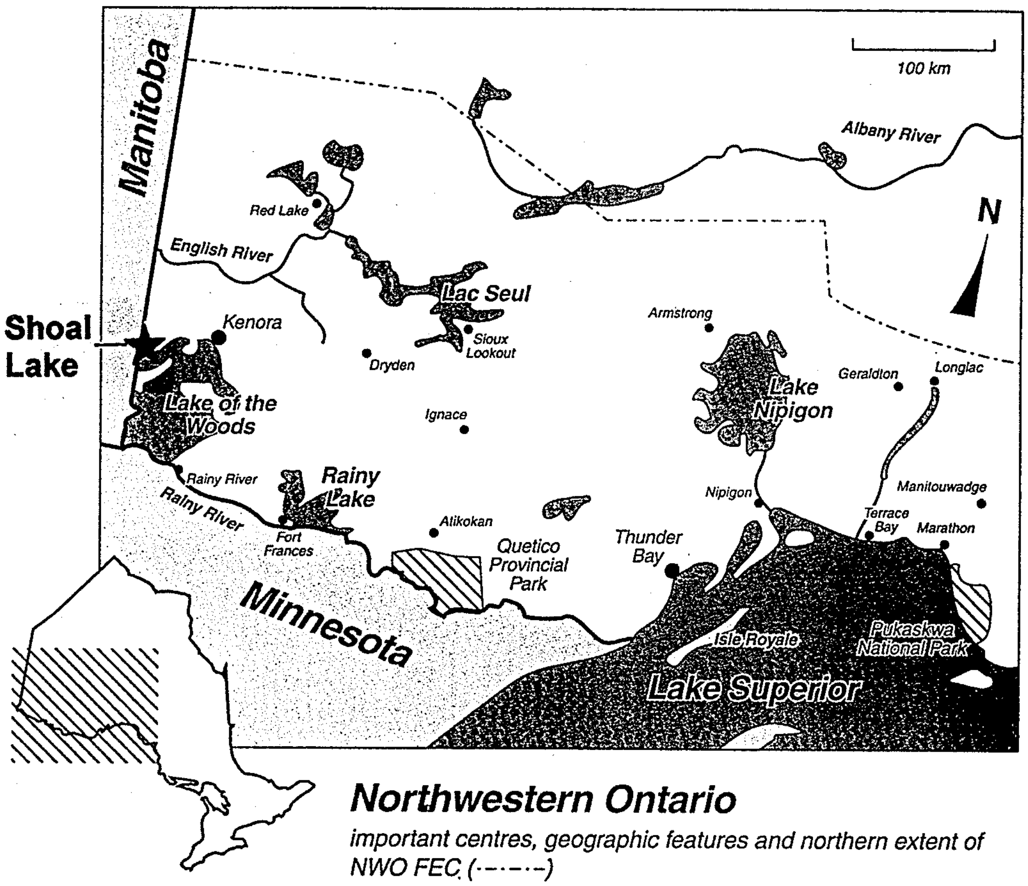


Figure 1. Map of northwestern Ontario showing location of Shoal Lake.

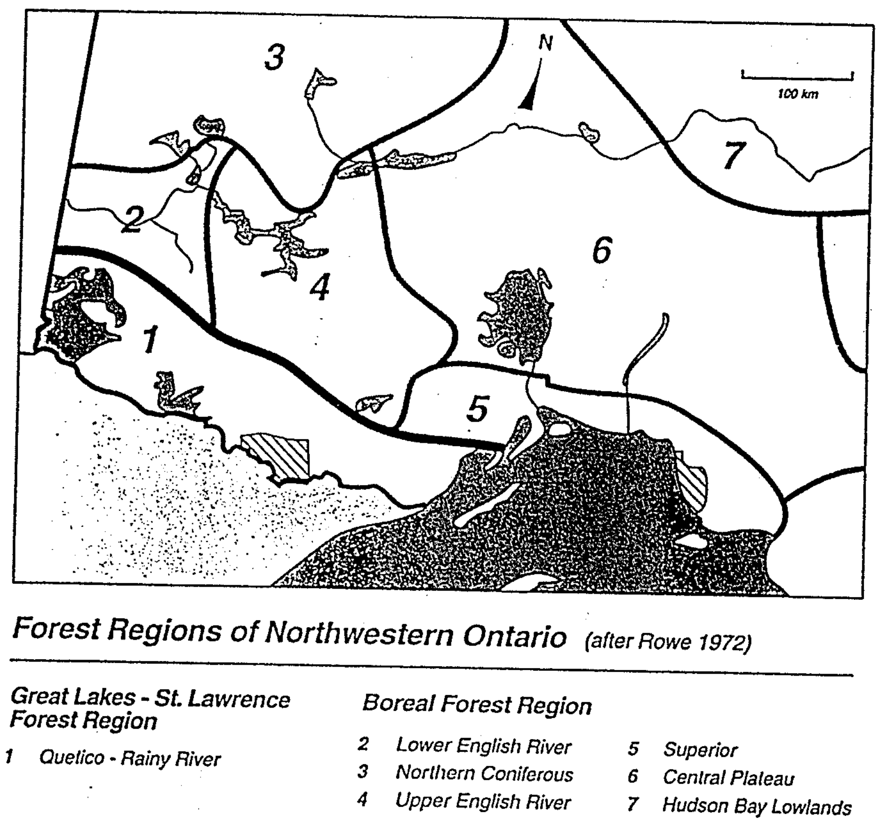
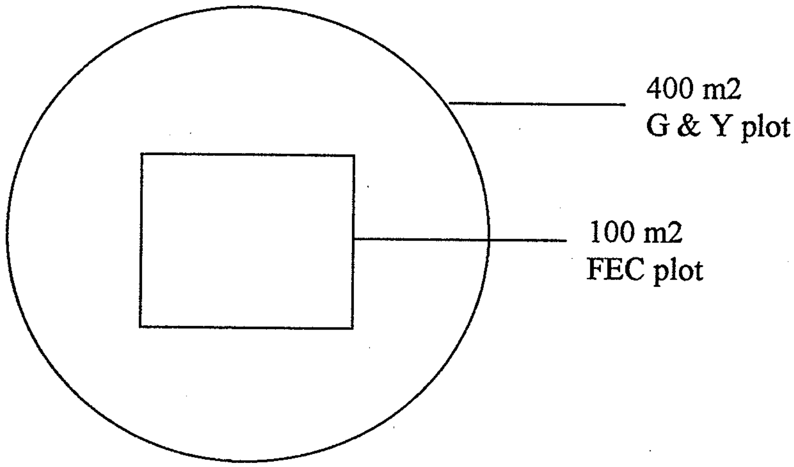


Figure 2. Map of the Forest Regions of Northwestern Ontario. *From*: Sims, R.A., Towill, W.D., Baldwin, K.A., Uhlig, P. and Wickware G.M. 1997. Field Guide to the Forest Ecosystem Classification for Northwestern Ontario – NWST Field Guide FG-03. Ontario Ministry of Natural Resources.



Circular Growth and Yield Plot (400 m2)
Measure **Trees (> 10 m)**

- Size of trees (dbh)
- Size of snags (dbh)
- % Cover
- Birch bark sample

Square Forest Ecosystem Classification Plot (100 m2)
Measure **Saplings, Seedlings, Shrubs, Herbs and Soil**

- Species
- % Cover
- Soil sample
- Other environmental variables

Figure 3. Ecosite sampling design: Growth and Yield plot and Forest Ecosystem Classification plot combination.

Chapter 4 – Birch Forest Patches

Overview

Paper birch is an important source of NTFPs as a wide variety of products are made from its bark, wood, branches, and sap. However, not only is the birch tree itself valuable, but also the birch stand as a whole. Plant species associated with birch forest patches may be valuable as NTFPs.

This chapter begins by describing the composition and abundance of plant species across ecosite types. The environmental variables associated with plant species across ecosite types are then described. This is followed by a section focusing on the twelve NTFP plant species selected based on their importance to a First Nation community at Shoal Lake. Their commercial uses, habitat, and abundance across ecosite types are discussed. The final section discusses the usefulness of ecosite types for identifying NTFP plant species for forest management purposes.

Plants Across Ecosite Types

The birch stands that were sampled occurred in four different ecosite types. Ecosite types are primarily defined by abiotic factors such as topography, soil and moisture characteristics. These factors in turn affect the vegetative communities found across ecosite types (Racey et al. 1996). In this study vegetation and environmental variables were measured in birch forest patches of each ecosite type in order to describe the four different ecosite types in the Shoal Lake watershed. This was done to get a sense of how accurately the ecosite type descriptions provided in the

Terrestrial and Wetland Ecosites of Northwestern Ontario NWST Field Guide FG-02 (Racey et al. 1996) (Appendix 1) applied in the field.

In this study there were 139 different plant taxa identified in the birch forest patches altogether (Appendix 5). Birch (*Betula papyrifera*) was the main forest patch tree species within the Birch Working Group stands that were sampled. However, 10 tree species, including birch, were encountered. There were 38 shrub and dwarf shrub taxa. The birch forest patches studied were also found to be quite rich in herbaceous species, with 91 different taxa identified (Appendix 5).

The presence of deciduous trees, such as birch, in the tree canopy can create favourable growing conditions for understory plant species. The richness of the understory plants in birch patches may be due in part to the seasonal deciduous canopy which creates open conditions in spring resulting in increased light and higher soil temperatures than closed canopy conifer patches (Carlton and Maycock 1981, Foster and King 1986). Also, the deterioration of birch litter rich in minerals can provide nutrients to understory plants (Pare and Bergeron 1996). Overall, the forest patches studied each contained a wide variety of plant species. This reinforced that birch forest patches in the boreal forest of northwestern Ontario are a potential source of plant NTFPs.

The plant species composition of the birch forest patches was described for each ecosite type to find out if any differences in composition existed across ecosite types. The canonical correspondence analysis (CCA) in Figure 4a shows ecosite centroids that are representative of the tree and shrub species composition found in the different ecosite types. The 36 different sites that were sampled were grouped around these centroids. The closer sites are to the centroid point, the more representative they are of that ecosite type. For the CCA in Figure 4a, axis 1 and 2 accounted for 9.1 % and 5.1 % of the variation respectively. When constrained, the species-ecosite correlations were 0.823 and 0.723 for axes 1 and 2 respectively. However, these species-ecosite correlations are only meaningful if the redundancy value, which explains the total variation within data once it is constrained, by ecosite type in this case, is sufficiently high. The redundancy value is normally only 20 to 50 % with 50 % being very high (Okland 1999). In this case, the redundancy value was 16 % and was considered meaningful, although low. Figure 4b is the same CCA as described above displaying selected tree and shrub species in relation to the ecosite types.

The CCA in Figure 5a shows ecosite centroids that are representative of the understory plant (including herbs, dwarf shrubs, and tree seedlings) composition in the different ecosite types. The 36 sites are shown in relation to the centroids. For the CCA in Figure 5a, axis 1 and 2 accounted for 13.9 % and 5.2 % of the variation respectively. When constrained, the species-ecosite correlations were 0.906 and 0.783 for axes 1 and 2 respectively. The redundancy value was 22 % and was considered meaningful. Figure 5b is the same CCA as described above displaying selected understory plants in relation to the ecosite types.

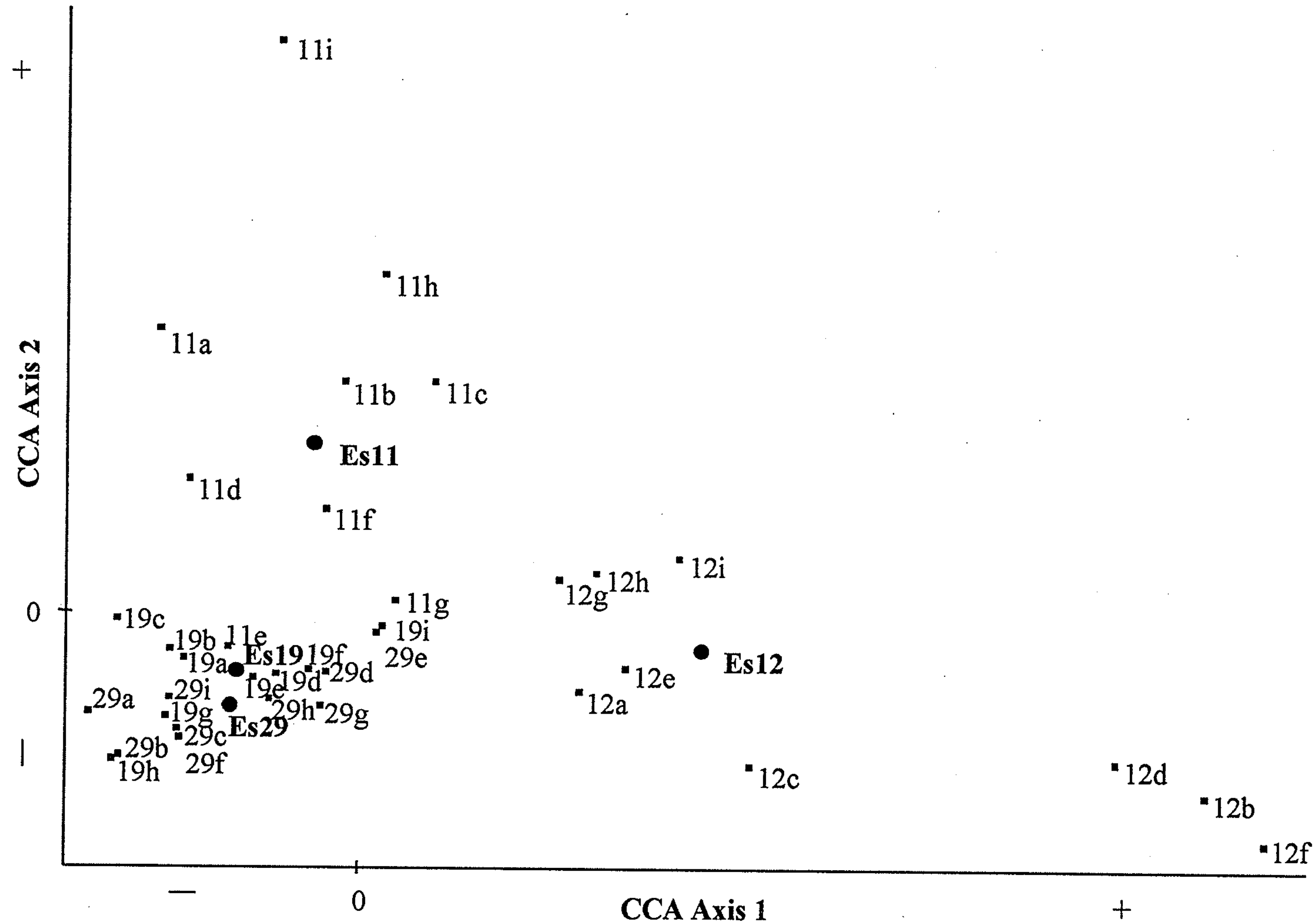


Figure 4a. Results of Canonical Correspondence Analysis (CCA) of tree and shrub composition of N = 36 birch forest patches (i.e. sites), constrained by ecosite types 11, 12, 19, and 29, showing the centroid for each ecosite type (black circle) for axes 1 and 2.

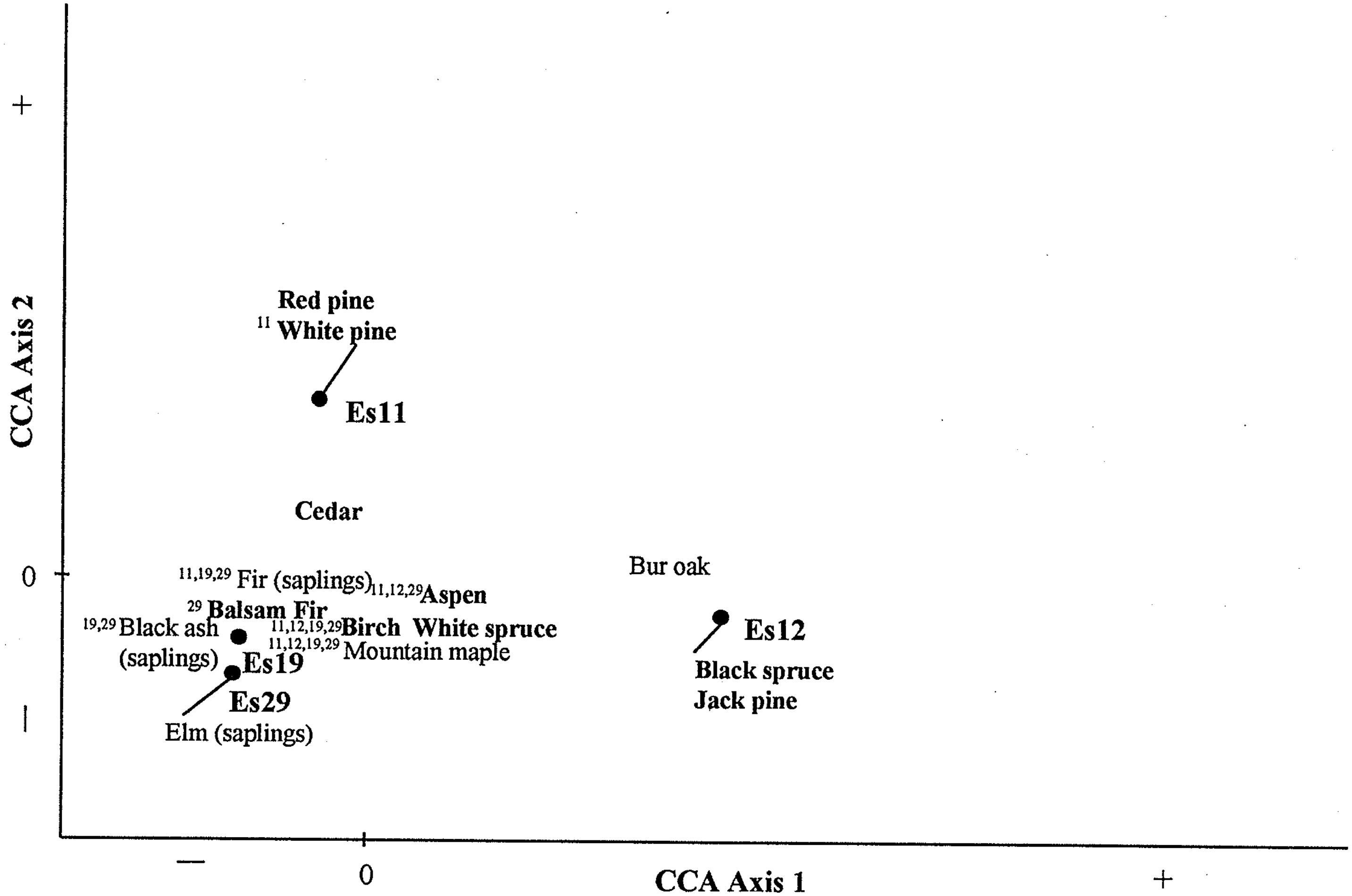


Figure 4b. Results of Canonical Correspondence Analysis (CCA) of tree and shrub composition of birch forest patches constrained by ecosite types 11, 12, 19, and 29. Selected trees (in bold) and shrubs are displayed in relation to the centroid for each ecosite (black cirle) for axes 1 and 2. Plant species designated by a line are exclusive to that ecosite type. The number in front of species indicates the ecosite type(s) in which that species occurred frequently (> 40 % of sample plots).

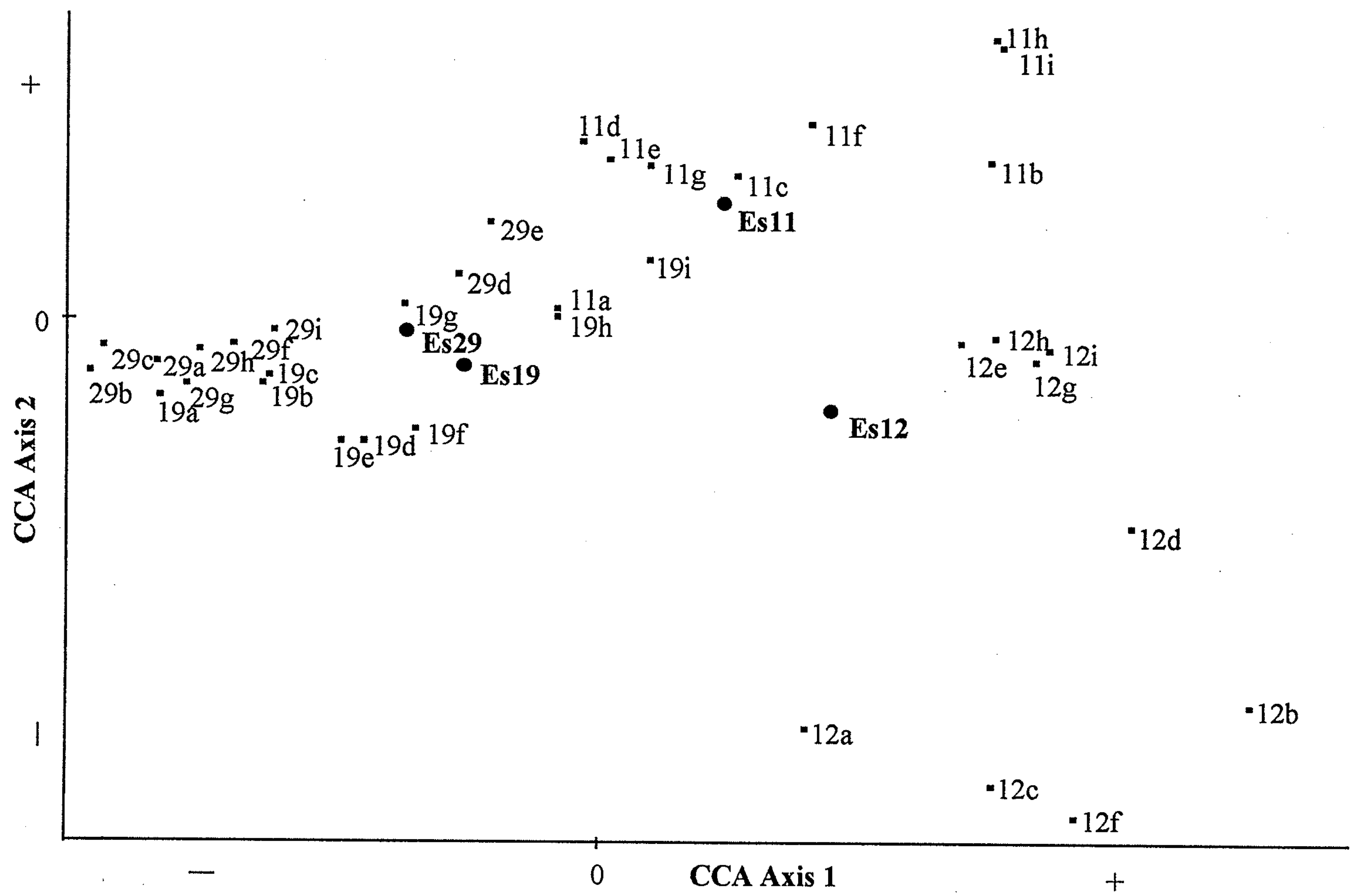


Figure 5a. Results of Canonical Correspondence Analysis (CCA) of understory plant species (herbs, dwarf shrubs, and tree seedlings) composition of N = 36 birch forest patches (i.e. sites), constrained by ecosite types 11, 12, 19, and 29, showing the centroid for each ecosite type (black circle) for axes 1 and 2.

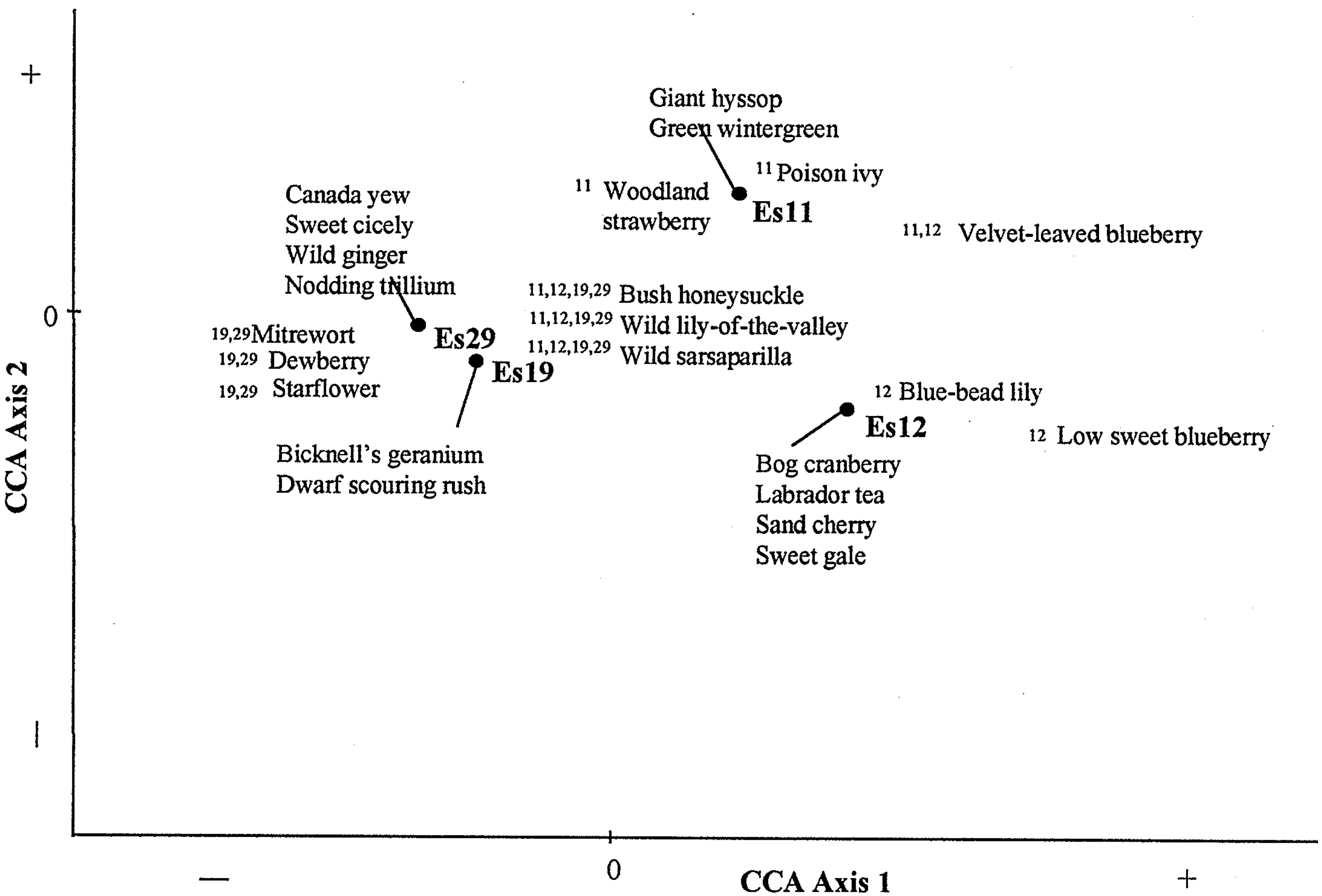


Figure 5b. Results of Canonical Correspondence Analysis (CCA) of understory plant species (herbs, dwarf shrubs, and tree seedlings) composition constrained by ecosite types 11, 12, 19, and 29. Selected plant species are displayed in relation to the centroid for each ecosite (black circle) for axes 1 and 2. Plant species designated by a line an ecosite type are exclusive to that ecosite type. The number in front of plant species indicates the ecosite type(s) in which that plant occurred frequently (> 40 % of the sample plots).

The generally low redundancy values resulting from both CCA analyses of trees/shrubs and understory plants indicated that ecosite types were not strongly distinguished from each other in species composition. The birch forest patches sampled in ecosite type 19 and ecosite type 29 stands were similar to each other in species composition and therefore clump together in the CCAs. The sites sampled in ecosite types 11 and 12 were more distinct from each other and separated out from each other and from the ecosite type 19 and 29 combination in the CCAs. This resulted in 3 groupings that differed from each other in composition: 11, 12, and a 19/29 combination (Fig. 4a, Fig. 5a).

Many plant species were not associated with any one ecosite type, but found frequently (> 40 % of the sample plots) across ecosite types. For example, the dwarf shrub bush-honeysuckle (*Diervillia lonicera*) and the herbs wild sarsaparilla (*Arailia nudicaulis*) and wild lily-of-the-valley (*Maianthemum canadense*) (Fig. 5b). These species are typically tolerant of a wide range of environmental conditions (Johnson et al. 1995) and occurred with relatively high abundance in all ecosite types (Table 1).

Table 1. Mean percent cover across plots of 3 selected species in ecosites 11, 12, 19, and 29.

Name: Common and (Scientific)	**Growth Form**	**Mean % Cover Across Plots in Ecosite**			
		11	**12**	**19**	**29**
Bush honeysuckle (*Diervillia lonicera*)	Shrub	6.7	11.8	6.1	7.6
Wild sarsaparilla (*Arailia nudicaulis*)	Herb	21.7	7.2	18.3	24.7
Wild lily-of-the-valley (*Maianthemum canadense*)	Herb	30	17.2	12.2	7.9

The rapid NTFP inventory data, however, also showed that birch forest patches in the different ecosite types could be distinguished by some frequently occurring species. Ecosite type 11 birch forest patches were defined by the presence of the tree species white pine (*Pinus strobus*) (Fig. 4b). In the understory, the frequently occurring dwarf shrub poison ivy (*Rhus radicans*) and the herb woodland strawberry (*Fragaria vesca*) distinguished ecosite type 11 from other ecosite types (Fig. 5b). Ecosite type 12 was distinguished by the frequently occurring dwarf shrub low sweet blueberry (*Vaccinium angustifolium*), the herb blue-bead lily (*Clintonia boreale*) (Fig. 5b). Ecosite types 19 and 29, were defined by different frequently occurring species such as black ash saplings (Fig. 4b) and the herbs mitrewort (*Mitella nuda*), dewberry (*Rubus pubescens*) and starflower (*Trientalis borealis*) (Fig. 5b).

It was also discovered from the rapid NTFP inventory data that abundance of plant species differed across ecosite types. For example, balsam fir saplings were more abundant in ecosite types 11, 19, and 29 (Table 2). The shrub mountain maple was mainly abundant in ecosite types 19 and 29, and beaked hazelnut occurred with the highest abundance in ecosite types 11 and 12. Some species also occurred in two ecosite types exclusive to the other two ecosite types. Usually ecosite types 11 and 12 differing from ecosite types 19 and 29. For example, coltsfoot occurring only in 19/29 and bearberry and pale comandra occurring only in 11/12 (Table 2). This is likely due to the distinct differences in moisture and nutrient regimes between these groups of ecosite types. Ecosite types 11 and 12 were generally drier and poorer in nutrients than ecosite types 19 and 29 that were moister, and richer in nutrients.

Table 2. Mean percent cover across plots of 6 selected species in ecosites 11, 12, 19, and 29.

Name: Common and (Scientific)	Growth Form	Mean % Cover Across Plots in Ecosite			
		11	12	19	29
Balsam fir (*Abies balsamea*)	Sapling	22.3	5.2	27.1	24.9
Mountain maple (*Acer spicatum*)	Shrub	13	1.7	37.2	40.9
Beaked hazelnut (*Corylus cornuta*)	Shrub	6.7	6.7	1	0.2
Bearberry (*Arctostapylos uva-ursi)*	Shrub	8	15	0	0
Palmate-leaved coltsfoot (*Petasites palmatus*)	Herb	0	0	3.1	2.9
Pale comandra (*Commandra umbellata*)	Herb	1.1	1.1	0	0

The rapid NTFP inventory also revealed that of the 139 plant taxa found in this study, there were 50 plants that were unique to birch forest patches of one ecosite type (Appendix 5). For example, the trees white pine and red pine (*Pinus resinosa*) were only found in ecosite type 11 (Fig. 4b). The trees black spruce (*Picea mariana*) and jack pine (*Pinus banksiana*) only occurred in ecosite type 12 (Fig. 4b). There were also many understory species unique to one ecosite type. For example, the evergreen shrub Canada yew (*Taxus canadensis*), and the herbs wild ginger (*Asarum canadense*) and sweet cicely (*Osmorhiza longistylis*) were unique to ecosite type 29 (Fig. 5b).

The majority of plants that were exclusive to one ecosite type, however, did not occur frequently or abundantly within the ecosite type. Abundance was usually low with mean percent cover of less than 5 % (Table 3). This may mean that these species are not unique to an ecosite type overall, but rather to particular site conditions on a smaller scale. For example, a few of the unique ecosite type 12 plants, shrubs sweet gale (*Myrica gale*) and the dwarf shrub bog cranberry (*Oxycoccus microcarpus*) only occurred in site 12f (Fig. 5a, Fig. 5b). These plants were likely more unique to the particular site conditions found in site 12f, which was an unusual wet organic soil site, than to ecosite type 12 birch forest patches in general.

Table 3. Mean percent cover across plots of 9 selected species in ecosites 11, 12, 19, and 29.

Name: Common and (Scientific)	**Growth Form**	**Mean % Cover Across Plots in Ecosite**			
		11	**12**	**19**	**29**
Giant hyssop (*Agastache foeniculum*)	Herb	0.2	0	0	0
Green-flowered wintergreen (*Pyrola virens*)	Herb	0.1	0	0	0
Sweet gale (*Myrica gale*)	Shrub	0	4.4	0	0
Bog cranberry (*Oxycoccus microcarpus*)	Shrub	0	0.6	0	0
Bicknell's geranium (*Geranium bicknelli*)	Herb	0	0	0.1	0
Dwarf scouring rush (*Equisetum scirpoides*)	Herb	0	0	0.2	0
Nodding trillium (*Trillium cernuum*)	Herb	0	0	0	0.3
American elm (*Ulmus Americana*)	Sapling	0	0	0	0.8

Environmental Variables Across Ecosite Types

Ecosites are large (10 to 100 hectares) as used by the Ontario Ministry of Natural Resources for forest management planning purposes. Due to the large size of ecosites, some variability in environmental conditions and related plant species composition of birch forest patches was expected. For example, walking through the various ecosite types during fieldwork, it was quite noticeable upon coming to a higher rocky area that the vegetation community would change from the lower areas within ecosite types.

To test the variability in environmental conditions and related species composition within and across ecosite types canonical correspondence analysis (CCA) was conducted. The CCA in Figure 6a shows how the composition of the 36 forest patches grouped according to ecosite type when constrained by the environmental variables. The CCA axes 1 and 2 accounted for 11.5 % and 5.5 % of the variation, respectively, and in total, accounted for 17 % of the variation within species data. When constrained by environmental variables, the species-environment correlations were high at 0.947 for axis 1 and 0.811 for axis 2. These correlations were meaningful, as the redundancy value was 31 %. Overall, the CCA indicated that species composition and abundance in the 36 sites was significantly related to the environmental variables measured. Figure 6b is the same CCA as described above displaying twelve selected plant species in relation to the environmental variables.

The relative importance of the environmental variables are displayed as vectors in Figures 6a and 6b. Vectors parallel to the axes are strongly correlated to those axes. Also, the longer the vectors, the more correlation there is to the particular axis. Vectors were strongly correlated with axis 1, which explained the highest amount of variation. Figure 6a showed that, of the environmental variables measured in this study, slope position, soil type, moisture regime, and tree canopy cover had the most influence over species composition in the study sites. Fire evidence had less influence as it was more weakly correlated with axis 1. Bare ground and evidence of human activity had the least influence as they were not strongly correlated with either axis 1 or 2.

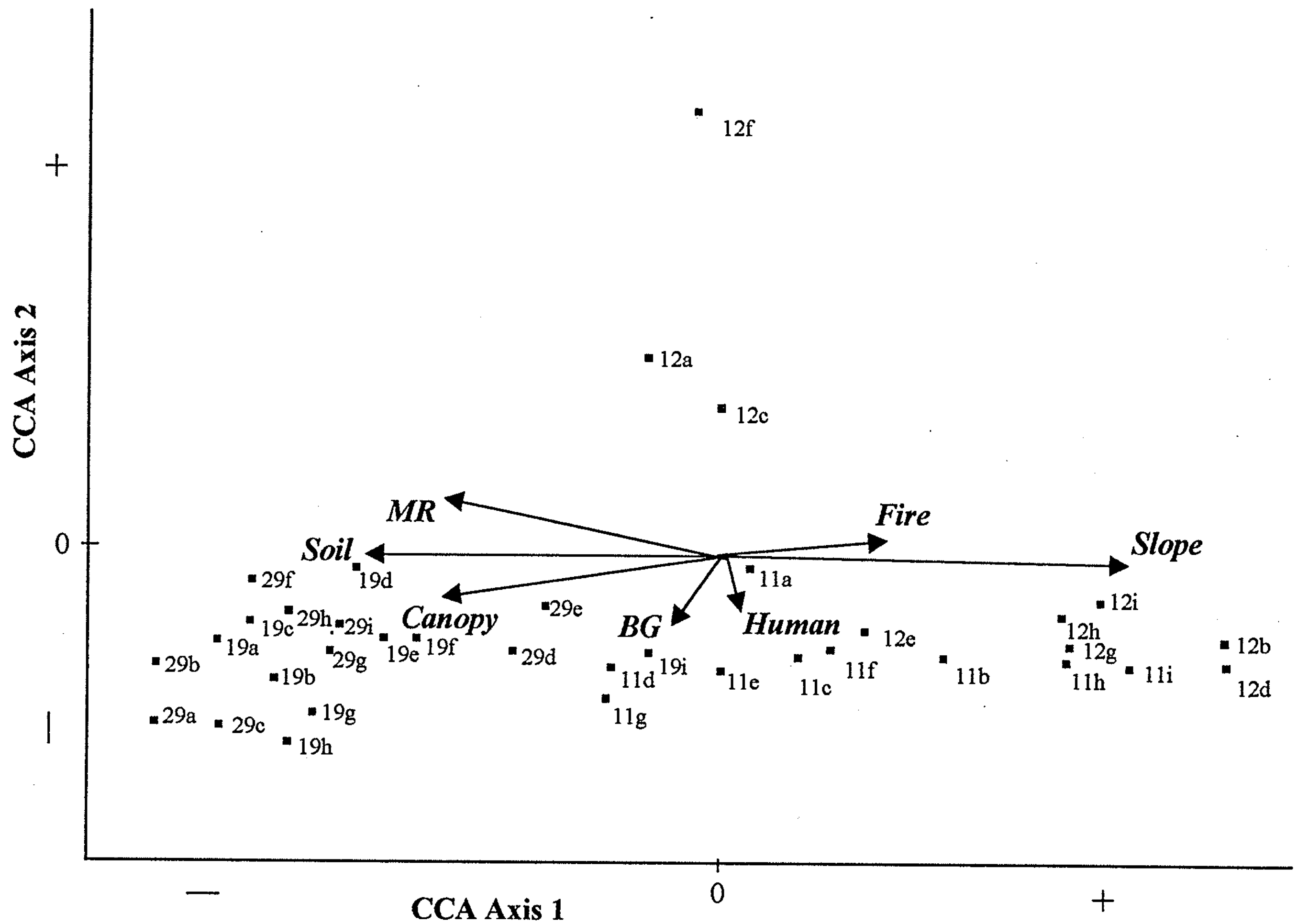


Figure 6a. Results of Canonical Correspondence Analysis (CCA) of N = 36 birch forest patches (i.e. sites), constrained by N = 7 environmental variables: Soil = Soil Type, MR = Moisture Regime, Canopy = tree canopy cover, BG = bare ground cover, Human = evidence of human activity, Fire = evidence of fire, and Slope = slope position.

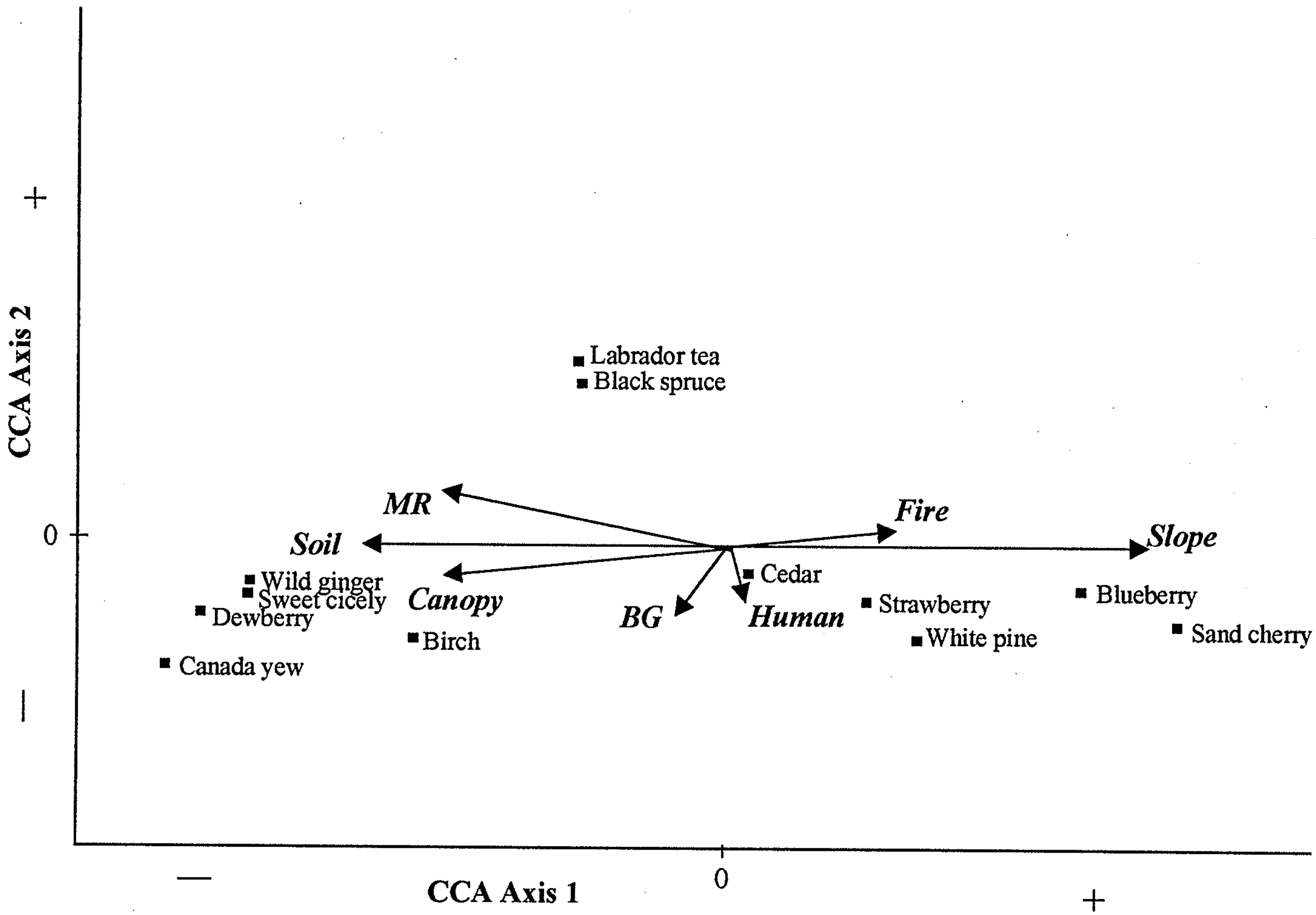


Figure 6b. Results of Canonical Correspondence Analysis (CCA) displaying the 12 selected plant species important to the people of Shoal Lake First Nation, constrained by N = 7 environmental variables: Soil = Soil Type, MR = Moisture Regime, Canopy = tree canopy cover, BG = bare ground cover, Human = evidence of human disturbance, Fire = evidence of fire, and Slope = slope position.

Overall, Figure 6a showed that ecosite types were not equally distinct from each other in environmental variables and hence not equally distinct from each other in plant species composition. The most distinct differences in composition across ecosite types occurred between groups of ecosite types 11 and 12 which had generally drier, shallower less nutrient-rich soils, open canopy conditions and higher slope positions in contrast to ecosite types 19 and 29 which had generally moister, deeper more nutrient-rich soils, more closed canopy conditions, and lower slope positions (Fig. 6a). Blueberry, sand cherry, woodland strawberry and white pine were more associated with the environmental conditions typical of ecosite type 11 and 12 sites while Canada yew, dewberry, sweet cicely, and wild ginger were more associated with the environmental conditions typical of ecosite type 19 and 29 sites (Fig. 6a, Fig. 6b).

Environmental conditions proved to be quite variable within the ecosite types sampled. Particularly ecosite type 12, which contained both rocky upland areas (Plate 1) with shallow dry soils and open canopy conditions, as well as lowland areas with deeper fresh or wet soils and more closed canopy conditions (Plate 2) (Table 4). Two groups of sites differing in plant species composition corresponding to differing environmental conditions emerged in ecosite type 12. For example, blueberry shrubs and sand cherry were associated with rocky upland sites such as 12b and 12i while black spruce and Labrador tea were associated with moister lowland sites such as 12a, 12c, and 12f (Fig. 6a, Fig.6b).

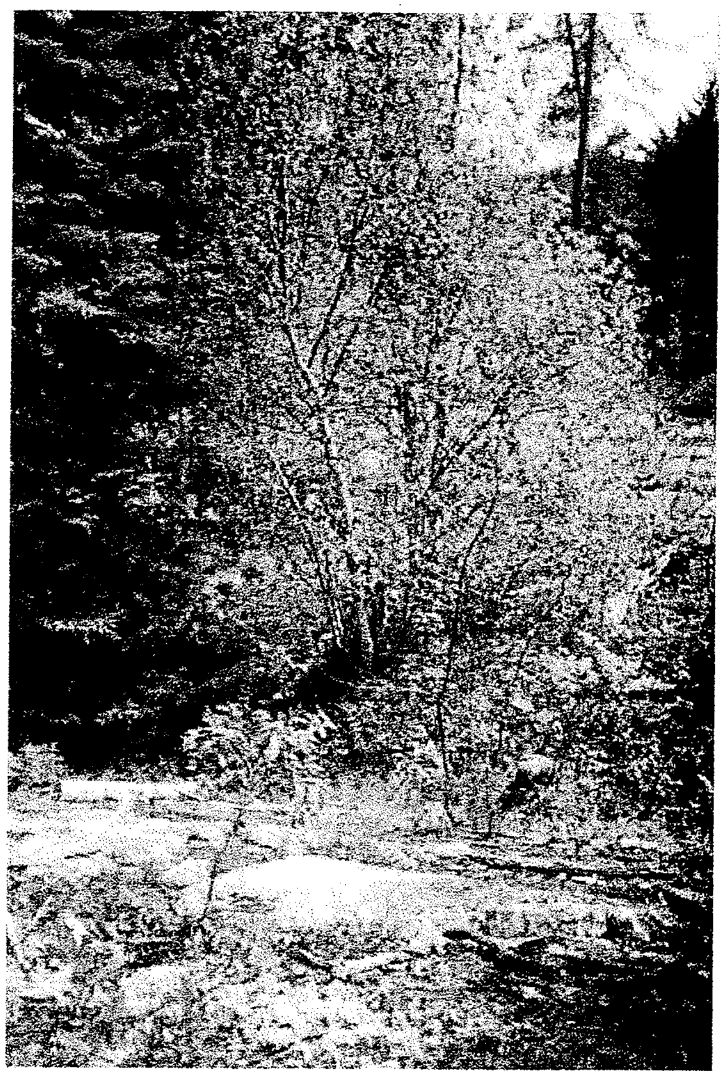


Plate 1. Ecosite type 12, showing typical upland site conditions and vegetation.

Plate 2. Ecosite type 12, showing typical lowland site conditions and vegetation.

Table 4. A summary of the environmental variables of soil type, moisture regime, slope position, canopy cover, bare ground, fire evidence, and human activity found in the birch forest patches in ecosite types 11, 12, 19, and 29.

Ecosite	**11**	**12**	**19**	**29**
Soil Type	Extremely-Very shallow soil on bedrock (7)*, Shallow-mod deep, silty-fine loamy clayey (2)	Extremely-Very shallow soil on bedrock (5), Shallow-mod deep, sandy (2) Shallow-mod deep coarse loamy (1), Deep, Organic (1) (*Sphagnum* moss)	Deep, Fine loamy-clayey (5), Deep, Clayey (2), Shallow-mod deep, sandy (1), Very shallow soil on bedrock (1)	Shallow- mod deep coarse loamy (5), Deep, Fine loamy clayey (3), Deep, Coarse loamy (1)
Moisture Regime	Dry (7), Fresh (2)	Dry (5), Fresh (3), Wet (1)	Fresh (4), Moist (3), Dry (2)	Fresh (8), Moist (1)
Slope Position	Level (5), Lower (1), Upper (2), Crest (1)	Crest (3), Mid (3), Lower (2), Level (1)	Level (6), Lower (2), Mid (1)	Level (8), Lower (1)
Canopy Cover	0-50 % (7) 51-100 % (2) Avg. 43.3 %	0-50 % (8) 51-100 % (1) Avg. 37.7 %	0-50 % (6) 51-100 % (3) Avg. 56 %	0-50 % (2) 51-100 % (7) Avg. 62.2 %
Bare Ground	0-50 % (8) 51-100 % (1) Avg. 11.1 %	0-50 % (9) 51-100 % (0) Avg. 6.7 %	0-50 % (7) 51-100 % (2) Avg. 22.7 %	0-50 % (9) 51-100 % (0) Avg. 3.6 %
Fire Evidence	No (7), Yes (2)	No (8), Yes (1)	No (5), Yes (4)	No (6), Yes (3)
Human Activity	No (8), Yes (1)	No (8), Yes (1)	No (9)	No (8), Yes (1)

*Numbers in brackets are the number of sites (of 9 sites in each ecosite type) where that particular environmental characteristic was found.

Ecosite type 11 and 12 sites did separate out from each other somewhat in plant composition when constrained by environmental variables (Fig. 6a). For example, cedar, white pine and woodland strawberry were more associated with ecosite type 11 sites (Fig. 6b). Ecosite type 11 was similar to ecosite type 12 in that it generally had open conditions with dry, shallow soils over bedrock, although some deeper soils occurred (Plate 3). Topography, however, was less variable in ecosite type 11 and the majority of sites had a level slope position (Table 4). Also, other than the environmental variables measured, canopy composition may have played a role in separating these two ecosite types. Usually white pine and/or eastern white cedar was in the canopy with birch in ecosite type 11 and trembling aspen and/or jack pine was in the canopy with birch in ecosite type 12.

Plate 3. Ecosite type 11, showing typical site conditions and vegetation. Note large white pine (*Pinus strobus*) (right).

Ecosite types 19 and 29 were the least variable in environmental conditions within, and were very similar to each other in plant composition when constrained by environmental variables (Fig. 6a). Both ecosite types generally having deep, fresh to moist soils, a level or lower slope position, and closed canopy conditions (Plate 4,

Plate 5) (Table 4). It was notable that in the field it was difficult to key out ecosite types 19 and 29 using the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (Racey et al. 1996). For example, several forest stands that were designated as ecosite type 19, keyed out to ecosite type 29 based on soil and vegetation characteristics. It may be that some of the forest stands studied were mistyped. When ecosite types for northwestern Ontario were being developed the majority of vegetation and soil data was collected east of Lake of the Woods where acidic soils from the Canadian Shield are encountered. However, ecosite types developed from this data may not apply properly to the Shoal Lake watershed, where basic prairie soils from the west would influence the vegetation communities found there.

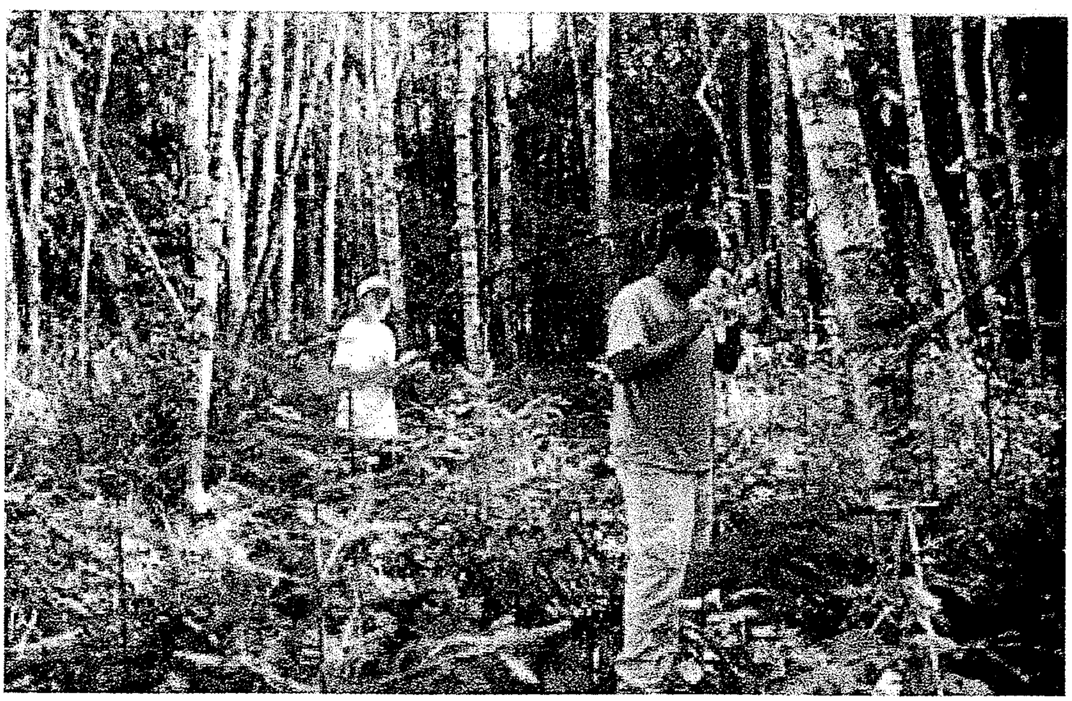


Plate 4. Ecosite type 19, showing typical site conditions and vegetation.

Plate 5. Ecosite type 29, showing typical site conditions and vegetation.

Ideally, site types that are relatively uniform in environmental conditions as well as distinct from other site types would be the most useful in identifying NTFP plant species. However, this was not the case regarding the ecosite types studied. Data analysis showed that the four ecosite types sampled were not equally distinct from each other in environmental variables and associated plant species composition. It was discovered that because ecosites are large and variable in habitat, certain NTFP plant species have specific habitat niches where they occur within ecosite types. Also, some ecosite types (e.g. ecosite type 19 as mentioned above) as described in the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide may not apply properly in Shoal Lake watershed. All of this indicated the need for field sampling such as conducted in this study to gain accurate information about environmental variables associated with plant NTFPs.

Selected Plant Species

The following section focuses on the plant species composition and abundance across ecosite types of the twelve selected plant species utilized or otherwise recognized as important by the First Nation people of the Shoal Lake Watershed. The species selected were four tree species: paper birch (*Betula papyrifera*), black spruce (*Picea mariana*), white pine (*Pinus strobus*), and eastern white cedar (*Thuja occidentalis*); four shrub species: Labrador tea (*Ledum groenlandicum*), sand cherry (*Prunus pumila*), Canada yew (*Taxus canadensis*) and velvet-leaved blueberry (*Vaccinium myrtilloides*); and four herbaceous species: wild ginger (*Asarum canadense*), woodland strawberry (*Fragaria vesca*), sweet cicely (*Osmorhiza longistylis*), and dewberry or dwarf raspberry (*Rubus pubescens*).

The commercial uses of these plant species as NTFPs are discussed. Each plant species is then described in relation to the environmental conditions where it was found growing within the different ecosite types. This is followed by a discussion of how these valuable plant species might be managed as NTFPs using ecosite type as a forest management unit.

Use Values

The commercial uses of the twelve selected species are considered here to highlight the non-timber value of some of the forest plant species in northwestern Ontario. With increasing interest in marketing of non-timber forest products it will be important for First Nation communities to be aware of which plants on their land may be sought after for their commercial value.

Eleven of the twelve selected species were found to be currently or potentially commercially valuable (Appendix 6). All of the tree species were found to be valuable as NTFPs. Boughs, cones, and bark for use as decorative items, leaf oils for aromatherapy or medicinal uses, as well as collection of tree seeds for nurseries were among the existing commercial uses. For example, birch was found to have a great variety of commercial uses (Table 5). All of the shrubs were also valuable as NTFPs. Canada yew was found to be particularly valuable as a source for drugs used to treat some types of cancers (Table 5). Other shrub NTFPs included preserved boughs for use in the floral industry, essential oil extracted from leaves, and use as landscaping plants. Of the herbaceous species, wild ginger, woodland strawberry and sweet cicely have commercial markets for edible products, essential oils, as well as medicinal products made from their various parts (Table 5). The herb dewberry was the only selected species that was not commercially viable due to lack of productivity.

The amount of commercial value found in only these few species suggested that plants traditionally harvested by First Nation people are often economically valuable. This agrees with other findings. For example, Turner lists 100 species of traditionally harvested native plants that have the potential to be developed as food products (Turner 1981). However, these selected species were important to the people of Shoal Lake First nation for reasons other than their economic value. Incorporation of NTFPs into forest management planning is critical for the preservation of cultural heritage. For example, although the herb dewberry is not economically viable, it has berries that are desirable for eating and is a generally important plant in Aboriginal culture in the boreal forest (Marles et al. 2000).

Table 5. Non-timber commercial use information* for 3 of the selected plant species that are important /recognized by a First Nation community in the Shoal Lake watershed, northwestern Ontario.

Scientific name: *Betula papyrifera* **Common name(s):** Paper birch, White birch **Commercial uses:** Specialty wood products such as toothpicks, clothespins, broom handles, toys, snowshoe frames, and canoes. Wood and bark oil for aromatherapy. Birch bark baskets, bark-biting artwork, other crafts, and decorative furniture. Birch bark is a source of drugs with antiviral activity. Birch bark identified by the National Aboriginal Forestry Association (NAFA) as having immediate market demand in Ontario. Sap used as food (e.g. syrup) or in making drinks. Seed collected for use in the forestry industry, landscaping nurseries, or other seed retail.
Scientific name: *Taxus canadensis* **Common name(s):** Canada yew **Commercial uses:** Drugs used to treat some types of cancer (e.g.Taxol®), originally from Pacific yew *Taxus brevifolia*, are now being developed from *T. canadensis*. For example, Prince Edward Island's Forestry Division has guidelines for the collection of *T. canadensis* and the island currently supports a small market for the tips of branches that have a concentrated amount of the active compound taxol. The seeds of Canada yew are identified by the NAFA as having immediate market demand in Ontario.
Scientific name: *Asarum canadense* **Common name(s):** Wild ginger **Commercial uses:** Dried roots for use to flavour foods, also sold for medicinal purposes. The seeds of wild ginger are identified by the NAFA as having immediate market demand in Ontario.

*See Appendix 6 for complete table of all twelve selected plant species and references.

Birch

Birch trees occurred in all ecosite types as expected. However, analysis of variance (ANOVA) of the rapid NTFP inventory data revealed that the abundance of birch trees (i.e. mean percent cover) was significantly different ($R^2 = 0.34$, $P = 0.0034$) across ecosite types. Birch trees had the highest abundance (i.e. mean cover) in ecosite types 19 and 29 with 43.3 % and 45 % mean cover respectively, and were less abundant in ecosite types 11 and 12 with 13.9 % and 11.1 % mean cover respectively (Fig. 7). The difference in abundance was likely related to the contrast in

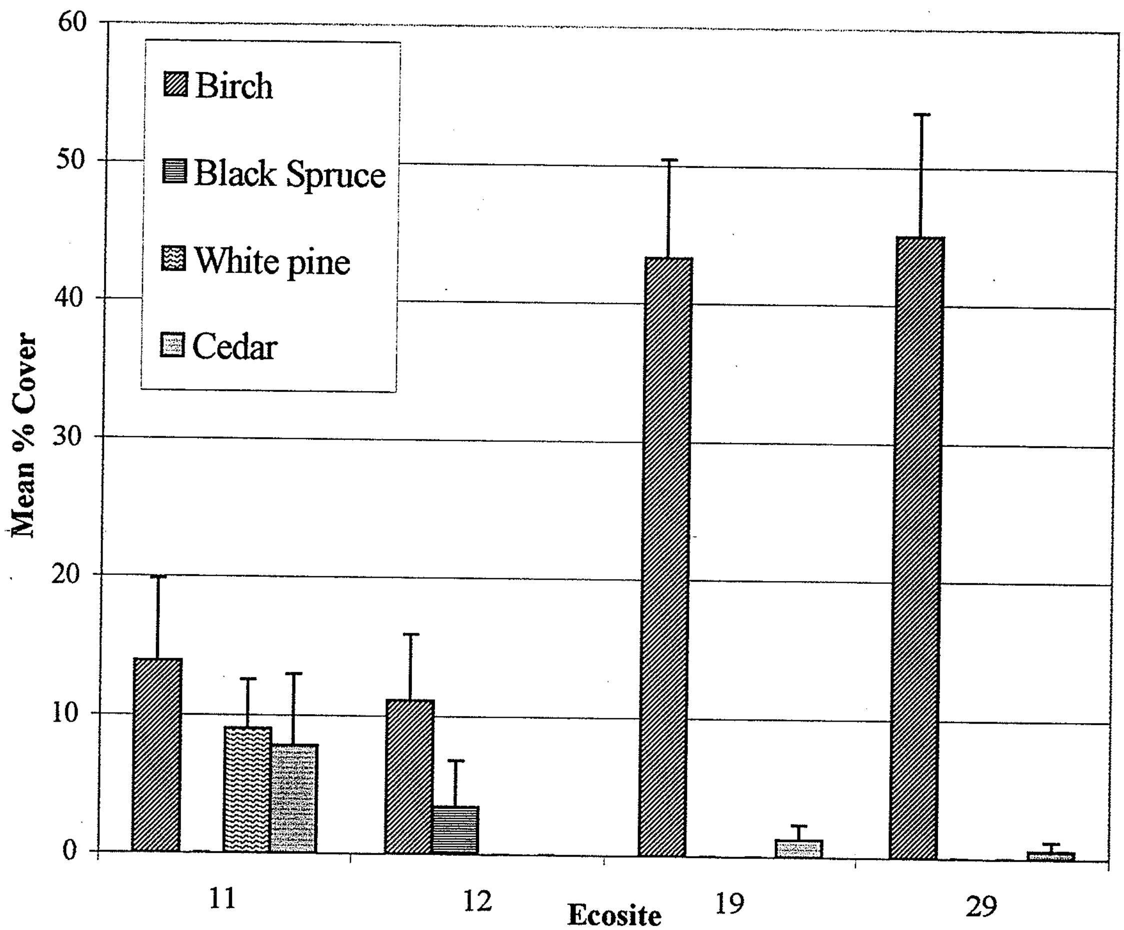


Figure 7. Mean percent cover of selected tree species: Birch (*Betula papyrifera*), Black spruce (*Picea mariana*), White pine (*Pinus strobus*) and Cedar (*Thuja occidentalis*) in ecosite types 11, 12, 19, and 29.

site conditions found between ecosite types 11 and 12 versus ecosite types 19 and 29. Birch trees were most related to the environmental variables typical of ecosite type 19 and 29 sites (Fig. 6a, Fig. 6b). Multiple regression showed that birch tree abundance was significantly related to soil type and canopy cover (Table 6). Birch was most abundant were deeper soils occurred, specifically coarse loamy soils (mainly sand in C-Horizon) as well as fine loamy clayey or clayey soils (mainly clay in C-Horizon) (Appendix 7, Appendix 8). High canopy cover also characterized sites where birch was abundant, although the canopy was mainly dominated by birch itself.

White Pine

The abundance of white pine was also significantly different ($R^2 = 0.40$, $P = 0.0012$) across ecosite types. White pine was exclusive to ecosite type 11 with 9 % mean cover in that ecosite type (Fig. 7). It occurred in the majority (6 out of 9) ecosite type 11 sites. White pine was not observed growing in large stands but usually as one or two large individual trees within or near the birch forest patch that was being sampled (Plate 3). White pine was not significantly related to any of the measured environmental variables. However, the site conditions where white pine was encountered were normally open with dry, shallow soil over bedrock. For white pine in particular, it is noteworthy that it did not also occur in ecosite type 12, since environmental conditions are similar in ecosite types 11 and 12. It was observed that white pine was most abundant near the shores and on the islands of Shoal Lake. Ecosite type 11 sites in this study were located in close proximity to the lake which would moderate temperature and may have allowed for favorable growth of white pine over the more inland ecosite type 12 sites.

Table 6. Results of multiple regression testing the relationship of species abundance with the environmental variables measured.

Species	P	R^2	*Standardized β ♦ for environmental variables*						
			Soil	MR	Slope	Fire	Human	BG	Canopy
Birch	<0.0001	0.63	0.462 *	-0.356 NS	-0.357 NS	0.111 NS	0.090 NS	0.303 NS	0.408*
Black spruce	0.0024	0.52	0.961 *	-0.813 *	-0.064 NS	0.259 NS	-0.062 NS	0.151 NS	-0.263 NS
Labrador tea	0.0531	0.37	0.781 *	-0.693 *	-0.157 NS	0.289 NS	-0.059 NS	0.145 NS	-0.276 NS
Blueberry	0.0094	0.46	-0.163 NS	-0.047 NS	0.625 *	-0.093 NS	0.245 NS	-0.274 NS	0.216 NS
Canada yew	0.0092	0.46	0.697 *	-0.479 **	0.009 NS	-0.057 NS	-0.222 NS	-0.242 NS	0.405 **

♦ Standardized β is a standardized partial regression coefficient
* $P < 0.05$, ** $P < 0.01$, NS = not significant ($P > 0.05$)

Black Spruce

Black spruce was exclusive to ecosite type 12 sites but had relatively low abundance with 3.4 % mean cover (Fig. 7). Black spruce only occurred in 2 of 9 ecosite type 12 sites. It was unusual that this tree species was not encountered more often as it was described as being prominent within this ecosite type entitled "black spruce – jack pine on very shallow soil" according to Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (Racey et al. 1996). If sample size were increased black spruce would likely have more of a presence because areas of black spruce were observed. However, within ecosite type 12, black spruce may not be highly associated with birch. In the ecosite type 12 forest stands that were sampled, black spruce occurred mainly in noticeably moister lowland areas (Plate 2) in contrast to a larger expanse of higher rocky areas dominated by birch with some trembling aspen or jack pine. Multiple regression showed that black spruce was significantly related to the environmental variables of soil type and moisture regime (Table 6). The highest abundance occurred in site 12f which was a low, wet, organic soil site dominated by sphagnum moss (Appendix 7, Appendix 8). These black spruce lowland areas may be more prominent in ecosite type 12 stands that are not classed as Birch Working Group.

Eastern White Cedar

The tree eastern white cedar occurred with 7.8 % cover in ecosite 11, and was less abundant in ecosites 19 and 29 with 1.2 % and 0.6 % cover respectively (Fig. 7). Cedar trees, normally in the sub-dominant canopy position, usually occurred as small stands within or near the birch forest patches sampled (Plate 6). In the Terrestrial and

Wetland Ecosites of Northwestern Ontario Field Guide white cedar is described as sometimes locally abundant within ecosite type 11 (Racey et al. 1996), this was found to be true during sampling. However, cedar was not particularly related to any of the environmental variables measured or representative of any one ecosite type (Fig. 6a, Fig. 6b). Eastern white cedar can establish equally well on dry upland sites and lower moist sites (Bergeron and Dubuc 1989). In this study, cedar was also found in both types of site conditions. Within ecosite type 11, cedar occurred in two sites, sites 11a and 11f. These sites were on dry, shallow soils over bedrock (Appendix 7, Appendix 8). However, cedar also occurred in sites 19b, 19c, and 29a in ecosite types 19 and 29. In these ecosite types it was found at level slope position on moist, fine loamy clayey soil (Appendix 7, Appendix 8).

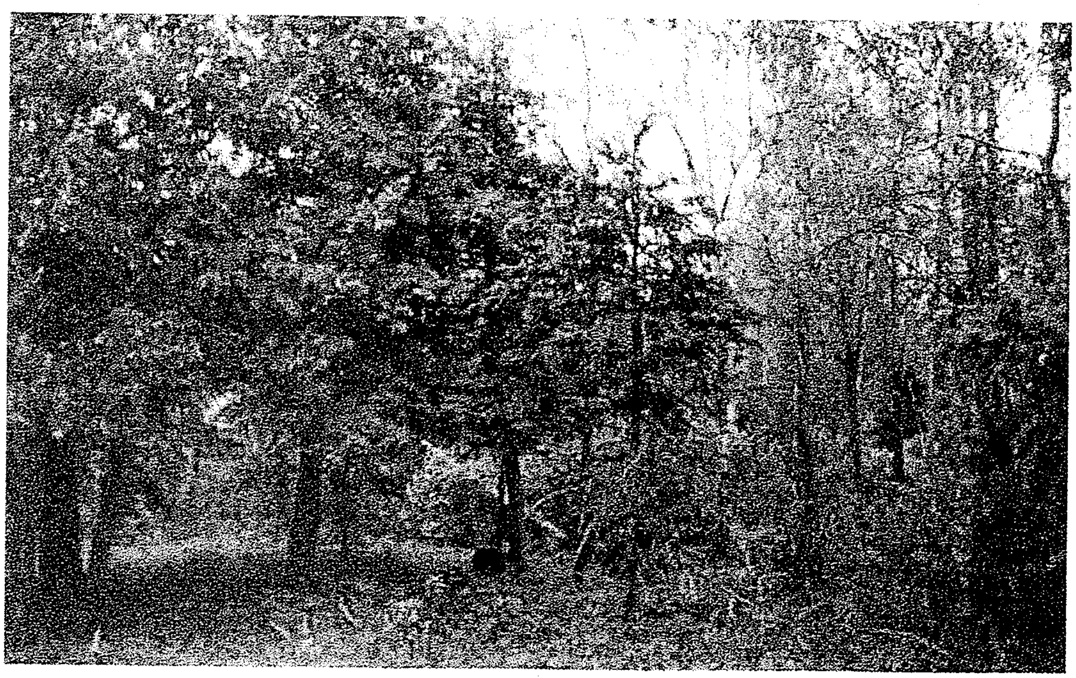


Plate 6. Eastern white cedar (*Thuja occidentalis*) trees (left) near birch (right) in ecosite type 11.

Canada Yew

Canada yew, an evergreen shrub (Plate 7), stood out because it only occurred in ecosite type 29 and was abundant with 21.1 % mean cover (Fig. 8). ANOVA showed that the mean percent cover of Canada yew approached significant difference ($R^2 = 0.27$ and $P = 0.0181$) across ecosites. The shrub occurred in 3 of 9 sites, all within an ecosite type 29 Birch Working Group stand on an island in Shoal Lake. Multiple regression showed that Canada yew was significantly related to the environmental variables of soil type, moisture regime, and canopy cover (Table 6). The conditions existing in sites 29a, 29b, and 29c were Canada yew occurred were fine loamy-clayey soil with a fresh moisture regime and high tree canopy cover. Canada yew was found in the only three fine loamy-clayey sites that occurred in ecosite type 29 in this study (Appendix 7, Appendix 8). This reinforced that soil type was an important factor in determining where Canada yew grows.

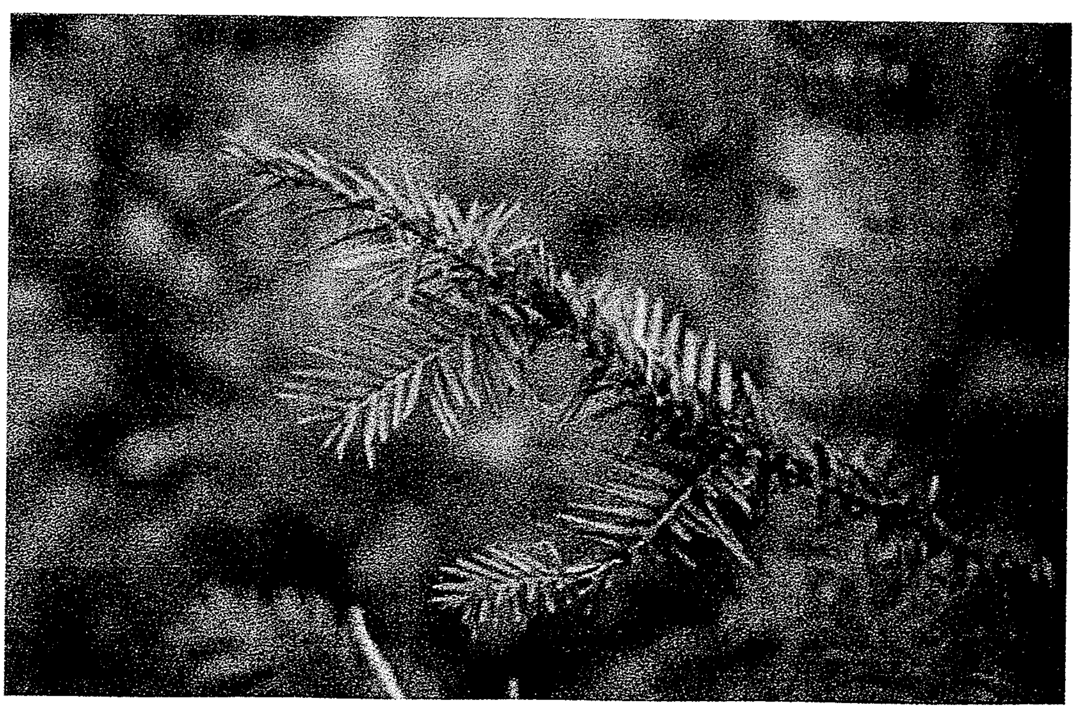


Plate 7. The evergreen shrub Canada yew (*Taxus canadensis*)

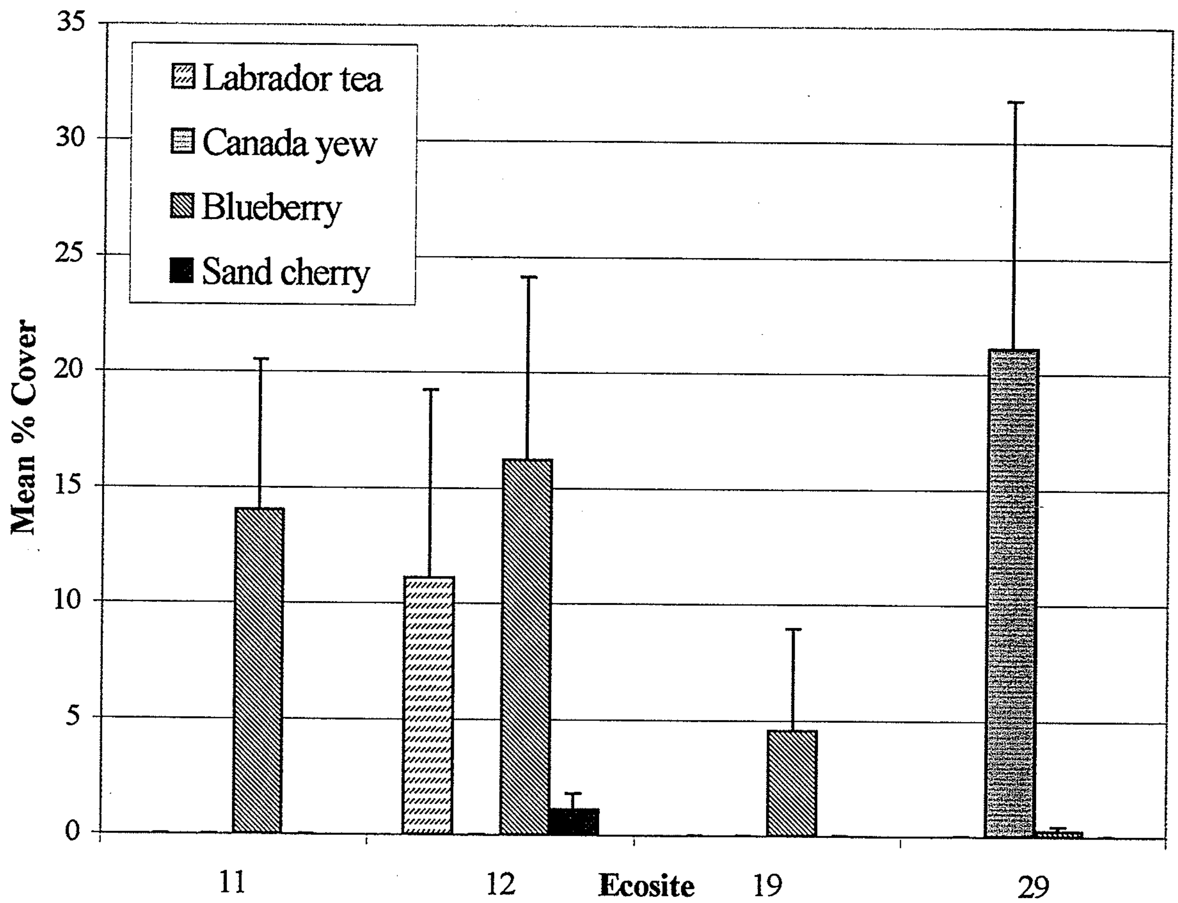


Figure 8. Mean percent cover of selected shrub species: Labrador tea (*Ledum groenlandicum*), Canada yew (*Taxus canadensis*), Velvet-leaved blueberry (*Vaccinium myrtilloides*), and Sand cherry (*Prunus pumila*) in ecosite types 11, 12, 19, and 29.

Velvet-leaved Blueberry

Velvet-leaved blueberry is a shrub (Plate 8) that was relatively abundant in ecosites 11 and 12 with 14 % and 16 % cover respectively, and was less abundant in ecosites 19 and 29 with 4.6 % and 0.2 % respectively (Fig. 8). Figures 6a and 6b showed its association with the upland sites with shallow sandy soil and open, high light conditions generally representative of ecosite types 11 and 12. Abundance of velvet-leaved blueberry shrubs was significantly related to the environmental variable of slope position (Table 6). For instance, velvet-leaved blueberry only occurred in high abundance (40 % cover of the 10 x 10 FEC plot) in one ecosite type 19 site, site 19i (Appendix 7). Site 19i was a higher, rocky area unlike the other ecosite type 19 sites that had either level or lower slope positions (Appendix 8).

Plate 8. The low shrub velvet-leaved blueberry (*Vaccinium myrtilloides*)

Labrador Tea

The dwarf shrub Labrador tea was only found in ecosite type 12 and occurred with 11.1 % mean cover (Fig. 8). Multiple regression showed that Labrador tea was significantly related to the environmental variables of soil type and moisture regime (Table 6). It was most abundant (70 % cover of the 10 x 10 FEC plot) in the wet, organic soil site, site 12f. This was not unusual as Labrador tea is often an indicator of the nutrient-poor, acidic conditions found at such sites (Johnson et al. 1995). The CCA in Figure 6b showed that Labrador tea was closely associated with black spruce. Labrador tea occurred in the same two sites as black spruce, sites 12c and 12f (Appendix 7).

Sand Cherry

Sand cherry is a dwarf shrub that was not very abundant with 1.1 % cover, and was exclusive to ecosite type 12 (Fig. 8). Sand cherry was not significantly related to any of the environmental variables measured. However, in the two sites where sand cherry did occur, sites 12b and 12i, it was found growing on shallow soil over bedrock, at mid and crest slope positions, with open canopy conditions (Appendix 7, Appendix 8). The CCA in Figure 6a and 6b also showed that sand cherry was generally associated with site conditions typical of the upland sites in ecosite type 12. Site 12i had relatively deep soil (shallow-deep coarse loamy) for ecosite type 12 (Appendix 8). However, sand cherry did not appear to be associated with this soil type as a large portion of exposed bedrock was also present in this site and sand cherry was found growing on very thin soil directly on the bedrock.

Woodland Strawberry

Woodland strawberry (Plate 9) is an herb that was significantly different ($R^2 = 0.54$, P = <0.0001) in abundance across ecosites. Woodland strawberry was common throughout all ecosite types sampled, however, it was noticeably more abundant within birch forest patches in ecosite type 11. Abundance of woodland strawberry in ecosite type 11 was 28.9 % mean cover in contrast to ecosite types 12, 19, and 29 which had less abundance with 1.1 %, 7.3 %, and 6.3 % mean cover respectively (Fig. 9). Woodland strawberry occurred in 8 of the 9 ecosite type 11 sites. Woodland strawberry was not significantly related to any of the environmental variables measured. However, it was observed mainly in open, level, herb-rich areas. Shade/light may be a determining factor as the only ecosite type 11 site that it did not occur in had very high tree canopy cover of 90 %.

Plate 9. The herb woodland strawberry (*Fragaria vesca*).

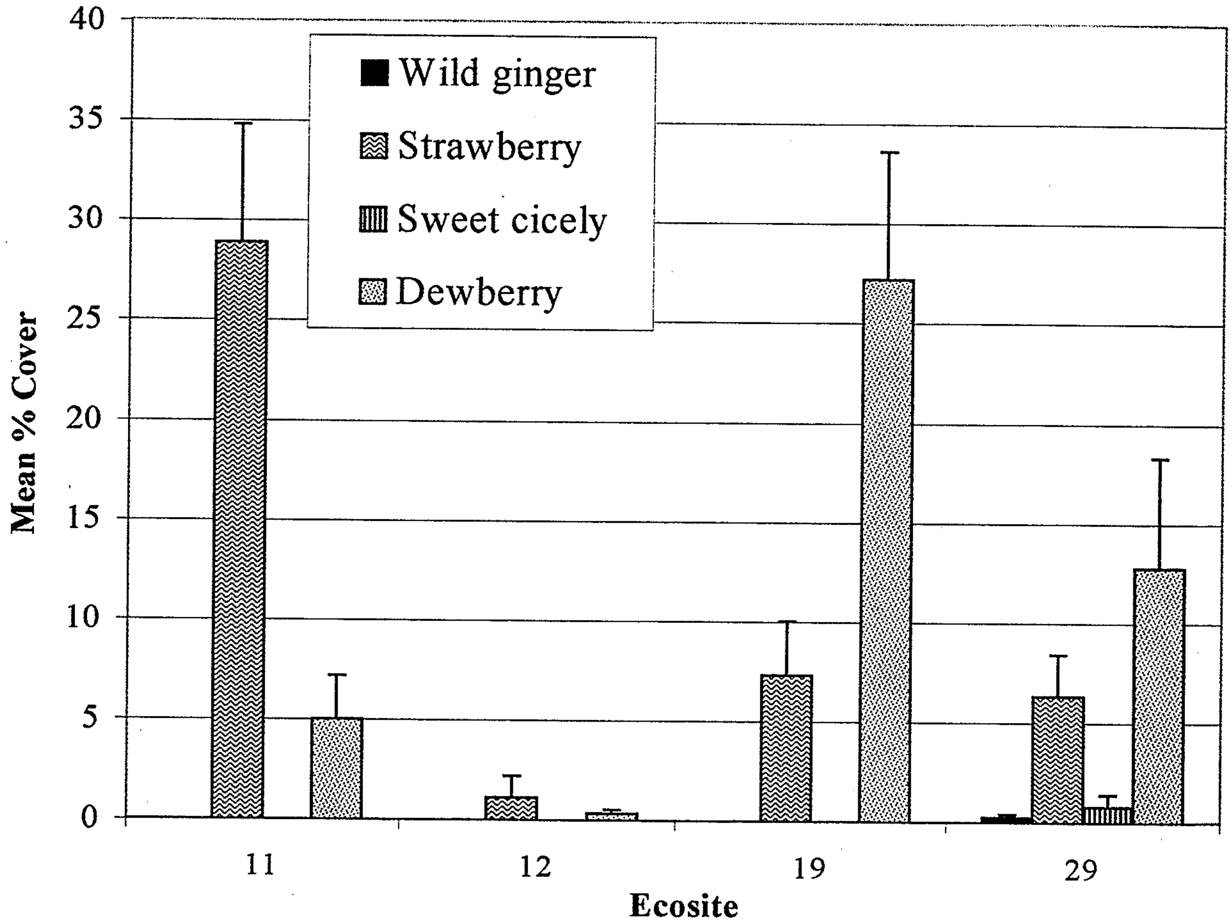


Figure 9. Mean percent cover of selected herbaceous species: Wild ginger (*Asarum canadense*), Woodland strawberry (*Fragaria vesca*), Sweet cicely (*Osmorhiza longistylis*), and Dewberry (*Rubus pubescens*) in ecosite types 11, 12, 19, and 29.

Dewberry

Dewberry (Plate 10) was another herb that was significantly different (R^2 = .40, P = 0.0008) across ecosites. It was relatively abundant in ecosite type 19 birch forest patches with 27.2 % mean cover, and also occurred in ecosite type 29 with 12.8 % mean cover. Dewberry occurred in ecosite types 11 and 12 as well but with much less abundance, 5 % and 0.3 % mean cover respectively (Fig. 9). Dewberry was not significantly related to any of the environmental variables in multiple regression analysis. However, the CCA showed that dewberry was generally associated with ecosite types 19 and 29 characterized by deeper soils with some clay content, moist or fresh moisture regimes, level or lower slope positions and relatively high canopy cover (Fig. 6a, Fig. 6b). Ecosite type 19 had the higher mean cover, however, dewberry was also locally abundant in ecosite type 29. For example, the highest abundance of dewberry (50 % cover of the 10 x 10 FEC plots) occurred in sites 19a, 19c, as well as site 29h (Appendix 7, Appendix 8).

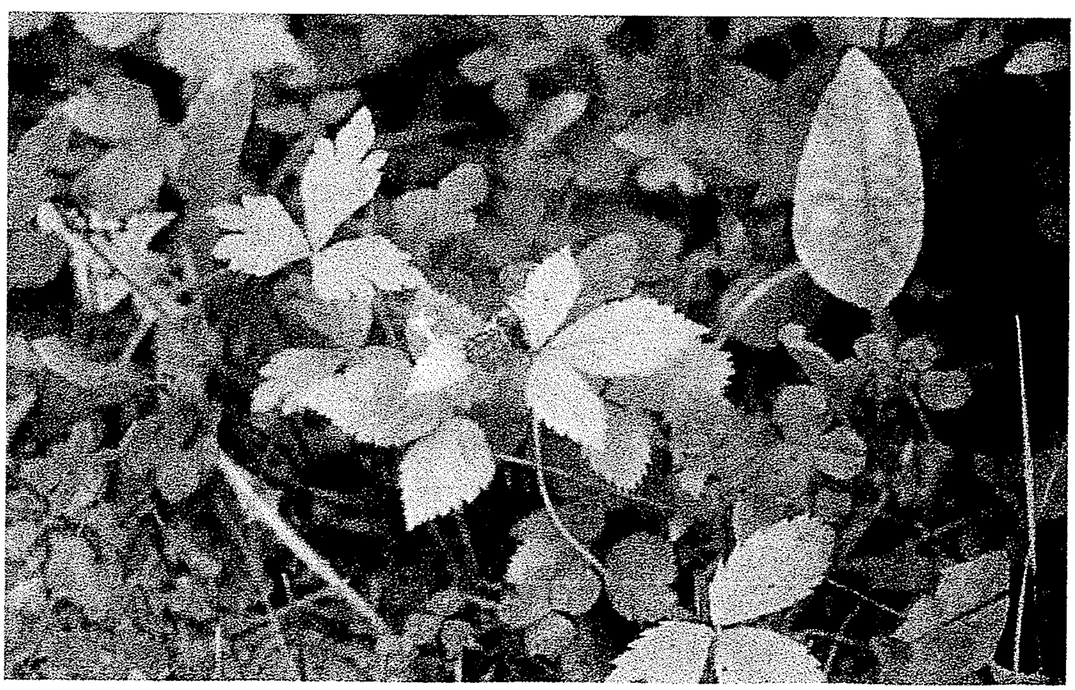


Plate 10. The herb dewberry (*Rubus pubescens*).

Wild Ginger and Sweet Cicely

Both of the herbs wild ginger (Plate 11) and sweet cicely occurred with minimal cover, 0.2 % and 0.8 % respectively, only in ecosite type 29 (Fig. 9). Sweet cicely occurred in sites 29h and 29i and wild ginger occurred in site 29i. These two sites had fresh, shallow-moderately deep coarse loamy soils, level slope positions, and high canopy cover indicating high shade (Appendix 7, Appendix 8). The CCA analysis showed that both of these herbs were generally associated with site conditions representative of ecosite type 29.

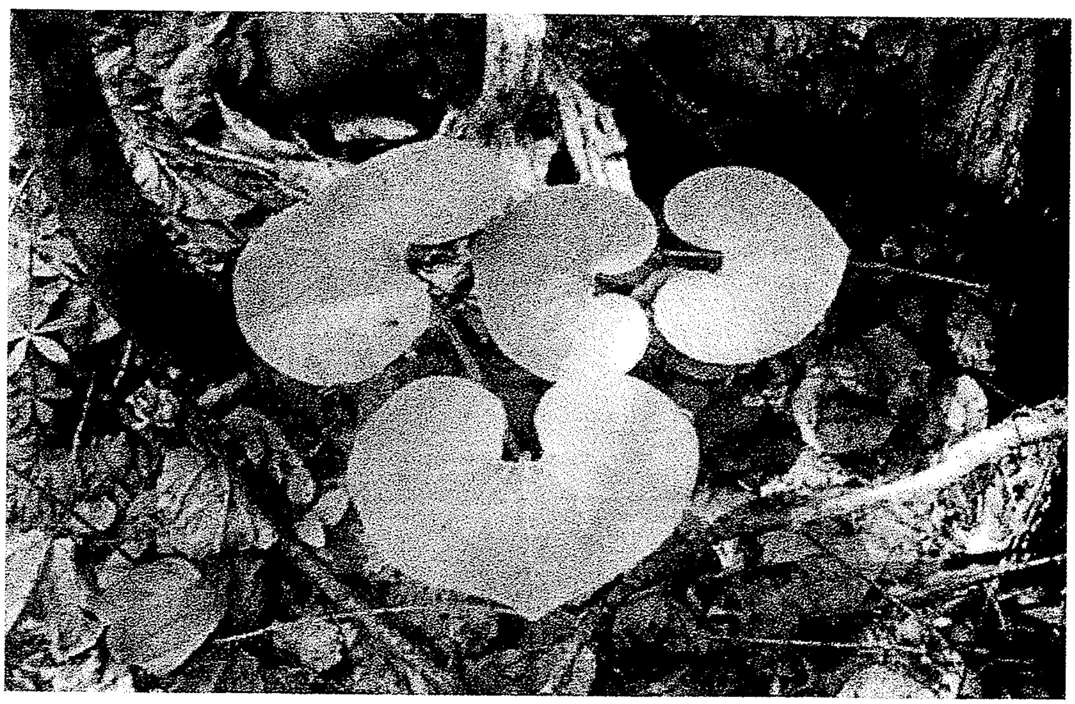


Plate 11. The herb wild ginger (*Asarum canadense*).

Ecosite Utility

This section discusses the value of using ecosite types to identify NTFP plant species distribution and abundance for forest management planning purposes. The twelve selected plant species of importance are used as examples.

Ecosite type descriptions as found in the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (Racey et al. 1996) gave information concerning what types of plant species would frequently be encountered within a given ecosite type (Appendix 1). For example, the field guide indicated that white pine frequently occurs in ecosite type 11, which was reinforced in this study. Therefore, if this valuable species were to be managed as an NTFP in this area, ecosite type would likely be a good indicator of where to focus on managing for white pine. However, the rapid NTFP inventory in this study revealed information about plant species and associated environmental variables beyond what is available in current ecosite type descriptions (Table 7).

The ecosite type descriptions in the field guide tended to focus on overstory tree composition. The rapid NTFP inventory in this study was particularly useful in gaining more complete data on understory plant species composition and abundance. For example, the shrub Canada yew was not listed as a species representative of ecosite type 29 in the ecosite field guide (Appendix 1). However, the rapid NTFP inventory revealed that it occurred in 3 of the 9 ecosite type 29 birch forest patches that were sampled and had a mean percent cover of 21 % (Fig. 8).

Table 7. Plant and environment information provided in an ecosite type description from the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (Racey et al. 1996) in comparison to data gathered from the rapid NTFP inventory conducted in an ecosite type in this study.

Field Guide Ecosite Type Description Provides:	Rapid NTFP Inventory Description Provides:	Comparative
• Frequently occurring [A] trees, shrubs, and herbs	• Frequently occurring [B] trees, shrubs, and herbs • Less frequently occurring trees, shrubs, and herbs • Abundance (percent cover)	• Similar general plant community composition information, although Rapid NTFP Inventory allows for more complete composition data and adds information about less frequently occurring plants • Rapid NTFP Inventory adds abundance data, which can then be compared to abundance in other site types.
• Frequently encountered parent materials and soil types • General description of topography	• Soil type and moisture regime • Other environmental data (e.g. slope position, canopy closure i.e. shade/light, evidence of fire, presence of human activity)	• Rapid NTFP Inventory adds site specific information about soil types and moisture • Rapid NTFP Inventory allows for more detailed description of environment which can then be linked to plant composition and abundance data

Information about less frequently occurring species was gained from this rapid NTFP inventory. For example, the herbs wild ginger and sweet cicely were discovered in only two ecosite type 29 birch forest patches. These herbs were not frequently occurring and so where not identified in the current ecosite type descriptions as found in the field guide (Appendix 1). The particular habitat where these herbs were found growing, was generally typified by ecosite type 29, i.e.

shallow-moderately deep coarse loamy soils, fresh moisture regime, level slope position, and relatively high tree canopy cover. Therefore, looking at where ecosite type 29 occurs on the landscape may narrow down areas where these species are likely to exist. However, it would first be necessary to add rapid NTFP inventory data about less frequently occurring species such as these to current ecosite type descriptions.

The rapid NTFP inventory in this study was especially useful in identifying areas of plant species abundance. Many of the species occurred in all ecosite types such as the shrub velvet-leaved blueberry, and herbs woodland strawberry, and dewberry. The rapid NTFP inventory revealed that there was a significant contrast in abundance of these species across ecosite types. This suggested that there may be the potential to link ecosite type with varying levels of abundance of NTFP plant species. However, ecosite types were large and found to be quite variable in habitat. The rapid NTFP inventory was necessary to define areas of plant species abundance and associated environmental variables within ecosite types. For example, the dwarf shrubs Labrador tea and sand cherry both occurred exclusively in ecosite type 12. At the landscape level ecosite type could be used to narrow down areas where these species are likely to occur, i.e. ecosite type 12. However, within ecosite type 12 Labrador tea was found growing at a lower slope position on wet, organic soil associated with black spruce cover and sand cherry was found growing at mid or crest slope position on shallow soil over bedrock, in open high light conditions. If these shrubs were to be included in a forest management plan due to their NTFP value, different habitats where these plants are most abundant would have to be identified within an ecosite type.

Results indicated that smaller and more defined units than ecosite types, which are generally 10 to 100 ha, are necessary to accurately identify plant NTFPs and areas of abundance. Smaller Ecological Land Classification units called ecoelements (100-100,000 m^2) made up of Vegetation Types and Soil Types, also used by the OMNR, may be more appropriate units. The problem is that the OMNR normally considers ecoelements to be too small for mapping purposes. However, if through a rapid NTFP inventory, such as conducted in this study, it is discovered that plant NTFPs are linked with ecoelements, then ecoelements may in turn be linked to larger mapable ecosite types. For example, in this study Canada yew was abundant in sites with a moist, fine loamy-clayey Soil Type. Therefore, mapable ecosites with the highest incidence of this Soil Type may be targeted as areas to manage for this NTFP plant.

Chapter Summary

The birch forest patches sampled were found to contain a wide variety of plant species. Many of these plants were not associated with birch forest patches of any one ecosite type, but were found frequently (> 40 % of the sample plots) across ecosite types. However, the rapid NTFP inventory data showed that birch forest patches in the different ecosite types could be distinguished by some frequently occurring species. Abundance, more so than composition, differed across ecosite types. For example, velvet-leaved blueberry shrubs were not absent from any ecosite types but their percent cover was higher in ecosite types 11 and 12.

The rapid NTFP inventory also revealed that some plant species were unique to birch forest patches of one ecosite type. For example, the shrub Canada yew was exclusive to ecosite type 29. The majority of these unique plants, however, did not occur frequently or abundantly within an ecosite type. This may mean that these species are not unique to an ecosite type overall, but rather to particular site conditions on a smaller scale.

Differences in plant composition and abundance in the birch forest patches were reflective of differences in environmental variables. The most distinct differences in composition and abundance were between birch forest patches which had open canopy conditions and drier, shallower less nutrient-rich soils, which included the majority of ecosite type 11 and 12 sites, in contrast to those which had closed canopy conditions and moister, deeper more nutrient-rich soils, which included the majority of ecosite type 19 and 29 sites. However, within each ecosite type, habitat could be variable from one birch forest patch to the next. Ecosite type 12, in particular, contained both rocky upland areas and moister lowland areas. This rapid NTFP inventory showed that certain NTFP plant species have specific habitat niches where they are most abundant within ecosite types. For example, sand cherry was associated with the rocky uplands while Labrador tea was associated with the lowland areas within ecosite type 12.

Overall, this study found that the Ecological Land Classification system of ecosite types currently in use by forest managers in Ontario were not useful units for identifying the composition and abundance of plant NTFPs in birch forest patches. Rapid NTFP inventories such as conducted in this study are necessary in order to gain accurate information about what kind of NTFP plant species are occurring and where they are most abundant on the land. The rapid NTFP inventory in this study revealed information about plant species composition and abundance beyond what is available in ecosite type descriptions. In particular, information was gained about understory species, infrequently occurring species, and abundance of plant species in different site conditions.

The information gained from a rapid NTFP inventory such as this would be useful in identifying important NTFP areas to be included in forest management plans. It would also be important for First Nation communities to have a record of what plant NTFPs are on their land, especially those that may be sought after for their commercial value. In this study eleven of the twelve plant species selected based on their importance to the Shoal Lake First Nation were of commercial value. The rapid NTFP inventory in this study detailed the type of habitat associated with these twelve valuable plant species and the abundance of the plants across ecosite types. This type of data would aid in defining areas where plant NTFPs are most abundant and have the potential to maintain a sustainable harvest. This type of information would also help to define areas where it is crucial to protect valuable NTFP plant species.

Chapter 5 – Birch Growth and Bark Quality

Overview

Paper birch was identified as a species of significance in this study due to its high NTFP value and this chapter focuses specifically on birch trees in the forest patches studied. The first section, Birch Growth, compares and discusses how birch was growing in the different ecosite types. Knowledge of how birch is growing, such as the quantity and size of birch, across the landscape may prove useful in selecting areas for managing birch as an NTFP. The second section, Bark Quality, describes differences in bark characteristics across ecosite types. Bark quality was examined because differing bark characteristics are an important consideration when harvesting bark for use in NTFPs, such as birch bark baskets. If areas of birch were to be managed for bark harvest it would be important to know how different site conditions affect bark quality.

Birch Growth

Birch growth was described using the number and size of birch trees occurring in the different ecosite types. The number and size of birch snags (standing dead trees) was also used to give some idea of birch forest patch dynamics in the different ecosite types. Data gathered from the G & Y plots was used to compare the mean number and mean size, i.e. diameter at breast height (DBH), of birch trees and snags across ecosites. Birch growth was also described by the vegetation structure of birch in the different ecosite types. This was done using mean percent cover values of mature trees, saplings, and seedlings from the FEC plots and comparing cover values across ecosite types.

Number and Size of Birch Trees

The mean number of trees per G & Y plot was not significantly different across ecosite types (Fig. 10). Individual sites with relatively high quantities of birch trees (> 20 trees) were found in all ecosite types. High quantities of birch occurred both on dry, shallow sandy soils characteristic of ecosite types 11 and 12 such as sites 11b with 24 trees, 12a with 35 trees, and 12b with 40 trees, as well as deeper, fresh, loamy-clayey soils characteristic of ecosite types 19 and 29 such as sites 19g with 62 trees, 19h with 56 trees, and 29c with 36 trees (Appendix 9). However, the majority of sites in ecosite types 11 and 12 had under 10 mature birch per G & Y plot, and the majority of sites in ecosite types 19 and 29 had over 10, and often over 20, mature birch per G & Y plot (Appendix 9). This agrees with other studies that indicate, although paper birch is able to tolerate a wide variety of soil and moisture conditions, it prefers relatively moist, nutrient-rich sites (Rowe 1956, Bell 1991, Wang et al. 1998).

Other factors besides soil and moisture may affect the quantity of birch as well. For example, there were two sites with an exceptionally high number of birch, sites 19g with 62 trees and 19h with 56 trees (Appendix 9). Each site had a different soil type and moisture regime, but both had evidence of a past fire, i.e. charcoal pieces in the soil (Appendix 8). Birch is a pioneer species and establishes readily following fire due to exposed mineral soil, particularly where other birch stands occur nearby and act as a seed-source (Rowe 1956, Foster and King 1986).

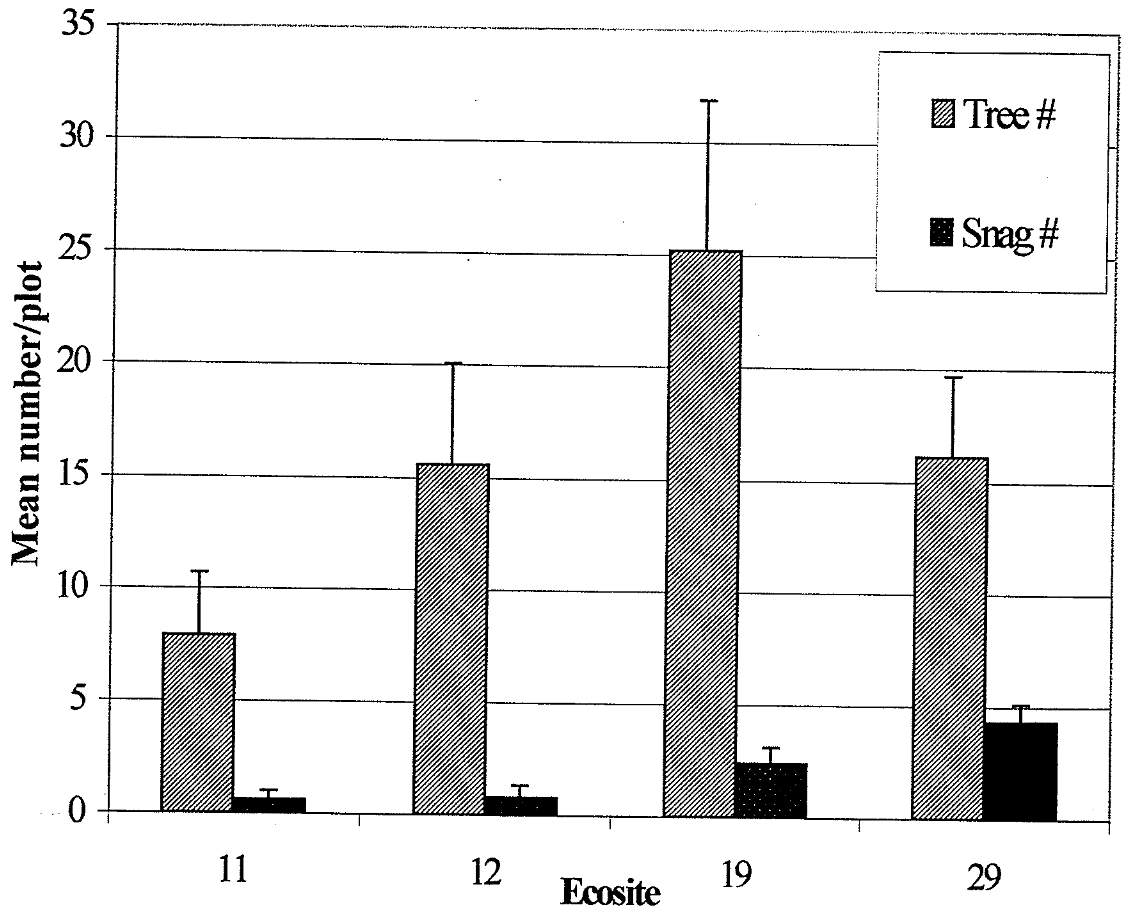


Figure 10. Mean number of birch (*Betula papyrifera*) trees (> 10 m) and snags (dead trees > 1.3 m) per G & Y plot in ecosite types 11, 12, 19, and 29.

Peterson et al. (1997) suggests that burns of light or moderate intensity produce high density birch stands. A fire of the appropriate intensity in that area could have contributed to a high number of birch in those forest patches.

The size or diameter at breast height (DBH) in centimeters of birch trees was significantly different ($R^2 = 0.42$, $P = 0.0008$) across ecosite types (Fig. 11). Birch trees were generally larger in ecosite types 19 and 29 with mean DBH of 14.1 cm and 14.4 cm respectively than in ecosite types 11 and 12 with mean DBH of 10.9 cm and 7.8 cm respectively (Fig. 11). Although paper birch grows successfully in a wide variety of soil and moisture conditions, the type of conditions determine how large birch is allowed to become (Wang et al. 1998). For example, ecosite type 12 had a similar mean number of trees to ecosite type 29, although ecosite type 29 had larger trees (Fig. 10, Fig. 11).

A technical report on tree silvics in northwestern Ontario indicates that optimal growth for birch occurs on dry to fresh sandy loams or silty soils (Bell 1991). This study found that the largest birch trees occurred on some fresh, coarse loamy soils, but also on soils that were moist (mottles present in C-Horizon) and relatively high in clay content. These soil types were typical of ecosite type 19 and 29 birch forest patches. Also, ecosite type 19 and 29 sites were often found on level or lower slope positions which allows for deeper soil development and less rapid drainage may mean that moisture, through run-off, is more available for optimal growth. On the other hand, ecosite type11 and 12 sites were generally more rocky and drier, not allowing for optimal growth. Mid, upper, and crest slope positions were common in these ecosite types where bedrock was normally exposed, soil development was

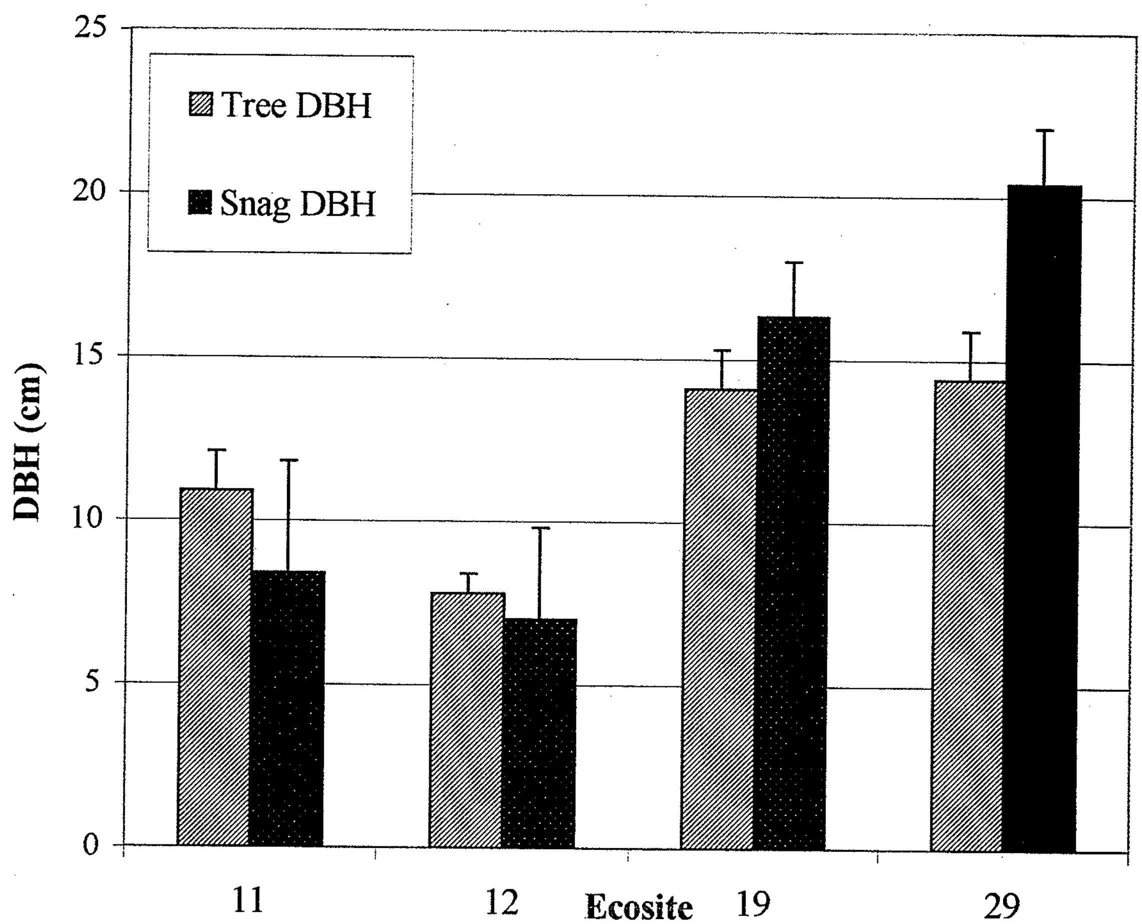


Figure 11. Mean diameter at breast height (DBH) in centimeters of birch (*Betula papyrifera*) trees (> 10 m) and snags (standing dead trees > 1.3 m) in ecosite types 11, 12, 19, and 29.

generally shallow, and drainage was rapid (Table 4). This indicated that groups of ecosite types similar in environmental conditions could be used to determine where larger versus smaller birch would occur across the landscape.

Number and Size of Birch Snags

The number and size of birch snags or standing dead trees lends some clues to birch forest patch dynamics in the various ecosite types. Birch snags were significantly different in number ($R^2 = 0.42$, $P = 0.0005$) and DBH ($R^2 = 0.57$, $P = 0.0020$) across ecosite types (Fig. 10). The mean number of birch snags was highest in ecosite types 19 and 29 with 2.4 and 4.3 snags respectively. Mean number of snags was lower in ecosite types 11 and 12 with 0.6 and 0.8 snags respectively (Fig. 10). Birch snags were also larger in ecosite types 19 and 29 with mean DBH of 16.3 cm and 20.4 cm respectively than in ecosite types 11 and 12 with mean DBH of 8.4 cm and 7 cm respectively (Fig. 11).

In mature forest stands, tree mortality is affected by a variety of factors such as insect damage, disease, or injury caused by other falling trees (Greif and Archibold 2000). At the time the study was conducted there was an outbreak of forest tent caterpillars that were feeding on deciduous trees, including birch. In the future, some of the currently living birch trees in the study area may eventually be weakened by this insect attack and die as a result. However, most of the birch snags found were at a later stage of decay indicating that they were not recently dead from this insect attack. Also, of all of the birch stands that were studied, one did not appear to be more severely affected than the others, so differences are likely not entirely attributable to insect infestation.

It would seem that a higher amount of large snags would indicate older birch stands that are beginning to deteriorate. In this study, all of the birch forest stands of the various ecosite types were chosen to be of a similar, mature age (50 – 80 years according to OMNR FRI data). Although similarity of age was assumed, slight differences in age of the birch forest patches that were sampled may have contributed to snag differences across ecosite types. However, differences in site conditions between ecosite types were likely more prevalent. Site conditions such as soil and moisture play a role in determining how long trees will live. Usually the faster trees are allowed to grow, the sooner they will begin to senesce (Rowe 1956). Therefore, assuming site conditions for birch growth were optimal in ecosite types 19 and 29 versus ecosite types 11 and 12, birch may have gone through their cycle of growth at a faster rate and began to die off sooner in ecosite types 19 and 29. The smaller trees in ecosite types 11 and 12 may have been growing slower and persisting longer as live trees, so that there were fewer snags found in these ecosite types.

Vegetation Structure of Birch

The mean percent cover of mature birch, saplings, and seedlings contributes to information about birch growth in the different ecosite types by describing the vertical vegetation structure of birch. These data were gathered from the 10 x 10 m FEC plots. Percent cover takes into account not only the quantity of birch found within the FEC plot, but also the size and robustness of birch, particularly in regards to mature birch trees.

Figure 12 shows the overall birch structure found in each of the ecosite types. Mature birch tree mean percent cover was significantly different ($R^2 = 0.34$,

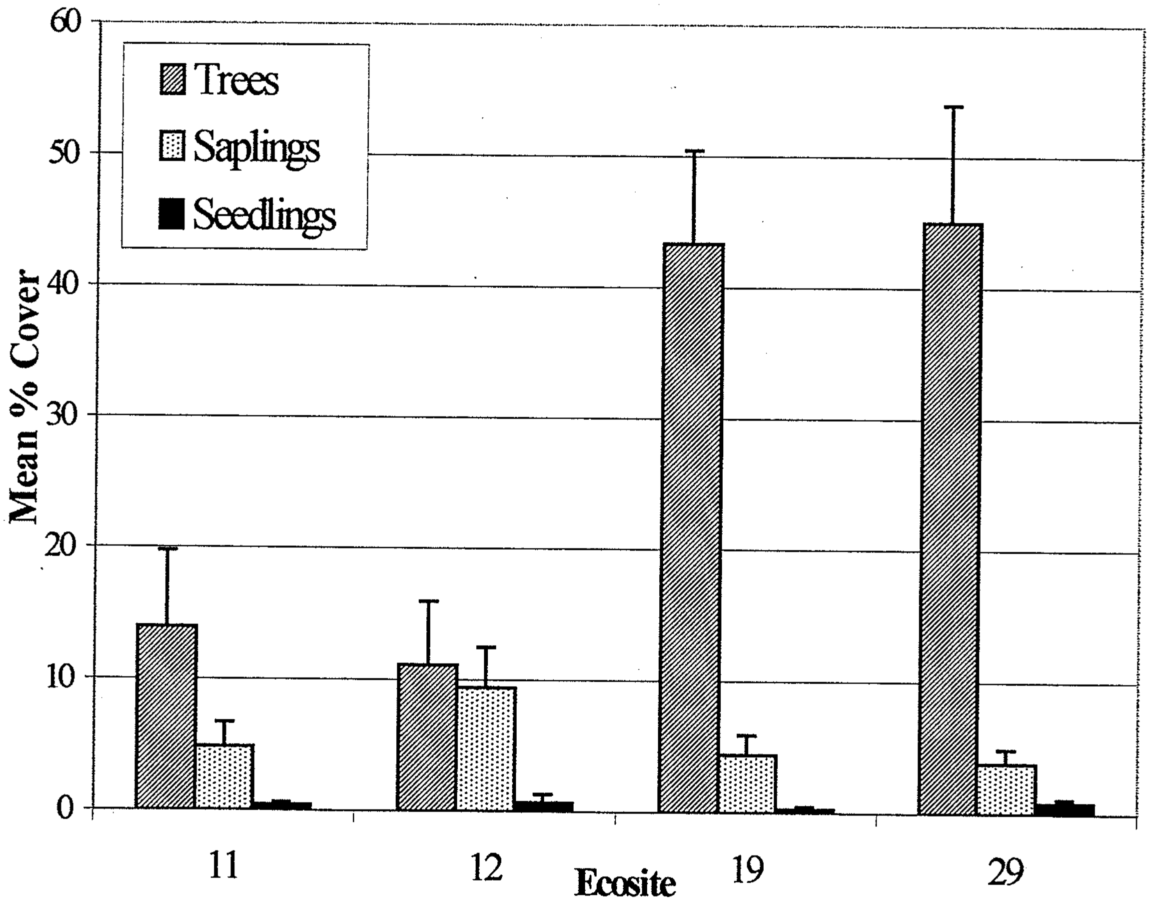


Figure 12. Mean percent cover of birch (*Betula papyrifera*) trees (> 10 m), saplings (0.5 - 10 m) and seedlings (0-0.5 m) in ecosite types 11, 12, 19, and 29.

P = 0.0034) across ecosite types. Ecosite types 19 and 29 had the highest mean percent cover of trees, 43.3 % and 45 %, in comparison with ecosites 11 and 12 that had less than half of that cover with 13.9 % and 11.1 % respectively (Fig. 12). Neither birch saplings nor seedlings had significantly different mean percent covers across ecosites. However, birch saplings were slightly higher in mean percent cover in ecosite type 12 with 9.4 % compared to ecosite types 11, 19, and 29 with similar mean percent covers of 4.8 %, 4.4 % and 3.8 % respectively. Mean percent cover of seedlings did not vary greatly from ecosite type to ecosite type with 0.4 % in 11, 0.7 % in 12, 0.3 % in 19, and 0.8 % in 29 (Fig. 12).

Looking at overall structure of birch growth, ecosite types 19 and 29 were similar in structure, both having a high cover of mature trees and a relatively low cover of saplings and seedlings. More mature birch in ecosite types 19 and 29 relative to the other ecosite types is likely a reflection of differences in growing conditions such as soil and moisture regime that would allow more birch to become established, and once established to thrive and grow into mature trees. Birch is generally a shade-intolerant species and young birch requires full sun for the best growth (Rowe 1956). In ecosite types 19 and 29, saplings may be suppressed by overstory shade, unless canopy gaps present themselves. Birch structure in ecosite type 12 is notable, as the cover of mature trees is similar to the cover of saplings. Ecosite type 11 also had a high amount of sapling cover relative to mature trees. It is likely that the higher light conditions in these ecosites characterized by open-canopy conditions allow birch saplings, once they become established, to persist.

All forest stands are dynamic, and vegetation structure will change somewhat over time. It is possible that birch cover will increase over time in ecosite types 11 and 12 as birch saplings grow into mature trees. However, distinct environmental differences between ecosite types 11 and 12 versus ecosite types 19 and 29 exist in overall moisture regime and soil characteristics. Hence, simply due to less optimal growing conditions, the future abundance of mature birch found in ecosite types 11 and 12 will likely not be comparable to that found in more nutrient-rich ecosite types such as 19 and 29. Also, once forest stands reach maturity they will likely maintain their basic structure and composition until a major disturbance such as wildfire comes along to renew forest stands. This is normally the case in northwestern Ontario, where the fire cycle is relatively short and prevents deterioration of stands or progression of succession into old growth communities (Zoladeski and Maycock 1990).

Birch Growth and Ecosite Utility

All of the ecosite types in this study were designated as Birch Working Group (i.e. all contained a high amount of birch relative to other overstory trees). However, the rapid NTFP inventory revealed that birch trees were significantly more abundant and larger in ecosite types 19 and 29 than in ecosite types 11 and 12. This suggested that ecosite types could be useful units in managing birch as an NTFP resource. For example, large trees may be desired for selective harvesting for specialty wood products such as canoe parts or required for harvesting large strips of bark. Ecosite types, for instance ecosite types 19 and 29, could be used to determine where such trees are likely to be found.

Dynamics varied in that birch may have grown and matured faster ultimately producing more and larger snags in ecosite types 19 and 29 versus ecosite types 11 and 12. In this study the purpose of examining snags was to lend clues about birch dynamics in the different ecosite types. However, snags or standing dead birch trees may also be valuable for NTFP use. Peterson et al. (1997), in a paper birch management handbook for B.C., note that "spalted" wood of birch may be used for decorative items. This is wood that has begun to decompose and the bacteria in the wood have created ink lines in various patterns. If birch snags were to be managed as an NTFP in northwestern Ontario, ecosite type, for example ecosite type 29, would be an indicator of where more and larger birch snags would occur in mature birch stands.

The overall the vertical vegetation structure of birch differed across ecosite types. In mature birch stands, ecosite type may be related to the relative abundance of different growth forms of birch. For example, if a stand providing both mature trees as well as saplings is desired for NTFP use, then ecosite type 12 stands might be identified as areas where this mix is likely to occur.

If birch stands are not disturbed naturally, it is possible they may be clear-cut as forestry companies increase their interest in paper birch as wood or pulp. Since paper birch regenerates abundantly through seeding or sprouting on sites that have been disturbed by fire (Rowe 1956, Foster and King 1986) or clear-cutting (Peterson et al. 1997, Wang et al. 2000) it may be possible to manage birch as an NTFP in conjunction with on-going forest disturbances. Basic ecosite type characteristics such as topography, soil depth and texture continue to persist and influence the renewed vegetation community following fire or logging (Racey et al. 1996). In this case, ecosite types could potentially be used to predict the type of future birch growth that will occur in disturbed areas colonized by birch, in order to designate areas for NTFP management. For instance, due to better growing conditions, ecosite types such as 19 or 29 may produce larger birch at a faster rate for NTFP use.

Overall, it was difficult to separate the type of birch growth between ecosite types 11 and 12 and similarly ecosite types 19 and 29. This indicated that birch was responding to the fairly distinct differences in soil and moisture conditions as well as topography between these pairs of ecosite types. This, in turn, suggested that groups of ecosites similar in environmental conditions could be used to identify areas of differing birch growth across the landscape. However, current ecosite type descriptions only give information concerning where birch trees frequently occur. If ecosite types were to be utilized for NTFP management purposes, it would first be necessary to further define different types of birch growth across more ecosite types using a rapid NTFP inventory method as in this study to gather growth data like size and abundance of trees.

Birch Bark Quality

Bark quality was examined to determine whether characteristics of a plant species, birch, required for creating an NTFP, specifically birch bark baskets in regards to use by the Shoal Lake First Nation people, varied with ecosite type. In this study bark thickness was a measure of quality because it affects flexibility when basket-making. Lenticels, which are the horizontal pores used for gas exchange in the outer bark of the birch tree, where also measured. The ease of working with the bark and the structural stability of the basket depends upon the number and size of lenticels (Chapter 3). Bark data was gathered from a sample birch tree in each birch forest patch as outlined in Chapter 3 (Plate 12). It is important to note this was only a preliminary study of bark quality-site type relationships, with quality measures developed in the field and a limited sample size.

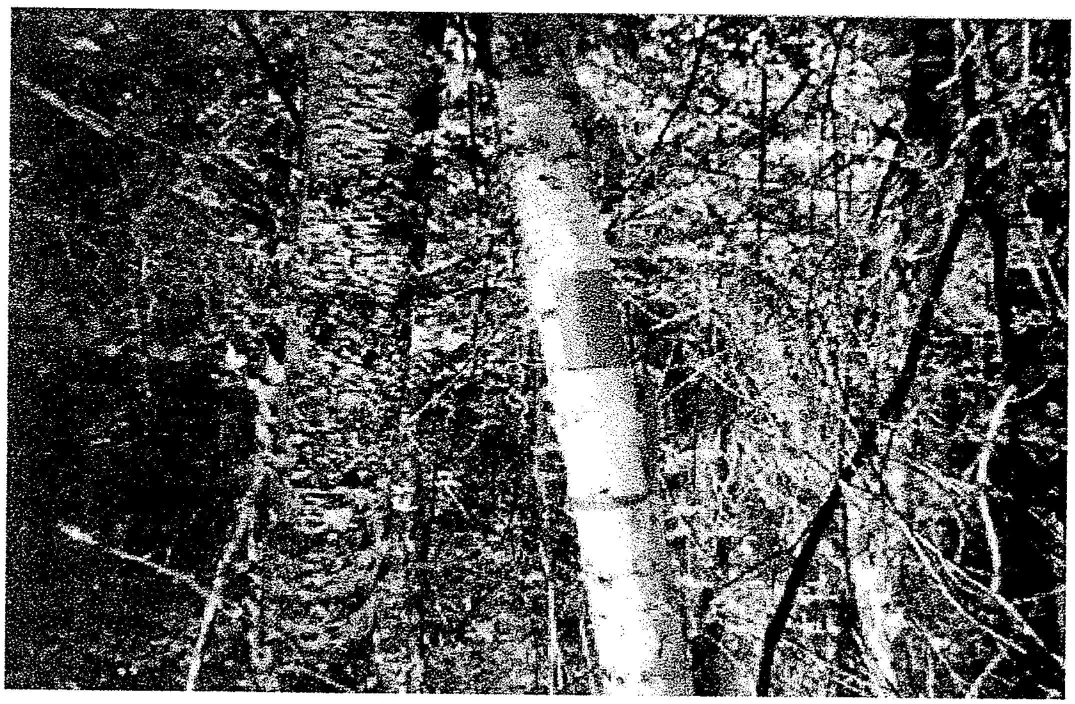


Plate 12. Birch (*Betula papyrifera*) bark sample tree with the bark sample already removed.

Mean bark thickness, lenticel length, or number of lenticels did not vary greatly across ecosite types (Table 8). Analysis of variance revealed that there were no significant differences in any of the bark quality measures across ecosite types.

Table 8. Mean bark thickness in millimeters, mean lenticel length in centimeters, and mean number of lenticels of birch bark samples from ecosite types 11, 12, 19, and 29.

Bark Quality Measure	Mean Value per Ecosite Type			
	11	**12**	**19**	**29**
Thickness (mm)	2.03	1.98	1.91	2.42
Lenticel length (cm)	1.30	1.60	1.50	1.70
Number of lenticels	111	77	73	81

The age as determined from a tree core, DBH in centimeters, and height in meters of each birch bark sample tree was also recorded during sampling (Appendix 10). Multiple regression was conducted to test the relationship of the birch bark quality measures of thickness, lenticel length, and number of lenticels with the birch bark sample tree characteristics of age, DBH and height. The results of multiple regression indicated that birch bark thickness and lenticel length were significantly related to tree age (Table 9). In general, as age increased, so did bark thickness and length of lenticels (Appendix 10).

Table 9. Results of multiple regression testing the relationship of birch bark quality measures of thickness, lenticel length, and number of lenticels with birch bark sample tree characteristics of age, diameter at breast height (DBH), and height.

			Standardized β ♦for Sample Tree Characteristics		
Bark Quality Measure	**P**	**R^2**	**Age**	**DBH**	**Height**
Thickness	0.0033	0.37	0.542*	0.040 NS	0.044 NS
Lenticel length	0.0258	0.27	0.666*	-0.290 NS	0.078 NS
Lenticel number	0.0402	0.25	-0.455 NS	0.436 NS	-0.451 NS

♦ Standardized β is a standardized partial regression coefficient
* P < 0.05, ** P < 0.01, NS = not significant (P > 0.05)

Tree age may be one important factor, as was found in this study, but it is likely a complex interaction of factors that determine the type of bark a tree will have. Zasada, an expert on birch with the U.S. Forest Service in Minnesota, has harvested birch bark for many years and suspects that site conditions such as soil type and moisture affect bark characteristics. Zasada has also found that trees that have not grown from seed, but have sprouted from the same stump appear to have similar bark, suggesting that genetic control plays a role in bark quality (Zasada, personal communication 2002).

Bark Quality and Ecosite Utility

There were no significant differences in bark thickness, lenticel length, or number of lenticels across ecosite types. This suggested that ecosite types were not appropriate units to relate to bark quality. However, in this study it was discovered that older birch indicated thicker bark and longer lenticels. This indicated that age of the individual tree would be important in determining bark quality. Hence, ecosite type may still lend clues to the kind of bark quality that would exist for basket-making in a birch forest patch. For example, as was found in this study, more younger birch were persisting in the less nutrient rich, open-canopy conditions of ecosite types 11 and 12 while more mature birch trees occurred in the nutrient-rich conditions of ecosite types 19 and 29.

Overall, ecosite types are likely too large and variable in environmental conditions to predict a consistent type of bark quality throughout. However, there may be certain site conditions associated with patches of high quality bark trees within ecosite types. Further rapid NTFP inventory studies, with increased sample size, would be required to define such areas. It may also be desirable to have harvesters identify optimal sites for bark harvesting. Site conditions such as topography, soil type, and moisture regime, fire history, etc. could then be described for these optimal harvesting sites in order to identify similar sites across the landscape.

In defining optimal sites, it would be important to consider that "quality" will depend on what the bark is being used for and should ultimately be determined by the harvesters. The qualities measured in this study were based on requirements for basket-making by the First Nation people at Shoal Lake. Different qualities may be required for different NTFPs. During the summer 2001 field season, a birch bark workshop involving elders and other community members was held at Iskatewizaagegan First Nation as part of the traditional ecological research portion of the larger research project. At the workshop, it was determined that a section of birch bark may be too thick for artwork like basketry, but too thin for constructing the outer shell of a dwelling such as a wigwam. Also, other qualities than the ones measured in this study may be equally important, such as lichen growth or other blemishes on the bark (NTFP project Birch Bark Workshop 2001).

Chapter Summary

The rapid NTFP inventory in this study revealed different types of birch growth in the birch forest patches across the landscape. Individual sites with relatively high quantities of birch trees were found in all ecosite types, however, mature birch trees were significantly larger and more abundant in ecosite types 19 and

29 in contrast to ecosite types 11 and 12. There were also more and significantly larger birch snags in ecosite types 19 and 29, indicating that birch grew more rapidly and reached a larger size in these ecosite types versus ecosite types 11 and 12.

Overall differences in birch growth were reflective of the contrast in site conditions between groups of ecosite types, 11/12 and 19/29. Ecosite types 11 and 12 generally had a drier moisture regime and a poorer nutrient regime in comparison to ecosite types 19 and 29 that generally had a moister moisture regime and richer nutrient regime. This indicated that groups of ecosite types similar in environmental conditions would be useful in identifying areas of different birch growth across the forested landscape. However, it would first be necessary to further define different types of birch growth across other ecosite types using a rapid NTFP inventory method as in this study to gather growth data such as size and abundance of trees.

Bark quality was examined to determine whether characteristics birch, required for creating an NTFP, birch bark baskets, varied with ecosite type. Birch bark quality measures of bark thickness, lenticel length, and number of lenticels were not significantly different across ecosite types. However, it was discovered that these quality measures were related to tree age. Ecosite types were found to be too large to be useful units to relate to bark quality, but there may be certain site conditions associated with patches of high quality bark trees at a smaller scale. Ultimately this was a preliminary study of bark quality and further studies, with increased sample size, would be required to better define the relationship between bark quality and site conditions.

Chapter 6 – Conclusions

This study described the culturally important birch forest patches of the Shoal Lake watershed by identifying what kind of NTFP plant species occurred and how abundant they were in different site conditions. Many plant species occurred ubiquitously across ecosite types. However, the rapid NTFP inventory data showed that the different ecosite types could be distinguished by some frequently occurring species. For example, white pine was found frequently in ecosite type 11, but not in the other ecosite types. Other plant species were found to be unique to birch forest patches of one ecosite type such as Canada yew in ecosite type 29. It was revealed that abundance, more than composition, differed across ecosite types. For example, velvet-leaved blueberry shrubs were present in all ecosite types but their percent cover was higher in ecosite types 11 and 12.

Ideally, site types that are relatively uniform in environmental conditions as well as distinct from other site types would be the most useful in identifying NTFP plant species across the forested landscape. This was not the case regarding the ecosite types that were studied. For example, ecosite types 19 and 29 were difficult to distinguish from one another. This may have been due in part to the potential mistyping of some of the forest stands that were studied. Other ecosite types, such as ecosite type 12, were highly variable in environmental conditions and associated plant species composition. Certain plant NTFPs were found to have specific habitat niches where they occurred across or within ecosite types. All of this indicates the need for field sampling such as conducted in this study to gain accurate information about the environmental variables associated with plant NTFPs.

Paper birch was a species of significance in this study due to its high NTFP value. The rapid NTFP inventory revealed significant differences in birch growth across ecosite types. Birch trees had significantly higher abundance of mature trees that were larger in size in birch forest patches of ecosite types 19 and 29. There were also more and significantly larger birch snags in ecosite types 19 and 29, indicating that birch grew more rapidly and reached a larger size in these ecosite types versus ecosite types 11 and 12. Overall differences in birch growth were reflective of the contrast in site conditions between groups of ecosite types, 11/12 and 19/29. Groups of ecosite types similar in environmental conditions have the potential to be useful in identifying areas of different birch growth across the forested landscape. However, current ecosite type descriptions as found in the ecosite field guide only give information concerning where birch trees frequently occur. If ecosite types were to be utilized for NTFP management purposes, it would first be necessary to further define different types of birch growth in other ecosite types using an inventory method as in this study to gather growth data like size and abundance of trees.

Bark quality was examined to determine whether characteristics of a plant species, birch, required for creating an NTFP, specifically birch bark baskets at Shoal Lake First Nation, varied with ecosite type. Birch bark quality measures of bark thickness, lenticel length, and number of lenticels were not significantly different across ecosite types. Age of the birch tree, however, was a factor that affected bark quality. Overall, ecosite types were too large and variable in environmental conditions to define a certain type of bark quality throughout. Despite this, there may be certain site conditions at a smaller scale associated with patches of birch trees with high quality bark for constructing NTFPs. Ultimately this was a preliminary study of bark quality and further NTFP inventory work such as this, with increased sample size, would help to define the relationship between bark quality and site conditions. If a similar study of bark quality were conducted again it may be more useful to focus on sites where harvesting already occurs or to have harvesters help to locate sites where they would consider harvesting bark. Site conditions such as topography, soil type, and moisture regime, fire history, etc. could then be described for these optimal harvesting sites in order to identify similar sites across the landscape.

Overall, results of this study showed that the Ecological Land Classification system of ecosite types currently in use by forest managers in Ontario are not useful units for identifying the composition and abundance of plant NTFPs in birch forest patches. Rapid NTFP inventories such as conducted in this study are necessary in order to gain additional information about what kind of NTFP plant species are occurring and to define where they are most abundant on the land.

The Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (Racey et al. 1996) described frequently occurring plant species, with the main focus being on overstory tree composition. The rapid NTFP inventory in this study revealed information about plant species composition and abundance, particularly understory plant species, beyond what is available in current ecosite type descriptions. Information about infrequently occurring plant species was gained. The rapid NTFP inventory adds abundance information, which can then be compared to abundance of NTFP plants in other site types. A rapid NTFP inventory such as this also allows for description of how a particular plant NTFP (e.g. birch) is growing, and the quality of the NTFP, in different site types. The Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (Racey et al. 1996) also described frequently encountered parent materials and soil types as well as a general description of topography. Conducting an NTFP field inventory such as in this study, however, allows for a more detailed description of environmental variables that can then be linked to plant composition and abundance data.

Management Implications

Rapid NTFP inventory data such as collected in this study would allow local forest managers, such as First Nations, and provincial forest managers, such as the OMNR, to make decisions about how best to manage NTFP resources. In northwestern Ontario, there is a need for the careful management of birch forest patches as they are valuable to First Nations as a source of NTFPs, and there is an increasing interest in harvesting of birch to supply timber mills. It will be especially important to assess the NTFP value of birch stands, using a rapid NTFP inventory such as in this study, before they are designated for harvest.

All of the ecosites in this study were designated as birch working group (all contained a high amount of birch relative to other overstory trees), however, the rapid NTFP inventory revealed that ecosite types 19 and 29 contained the most abundant and largest birch trees. It would be important to keep a percentage of these ecosite types on the landscape for NTFP use, such as harvesting large strips of bark or constructing specialty wood products. However, in harvesting bark for birch basketry, an area containing smaller, younger aged trees with bark that has less blemishes may be preferable an area containing many large, older birch. Ultimately it would be important to keep a variety of different ecosite types on the landscape to ensure that a wide range of size and age classes of birch are available for a variety of NTFP uses in the future.

Information about understory plant species in birch forest patches gained from a rapid NTFP inventory such as this would be useful in identifying important NTFP areas to be included in forest management plans. It would also be important for First Nation communities to have a record of what plant NTFPs are on their land, especially those that may be sought after for their commercial value. In this study eleven of the twelve plant species selected based on their importance to the Shoal Lake First Nation were of commercial value. For example, sand cherry is a dwarf shrub that is culturally valuable to the First Nation people at Shoal Lake, as well as being identified as a rare wild plant of economic importance in Ontario (Catling and Porebski 1998). The rapid NTFP inventory in this study detailed the type of habitat associated with this plant and the abundance of the plant. This type of information would help to define areas where it is crucial to protect valuable NTFP plant species. Also, this type of data would aid in defining areas where plant NTFPs are most abundant, and have the potential to be sustainably harvested.

It is important that a standardized methodology for a rapid inventory of NTFP plant species to be developed for use in the province of Ontario. If possible, this rapid NTFP inventory methodology should be one, or a combination of, methods already in use by forest managers, such as the FEC and G & Y plot systems used in this study.

This would make the transition to including NTFP data into management plans much easier and allows for the potential to link newly gathered data with previously gathered data. The methodology used in this study was easy set up, particularly the FEC plot portion, and allowed for detailed data collection without being too time-consuming. This type of methodology could be used by local harvesters such as First Nation communities interested in gathering NTFP data in their area.

Building an NTFP database at the Ontario Ministry of Natural Resources would aid in incorporating NTFPs into forest management planning. The database could include the type of information gathered from a rapid NTFP inventory such as this, including abundance and habitat information. Such a database should be open to local harvesters who may want to add species habitat information to the database. It would be helpful for OMNR staff to communicate with local harvesters about what harvesters think goals should be for NTFP management and which species would be most important to include in management plans.

Future Research Directions

Research into ways to incorporate information about plant NTFPs into forest management practices that are already in use by forest managers should continue. Due to time and money constraints, only four forested ecosite types were studied. More ecosite types should be explored in relation to different types of birch growth in order to manage for this valuable NTFP.

This study determined that for most other plant NTFPs, ecosite types (10 – 100 ha) are not appropriate management units. Smaller Ecological Land

Classification units called ecoelements (100-100,000 m2) composed of Vegetation Types and Soil Types deserve further exploration as a means to more accurately incorporate NTFP data into forest management plans. The OMNR usually considers ecoelements to be too small for mapping purposes (Racey et al. 1996). However, if through rapid NTFP inventory data, it is discovered that plant NTFPs are linked with ecoelements, then ecoelements may in turn be linked to larger mapable ecosites to identify areas of high NTFP interest at the landscape level.

In this study some observations were made on what type of environmental conditions NTFP plant species were growing under. NTFP inventories should continue to be conducted to gather more data on the natural distribution and biology of NTFP plant species. Particularly understory herbs. For example, it was very difficult to find information in the literature about the natural history of some of the selected herbs of NTFP value such as sweet cicely (*Osmorhiza longistylis*) or wild ginger (*Asarum canadense*).

The focus of research should continue to lie on valuable NTFP plant species, such as the twelve selected plant species discussed in this study. These kinds of species would be the most important to include in forest management planning as they would be of the highest interest to local communities. The interest would lie in preserving cultural heritage, such as areas where medicinal herbs are harvested, as well as contributing to household incomes, from berry-harvests for example.

More research is also needed on the quality of NTFPs in different site conditions in order to identify and preserve high quality areas for NTFP use. As was discussed in this study, birch bark was a culturally and economically valuable raw material for constructing NTFPs. However, no quantitative data on how quality varied with site conditions was found in the literature. This study established some quantitative data, but was only preliminary, and more extensive studies are needed.

Future NTFP research should involve local harvesters whenever possible. Research involving First Nation communities will be particularly important. First Nation people, particularly elders, have a wealth of knowledge about plant NTFPs and experience harvesting them. Sharing traditional ecological knowledge and scientific knowledge in a mutually beneficial manner will help to determine which plant species are important as NTFPs and to gain more information about their biology and ecological relationships.

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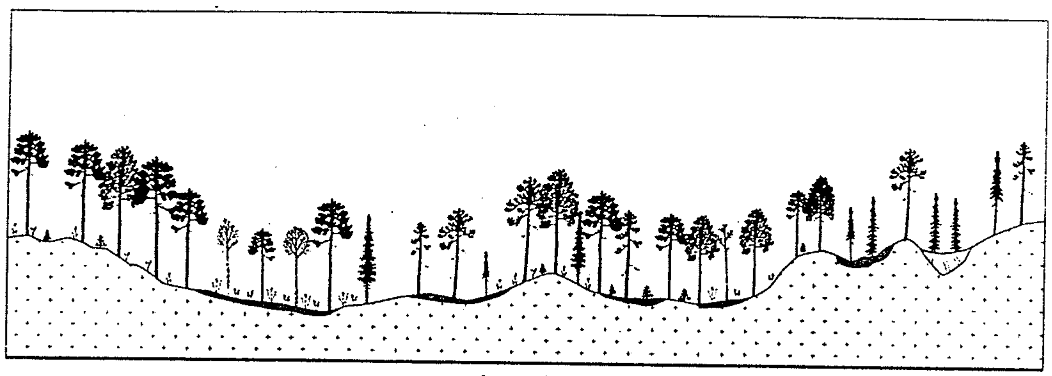
Appendix 1

Description of plants and environmental conditions found in ecosite types 11, 12, 19, and 29 according to the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (NWST Field Guide FG-02) (Racey et al. 1996).

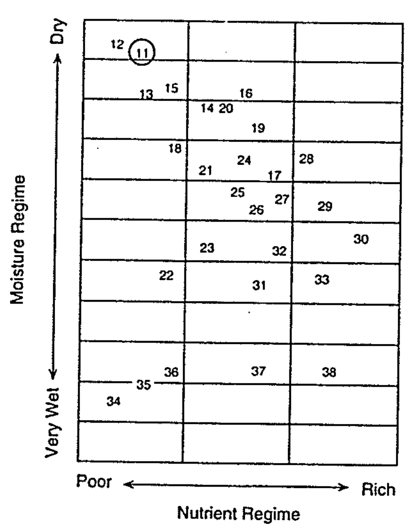
Red Pine–White Pine–Jack Pine: Very Shallow Soil **ES11**



approximately 250 m

General Description

Conifer dominated stands with red, white and jack pine. Trembling aspen, large-toothed aspen, white birch and white spruce occur occasionally. White cedar may be locally abundant. Shrub- and herb-poor. Soils very shallow (<20 cm) with bedrock outcrops. Ground cover consists of bedrock, needle litter, feathermoss and lichen.



Soil Types
SS1, SS2, SS3, SS4, SS5

Mode of Deposition
bedrock, morainal

Humus Form
fibrimor

Overstory
jack pine, red pine, white pine

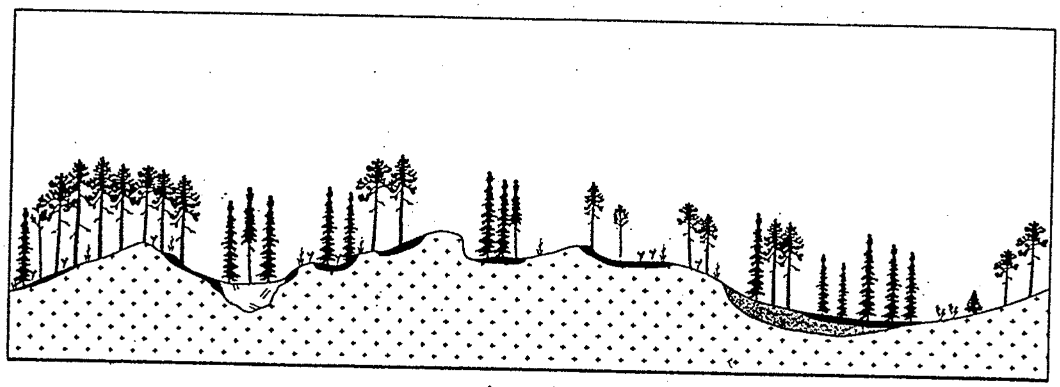
Shrubs/Trees (<10 m)
Diervilla lonicera, balsam fir, *Linnaea borealis, Vaccinium myrtilloides, Vaccinium angustifolium, Arctostaphylos uva-ursi, Rosa acicularis, Juniperus communis*

Herbs and Graminoids
Aralia nudicaulis, Maianthemum canadense, Oryzopsis asperifolia, Fragaria virginiana, Aster macrophyllus

Appendix 1

Description of plants and environmental conditions found in ecosite types 11, 12, 19, and 29 according to the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (NWST Field Guide FG-02) (Racey et al. 1996).

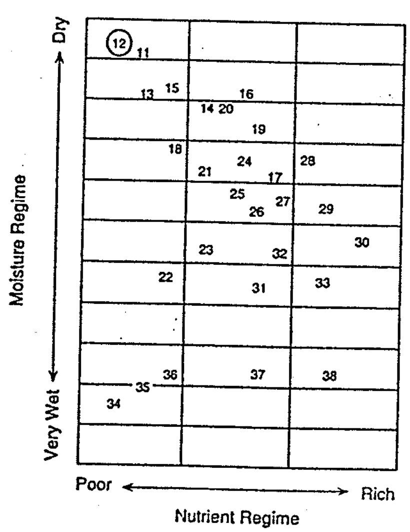
ES12 Black Spruce–Jack Pine: Very Shallow Soil



approximately 250 m

General Description

Overstory open and patchy to close-crowned. Dominated by black spruce and jack pine. Balsam fir and trembling aspen in patches. Shrub- and herb-poor. Soils very shallow (<20 cm) with bedrock outcrops. Bedrock frequently covered only by a shallow litter layer. Ground cover consists of bedrock, needle litter, lichen and feathermoss.

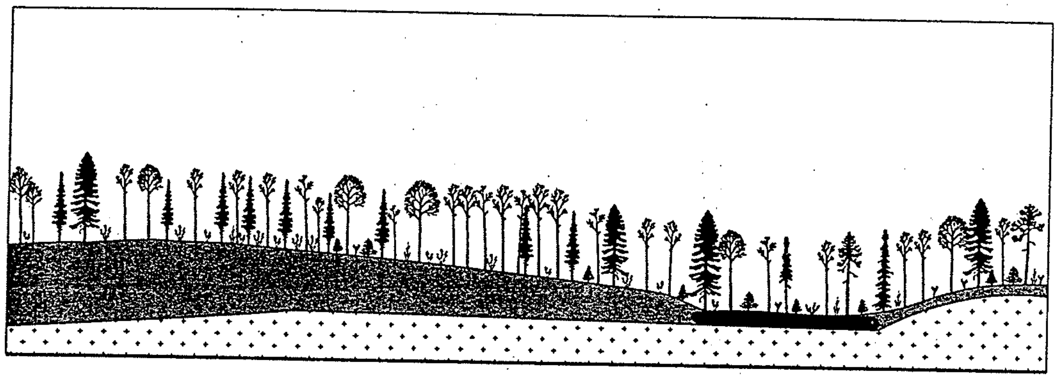


Soil Types
SS1, SS2, SS3, SS4, SS5
Mode of Deposition
bedrock, morainal
Humus Form
fibrimor, humifibrimor
Overstory
black spruce, jack pine, white birch
Shrubs/Trees (<10 m)
Vaccinium myrtilloides, Vaccinium angustifolium, Gaultheria hispidula, black spruce, balsam fir, *Linnaea borealis*
Herbs and Graminoids
Aralia nudicaulis, Cornus canadensis, Trientalis borealis, Clintonia borealis, Maianthemum canadense

Appendix 1

Description of plants and environmental conditions found in ecosite types 11, 12, 19, and 29 according to the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (NWST Field Guide FG-02) (Racey et al. 1996).

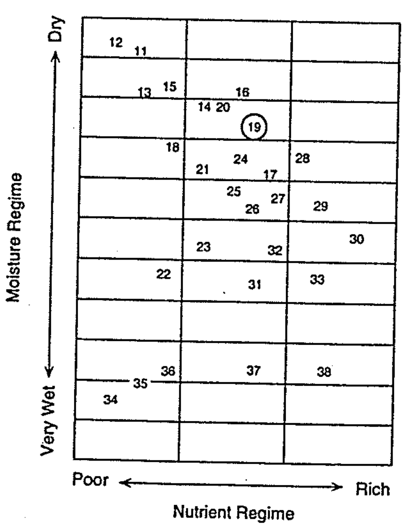
Hardwood–Fir–Spruce Mixedwood: Fresh, Sandy–Coarse Loamy Soil **ES19**



approximately 250 m

General Description

Dominated by trembling aspen, white birch and balsam fir, with occasional occurrences of white and black spruce. Deciduous tree component exceeds 50% of the canopy. Understory composition variable; shrub- and herb-rich. Soils are fresh, well drained, coarse loamy to fine sandy. Parent materials are commonly glaciofluvial on deep soil sites and morainal on shallow sites. Ground cover consists of broadleaf litter, conifer litter, wood and feathermoss.



Soil Types
S3, S2, SS6, SS5, S1

Mode of Deposition
glaciofluvial, morainal

Humus Form
fibrimor, humifibrimor

Overstory
trembling aspen, white birch, white spruce, black spruce, jack pine, balsam fir

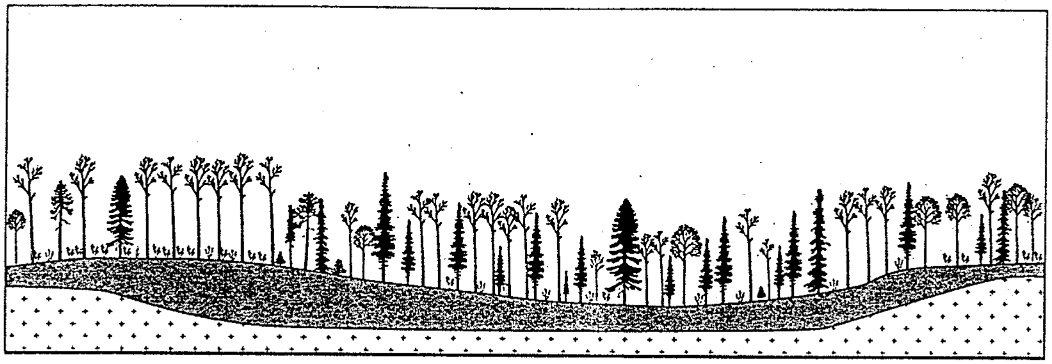
Shrubs/Trees (<10 m)
Acer spicatum, Corylus cornuta, Diervilla lonicera, Lonicera canadensis, Linnaea borealis, balsam fir, white spruce, *Sorbus decora*, trembling aspen

Herbs and Graminoids
Aster macrophyllus, Aralia nudicaulis, Mitella nuda, Streptopus roseus, Viola renifolia, Galium triflorum, Clintonia borealis, Trientalis borealis, Maianthemum canadense, Cornus canadensis, Actaea rubra

Appendix 1

Description of plants and environmental conditions found in ecosite types 11, 12, 19, and 29 according to the Terrestrial and Wetland Ecosites of Northwestern Ontario Field Guide (NWST Field Guide FG-02) (Racey et al. 1996).

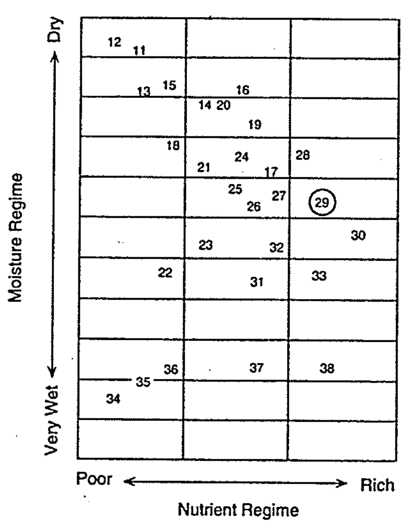
Hardwood–Fir–Spruce Mixedwood: Fresh, Fine Loamy–Clayey Soil **ES29**



approximately 250 m

General Description

Dominated by trembling aspen and occasionally white birch, with a conifer mix of balsam fir, white spruce, black spruce and occasionally jack pine. Deciduous trees comprise more than 50% of the canopy. Shrub- and herb-rich. Soils fresh, moderately well to well drained, fine loamy–clayey. Developed primarily on lacustrine parent material. Ground cover consists of broadleaf litter, conifer litter, feathermoss and wood.



Soil Types
S5, S6, SS7
Mode of Deposition
lacustrine
Humus Form
fibrimor, humifibrimor
Overstory
trembling aspen, balsam fir, white spruce, black spruce, white birch, jack pine, balsam poplar
Shrubs/Trees (<10 m)
Acer spicatum, Corylus cornuta, Cornus stolonifera, Viburnum edule, Ribes triste, Diervilla lonicera, Lonicera canadensis, Linnaea borealis, balsam fir, *Sorbus decora*, trembling aspen
Herbs and Graminoids
Aster macrophyllus, Fragaria virginiana, Aralia nudicaulis, Streptopus roseus, Viola renifolia, Anemone quinquefolia, Galium triflorum, Clintonia borealis, Trientalis borealis, Maianthemum canadense, Cornus canadensis, Mitella nuda

Appendix 2

Vegetation layers according to Describing Ontario's Ecosystems: Data Collection Standards for Ecological Land Classification (Harris et al. 1999).

Layer	Vegetation	Position	Height
1	Tree	Dominant canopy	> 10 m
2	Tree	Subdominant canopy	> 10 m
3	Tree or shrub	Tall shrubs and saplings	2-10 m
4	Tree or shrub	Low shrubs / regeneration	0.5-2 m
5	Tree or shrub	Dwarf shrubs / seedlings	0-0.5 m
6	Herbaceous	Forbs and graminoids	Any height
7	Mosses, lichens	Soil surface, bedrock, or downed woody debris	Any height

Appendix 3

Slope position according to Describing Ontario's Ecosystems: Data Collection Standards for Ecological Land Classification (Harris et al. 1999).

Slope Position Name	Description
Crest	Uppermost portion of a slope, shape usually convex (diverging)
Upper slope	The upper portion of the slope immediately below the crest, slope shape usually convex (diverging)
Mid slope	The area of the slope between the upper slope and the lower slope, slope shape usually straight or concave (converging), grading to level
Lower slope	The lower portion of the slope immediately below and adjacent to the lower mid slope, slope shape usually concave (converging), grading to level
Level	Any flat area excluding lower slopes, generally horizontal

Appendix 4

Description of soil depth and texture for each Soil Type found in this study according to the Field Guide to the Forest Ecosystem Classification for Northwestern Ontario (Sims et al. 1997). Soil Types are listed in the order that they were ranked for the purpose of data analysis. Figure A applies to Soil Types without a defined C-horizon including 1) Extremely Shallow Soil on Bedrock and 2) Very Shallow Soil on Bedrock as well as 9) Deep Organic (*Sphagnum* moss). Figure A is a representative soil profile showing substrate classes and ranges of possible substrate depths for the Soil Type. Figure B applies to Soil Types with a defined C-horizon including the following Soil Types 3) through 8). Figure B is a texture triangle illustrating C-horizon texture classes according to frequency of occurrence within the Soil Type.

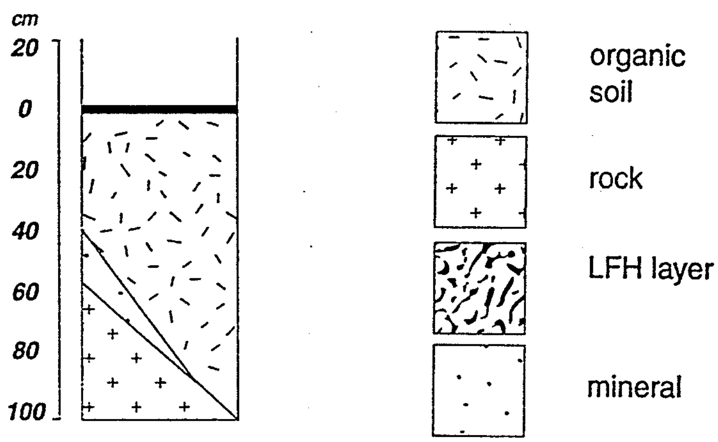
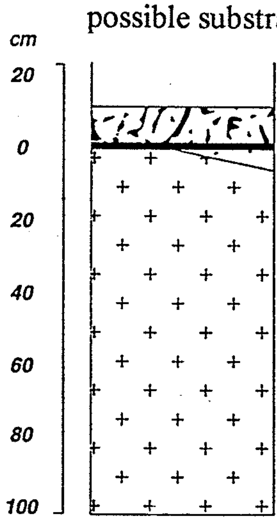
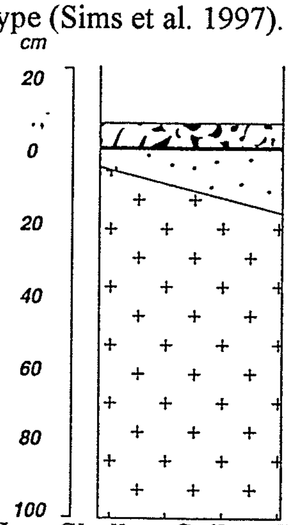


Figure A. Representative soil profile showing substrate classes and ranges of possible substrate depths for the Soil Type (Sims et al. 1997).



1) Extremely Shallow Soil on Bedrock
Too shallow for C-horizon, texture of mineral soil normally coarse sand.



2) Very Shallow Soil on Bedrock
Too shallow for C-horizon, texture of mineral soil normally sandy loam.

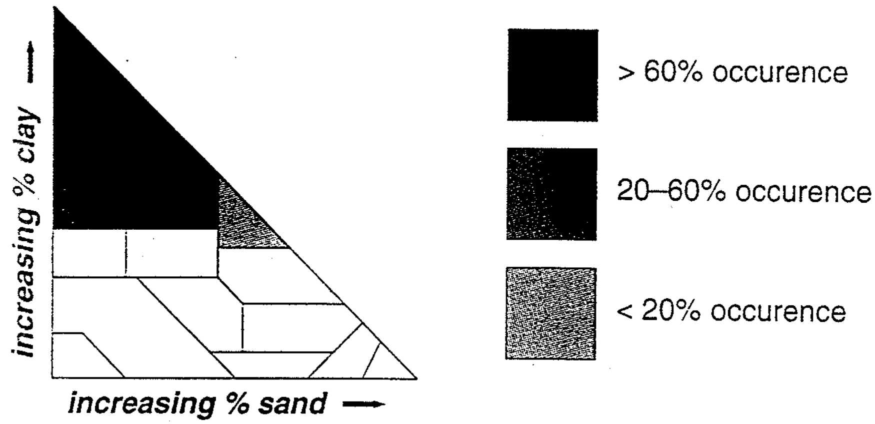
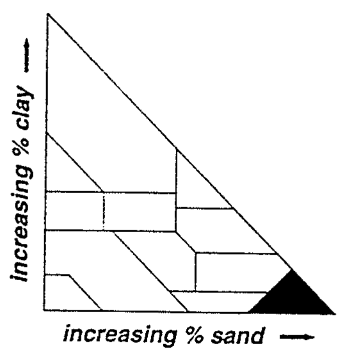
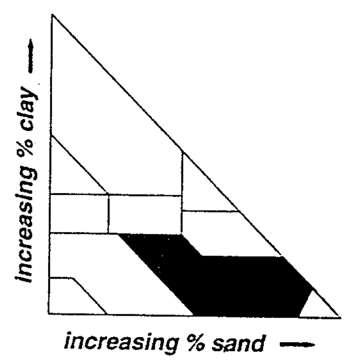


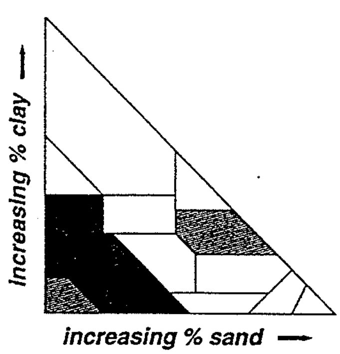
Figure B. Texture triangle illustrating C-horizon texture classes according to frequency of occurrence within the Soil Type (Sims et al. 1997).



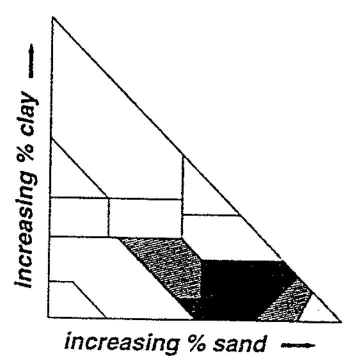
3) Shallow–Moderately Deep, Sandy



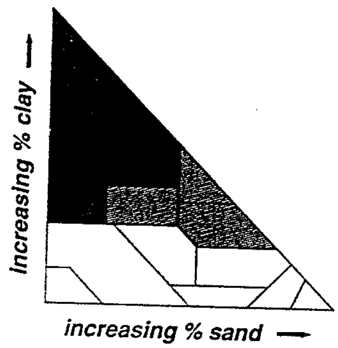
4) Shallow-Moderately Deep, Coarse Loamy



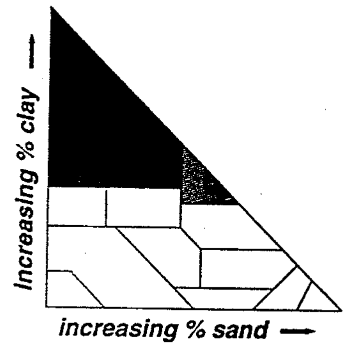
5) Shallow–Moderately Deep, Silty, Fine-Loamy Clayey



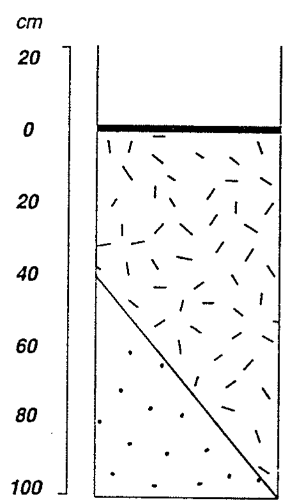
6) Deep, Coarse Loamy



**7) Deep,
Fine-Loamy Clayey**



**8) Deep,
Clayey**



**9) Deep,
Organic (*Sphagnum* moss)**

Appendix 5

Mean percent cover of trees, shrubs and saplings, dwarf shrubs and seedlings, herbaceous plants, lichens, and mosses in ecosites 11, 12, 19, and 29.

Scientific Name (Genus or species)	**Common Name(s)**	**Mean % Cover Across Plots in each Ecosite**			
		11	**12**	**19**	**29**
Trees [includes Layer 1 (dominant > 10 m) and Layer 2 (subdominant >10 m)]					
Abies balsamea	Balsam fir	2.2	0.6	5.6	6.3
Betula papyrifera	Paper birch, White birch	13.9	11.1	43.3	45.0
Fraxinus nigra	Black ash	1.1	0	3.3	1.7
Picea glauca	White spruce	2.2	2.2	0.8	8.0
Picea mariana	Black spruce	0	3.4	0	0
Pinus banksiana	Jack pine	0	10	0	0
Pinus resinosa	Red pine	3.3	0	0	0
Pinus strobus	White pine	9.0	0	0	0
Populus tremuloides	Trembling aspen, White poplar	3.9	11.1	5.6	6.1
Thuja occidentalis	Eastern white cedar	7.8	0	1.2	0.6
Shrubs and saplings [includes Layer 3 (2-10 m shrubs and saplings) and Layer 4 (0.5-2 m low shrubs and regeneration)]					
Abies balsamea	Balsam fir	22.3	5.2	27.1	24.9
Acer spicatum	Moose maple, Mountain maple	13.0	1.7	37.2	40.9
Alnus crispa	Green alder	0	5.2	0	0
Amelanchier spp.	Saskatoon, Serviceberry	1.6	6.1	1.4	3.2
Betula papyrifera	Paper birch, White birch	4.8	10.7	4.4	3.8
Cornus stolonifera	Red osier dogwood	10	11.8	8.9	7.7
Corylus cornuta	Beaked hazelnut	6.7	6.7	1.0	0.2
Fraxinus nigra	Black ash	6.2	0	6.1	6.2
Lonicera dioica	Twining honeysuckle	0.9	0	0.3	0
Myrica gale	Sweet gale	0	4.4	0	0
Picea glauca	White spruce	1.1	0.8	1.3	0

Appendix 5

Scientific Name (Genus or species)	**Common Name (s)**	**Mean % Cover Across Plots in each Ecosite**			
		11	**12**	**19**	**29**
Picea mariana	Black spruce	0	2.2	0	0
Pinus banksiana	Jack pine	0	0.3	0	0
Pinus strobus	White pine	2.4	0	0.1	0
Populus tremuloides	Trembling aspen, White poplar	10.2	4.7	4.1	5.7
Prunus pensylvanica	Pin cherry	1.2	0	0	0
Prunus virginiana	Choke cherry	1.3	2.4	0.7	1.6
Quercus macrocarpa	Bur oak	0.4	15.8	0.4	0
Salix spp.	Willow	0	0.6	0	0
Thuja occidentalis	Eastern white cedar	1.1	0	0.1	0.9
Ulmus americana	American elm	0	0	0	0.8
Viburnum rafinesquianum	Downy arrowwood	7.8	15.6	0.8	0.3
Dwarf shrubs and seedlings [includes Layer 5 (0 – 0.5 m)]					
Abies balsamea	Balsam fir	3.8	0.8	6.4	7.8
Acer spicatum	Moose maple, Mountain maple	2.3	1.3	16.8	7.9
Alnus crispa	Green alder	0	0.7	0	0
Amelanchier spp.	Saskatoon, Serviceberry	1.7	9.0	0.3	1.4
Arctostaphylos uva-ursi	Bearberry, Kinnickinnick	8.0	15.0	0	0
Betula papyrifera	Paper birch, White birch	0.4	0.8	0.3	0.8
Cornus stolonifera	Red osier dogwood	1.7	2.8	1.8	1.2
Corylus cornuta	Beaked hazelnut	1.4	0.8	8.4	1.2
Diervillia lonicera	Bush honeysuckle	6.7	11.8	6.1	7.6
Fraxinus nigra	Black ash	2.8	0	1.2	7.0
Gaultheria hispidula	Creeping snowberry	0	0.1	0	0
Juniperus communis	Common juniper	3.3	0.7	0	0
Ledum groenlandicum	Labrador tea	0	11.1	0	0
Linnaea borealis	Twinflower	0	1.6	7.1	7.1
Lonicera dioica	Twining honeysuckle	0.2	0.8	0.3	0
Lonicera villosa	Fly honeysuckle	0.1	0	0	0.6
Myrica gale	Sweet gale	0	0.6	0	0

Appendix 5

Scientific Name (Genus or species)	**Common Name (s)**	**Mean % Cover Across Plots in each Ecosite**			
		11	**12**	**19**	**29**
Oxycoccus microcarpus	Small bog cranberry	0	0.6	0	0
Picea glauca	White spruce	0.1	0	0.3	0
Picea mariana	Black spruce	0	0.2	0	0
Pinus strobus	White pine	0.6	0	0.1	0.1
Populus tremuloides	Trembling aspen, White poplar	2.1	0.4	0.7	4.7
Prunus pensylvanica	Pin cherry	0	0.1	0	0
Prunus pumila	Sand cherry	0	1.1	0	0
Prunus virginiana	Choke cherry	1.4	1.7	1.8	0.8
Quercus macrocarpa	Bur oak	0.6	0.3	0.7	0
Rhus glabra	Smooth sumac	0	1.1	0	0
Rhus radicans	Poison ivy	7.1	0.3	0.7	0
Ribes glandulosum	Skunk currant	0.2	0.3	1.1	0
Ribes lacustre	Black gooseberry, Bristly black currant	0	0	0.2	0.4
Ribes oxyacanthoides	Northern gooseberry	2.3	2.2	0.4	0
Ribes triste	Swamp red currant, Wild red currant	2.2	0.1	2.1	2.1
Rosa acicularis	Prickly rose	5.6	6.7	4.0	1.0
Rubus idaeus	Wild red raspberry	7.2	2.8	2.8	6.3
Shepherdia canadensis	Canada buffaloberry, Soapberry	0	0.6	0	0
Sorbus decora	Mountain ash	0.1	0	0.1	0.4
Spirea alba	Narrow-leaved meadowsweet	0	2.2	0	0
Symphoricarpos albus	Snowberry	10.6	5.0	0.1	0.6
Taxus canadensis	Canada yew	0	0	0	21.1
Thuja occidentalis	Eastern white cedar	0.4	0	0.2	1.3
Vaccinium angustifolium	Low sweet blueberry	0.2	11.3	0	0
Vaccinium myrtilloides	Common blueberry, Velvet leaved blueberry	14.0	16.2	4.6	0.2
Vaccinium vitis-idaea	Bog cranberry, Lingonberry	0	1.2	0	0
Viburnum rafinesquianum	Downy arrowwood	6.2	6.7	0.8	1.4

Appendix 5

Scientific Name (Genus or species)	Common Name (s)	Mean % Cover Across Plots in each Ecosite			
		11	12	19	29
Herbaceous [Layer 6 (any size)]					
Achillea millefolium	Yarrow	1.0	0.1	0	0.1
Actaea rubra	Baneberry	0.1	0	0.3	1.6
Agastache foeniculum	Giant hyssop	0.2	0	0	0
Agropyron sp.	Wheat grass	0.2	0	0	0
Agrostis sp.	Rough hair grass, tickle grass, hair bentgrass	0	1.3	0	0
Anemone cinquefolia	Wood anemone	0.2	0.3	0	0.4
Anemone riparia	Riverbank anemone	0.1	0.1	0	0
Antennaria neglecta	Pussytoes	0.1	0.1	0	0
Apocynum androsaemifolium	Spreading dogbane	0.6	0.6	0.1	0.1
Aquilega canadensis	Canada columbine	0.1	0	0	0.2
Arabis divaricarpa	Rock cress	0.3	0.2	0	0
Arailia nudicaulis	Wild sarsaparilla	21.7	7.2	18.3	24.7
Arenaria lateriflora	Blunt-leaved sandwort	0.2	0	0	0
Asarum canadense	Wild ginger	0	0	0	0.2
Aster boreale	Marsh aster, Rush aster	0	0	0.1	0
Aster ciliolatus	Fringed aster	1.7	1.1	0.2	2.8
Aster macrophyllus	Large-leaved aster	6.7	0.3	1.0	8.9
Athyrium filix-femina	Lady fern	0	0	0.4	0.6
Botrychium virginianum	Virginia grape fern, Rattlesnake fern	0	0	0.1	0.1
Bromus sp.	Brome grass	0.1	0	2.6	0.7
Calamagrostis sp.	Reed grass	0	0.2	0.6	0
Campanula rotundifolia	Blue bell, Hare bell	0.3	0.2	0	0
Cardamine pensylvanica	Bitter cress	0	0.1	0	0
Carex spp.	Sedge	4.4	1.1	3.4	2.0
Chimaphila umbellata	Pipsissewa, Prince's pine	0.3	0.2	0	0.1
Circaea alpina	Small enchanter's nightshade	0	0	0.2	0.9
Clintonia borealis	Blue bead lily	0.1	3.0	1.7	0.1
Comandra umbellata	Bastard toadflax, Pale comandra	1.1	1.1	0	0
Coptis trifolia	Goldthread	0	0.3	0	0

Appendix 5

Scientific Name (Genus or species)	**Common Name (s)**	**Mean % Cover Across Plots in each Ecosite**			
		11	**12**	**19**	**29**
Corallorhiza maculata	Spotted coralroot	0.2	0	0	0
Cornus canadensis	Bunchberry	14.4	1.0	13.0	5.1
Corydalis sempivirens	Pink corydalis	0	0.6	0	0
Cypripedium acaule	Mocassin flower, Stemless lady's slipper	0	0.1	0	0
Cystopteris fragilis	Fragile bladder fern	0	0.1	0	0
Danthonia sp.	Oat grass	0	0.3	0	0
Deschampsia sp.	Hair grass	0	0	0	0.1
Epilobium angustifolium	Fireweed	0.2	0	0.3	0
Equisetum scirpoides	Dwarf scouring rush	0	0	0.2	0
Equisetum sylvaticum	Woodland horsetail	0	2.2	0.1	0.6
Festuca sp.	Fescue	0.1	0	0	0
Fragaria vesca	Woodland strawberry	28.9	1.1	7.3	6.3
Fragaria virginiana	Smooth wild strawberry	0	4.8	2.4	0
Galium boreale	Northern bedstraw	11.7	3.3	2.2	0.6
Galium triflorum	Sweet-scented bedstraw	2.6	0	3.6	7.6
Geranium bicknelli	Bicknell's geranium	0	0	0.1	0
Geum allepicum	Yellow avens	0	0	0	0.1
Gymnocarpum dryopteris	Oak fern	0	0.1	3.2	1.8
Heuchera richardsonii	Richardson's alumroot	0	0.2	0	0
Hieracium umbellatum	Narrow-leaved hawkweed	0	0.2	0	0.1
Lathyrus ochroleucus	Creamy peavine	7.1	3.3	0.1	0.2
Lathyrus venosus	Purple peavine, Veined peavine	5.8	1.7	1.6	0.4
Lithospermum canescens	Hoary puccoon	0	0.7	0	0
Lycopodium annotinum	Stiff club moss	0	2.3	0	0
Lycopodium obscurum	Ground pine	0	3.3	0	0
Lycopus uniflorus	Bugleweed, Northern water-horehound	0	0	0	0.2
Maianthemum canadense	Wild lily of the valley	30	17.2	12.2	7.9
Melampyrum lineare	Cow wheat	0	0.6	0	0
Mitella nuda	Bishop's cap, Mitrewort	0.7	0	10.0	9.1

Appendix 5

Scientific Name (Genus or species)	Common Name (s)	Mean % Cover Across Plots in each Ecosite			
		11	12	19	29
Oryzopsis asperifolia	Rough-leaved rice grass	11.6	3.7	1.7	1.9
Osmorhiza longistylis	Sweet cicely	0	0	0	0.8
Panicum sp.	Panic grass	0	0.1	0	0
Petasites palmatus	Palmate-leaved coltsfoot	0	0	3.1	2.9
Petasites sagittatus	Arrow-leaved coltsfoot	0	0	0	0.1
Poa sp.	Bluegrass	5.1	0.2	0	0.1
Polygonum convolvulus	Black bindweed, Wild buckwheat	0.1	0.1	0	0.1
Polypodium virginianum	Rock polypody	0.6	1.0	0.1	0
Potentilla arguta	White cinquefoil	0	0.1	0	0
Potentilla tridentata	Three-toothed cinquefoil	0	1.3	0	0
Pteridium aquilinum	Fern	0	1.1	6.1	2.8
Pyrola asarifolia	Pink wintergreen	0.1	0	3.1	4.1
Pyrola elliptica	White wintergreen	0	0	0.2	0.8
Pyrola secunda	One-sided wintergreen	0.9	0	1.6	0.9
Pyrola virens	Green-flowered wintergreen	0.1	0	0	0
Rubus pubescens	Dewberry, Dwarf raspberry	5.0	0.3	27.2	12.8
Sanicula marilandica	Black sanicle, Snakeroot	0.1	0.1	0.3	0.1
Satureja vulgaris	Wild basil	0	0	0	0.1
Schizachne purpurescens	False melic, Purple oat grass	21.1	6.7	0.1	0.7
Senecio pauperculus	Balsam groundsel, Canadian bittersweet	0	0.1	0	0
Solidago nemoralis	Gray goldenrod	0	0.7	0	0
Solidago rigida	Stiff-leaved goldenrod	0.2	0	0	0
Stellaria longifolia	Long-leaved chickweed	0.2	0	0	0
Streptopus roseus	Rose twisted stalk, Rosybells	0	0.2	2.0	0.6
Trientalis borealis	Starflower	6.7	0.4	5.6	5.0
Trillium cernuum	Nodding trillium	0	0	0	0.3

Appendix 5

Scientific Name (Genus or species)	**Common Name (s)**	**Mean % Cover Across Plots in each Ecosite**			
		11	**12**	**19**	**29**
Vicia americana	American vetch, Wild vetch	0.8	0.7	0.4	0
Viola adunca	Early blue violet	1.0	0.6	0.6	0
Viola canadensis	Canada violet	0	0	0	0.2
Viola renifolia	Kidney-leaved violet	0.2	0	0.8	1.4
Woodsia ilvensis	Rusty woodsia	0	0.2	0	0
Lichens [Layer 7] (General group including all species)		8.2	10.3	1.2	1.3
Mosses [Layer 7] (General group including all species)		22.8	26.1	18.9	9.7
Number of plant genera or species (excluding lichens and mosses) **found in each ecosite**		**79**	**94**	**69**	**74**
Total number of plant genera or species (excluding lichens and mosses) **found in all ecosites = 139**					

Appendix 6

Non-timber commercial use information for 12 selected plant species that are important /recognized by a First Nation community in the Shoal Lake watershed, Northwestern Ontario.

Trees
Scientific name: *Betula papyrifera* **Common name(s):** Paper birch, White birch **Commercial uses:** Specialty wood products such as toothpicks, clothespins, broom handles, toys, snowshoe frames, and canoes. Wood and bark oil for aromatherapy [2]. Birch bark baskets, bark-biting artwork, other crafts, and decorative furniture. Birch bark a source of drugs with antiviral activity [1]. Birch bark identified by the NAFA as having immediate market demand in Ontario [5]. Sap used as food (e.g. syrup) or in making drinks [3]. Seed collected for use in the forestry industry, landscaping nurseries, or other seed retail [5].
Scientific name: *Picea mariana* **Common name(s):** Black spruce **Commercial uses:** Cones for use as decorative items. Essential oils for aromatherapy and in perfumes, soaps, cosmetics, flavorings, floor polishes, and disinfectants. Potential for use of volatile oil in a drug to fight tuberculosis [1]. Sap for use as glue substitute [2]. Seed collected for use in the forestry industry, landscaping nurseries, or other seed retail [5].
Scientific name: *Pinus strobus* **Common name(s):** White pine **Commercial uses:** Pine oil as disinfectant in products such as cleansers [1]. Floral and craft industry uses pine branches e.g. wreaths [2], hollowed pine branches/logs as candle-holders, and cones e.g. wreaths, potpourri (Mater Engineering 1993 cited by Marles et al. 2000) [1]. Harvested in Ontario as Christmas greenery [5]. Seed collected for use in the forestry industry, landscaping nurseries, or seed retail [5].
Scientific name: *Thuja occidentalis* **Common name(s):** Eastern white cedar **Commercial uses:** Market exists for volatile oils from cedar leaves which may have medicinal uses (against parasites, bacteria, fungi, viruses, and possible anticancer activity). Note of caution: contains the toxic compound Thujone [1]. Leaf oil used to scent cologne, incense, as well as wood furniture and closets, and in hardwood floor cleaning products. Oil used in natural insect repellant [2]. Cedar has also been cultivated as an ornamental [1,4]. Harvested in Ontario as Christmas greenery e.g. wreaths [5].

Shrubs

Scientific name: *Ledum groenlandicum*
Common name(s): Labrador tea
Commercial uses: Use as an ornamental shrub [1]. Insect repellant made from leaves [2]. Use preserved in floral industry. Potential for herbal tea production. Essential oils for aromatherapy. Labrador tea identified by the NAFA as having good potential in Ontario to support a market for essential oils [5].

Scientific name: *Prunus pumila**
Common name(s): Sand cherry
Commercial uses: Potential for use in landscaping: dense low growth and attractive flowers [4]. Use as dwarf grafting stock for nurseries. Edible fruit [2] (literature examined did not reveal that the fruit was being sold commercially). *Classed as a rare wild plant in Ontario [6].

Scientific name: *Taxus canadensis*
Common name(s): Canada yew
Commercial uses: Drugs used to treat some types of cancer (e.g.Taxol®), originally from Pacific yew *Taxus brevifolia*, are now being developed from *T. canadensis* [2]. For example, Prince Edward Island's Forestry Division has guidelines for the collection of *T. canadensis* and the island currently supports a small market for the tips of branches that have a concentrated amount of the active compound taxol [7]. The seeds of Canada yew are identified by the NAFA as having immediate market demand in Ontario [5].

Scientific name: *Vaccinium myrtilloides*
Common name(s): Common blueberry, Velvet-leaved blueberry
Commercial uses: Fruit fresh, frozen, or in jams, jellies, syrups, and beverages. Note: Blueberry fruit already has a well established market. Pharmaceutical companies are currently investigating medicinal potential of blueberry plant leaves [1].

Herbs

Scientific name: *Asarum canadense*
Common name(s): Wild ginger
Commercial uses: Dried roots for use to flavor foods, also sold for medicinal purposes [2, 5]. The seeds of wild ginger are identified by the NAFA as having immediate market demand in Ontario [5].

Scientific name: *Fragaria vesca*
Common name(s): Wild strawberry, Woodland strawberry
Commercial uses: Note: the following is in reference to *Fragaria vesca* and *F. virginiana*, both termed "wild strawberry". Fruit eaten fresh or preserved, although normally plants not productive enough to be commercially viable. Essential oils from leaves used for aromatherapy. Leaves of *F. vesca* contain tannins and may be used as an astringent externally for rashes or internally for diarrhea. Wild strawberry leaves are also used in teas as a food additive [1].

Scientific name: *Osmorhiza longistylis* **Common name(s):** Sweet cicely **Commercial uses:** Use in alternative medicinal products e.g. medicinal teas, eye-wash, birthing aid [8,9]. Leaves, seeds, and root of the plant also edible and can be used to flavor foods [8,9] (literature examined did not reveal plant was being sold commercially as food).
Scientific name: *Rubus pubescens* **Common name(s):** Dewberry, Dwarf raspberry **Commercial uses:** Fruit eaten fresh, although normally plants not productive enough to be commercially viable [1].

References: [1] Marles et al. 2000, [2] Mohammed 1999, [3] Ganns et al. 1982, [4] USDA www.plants.usda.gov 2001, [5] Brubacher (National Aboriginal Forestry Association) 1999, [6] Catling and Porebski 1998, [7] Government of Prince Edward Island www.gov.pe.ca 1999, [8] Plants for a Future: Species Database www.pfaf.org 2000, [9] Jackson and Shelton www.altnature.com 2000.

Appendix 7

Percent cover data of 12 selected plant species from birch forest patches in ecosites 11, 12, 19, and 29 in the Shoal Lake watershed, Northwestern Ontario. Trees: Bet pap = Birch (*Betula papyrifera*), Pic mar = Black spruce (*Picea mariana*), Pin str = White pine (*Pinus strobus*), Thu occ = Eastern white cedar (*Thuja occidentalis*); Shrubs: Pru pum = Sand cherry (*Prunus pumila*), Tax can = Canada yew (*Taxus canadensis*), Vac myr = Velvet-leaved blueberry (*Vaccinium myrtilloides*); Herbs: Asa can = Wild ginger (*Asarum canadense*), Fra ves = Woodland strawberry (*Fragaria vesca*), Osm lon = Sweet cicely (*Osmorhiza longistylis*), and Rub pub = dewberry or dwarf raspberry (*Rubus pubescens*).

Eco site	Bet pap	Pic mar	Pin str	Thu occ	Led Gro	Pru pum	Tax can	Vac myr	Asa can	Fra ves	Osm lon	Rub pub
11a	5	0	10	40	0	0	0	5	0	40	0	5
11b	20	0	1	0	0	0	0	30	0	50	0	0
11c	35	0	10	0	0	0	0	10	0	10	0	10
11d	5	0	30	0	0	0	0	0	0	10	0	5
11e	0	0	0	0	0	0	0	10	0	40	0	20
11f	10	0	0	30	0	0	0	60	0	40	0	5
11g	50	0	0	0	0	0	0	1	0	0	0	0
11h	0	0	10	0	0	0	0	0	0	40	0	0
11i	0	0	20	0	0	0	0	10	0	30	0	0
12a	10	0	0	0	0	0	0	1	0	0	0	0
12b	0	0	0	0	0	5	0	0	0	0	0	0
12c	40	1	0	0	30	0	0	10	0	0	0	2
12d	0	0	0	0	0	0	0	30	0	0	0	0
12e	30	0	0	0	0	0	0	30	0	0	0	0
12f	5	30	0	0	70	0	0	5	0	0	0	0
12g	5	0	0	0	0	0	0	70	0	10	0	0
12h	10	0	0	0	0	0	0	0	0	0	0	0
12i	0	0	0	0	0	5	0	0	0	0	0	1
19a	40	0	0	0	0	0	0	0	0	20	0	50
19b	45	0	0	1	0	0	0	0	0	10	0	40
19c	40	0	0	10	0	0	0	0	0	5	0	50
19d	10	0	0	0	0	0	0	0	0	0	0	20
19e	35	0	0	0	0	0	0	1	0	10	0	40
19f	45	0	0	0	0	0	0	0	0	0	0	20
19g	70	0	0	0	0	0	0	0	0	1	0	5
19h	80	0	0	0	0	0	0	0	0	0	0	0
19i	25	0	0	0	0	0	0	40	0	20	0	20

Appendix 7

Eco site	Bet pap	Pic mar	Pin str	Thu occ	Led gro	Pru pum	Tax can	Vac myr	Asa can	Fra ves	Osm lon	Rub pub
29a	50	0	0	5	0	0	70	0	0	2	0	0
29b	65	0	0	0	0	0	50	0	0	20	0	5
29c	90	0	0	0	0	0	70	0	0	10	0	0
29d	50	0	0	0	0	0	0	2	0	0	0	10
29e	0	0	0	0	0	0	0	0	0	10	0	5
29f	15	0	0	0	0	0	0	0	0	5	0	5
29g	35	0	0	0	0	0	0	0	0	5	0	10
29h	60	0	0	0	0	0	0	0	0	5	5	50
29i	40	0	0	0	0	0	0	0	2	0	2	30

Appendix 8

The 7 environmental variables at each site of ecosite types 11, 12, 19, and 29.

Ecosite/ Site	**Soil Type**	**Moisture Regime**	**Slope**	**Fire**	**Human activity**	**Bare grnd (%)**	**Tree Canopy (%)**
11a	Extremely shallow soil on bedrock	Dry	Level	Yes	No	1	50
11b	Very shallow soil on bedrock	Dry	Crest	No	No	1	10
11c	Very shallow soil on bedrock	Dry	Lower	No	No	10	40
11d	Shallow-mod deep, silty-fine loamy clayey	Fresh	Level	No	No	5	60
11e	Shallow-mod deep, silty-fine loamy clayey	Fresh	Level	No	No	5	20
11f	Very shallow soil on bedrock	Dry	Upper	No	No	2	50
11g	Very shallow soil on bedrock	Dry	Level	Yes	No	70	90
11h	Very shallow soil on bedrock	Dry	Upper	No	Yes	5	30
11i	Very shallow soil on bedrock	Dry	Level	No	No	1	40
12a	Shallow-mod deep, sandy	Fresh	Lower	Yes	Yes	1	80
12b	Very shallow soil on bedrock	Dry	Crest	No	No	10	30
12c	Shallow-mod deep, sandy	Fresh	Level	No	No	1	50
12d	Very shallow soil on bedrock	Dry	Crest	No	No	30	50
12e	Very shallow soil on bedrock	Dry	Mid	No	No	2	50
12f	Deep, organic (*Sphagnum* moss)	Wet	Lower	No	No	1	30
12g	Very shallow soil on bedrock	Dry	Crest	No	No	1	30
12h	Extremely shallow soil on bedrock	Dry	Mid	No	No	10	20
12i	Shallow-mod deep, Coarse loamy	Fresh	Mid	No	No	5	0

Appendix 8

Ecosite/ Site	Soil Type	Moisture Regime	Slope	Fire	Human activity	Bare grnd (%)	Tree Canopy (%)
19a	Deep, fine loamy-clayey	Fresh	Level	Yes	No	2	40
19b	Deep, fine loamy-clayey	Fresh	Level	Yes	No	5	40
19c	Deep, fine loamy-clayey	Moist	Level	No	No	1	50
19d	Deep, fine loamy-clayey	Moist	Level	No	No	1	90
19e	Deep, clayey	Fresh	Level	No	No	2	40
19f	Deep, clayey	Fresh	Level	No	No	1	50
19g	Deep, fine loamy-clayey	Moist	Lower	Yes	No	95	70
19h	Shallow-mod deep, sandy	Dry	Lower	Yes	No	95	90
19i	Very shallow soil on bedrock	Dry	Mid	No	No	1	30
29a	Deep, fine loamy-clayey	Fresh	Level	Yes	Yes	10	70
29b	Deep, fine loamy-clayey	Fresh	Level	Yes	No	2	70
29c	Deep, fine loamy-clayey	Fresh	Level	No	No	2	90
29d	Shallow-mod deep, Coarse loamy	Fresh	Level	No	No	1	60
29e	Shallow-mod deep, Coarse loamy	Fresh	Level	Yes	No	1	20
29f	Deep, coarse loamy	Moist	Lower	No	No	1	20
29g	Shallow-mod deep, Coarse loamy	Fresh	Level	No	No	10	90
29h	Shallow-mod deep, Coarse loamy	Fresh	Level	No	No	1	80
29i	Shallow-mod deep, Coarse loamy	Fresh	Level	No	No	5	60

Appendix 9

Number and average diameter at breast height (DBH) of birch trees and snags at each site and the mean number and mean DBH for ecosite types 11, 12, 19, and 29.

Ecosite /Site	Birch Trees		Birch Snags	
	Number	Mean DBH	Number	Mean DBH
11a	5	9.2	0	-
11b	24	6.7	1	6.6
11c	18	12.8	0	-
11d	5	9.9	0	-
11e	0	-	0	-
11f	2	16.9	0	-
11g	13	11.6	4	10.2
11h	0	-	0	-
11i	4	9.5	0	-
Mean	**7.9**	**10.9**	**0.6**	**8.4**
12a	35	10.9	4	8.9
12b	5	5.1	0	-
12c	40	8.9	0	-
12d	5	6.6	0	-
12e	19	10.3	1	5.9
12f	16	6.6	2	6.1
12g	4	7.1	0	-
12h	7	7.9	0	-
12i	9	6.7	0	-
Mean	**15.6**	**7.8**	**0.8**	**7**
19a	26	18.9	3	15.8
19b	16	14.9	2	17.2
19c	21	17.3	2	18.0
19d	8	15.5	2	14.3
19e	17	15.1	7	19.7
19f	14	15.6	1	22.3
19g	62	10.1	4	17.8
19h	56	11.3	1	5.0
19i	7	7.8	0	-
Mean	**25.2**	**14.1**	**2.4**	**16.3**

Appendix 9

Ecosite/Site	**Birch Trees**		**Birch Snags**	
	Number	**Mean DBH**	**Number**	**Mean DBH**
29a	21	15.6	6	20.4
29b	27	17.7	7	16.3
29c	36	15.1	4	17.0
29d	20	11.1	6	20.7
29e	2	5.7	0	-
29f	5	18.2	6	23.9
29g	14	17.3	1	11.8
29h	9	18.7	3	27.1
29i	11	10.5	6	25.9
Mean	**16.1**	**14.4**	**4.3**	**20.4**

Appendix 10

Mean bark thickness in millimeters, mean lenticel length in centimeters, and number of lenticels per birch bark sample from each site and means per ecosite types 11, 12, 19, and 29. Also tree age, DBH in centimeters, and tree height of bark sample tree.

Ecosite/ Site	Thickness (mm)	Lenticel length (cm)	Number of lenticels	Age	DBH (cm)	Height (m)
11a	2.09	1.75	67	86	28	19
11b	1.06	1.09	162	45	13	10
11c	1.24	0.98	130	58	20	14
11d	2.19	1.46	74	78	21	20
11e	2.63	1.85	52	82	25	16
11f	2.10	1.69	85	75	21	13
11g	2.56	0.89	156	65	18	16
11i	2.41	0.69	162	32	10	10
Mean	**2.03**	**1.30**	**111**			
12a	3.88	2.67	31	89	19	17
12c	2.25	2.56	49	85	18	16
12d	1.10	0.64	69	46	11	10
12e	1.53	1.25	66	56	15	15
12f	2.15	1.61	58	40	8	16
12g	1.83	1.08	106	55	13	15
12h	1.39	0.74	168	39	8	10
12i	1.69	2.40	68	62	16	10
Mean	**1.98**	**1.60**	**77**			
19a	2.50	1.21	58	71	23	18
19b	2.03	1.40	69	70	23	18
19c	1.73	1.00	124	92	27	23
19d	2.25	1.35	43	80	26	20
19e	3.45	1.71	50	78	25	18
19f	2.20	2.30	41	65	27	21
19g	0.93	0.91	98	42	16	14
19h	1.03	1.23	110	50	16	15
19i	1.05	2.00	60	45	12	14
Mean	**1.91**	**1.50**	**73**			
29a	2.00	1.87	50	76	25	18
29b	2.10	1.76	89	73	28	18
29c	2.53	2.06	56	75	26	17
29d	2.98	1.84	83	117	36	25
29f	2.63	2.58	34	85	32	22
29g	1.90	0.90	120	55	22	19
29h	2.71	1.18	111	85	32	20
29i	2.53	1.73	104	46	17	16
Mean	**2.42**	**1.70**	**81**			