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Paper Birch (Wiigwaas) of the Lake States, 1980-2010

With Special Emphasis on Bark Characteristics in the Territories Ceded in the Treaties of 1836, 1837, 1842, and 1854

Forest Service
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Abstract

Data on paper birch (Betula papyrifera L.; wiigwaas in the Ojibwe language), collected by the Forest Inventory and Analysis (FIA) program of the U.S. Forest Service on forested lands in the Great Lakes region (Michigan, Minnesota, and Wisconsin) from 1980 through 2010, are reported. Also presented are results and analysis of a supplemental inventory designed to identify the characteristics of paper birch bark that influenced Native American harvesters' evaluation of potential uses (e.g., baskets, canoes).

Paper birch has long been an important part of the daily life and culture of the Great Lakes Ojibwe (Anishinaabe) people. The Ojibwe and other Native American tribes of the Upper Midwest signed treaties in 1836, 1837, 1842, and 1854 ceding land ("ceded territories") in northern Michigan, Wisconsin, and Minnesota to the Federal government, but retaining certain rights in the region. To help implement these retained rights on national forests in the ceded territories, member tribes of the Great Lakes Indian Fish and Wildlife Commission and the U.S. Forest Service entered into a memorandum of understanding which, among other things, provides for tribes to regulate their members' harvest of nontimber forest products (including paper birch bark) on national forest lands.

The U.S. Forest Service, GLIFWC, and tribal harvesters created a supplement to the FIA inventory protocol to provide a detailed inventory of birch bark characteristics. These data were collected on FIA plots in 2004, 2005, and 2006 in conjunction with the standard forest inventory annual panels. Forest land in the ceded territories contains 65.9 percent of all paper birch trees ≥5 inches diameter at breast height (d.b.h.) and 66.2 percent of the large (≥11 inches d.b.h.) paper birch trees in the Great Lakes region. The number of birch trees has decreased by 49 percent and total bark supply has decreased by 45.5 percent on forest land in the ceded territories since 1980. The proportion of paper birch bark found in the larger diameter trees has increased. The decline in paper birch, both in number and as a proportion of all trees, across the ceded territories should not materially diminish near-term bark harvest in the region as a whole, but may do so in selected locations. But the long-term trend suggests a lack of regeneration and a continued decrease in the total number of trees across the region.

Cover Photo

Paper birch trees. Photo by Maria Janowiak, U.S. Forest Service and Northern Institute of Applied Climate Science.

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Paper Birch (Wiigwaas) of the Lake States, 1980-2010

With Special Emphasis on Bark Characteristics in the Territories Ceded in the Treaties of 1836, 1837, 1842, and 1854

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Paper birch stand in northern Minnesota. Photo by Joseph O'Brien, U.S. Forest Service.

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INTRODUCTION

Photo by David Lee, bugwood.org 5445764.

Paper birch (*Betula papyrifera* L.; wiigwaas in the Ojibwe language) is a deciduous tree of the Betulaceae family common in the sub-boreal forests of the northern United States and Canada. Crossing six time zones and ranging from northwest Alaska and northeast Labrador to the southern Appalachian Mountains of North Carolina and Tennessee, paper birch is one of the most geographically widespread species in North America. A distinctive component of forests around the Great Lakes, paper birch has long been an important part of the daily life and culture of the Great Lakes Ojibwe (Anishinaabe) people (Densmore 1928, Meeker et al. 1993). Wiigwaas is used in many ways, ranging from basketry to canoe making. Each of these uses requires bark with different characteristics.

Paper birch is among the dozens of tree species recorded in the periodic inventories conducted by the Forest Inventory and Analysis (FIA) program of the U.S. Department of Agriculture, Forest Service. This program conducts regular forest inventories and estimates several attributes of trees on U.S. forest land including area, volume, growth, removals, mortality, and other features based on a sample of one inventory plot per 6,000 acres at its base grid (McRoberts 1999, 2005; Woudenberg et al. 2010). The national FIA program is divided into four regional FIA programs. The Northern Research Station FIA program conducts forest inventory over the 24 states of the Great Plains, Upper Midwest, and northeastern United States.

The Ojibwe and other Native American tribes of the Upper Midwest signed treaties in 1836, 1837, 1842, and 1854 with the U.S. Government. In those treaties they ceded land in northern Michigan, Wisconsin, and Minnesota to the U.S. Government, but the tribes retained hunting, fishing, and gathering rights in the region (Great Lakes Indian Fish and Wildlife Commission [GLIFWC], n.d.). To help implement these retained rights on national forests in the ceded territories, member tribes of GLIFWC entered into a memorandum of understanding with the U.S. Forest Service. This agreement allows for regulating the harvest of nontimber forest products (including paper birch bark) following standardized protocols and provides mechanisms for tribes to participate in the drafting of National Forest management plans and of U.S. Forest Service research project proposals.

The Lake Superior Ojibwe have used paper birch bark to make everything from wild rice winnowing baskets to birch bark canoes that could carry more than 2 tons of cargo (Gikinoo'wizhiwe Onji Waaban, n.d.). The Ojibwe continue these traditions today. As pressure increased on the forest resources of the Upper Great Lakes in the late 20th century, the Ojibwe became concerned about the long-term viability of the paper birch bark resource. They sought assistance from the U.S. Forest Service.

Photo by John Zasada, U.S. Forest Service, retired.

This report is based on FIA data from four inventories of all forest land in the Great Lakes region (Michigan, Minnesota, and Wisconsin) that were conducted from1980 through 2010. Data examined in this report are a subset that includes plot measurements from only the area that was ceded in the Treaties of 1836, 1837, 1842, and 1854 (hereafter referred to as ceded territories). The data were collected from basic forest inventory plots on both public and private land.

In this report we present inventory estimates for 1980, 1990, 2005, and 2010. All of these estimates are based on field plot measurements taken over a period of several years. Information for the 1980 estimates is from measurements taken on 14,330 forest plots measured from 1975 through 1982. Information for the 1990 estimates is from measurements taken on 16,563 forest plots measured from 1986 through 1995. In 1999 FIA implemented an annual inventory system where plot locations are established and measured every fifth year with one-fifth of the plots being measured each year and inventory estimates for a specific year based on those plots measured in the 5-year period ending with that year, according to methods presented by Scott et al. (2005). Under this system, information for the 2010 estimates are from measurements taken on 10,114 forest plots measured from 2006 through 2010. Information for the 2005 estimates is from measurements taken on 12,196 forest plots measured from 2001 through 2005.

In addition to the regularly collected forest inventory data, GLIFWC and the U.S. Forest Service, together with tribal harvesters, developed a supplement to the inventory protocol (Danielsen and White 2003; Emery et al. 2014; U.S. Forest Service 2003, 2005). This supplemental protocol was developed in close consultation with Ojibwe gatherers, who identified the paper birch bark characteristics that influenced their evaluation of products that could be created. This protocol is in contrast to traditional wood-grading standards, which emphasize a hierarchy of wood quality, usually based on utilization potential and reflected by price paid. Instead, the paper birch bark grading protocol does not reject any bark features, but rather recognizes the potential for bark characteristics to shape the choice(s) of products that can be made (GLIFWC 2002). This supplementary protocol was implemented on all plots measured from 2004 through 2006. Using estimates of different birch bark features as a function of the overall paper birch resource uncovered during this study period, we extrapolated the 2004-2006 analysis to two 5-year inventory periods: 2001-2005 (hereafter referred to as the 2005 inventory) and 2006-2010 (hereafter referred to as the 2010 inventory). This report analyzes these data for trends and contrasting public and private land ownership of the resource, within the ceded territories' boundaries.

An example of birch bark biting, or mazinibaganjigan, an ancient folk art made by the Ojibwe and other Algonquian peoples. The design is created by biting down on small pieces of folded birch bark to form intricate patterns. Photo by John Zasada, U.S. Forest Service, retired.

WHERE IS PAPER BIRCH LOCATED?

The natural range of paper birch spans Canada and the northern United States (Harlow and Harrar 1969). Paper birch can be found on any soil and topography, ranging from rocky outcrops of the Canadian Shield to flat, poorly drained swamps. It grows best, as measured by volume over time, on deeper well-drained to moderately well-drained Spodosols, Inceptisols, and Entisols, which are common to the glacial deposits of the region (Safford et al. 1990). The 2010 FIA inventory found the ceded territories contain 29 percent of all paper birch trees in the United States. Paper birch is a large component of Lake States forests primarily in portions of north central and northeastern Minnesota, northwestern Wisconsin, and areas in Michigan's Upper Peninsula (Fig. 1, Table 1).

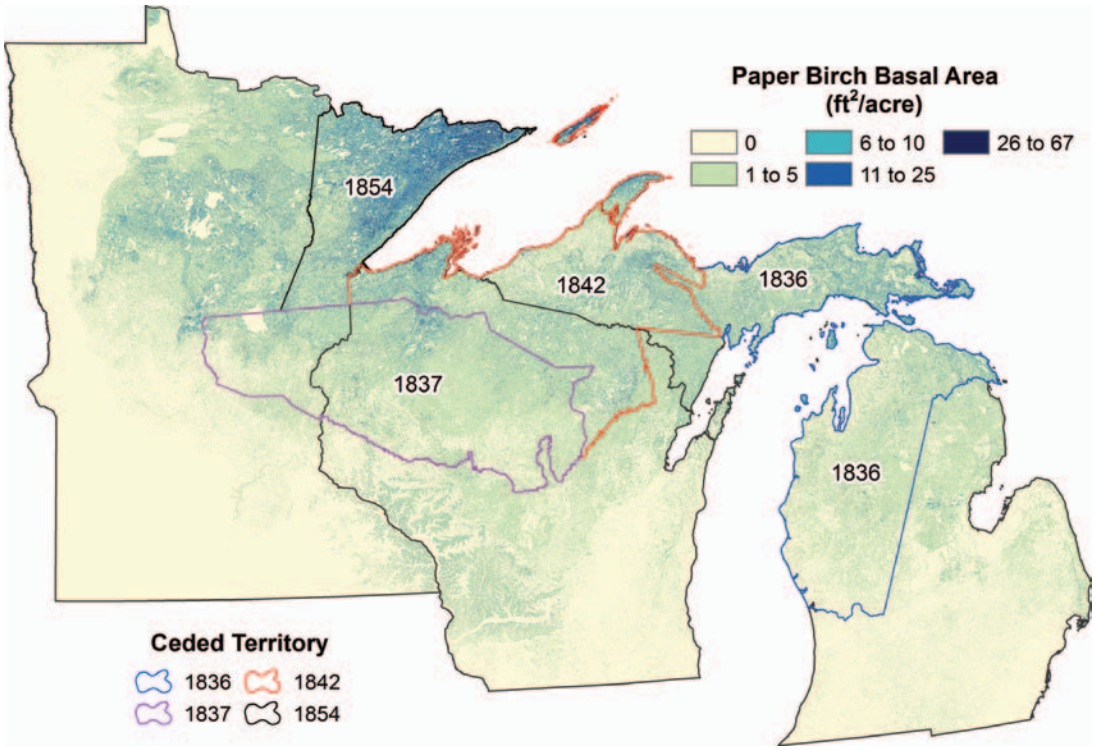


Figure 1.—Basal area of paper birch on forest land in the Lake States and within the boundaries of the ceded territories (Wilson et al. 2012, 2013).

The forest land of the ceded territories contains 65.9 percent of all paper birch trees ≥5 inches diameter at breast height (d.b.h.) and 66.2 percent of the large (≥11 inches d.b.h.) paper birch trees in the three Lake States (Table 2). For the remainder of this report, we limit analysis and discussion to timberland, the portion of forest land that is not reserved and meets the minimum productivity requirement of 20 cubic feet per acre per year at its peak. We are focusing on timberland because the early data from 1980 to 1990 included only timberland, limiting analysis of changes over time to this category. Second, most paper birch on nontimberland forest (reserved and unproductive) is not available for harvest for legal, practical, or logistical reasons, so our analysis is limited to the resource that can be harvested. In the ceded territories, timberland makes up 93 percent (28.4 million acres) of the total forest land area (30.6 million acres) in the 2010 inventory. The other 2.2 million acres of forest comprise 1.7 million acres of reserved public lands such as the Boundary Waters Canoe Area Wilderness (0.7 million acres) in Minnesota, Isle Royale National Park (0.1 million acres) in Michigan, and many other parks, wilderness areas, and other public lands where timber harvesting is excluded; plus an additional 0.5 million acres of forest land with low productivity in both public and private ownership.

Paper birch can be found in association with other species (Table 3). In the ceded territories balsam fir, red maple, and quaking aspen were the most frequently observed species on inventory plots where live paper birch was found.

Table 1.—Paper birch as a percentage of all live trees, 5 inches diameter and larger on forest land by county groups in the Lake States region, by ceded territory, 2010 inventory

Michigan – Lower Peninsula (LP)	percent
Alpena-Montmorency	3.1
Antrim	0.8
Benzie	0.8
Charlevoix	2.8
Cheboygan	3.9
Clare-Isabella	0.8
Crawford-Oscoda-Roscommon	1.3
Emmet	2
Grand Traverse	0.7
Ionia-Kent-Montcalm-Ottawa	1.2
Kalkaska	0.7
Lake	0.3
Leelanau	2.6
Manistee	1.1
Mason	0.3
Mecosta	1.6
Missaukee	1.1
Muskegon	0.3
Newaygo	0.7
Oceana	0.3
Osceola	3.1
Otsego	0.6
Presque Isle	4.7
Wexford	0.4

Michigan – Upper Peninsula (UP)	percent
Alger	1.3
Baraga	1.8
Chippewa	5
Delta-Dickinson-Menominee	2.8
Gogebic	0.9
Houghton	2.3
Iron	3
Keweenaw	13.7
Luce	3.8
Mackinac	5.2
Marquette	4.3
Ontonagon	1.5
Schoolcraft	2.9

Minnesota	percent
Aitkin-Carlton	7.3
Anoka-Isanti-Sherburne-Washington	2.5
Benton-Crow Wing-Morrison	4.8
Chisago	4.1
Cook	22.2
Kanabec	4
Lake	13.3
Mille Lacs	3.8
Pine	8
St. Louis	9.2

Wisconsin	percent
Ashland	4.3
Barron	6.9
Bayfield	6.6
Burnett	2.7
Chippewa	3.8
Clark-Eau Claire	4
Douglas	4.9
Dunn-Polk-St. Croix	6.1
Florence-Oconto-Marinette	4.4
Forest	2.6
Iron	2.7
Langlade-Menominee-Shawano	2.1
Lincoln	3.4
Marathon-Portage-Wood	1.5
Oneida	5.2
Price	3.2
Rusk	3.7
Sawyer	3.6
Taylor	2.7
Vilas	6
Washburn	3.5

Table 2.—Number (in millions) of paper birch and other species of live trees 5 inches diameter and larger on forest land in the Lake States region, by ceded territory and tree size class, 2010 inventory

	Number of trees					
	<5 inches diameter		5 to 10.9 inches diameter		≥11 inches diameter	
Treaty Area	All species	Paper birch	All species	Paper birch	All species	Paper birch
1836 LP	1,009.6	15.6	798.9	13.5	210.7	2.1
1836 UP	702.2	26.9	578.9	23.7	123.3	3.2
1837	1,035.4	40.7	835.8	36.5	199.5	4.2
1842	1,517.4	57.2	1,216.7	49.2	300.7	7.9
1854	667.2	82.8	574.5	72.5	92.7	10.4
Ceded Territories Total	4,931.8	223.2	4,004.8	195.4	926.9	27.8

Table 3.—Forest tree species associated with paper birch throughout the ceded territories by treaty area. The percentage values represent that portion of the 2010 inventory plots where paper birch was present.

		Treaty area					All ceded territories
Associated species	Scientific name	1836 LP	1836 UP	1837	1842	1854	
Balsam fir	*Abies balsamea*	47.7	78.4	30.9	65.1	71.3	58.6
Red maple	*Acer rubrum*	60.9	60.7	64.5	66.3	32.4	55.2
Quaking aspen	*Populus tremuloides*	41.6	34.8	59.3	49.7	59.7	52.3
Sugar maple	*Acer saccharum*	22.1	18.7	26.7	38.7	12.2	24.4
White spruce	*Picea glauca*	13.5	37.9	8.5	31.5	27.4	24.0
Black spruce	*Picea mariana*	13.2	37.9	8.0	22.3	34.9	23.5
Northern white-cedar	*Thuja occidentalis*	44.8	53.3	4.6	24.9	14.8	22.4
Black ash	*Fraxinus nigra*	25.3	19.0	18.0	13.4	17.2	17.3
Eastern white pine	*Pinus strobus*	18.1	21.8	12.9	18.2	10.3	15.2
Northern red oak	*Quercus rubra*	17.1	4.3	27.0	19.3	3.6	14.7
Bigtooth aspen	*Populus grandidentata*	19.9	11.4	17.6	16.9	5.5	13.4
Yellow birch	*Betula alleghaniensis*	8.9	14.2	12.1	23.2	5.7	13.2
Black cherry	*Prunus serotina*	8.9	6.6	17.3	10.9	0.9	9.0
American basswood	*Tilia americana*	6.8	3.3	18.5	8.5	3.4	8.8
Red pine	*Pinus resinosa*	7.5	9.0	7.2	11.4	7.7	8.7
Eastern hophornbeam	*Ostrya virginiana*	10.3	3.6	16.5	9.4	1.8	8.4
Balsam poplar	*Populus balsamifera*	14.9	19.2	0.5	5.7	8.9	7.8
Tamarack	*Larix laricina*	8.9	8.8	8.3	7.7	5.4	7.5
Eastern hemlock	*Populus deltoides*	13.9	14.9	4.5	11.3	0.0	7.2
American elm	*Ulmus americana*	13.5	3.6	16.3	3.7	1.1	6.9
Mountain maple	*Acer spicatum*	1.1	3.8	1.0	2.8	19.0	6.8
Green ash	*Fraxinus pennsylvanica*	14.9	3.6	13.4	2.9	2.0	6.3
Jack pine	*Pinus banksiana*	2.1	6.6	3.2	3.1	13.0	6.3
White ash	*Fraxinus americana*	14.9	1.9	9.9	4.4	0.0	5.1
Serviceberry	*Amelanchier* spp.	6.0	2.8	2.7	5.3	2.5	3.6
Bur oak	*Quercus macrocarpa*	0.4	0.5	12.3	0.1	1.3	3.5
Northern pin oak	*Quercus ellipsoidalis*	4.3	0.2	7.8	4.3	0.2	3.5
Pin cherry	*Prunus pensylvanica*	1.1	1.2	2.3	2.2	4.4	2.6
Chokecherry	*Prunus virginiana*	1.1	1.4	2.8	2.2	3.7	2.6
White oak	*Quercus alba*	6.0	0.0	8.0	0.1	0.0	2.5

Forest Types that Contain Paper Birch

There are many forest types in the Lake States region, but only four contain the bulk of the paper birch resource: northern upland hardwoods, lowland softwoods, aspen, and paper birch. These four forest types contain 90 percent of the paper birch trees ≥5 inches d.b.h. The proportion of paper birch trees in the larger diameter classes (≥11 inches d.b.h.) has increased slightly over time (Fig. 2). The northern hardwoods forest type had a greater proportion of the large-diameter paper birch trees than did the aspen and paper birch forest types. It should be remembered that considerable numbers of other species, not just paper birch, are present in these other forest types.

The presence of a higher proportion of large-diameter paper birch trees in northern hardwoods forest type suggests that these forests are still highly suitable sources for large diameter birch trees. Absent significant bark damage or other factors that limit production of usable bark, these results suggest that the rate of decline in large pieces of suitable bark (from the larger trees) might not be as great as the rate of decline in the overall bark supply. However, it may mean that in order to maintain the supply of large diameter birch in northern hardwoods, silvicultural practices will have to change to keep birch as a component of hardwood forests. The decline in smaller trees suggests that in the future, larger trees may be in shorter supply, unless the transition rate improves (that is the rate of change from small diameter to large diameter).

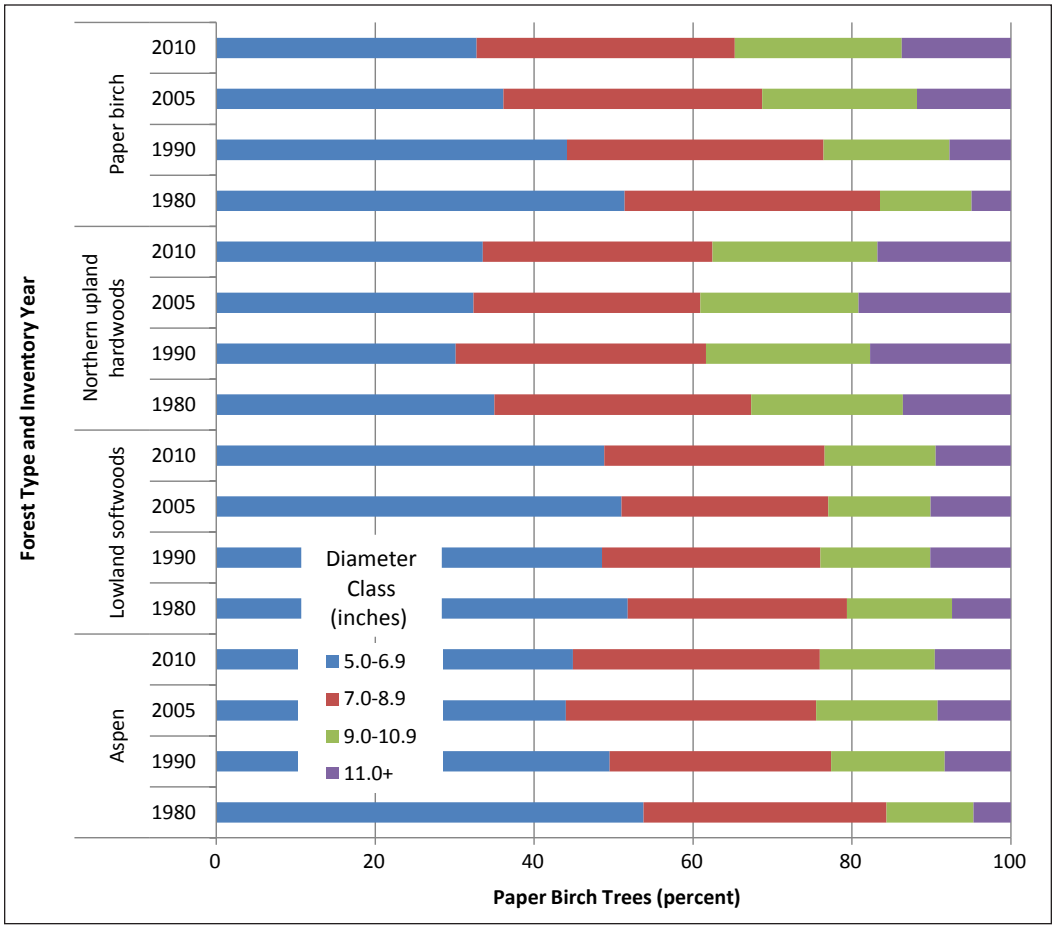


Figure 2.—Percentage of paper birch trees ≥5 inches d.b.h. on timberland in four major forest types in the ceded territories, by FIA inventory year.

HOW MANY PAPER BIRCH TREES ARE THERE?

To better understand the birch bark resource, it is valuable to look at trends in the number of paper birch trees in the ceded territories.

The number of birch trees on timberland in the ceded territories has decreased since 1980, going from 611 million trees ≥5 inches to 298 million, a 49-percent decrease. The most dramatic reduction was in paper birch and aspen forest types with a 55-percent decrease in trees ≥5 inches d.b.h. (246 million trees in 1980 to 110 million trees in 2010). The two smallest diameter classes in the paper birch forest type, ranging from 5 to 8.9 inches, were estimated to have decreased by 77 million trees (63.7 percent) between 1980 and 2010 (Fig. 3). In the aspen forest type alone, the number of paper birch trees in the smallest diameter classes decreased by 53 million trees (61.9 percent) during the same period. Much of the decline in this forest type occurred before 2005, after which the number of trees appears to stabilize somewhat. In contrast, the estimated number of paper birch trees in the paper birch forest type declined steadily over the 30-year period.

Disturbances that free up growing space create opportunities for the establishment of shade-intolerant, early-successional species such as paper birch. As these disturbances, such as fire management or clearcut harvesting, have declined over time, the number of new paper birch

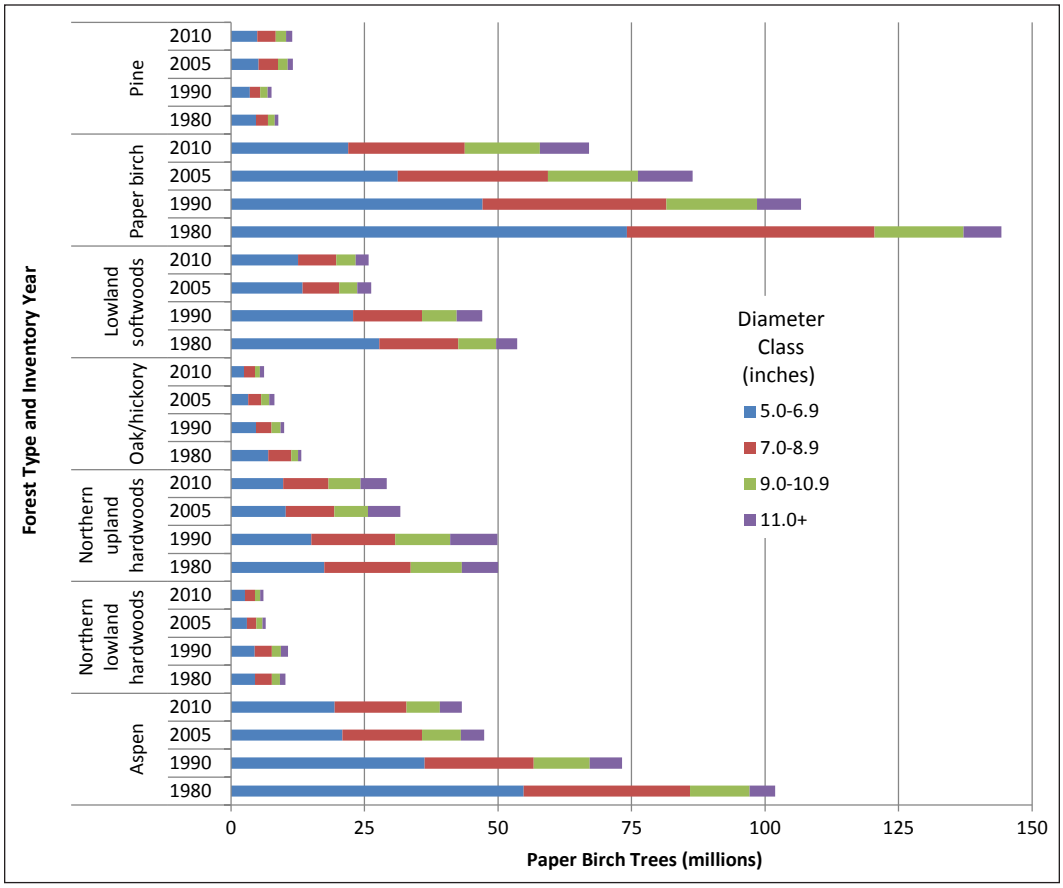


Figure 3.—Number of paper birch trees ≥5 inches d.b.h. on timberland in the ceded territories, from FIA inventories of 1980, 1990, 2005, and 2010, by forest type and diameter class.

trees has also declined. Without these disturbances, natural succession processes will result in more shade-tolerant species, such as sugar maple and American beech (*Fagus grandifolia*), occupying and eventually dominating the site.

TRENDS IN PAPER BIRCH COMPARED TO OTHER SPECIES

To better understand changes that are happening to paper birch, it is valuable to compare paper birch trends with changes in other species. Only 4 of the 10 most abundant tree species in the ceded territories—quaking aspen, paper birch, yellow birch, and balsam fir—decreased in number across all size classes from the 1980 to the 2010 inventory.

The other six most abundant tree species – bigtooth aspen, American basswood, sugar maple, northern white-cedar, red maple, and red pine—showed increases in the number of large diameter trees (Fig. 4). Bigtooth aspen increased by 15 percent. The other five species had 60- to 280-percent increases in the number of large diameter trees; these five species have much longer life spans than the others.

Among trees 5 to 10.9 inches d.b.h., the number of paper birch decreased by more than 50 percent, to 168 million trees in 2010 (Fig. 5). Fellow early-successional species quaking aspen also declined by about 120 million trees; it was formerly the top species in terms of number of individuals. Sugar maple numbers were steady at slightly less than 500 million trees, whereas red maple increased by almost 125 percent. Red pine and northern white-cedar numbers also increased.

The significant decrease in the number of trees of 5 to 10.9 inches d.b.h. in the early-successional species, including paper birch, likely resulted from a decline in the types of disturbances that occurred in the decades before 1980, as well as competition-induced mortality and timber harvesting. Sometimes a decline in one size class is reflected by an increase in the next size class as the trees grow larger. In this case, however, we did not see a comparable

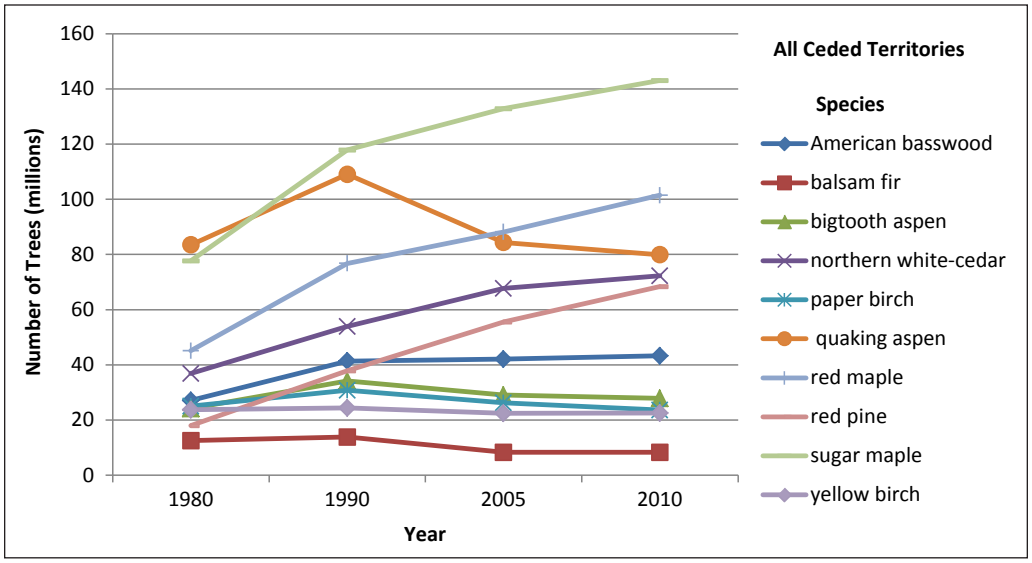


Figure 4.—Number of live trees on timberland ≥11 inches d.b.h. within the boundaries of the ceded territories for all ownerships for paper birch and other prominent species. For a breakdown of the number of trees by ceded territory, please see Appendix II.

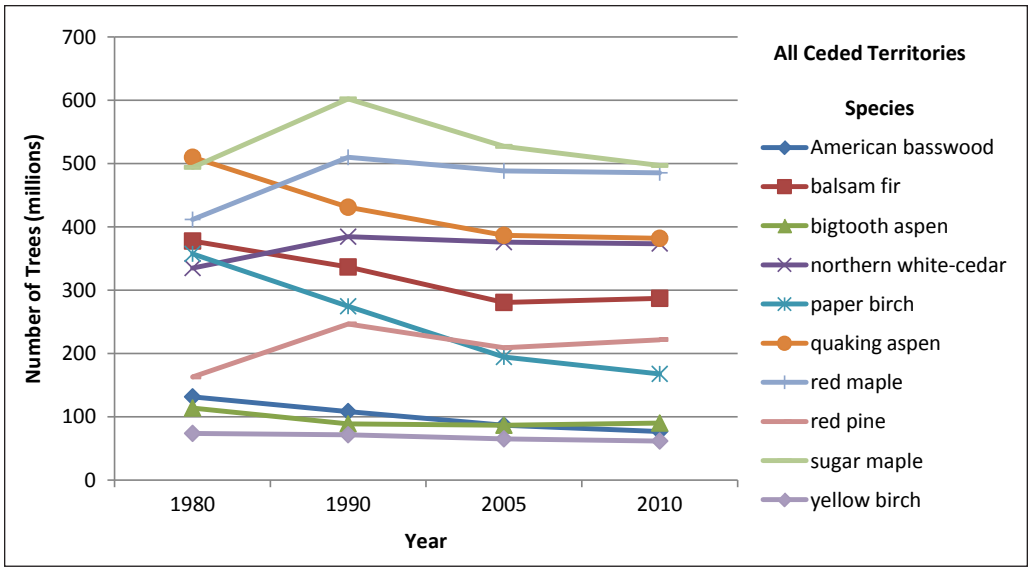


Figure 5.—Number of live trees on timberland 5-10.9 inches d.b.h. within the boundaries of the ceded territories for all ownerships for paper birch and other prominent species. For a breakdown of the number of trees by ceded territory, please see Appendix II.

increase in the ≥11-inch category for paper birch, suggesting that mortality or harvest accounted for the decrease in the number of midsize trees.

Among trees ≥11 inches d.b.h., we observed a dramatic increase in the number of trees of shade-tolerant species such as sugar maple (84.2 percent), red maple (124.9 percent), and northern white-cedar (95.9 percent). Paper birch and its frequently co-occurring species, quaking aspen, both declined in number in this diameter class (-5.6 and -4.3 percent, respectively) (Fig. 4). The greater number of sugar and red maple trees suggests that a combination of lack of harvest and successional processes is favoring *Acer* species. The only species that does not follow this trend is red pine, whose population increase likely reflects the coming of age of natural and planted stands from 40 to 60 years ago. This species also increased in number for the smaller diameter classes, but at a slower rate.

Over the entire ceded territories, paper birch is decreasing both in number and as a proportion of all trees. In the near term, this pattern should not materially diminish harvest on the regional level but will for selected locations. The long-term trend suggests a lack of regeneration and a continued decline in the total number of trees across the region.

PAPER BIRCH BARK SUPPLY

For purposes of the report, the bark supply is measured in square feet. This number represents the sum of the surface area of the trunks of all live paper birch trees on timberland from 1 foot to 9 feet above ground line. These estimates are based on tree d.b.h., stump diameter[1] prediction models (Raile 1982), and observed taper rates for paper birch trees across the Lakes States (Hahn 1984). Availability of this supply for harvesting is conditioned by ownership and location of the resource. Under the terms of a memorandum of understanding between

[1] Standard stump height is 1 foot above ground.

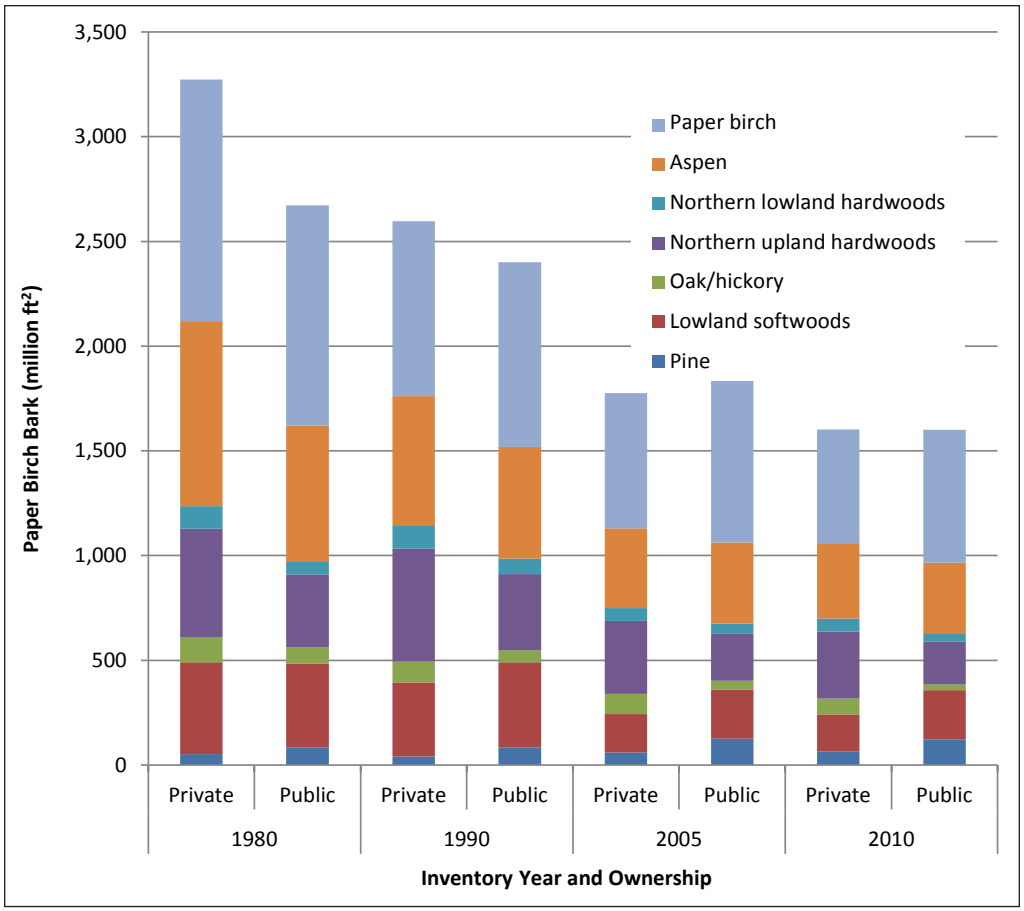


Figure 6.—Paper birch bark supply on timberland in the ceded territories by inventory year, ownership type, and forest type.

the Great Lakes Indian Fish and Wildlife Commission and U.S. Forest Service, harvest on national forest lands is governed by tribal rules and permits. On private lands, harvesters must obtain permission from the owner of the particular site where the harvesting is to occur. The geographic distribution of the resource is also of great importance to harvesters, for whom traveling a great distance to gather bark may not be possible. As both ownership and location are important to harvesters, we include breakdowns of the bark supply by ownership (public or private) and treaty area.

In 1980, the estimated paper birch bark supply for timberland on all ownerships was 6 billion square feet; the largest supply (2.2 billion square feet) was in the paper birch forest type (Fig. 6). The proportion of paper birch bark supply in lowland softwoods, aspen, and northern upland hardwoods forest types declined from 15.0, 24.4, and 13.0 percent, respectively, on public land in 1980 to 14.5, 21.3 and 12.7 percent in 2010 (Fig. 6).

Total bark supply has decreased substantially on timberland across the region over the past 30 years, ranging from a decline of 30.4 percent in the Upper Peninsula[2] portion of the 1836 treaty area, to a decline of 53.5 percent in the 1842 treaty area (Fig. 7). In the treaty areas of

[2] The Territory ceded in 1836 is divided between the upper and lower peninsulas of Michigan.

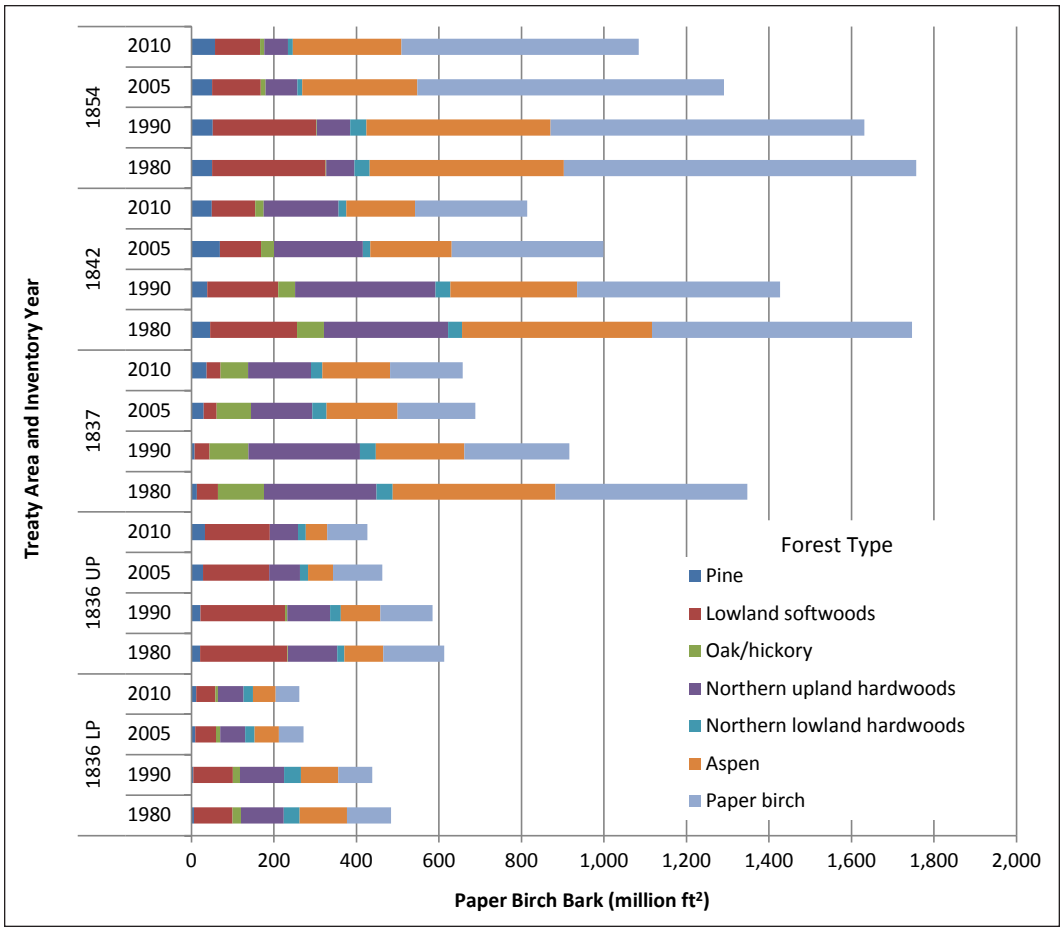


Figure 7.—Paper birch bark supply in each treaty area by inventory year and forest type for all ownerships.

1837, 1842, and 1854, more birch bark occurred in the paper birch and aspen forest types than in other forest types. In the Upper Peninsula portion of the 1836 treaty area, larger portions were found in the other forest types, with lowland softwoods (primarily spruce [*Picea* spp.], balsam fir, and northern white-cedar stands) containing 37 percent of the supply of birch bark (Fig. 7). In other treaty areas only 10 percent was in lowland softwoods forest type, and 38 percent was in the paper birch type.

The decline in the paper birch bark quantities reflects the decreasing number of paper birch trees throughout the region. The lack of disturbance that would create regeneration and growth opportunities for paper birch, combined with transition to late-successional species, has led to a large decline in the amount of birch bark in these areas.

The principal sources of birch bark are timberlands on Federal, State, and county-owned lands (Fig. 8). Although the total estimated quantity of paper birch bark has declined since 1980, the proportion of paper birch bark that is found in the larger diameter trees has increased. In 1980, a greater proportion of the bark of trees <9 inches d.b.h. was on private lands, perhaps reflecting a history of more intensive use of forests. By 2010, however, the proportions in each diameter class were similar, regardless of ownership.

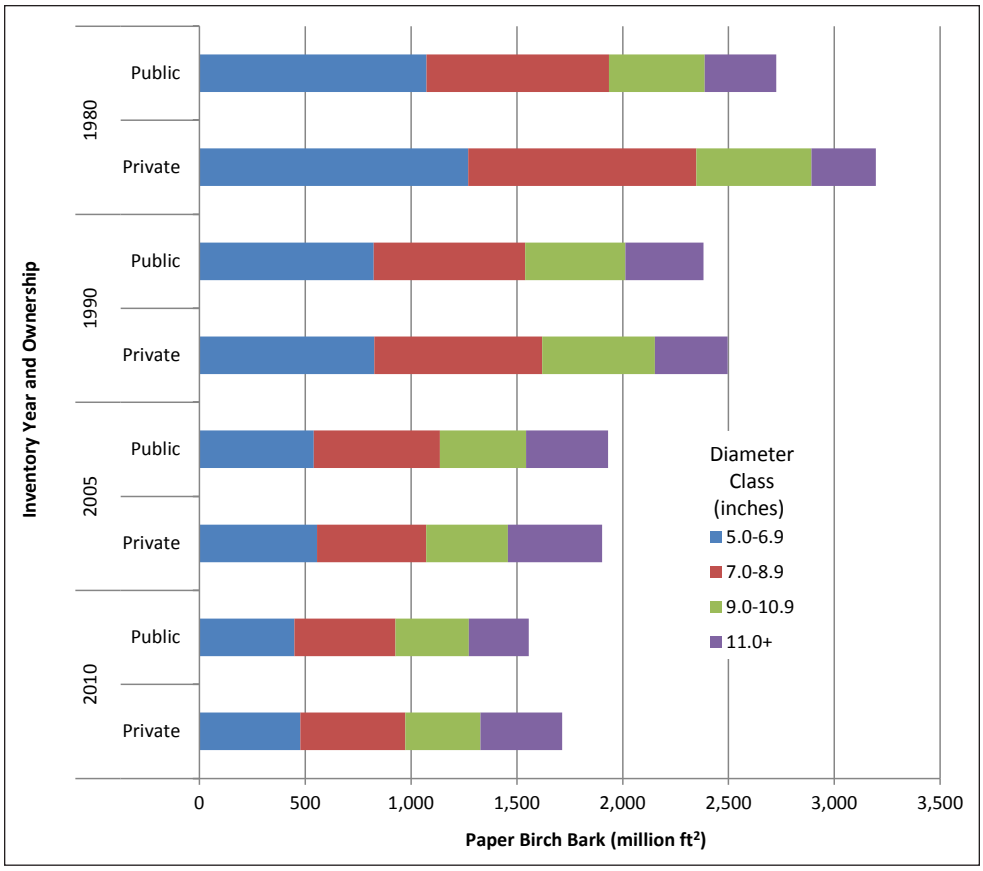


Figure 8.—Paper birch bark supply on timberland on the ceded territories by ownership, and diameter class, and FIA inventory year.

For gatherers who require larger pieces of bark, the slower decline in the number of larger trees compared to the bark resource overall suggests that current gathering opportunities are similar to those in the past. However, to ensure the future supply, active management of paper birch stand density may be needed to ensure adequate growth of this short-lived tree.

PAPER BIRCH BARK CHARACTERISTICS

The detailed inventory of birch bark characteristics was conducted by the FIA program in 2004, 2005, and 2006 in conjunction with the standard forest inventory annual surveys. On all FIA plots measured in those years across the entire three-state area (Michigan, Wisconsin, and Minnesota), additional bark characteristic information was collected on every live paper birch tree. Based on recommendations from Ojibwe bark gatherers and GLIFWC, FIA developed a grading protocol for nine bark characteristics for both the upper and lower bole (trunk) (Emery et al. 2014). Data on bark characteristics were collected from 12,397 live paper birch trees during the 3-year period with 8,268 of these trees (67 percent) measured on plots within the ceded territories.

There was relatively low correlation between different birch bark characteristics in the lower (Table 4) or upper (Table 5) bole. However, most bark feature types in the lower bole had a high correlation with those same types in the upper bole (Table 6). These results suggest that surveys of lower bole bark characteristics alone can be used as indicators of the same characteristics over the entire bole. However, the presence of one bark characteristic is not a good predictor of the presence of other types of bark features on the same tree. Thus, each bark feature must be measured independently.

Table 4.—Correlation of lower bole (trunk) bark characteristics

	Texture	Exfoliation	Coarse lichen and moss	Branching	Coarse lenticels	Coarse branch scars	Coarse blemishes	Coarse fungus	Straightness
Texture	1.000								
Exfoliation	0.369	1.000							
Coarse lichen and moss	0.115	0.119	1.000						
Branching	-0.116	-0.170	-0.015	1.000					
Coarse lenticels	0.382	0.107	0.284	-0.097	1.000				
Coarse branch scars	-0.010	-0.132	0.088	0.110	0.221	1.000			
Coarse blemishes	0.120	0.081	0.052	-0.066	0.173	0.041	1.000		
Coarse fungus	0.042	0.016	-0.044	0.102	0.047	-0.024	0.246	1.000	
Straightness	0.046	-0.003	0.041	0.067	0.021	0.106	0.070	0.120	1.000

Table 5.—Correlation of upper bole (trunk) bark characteristics

	Texture	Exfoliation	Coarse lichen and moss	Branching	Coarse lenticels	Coarse branch scars	Coarse blemishes	Coarse fungus	Straightness
Texture	1.000								
Exfoliation	0.398	1.000							
Coarse lichen and moss	0.199	0.187	1.000						
Branching	-0.048	-0.125	0.023	1.000					
Coarse lenticels	0.343	0.107	0.289	-0.023	1.000				
Coarse branch scars	0.071	-0.082	0.107	0.247	0.288	1.000			
Coarse blemishes	0.090	0.068	0.034	-0.122	0.207	0.075	1.000		
Coarse fungus	0.044	0.044	-0.022	0.075	0.019	0.027	0.218	1.000	
Straightness	0.148	0.029	0.039	0.152	0.097	0.229	0.029	0.089	1.000

Table 6.—Correlation of lower vs. upper bole (trunk) bark characteristics

	Lower bole characteristics								
Upper bole characteristics	Texture	Exfoliation	Coarse lichen and moss	Branching	Coarse lenticels	Coarse branch scars	Coarse blemishes	Coarse fungus	Straightness
Texture	0.909								
Exfoliation		0.895							
Coarse lichen and moss			0.946						
Branching				0.777					
Coarse lenticels					0.964				
Coarse branch scars						0.956			
Coarse blemishes							0.901		
Coarse fungus								0.869	
Straightness									0.574

Analysis of Paper Birch Bark Characteristics

Bark characteristic data were examined for trends by size, by forest type, and for relationships between bark characteristics (e.g., between moss and branchiness) on all paper birch sampled from 2004 to 2006 in the three states of the Great Lakes region, not just within the ceded territories. This somewhat larger data set allowed us to better determine what, if any, relationships existed. As a result of the relatively high correlations between upper and lower bole bark characteristics, we analyzed only selected lower-bole characteristics on trees.

Bark characteristic data can be summarized into two broad types: (1) presence or absence of a character, and (2) degree or ranking of a character. An example of the former would be the presence (1) or absence (0) of lichen or moss on the tree trunk. An example of the second type would be a ranking of exfoliation, ranging from least (1) to most (4). A summary of the 2004-2006 bark characteristic inventory data (Fig. 9) suggests that lichen or moss, lenticels, and branch scars were the most prominent bark characteristics.

Our analyses explored relationships of these characteristics to paper birch diameter, age, and importance value. Importance value is a measure of the relative dominance of species in a forest community.

The importance value of paper birch is calculated as the sum of the percentage of total basal area in paper birch, the percentage of the total trees per acre that were paper birch, and the ratio of paper birch stand density index (SDI) to total stand SDI.

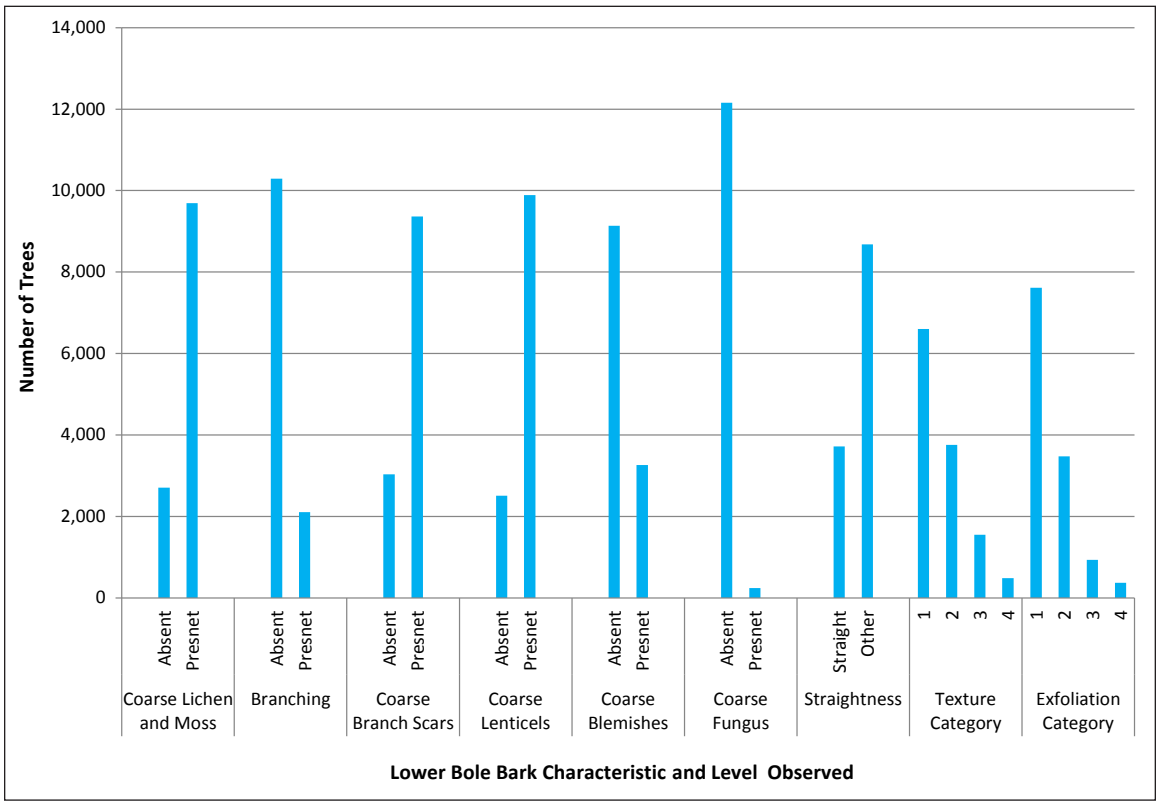


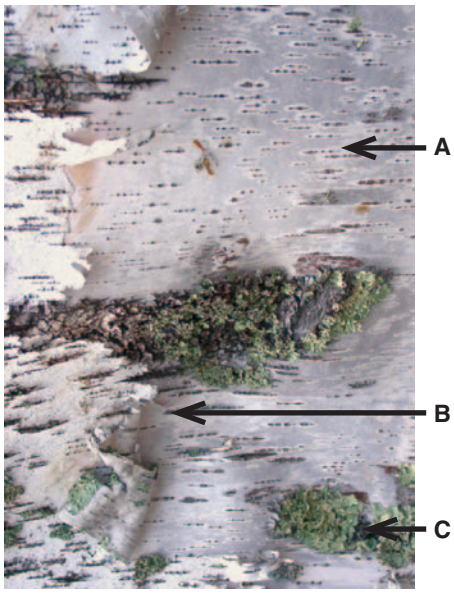
Figure 9.—Number of paper birch trees sampled in 2004-2006 by various lower bole bark characteristics. Categories 1 through 4 range from “less” to “more”; see text for explanation of categories.

For example, the minimum importance value observed was 0.012. This was for a stand with an observed total basal area of 133.0 square feet per acre, of which 16.6 square feet per acre were birch. This stand also had an average of 580.7 trees per acre, of which an average of 32.1 trees per acre were paper birch. The SDI was 231.3 for all species and 30.6 for birch. Thus, the calculation was 16.6/133.0 + 32.1/580.7 + 30.6/231.3 = 0.012. The maximum value observed was 3.0. This value is for any stand of pure birch.

Bark Texture

Bark Texture vs. Size

Trees with smooth-textured bark (texture level = 1) were a much higher proportion of the total trees in the two smaller diameter classes than in the larger diameter classes (Fig. 10). As the trees grow, the bark texture becomes a rougher, more uneven surface. We found an uneven distribution of trees with coarse texture in the smaller size classes. However, as the trees' sizes increase, the distribution of texture classes evens out. Gatherers who desire to create products requiring a smoother surface may wish to consider harvesting smaller trees.



Paper birch bark. Note the lenticels (A), exfoliating bark (B), and moss (C).
Photo by Photo by John Zasada, U.S. Forest Service, retired.

Bark Texture vs. Age

Though the numbers reflect the populations of paper birch sampled in the 2004-2006 panels, it is noteworthy that paper birch trees in age class 75 (trees on plots aged 51 through 75 years) display a more dramatic difference in numbers by texture class than do the age classes older and younger than 75 (Fig. 11). The generally short life span of paper birch is reflected by the low numbers in the older-age plots. Comparing Figure 11 with Figure 10, one might conclude that a high proportion of the smoother, smaller trees occurs in stands around 51 to 75 years in age.

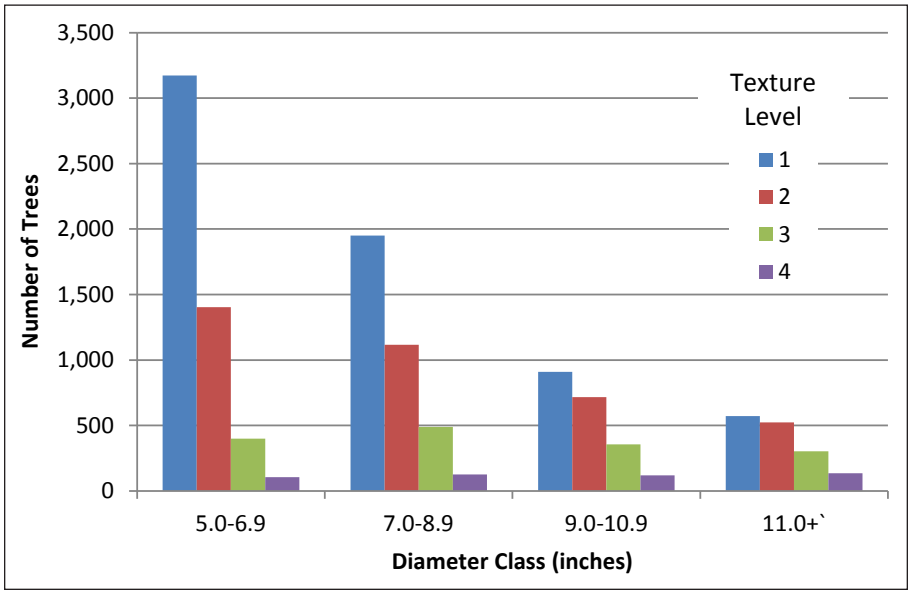


Figure 10.—Number of paper birch trees sampled in 2004-2006 by lower bark texture level and diameter class; see text for explanation of texture levels.

Bark Texture vs. Importance Value

Most paper birch trees measured in 2004-2006 for bark characteristics were in stands with predominantly nonbirch species, that is, those where the birch importance value was 50 or less (Fig. 12). In this category, there was a higher proportion of level 1 texture bark (little to no exfoliation) than in stands with a greater proportion of paper birch. If gatherers seek trees with minimal bark texture, data suggest that they are more likely to find such trees in stands where paper birch is not the predominant species.

Figure 11.—Number of paper birch trees sampled in 2004-2006 by lower bark texture level and age class; see text for explanation of texture levels.

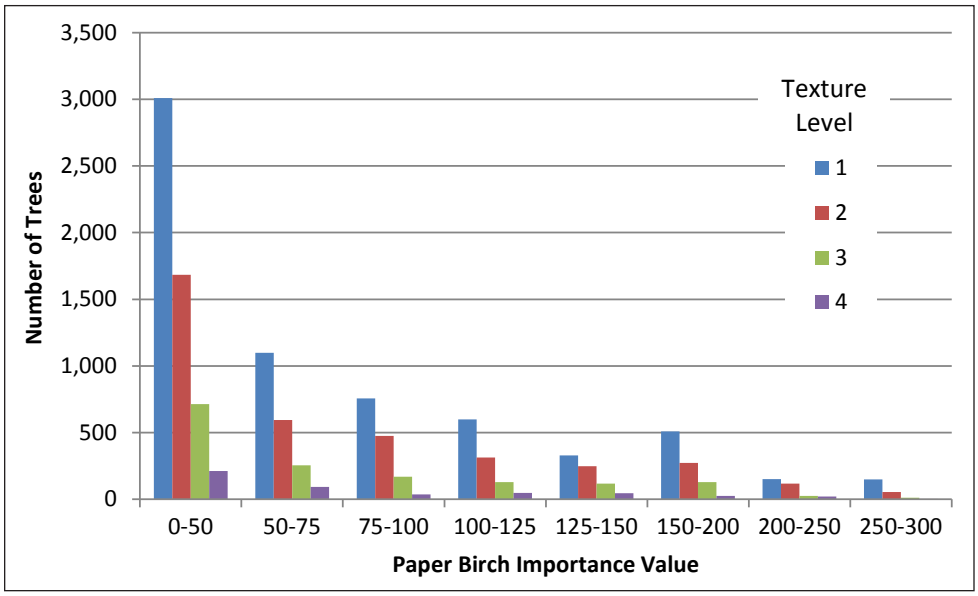


Figure 12.—Number of paper birch trees sampled in 2004-2006 by lower bark texture level and paper birch importance value; see text for explanation of texture levels.

Bark Exfoliation

Exfoliation refers to the natural process of bark peeling away from a tree trunk, a process that can be accelerated by weather or by the addition of new exfoliating layers below.

Bark Exfoliation vs. Size

Bark exfoliation level 1 (tight bark with little or no exfoliation) was the most common characteristic level found on trees regardless of diameter (Fig. 13). About half as many trees exhibited level 2 exfoliation as compared to level 1. Higher levels (3 and 4) were found on significantly fewer trees, although these two levels of greater exfoliation were found on a higher proportion of trees in the larger diameter classes (Fig. 14).

Exfoliating bark of paper birch.
Photo by Joseph O'Brien, U.S. Forest Service.

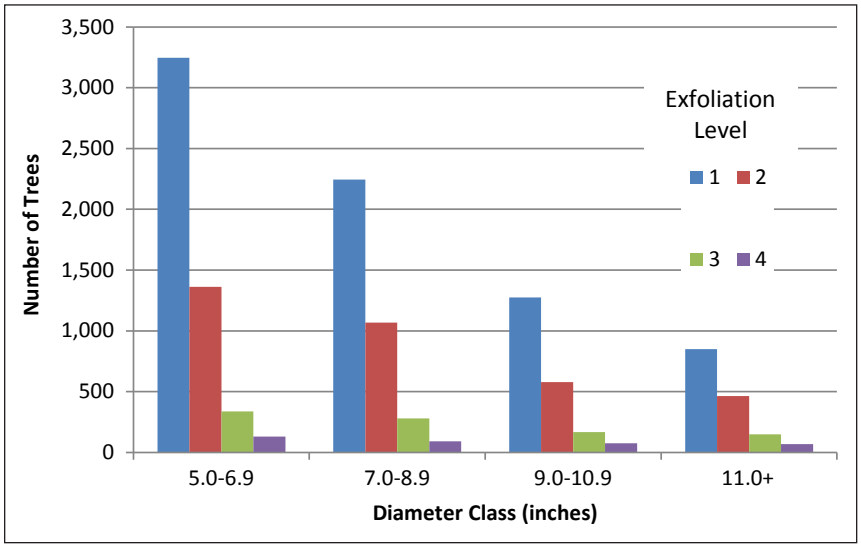


Figure 13.—Number of paper birch trees sampled in 2004-2006 by lower bark exfoliation level and diameter class; see text for explanation of exfoliation levels.

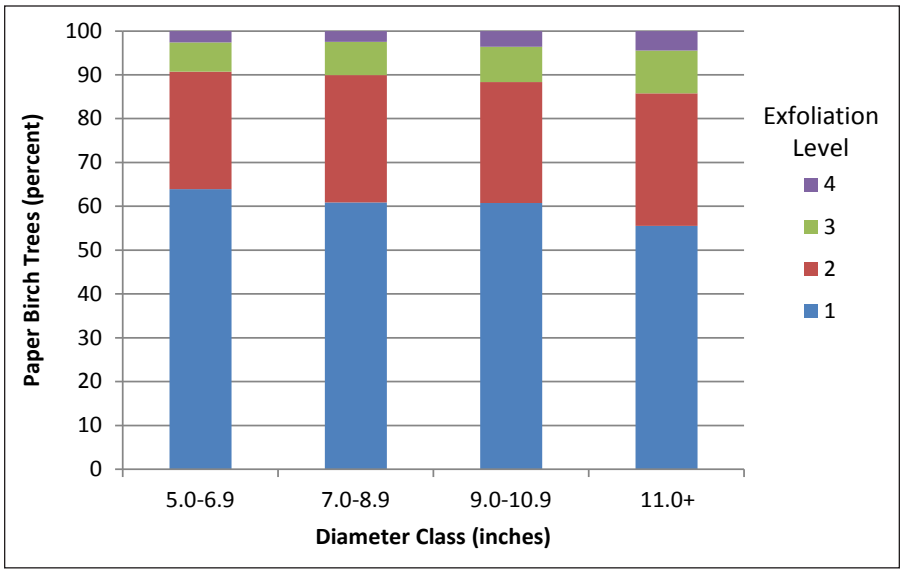


Figure 14.—Percentage of trees sampled in 2004-2006 by lower bark exfoliation level and diameter class; see text for explanation of exfoliation levels.

Bark exfoliation is a characteristic influencing ease of harvest as much as any particular product characteristic. Tight bark (exfoliation level 1) is difficult to remove whereas heavily exfoliated bark (level 4) is more easily removed.

Bark Exfoliation vs. Age

Bark exfoliation level 1 decreased as trees became older (Fig. 15). Trees with exfoliation levels 2 and 3 increased in proportion as plot age increased, but these results should be used with caution because few observations were recorded in the higher age classes and not all trees in the plot are the same age.

Exfoliation vs. Importance Value

Uncertainty exists as to whether bark characteristics are influenced by the community in which the tree lives.

We investigated whether the presence of other species with paper birch affected the level of exfoliation on the lower trunk.

There was no apparent pattern of exfoliation as a function of birch intermixing with other species (Fig. 16). Roughly two-thirds of all paper birch trees had the lowest level of bark exfoliation. These results suggest that focusing on individual paper birch trees in particular forest types, whether northern hardwoods, lowland softwoods, or paper birch, has no effect on the likelihood of finding a particular bark exfoliation characteristic.

Leech Lake Reservation, Superior National Forest. Photo by David L. Hansen, University of Minnesota, used with permission.

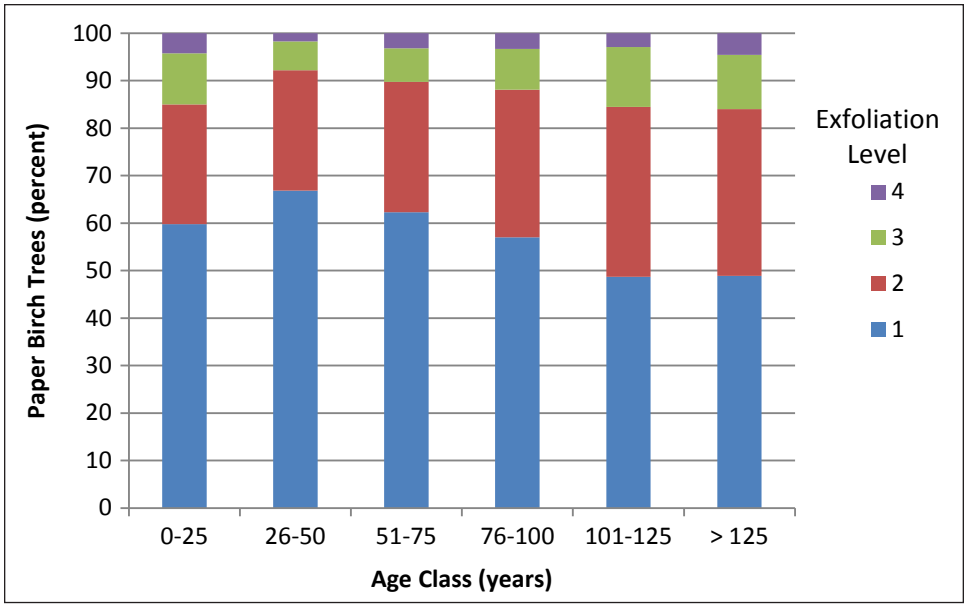


Figure 15.—Percentage of paper birch trees sampled in 2004-2006 by lower bark exfoliating level and age class; see text for explanation of exfoliation levels.

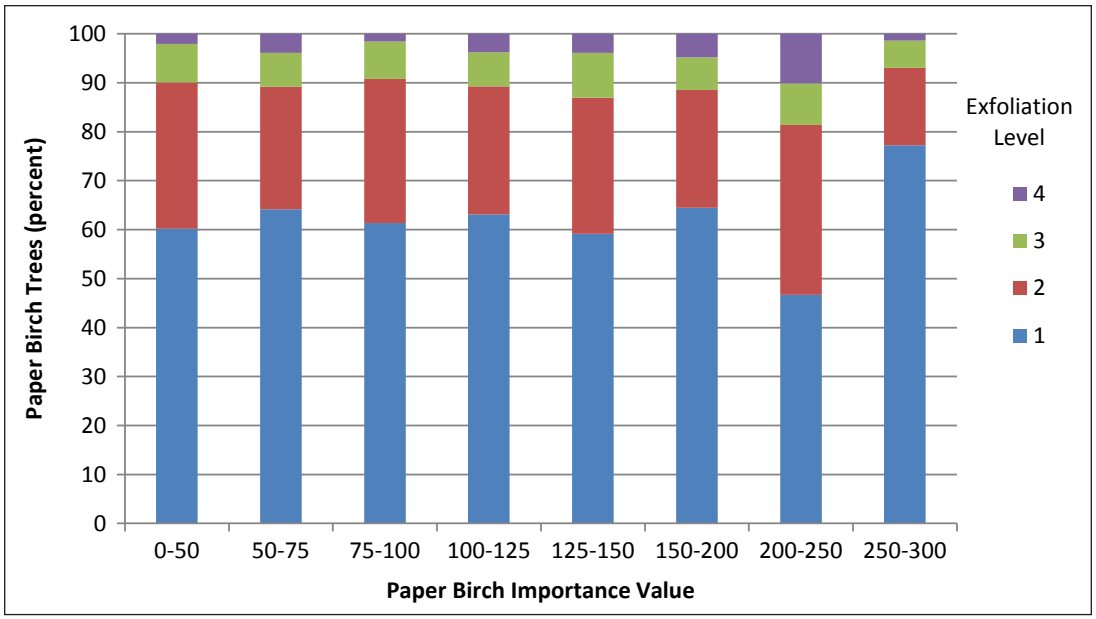


Figure 16.—Percentage of paper birch trees sampled in 2004-2006 by lower bark exfoliating level and importance value.

Lichen and Moss

Lichen or moss, or both, growing on a paper birch tree can provide differentiation in appearance and texture that may serve the purposes of birch bark gatherers as they construct specific products.

The proportion of trees that had lichen or moss on the bark of the lower 8 feet of the bole increased as the diameter class increased (Fig. 17). The proportion of trees with lichen or moss also varied by age class (Fig. 18). Gatherers seeking trees with lichen or moss should focus on older stands. There was no apparent connection between paper birch importance value and the presence of lichen or moss (Fig. 19).

Several burls at the base of a birch tree also showing lichen and moss. Photo by John Zasada, U.S. Forest Service, retired.

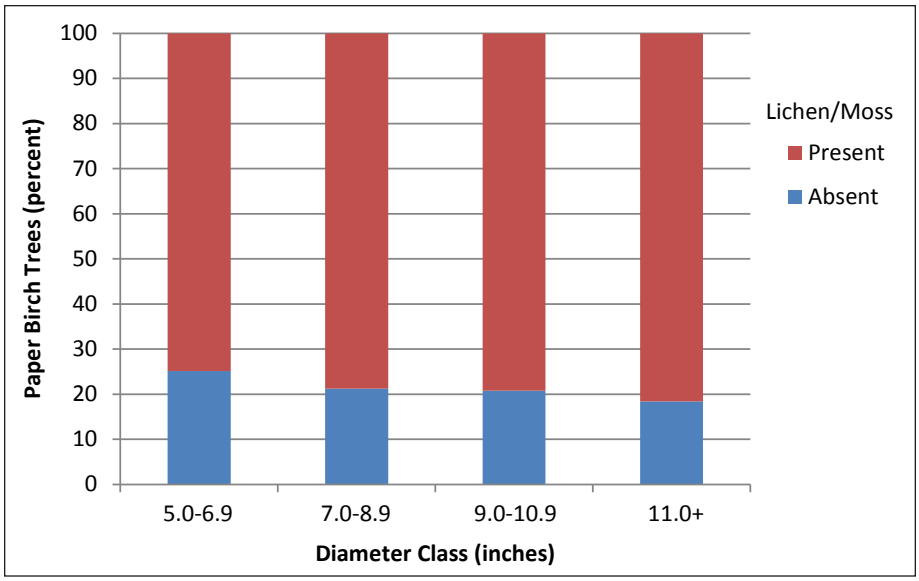


Figure 17.—Percentage of paper birch trees sampled in 2004-2006 by lichen or moss presence and diameter class.

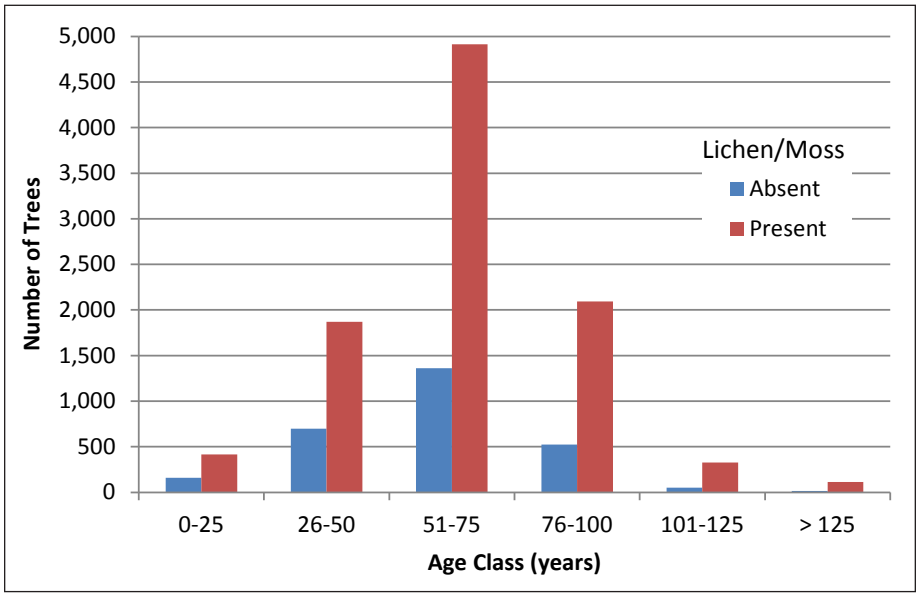


Figure 18.—Number of paper birch trees sampled in 2004-2006 by lichen or moss presence and age class.

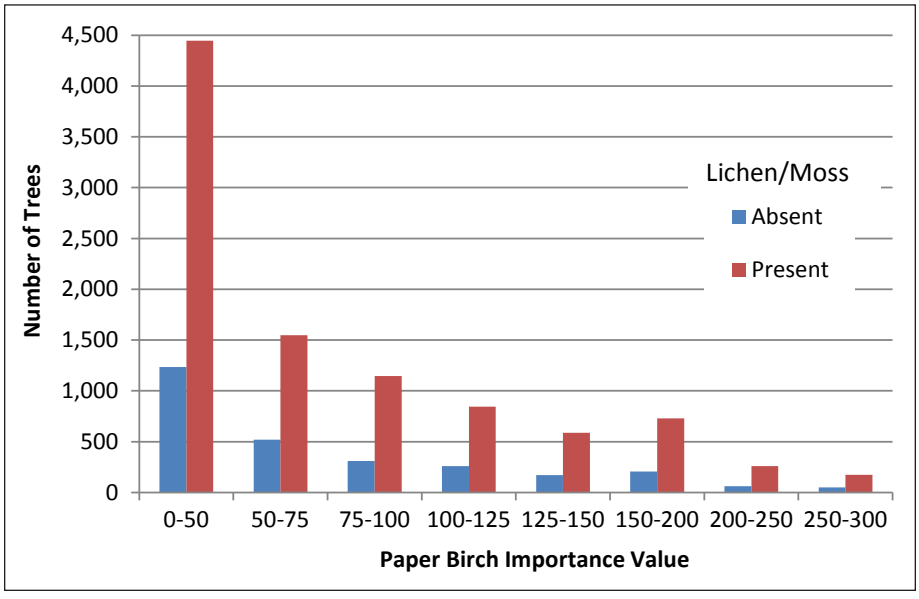


Figure 19.—Number of paper birch trees sampled in 2004-2006 by lichen or moss presence and importance value.

ESTIMATED SUPPLY OF BARK BY CHARACTERISTIC

We estimated the supply of paper birch bark with each of the nine bark characteristics in the 2005 and 2010 inventories. Both inventories included at least 1 year of measured paper birch bark characteristics, with the remaining years estimated. The 2005 inventory included actual measurements of paper birch on FIA plots in 2004 and 2005 and estimated bark characteristics for plots measured in 2001-2003. The 2010 inventory included actual measurements of paper birch on FIA plots in 2006 and estimated bark characteristics for plots measured in 2007-2010.

Exfoliation

Based on 2004-2006 actual measurements extrapolated to the years 2000-2010, we estimate that the quantity of bark with lower amounts of exfoliation has declined between the last two inventories (Fig. 20). The levels that represent the least amount of exfoliation (level 1 and level 2) declined 10 percent from about 2.4 billion square feet in the 2005 inventory to 2.2 billion square feet in the 2010 inventory.

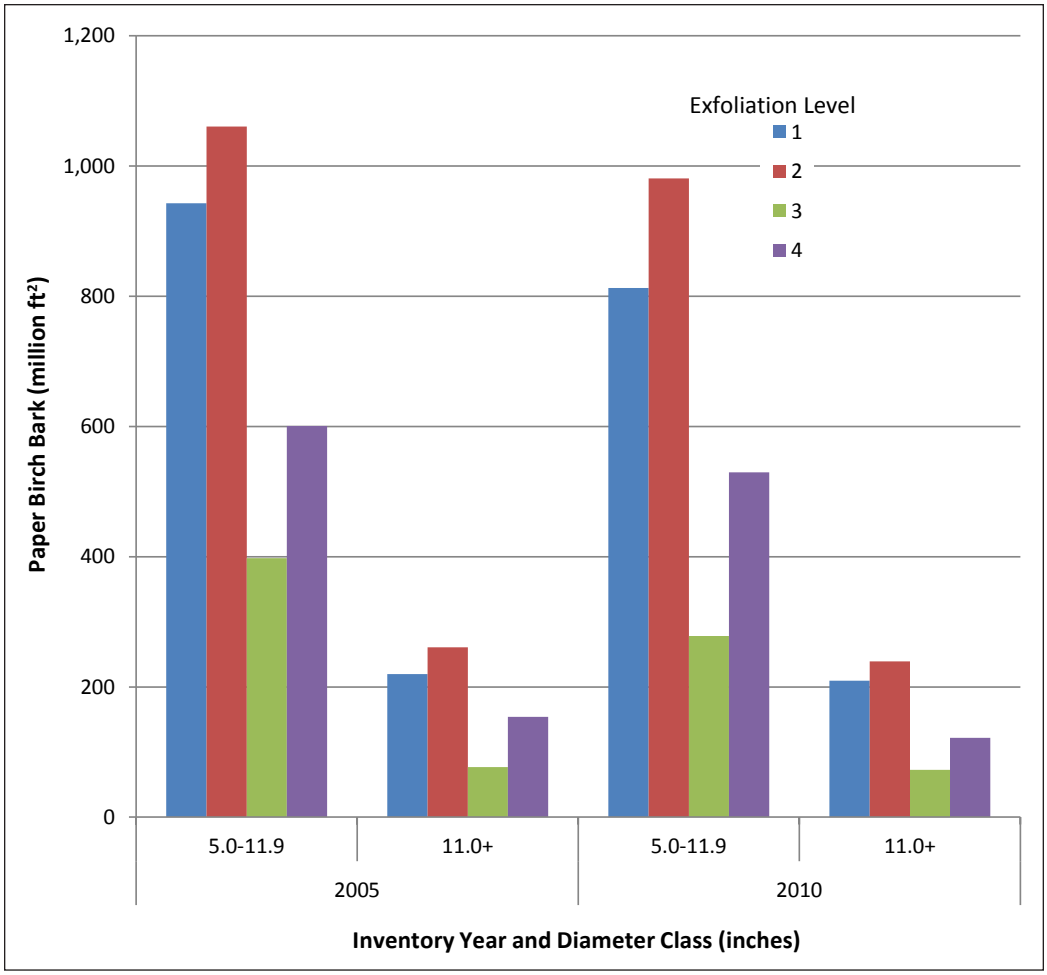


Figure 20.—Paper birch bark supply on the lower 8 feet of bole in the ceded territories for all ownerships, by diameter and exfoliation level, 2005 and 2010.

There is a higher proportion of high-exfoliation (exfoliation levels 3 and 4) paper birch trees in aspen forest types than there are in paper birch forest types (Fig. 21). This proportion increased between 2005 and 2010. Lowland softwoods, primarily northern white-cedar, and upland and lowland hardwoods had greater portions of the birch bark resource on trees with less exfoliation. Although highly exfoliated bark is not considered suitable for certain products, a greater supply of this type of bark might be found in paper birch stands.

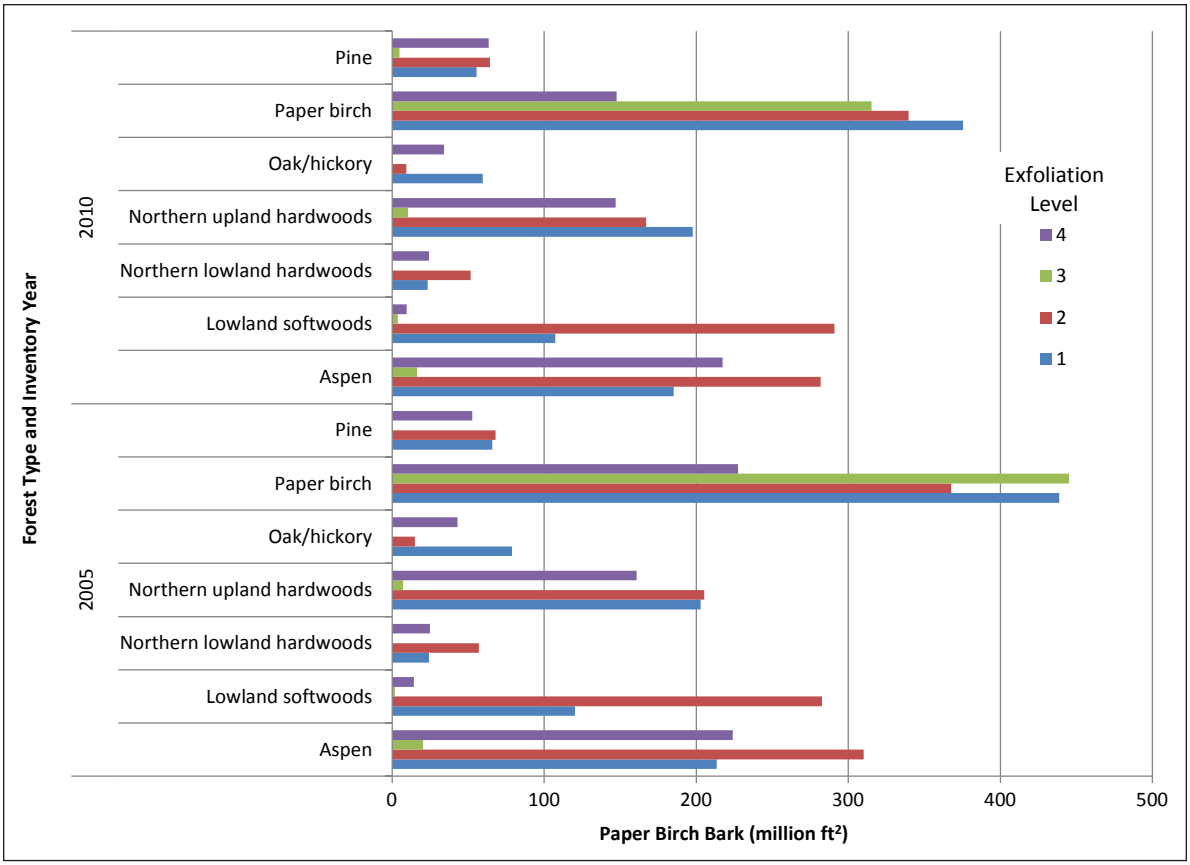


Figure 21.—Paper birch bark supply on the lower 8 feet of bole on timberland, in the ceded territories for all ownerships, by forest type, inventory year, and exfoliation level, 2005 and 2010.

Blemishes

Blemishes include any compromise to the integrity of the bark. The blemishes can be formed by the tree itself, animals, attempted bark harvest, or vandalism. Vandalism is any wound that appears to be human caused and is not an attempted bark harvest.

Lichen or Moss

Lichens or moss was recorded if present on the birch bark stem.

Lichen is the most prominent characteristic on paper birch bark in the ceded territories. In 2005, lichen was estimated to be present on more than 2.3 billion square feet of bark on trees <11 inches d.b.h. and 556 million square feet on trees ≥11 inches d.b.h. (Fig. 22). In 2010, these estimated numbers declined to 2.0 billion and 494 million square feet, respectively. During this period, the amount of bark free of lichen or moss remained largely the same, suggesting that the proportion of total bark that was not affected by lichen increased between 2005 and 2010.

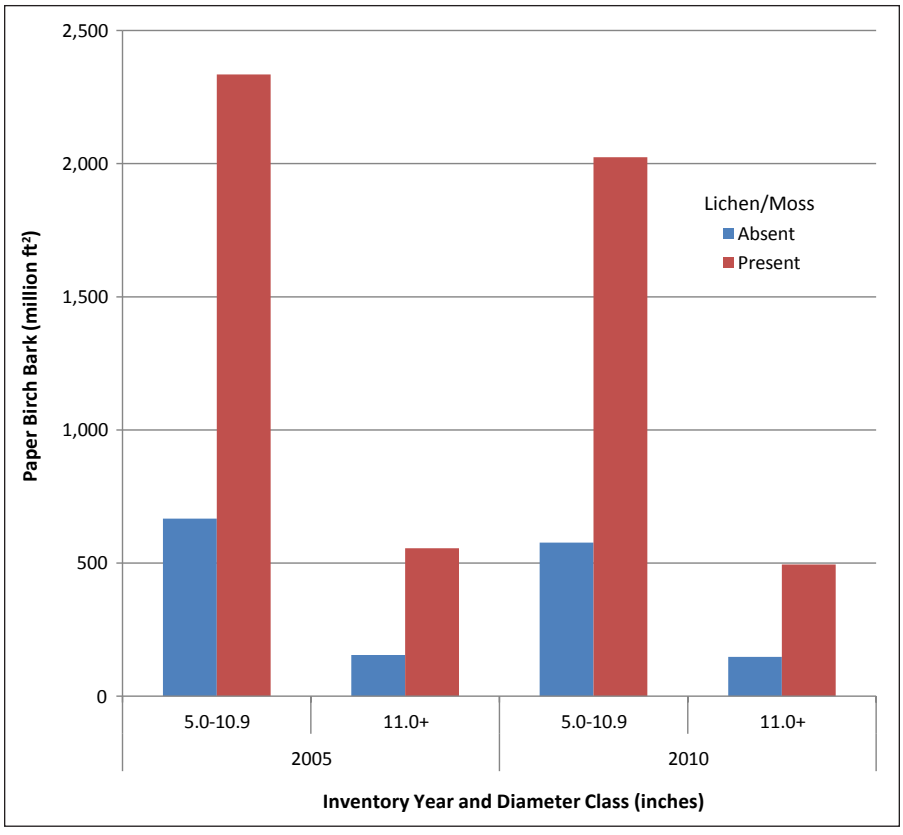


Figure 22.—Paper birch bark supply on timberland, in the ceded territories for all ownership groups, by presence of lichen on the bark, inventory year, and diameter class.

Fungus

Fungus was an uncommon feature on birch bark, regardless of tree size or inventory year (Fig. 23). Gatherers seeking birch bark with fungus will likely have to search longer to find the particular set of bark characteristics that they need.

Trunk Curvature

As with solid wood products, trunk curvature influences product yield (size) and type of birch bark products.

Most of the estimated birch bark supply was found on trees with no trunk curvature, that is, straight trees (Fig. 24). The birch bark supply on trees ≥11 inches d.b.h. declined overall, but the amount of bark on straight trees, though still the majority, declined as a proportion of the total birch bark resource on these larger trees.

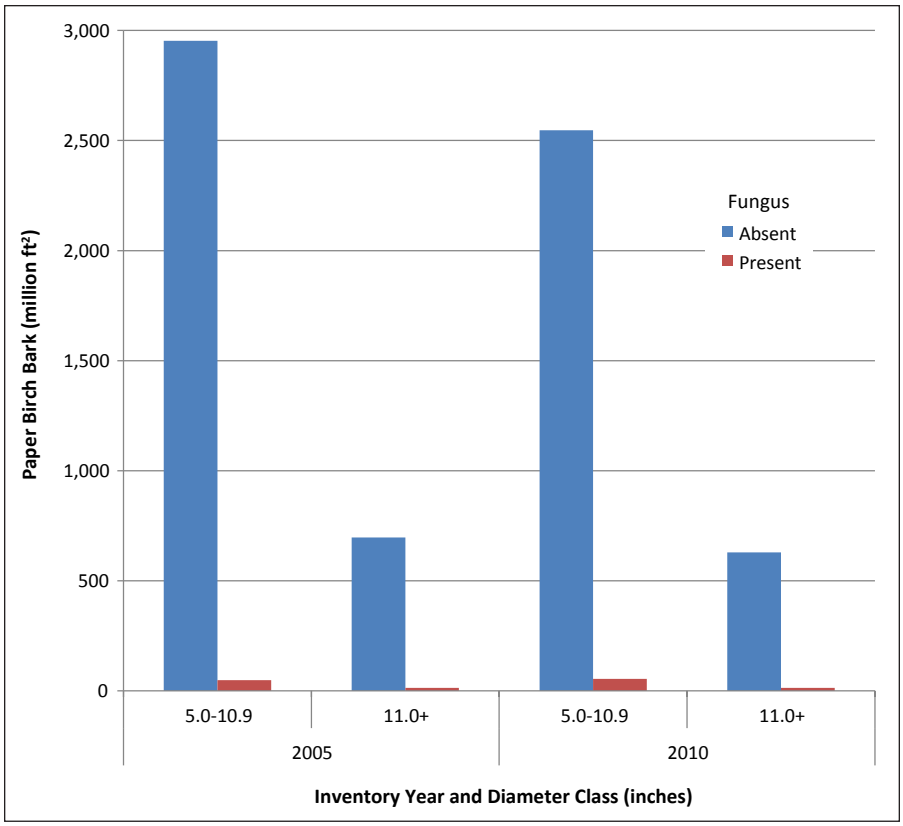


Figure 23.—Paper birch bark supply on timberland in the ceded territories for all ownership groups, by bark fungus presence, inventory year, and diameter class.

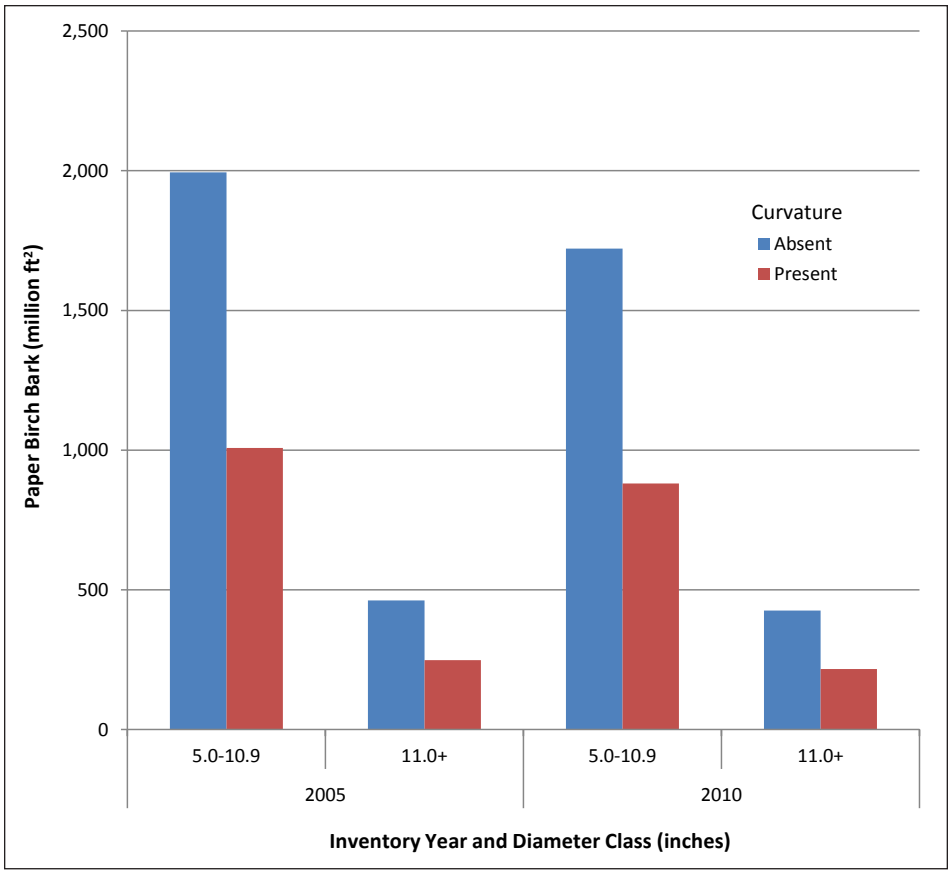


Figure 24.—Paper birch bark supply, in the ceded territories for all ownership groups, by presence of trunk curvature, inventory year, and diameter class.

As with solid wood products, trunk curvature influences product yield (size) and type of birch bark products. Photos by (L) Rob Routledge, Sault College, bugwood.org 5454111; (R) Elmer Verhasselt, bugwood.org 5510460.

Lenticels

Lenticels are aggregations of cells in the bark, usually shaped like a lens. Lenticels are a near-constant feature in paper birch bark. For those products that demand a smooth bark, lenticels might not be desirable, but in other situations, lenticels might add aesthetic character to a product.

The estimated proportion of paper birch bark with lenticels present did not change dramatically between the two inventories, even though the total estimated bark quantity had declined (Fig. 25). The proportion of paper birch bark with lenticels ranged from 79.9 to 86.1 (smaller vs. larger diameter classes) in 2005; in 2010, the proportions were 80.1 (smaller) and 85.8 (larger diameter classes).

A greater potential supply of birch bark would be available in the three Great Lakes states for products and crafts that permit the presence of lenticels in the bark than for products where smooth bark was preferred.

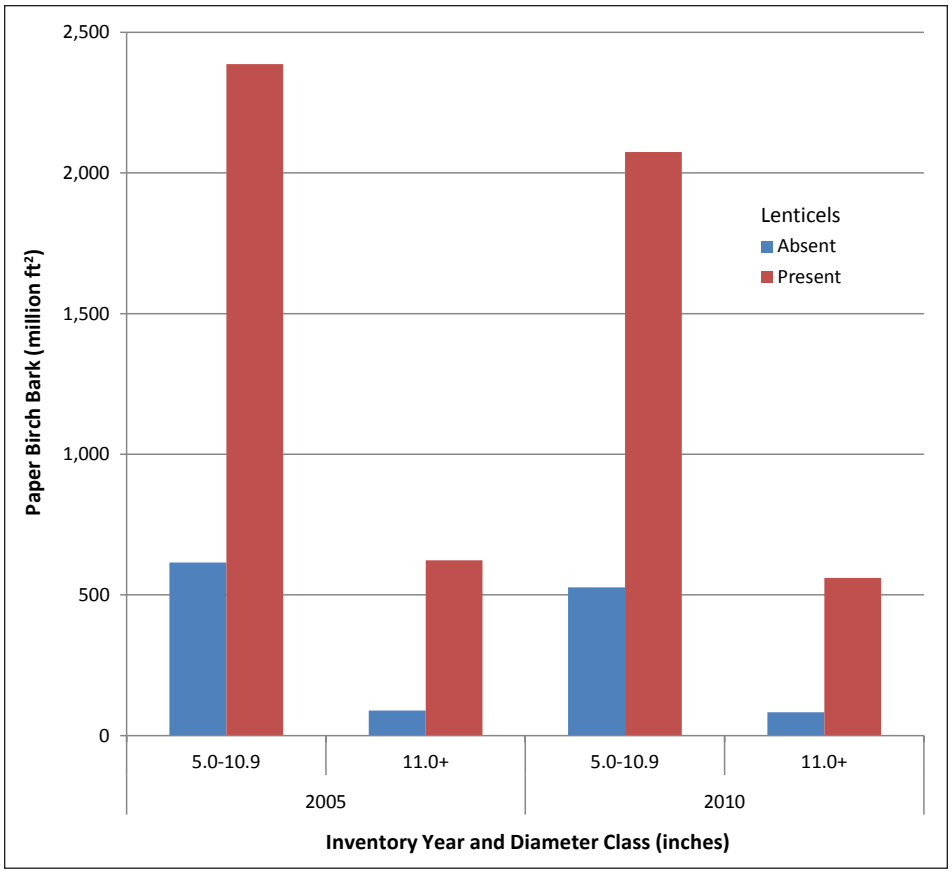


Figure 25.—Paper birch bark supply, in the ceded territories for all ownership groups, by lenticels presence, inventory year, and diameter class.

Interactions of Blemishes, Lichen-Moss, and Branching

The presence of lenticels, lichens, or some other blemish can shape a gatherer's decision as to what product to make. Something can usually be created from almost any piece of bark. Yet multiple factors may severely limit the alternatives. To see how such combinations might affect birch bark supply, we examined estimated bark quantities in light of overlapping bark factors of lichen/moss (LiMs), branching (Br), and blemishes (Bl).

Based on proportions extrapolated from the 2004-2006 samples, the greatest quantity of bark feature combination was lichen/moss with no blemishes or branching features (Bl-, LiMs+, Br-) (Fig. 26). The second most common combination was blemishes and lichen/moss with no branch features (Bl+, LiMs+, Br-) (Fig. 26). The proportion of the estimated bark quantity that was lichen alone (Bl-, LiMs+, Br-) decreased dramatically from the smaller to larger diameter classes.

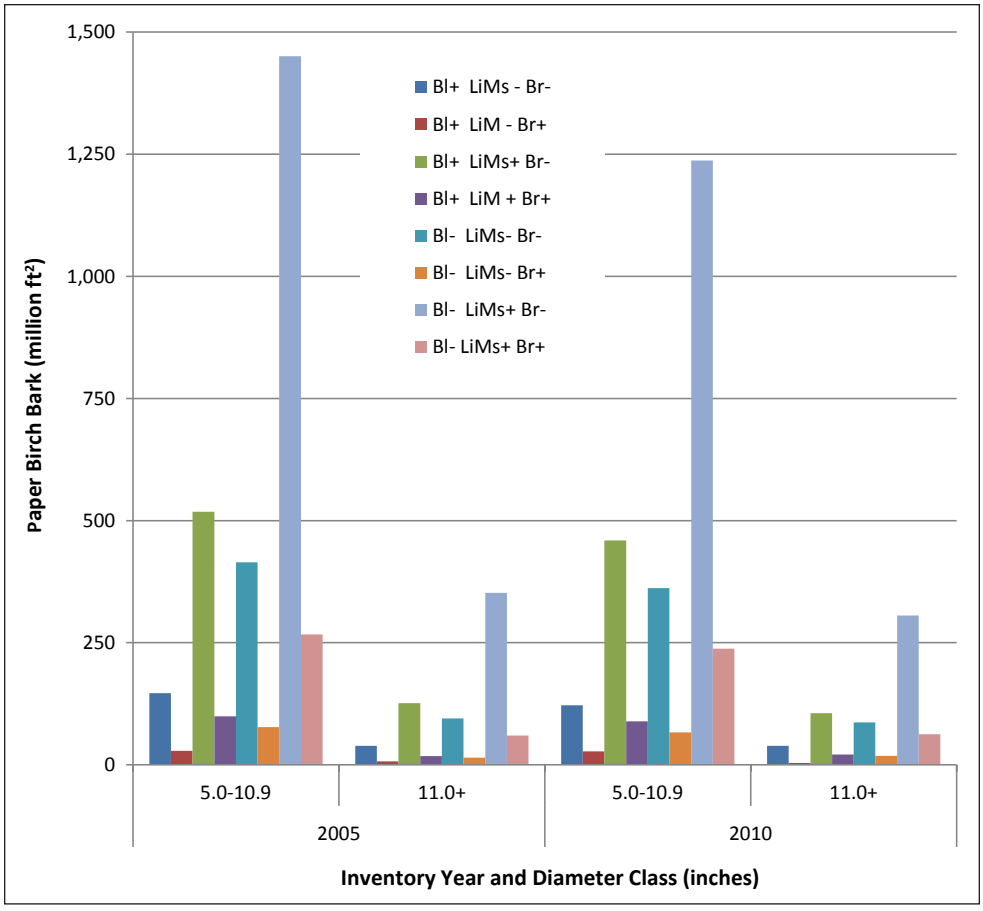


Figure 26.—Paper birch bark supply on timberland, in the ceded territories for all ownerships by combination of blemishes (Bl), lichen/moss (LiMs), and branching (Br), by inventory year and diameter class.

ACKNOWLEDGMENTS

The authors acknowledge the commitment and support of Great Lakes Indian Fish and Wildlife Commission Forest Ecologist, the late Karen Danielsen, and the expert Ojibwe paper birch bark gatherers (Lac Courte Oreilles: Mark Bisonette, Robert J. Sander, Donald G. White; Mille Lacs: Russell Boyd; Red Cliff: Marvin Defoe, Jr.; Fond du Lac: Jeff Savage; Lac du Flambeau: Leon C. Valliere, Wayne M. Valliere). Peggy S.B. Castillo (U.S. Forest Service) and David Bisonette (Lac Courte Oreilles Community College) provided valuable suggestions on earlier versions of the manuscript.

LITERATURE CITED

Danielsen, K.C.; White, S., Jr. 2003. **Field methods guide. Characteristics of Wiigwaasi-mitig (Paper Birch, *Betula papyrifera* Marsh.)**. Project report U.S. Forest Service Agreement #01-JV-11231300-OAS. Odanah, WI: Great Lakes Indian Fish and Wildlife Commission, Biological Services Division. 20 p.

Densmore, F. 1928. **Strength of the earth: the classic guide to Ojibwe uses of native plants.** St. Paul, MN: Minnesota Historical Society. 136 p.

Emery, M.R.; Wrobel, A.; Hansen, M.H.; Dockry, M.; Moser, W.K.; Stark, K.J.; Gilbert, J.H. 2014. **Using traditional ecological knowledge as a basis for targeted forest inventories: paper birch (*Betula papyrifera*) in the US Great Lakes Region**. Journal of Forestry. 112(2): 207-214.

Gikinoo'wizhiwe Onji Waaban [G-WOW]. [N.d]. **Ojibwe lifeway: maple sugaring and birch bark harvesting ("zziigwan"-spring).** Available at http://www.g-wow.org/en-us/maple_birch/default.aspx. (Accessed July 29, 2014).

Great Lakes Fish and Wildlife Commission [GLIFWC]. 2002. **Maniwiigwaase-gather birch bark**. Mazina'igan Supplement. Fall: 1, 8. Available at http://www.glifwc.org/publications/mazinaigan/Gathering_Supplement.pdf. (Accessed May 22, 2014).

Great Lakes Fish and Wildlife Commission [GLIFWC]. [N.d.]. **Treaty rights reserved.** Odanah, WI: Great Lakes Indian Fish and Wildlife Commission. Available at www.glifwc.org/TreatyRights/treatyrights.html. (Accessed July 29, 2014).

Hahn, J.T. 1984. **Tree volume and biomass equations for the Lake States.** Res. Pap. NC-250. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 10 p.

Harlow, W.M.; Harrar, E.S. 1969. **Textbook of dendrology.** New York, NY: McGraw Hill. 581 p.

McRoberts, R.E. 1999. **Joint annual forest inventory and monitoring system: the North Central perspective**. Journal of Forestry. 97(12): 27-31.

McRoberts, R.E. 2005. **The enhanced Forest Inventory and Analysis program**. In: Bechtold, W.A.; Patterson, P.L., eds. The enhanced Forest Inventory and Analysis program–national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 1-10.

Meeker, J.E.; Elias, J.E.; Heim, J.A. 1993. **Plants used by the Great Lakes Ojibwa.** Odanah, WI: Great Lakes Indian Fish and Wildlife Commission. 440 p.

Raile, G.K. 1982. **Estimating stump volume.** Res. Pap. NC-224. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 4 p.

Safford, L.O.; Bjorkbom, J.C.; Zasada, J.C. 1990. ***Betula papyrifera* Marsh. paper birch**. In: Burns, R.M.; Honkala, B.H., tech. coords. Silvics of North America: 2. Hardwoods. Agric. Hndbk. 654. Washington, DC: U.S. Department of Agriculture, Forest Service: 158-171.

Scott, C. T.; Bechold, W.A.; Reams, G.A.; Smith, W.D.; Westfall, J.A.; Hansen, M.H.; Moisen, G.G. 2005. **Sample-based estimators used by the Forest Inventory and Analysis National Information Management System.** In: Bechtold, W.A.; Patterson, P.L., eds. The enhanced Forest Inventory and Analysis program–national sampling design and estimation procedures. Gen. Tech. Rep. SRS-80. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 43-67.

U.S. Forest Service. 2003. **Forest Inventory and Analysis national core field guide volume I: Field data collection procedures for phase 2 plots.** St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 281 p.

U.S. Forest Service. 2005. **Forest Inventory and Analysis national core field guide volume I: Field data collection procedures for Phase 2 plots.** St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 282 p.

Wilson, B.T.; Lister, A.J.; Riemann, R.I. 2012. **A nearest-neighbor imputation approach to mapping tree species over large areas using forest inventory plots and moderate resolution raster data.** Forest Ecology and Management. 271: 182-198.

Wilson, B.T.; Lister, A.J.; Riemann, R.I.; Griffith, D.M. 2013. **Live tree species basal area of the contiguous United States (2000-2009).** Research Data Set. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. http://dx.doi.org/10.2737/RDS-2013-0013. [database]. (Accessed Sept. 23, 2013).

Woudenberg, S.W.; Conkling, B.L.; O'Connell, B.M.; LaPoint, E.B.; Turner, J.A.; Waddell, K.L. 2010. **The Forest Inventory and Analysis database: database description and users manual version 4.0 for Phase 2.** Gen. Tech. Rep. RMRS-GTR-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 336 p.

APPENDIX I

Paper Birch Bark Inventory Protocol (Excerpted from U.S. Forest Service 2003, 2005)

5.29NC Paper Birch Bark Characteristics

… The primary objective of this protocol is to acquire information on the status, abundance, and distribution of an important special forest product, birch bark, harvested by tribal members and non-Indians alike. As the stature of special forest products continues to increase, inventory and monitoring of these products may become necessary to promote sustainable harvest.

This protocol was developed with the following considerations:

1. Maximize usefulness by consulting with tribal harvesters. Six tribal members were interviewed on twenty separate occasions to identify the birch characteristics used most often to select the bark to be harvested. The tribal members are members of different Ojibwe bands and gather birch bark for a variety of purposes.
2. Maximize objectivity of birch bark assessments. Identified birch characteristics had to be described and categorized to ensure that the developed assessment methodology could be easily replicated by new field technicians with minimal training.
3. Maximize integration with previously established Forest Inventory and Analysis (FIA) protocols. The birch assessment was designed to be easily incorporated into existing methodology to minimize additional labor and time.

DATA ELEMENTS

These data are collected on two sections of the tree:

- Lower – 4.0 feet to 8.0 feet from the ground (record what is present if bole is broken)
- Upper – 8.0 feet to 16.0 feet from the ground (do not record any data if tree is broken off below 8.0 feet)

5.29.1NC Lower Trunk Curvature (LTRU)

Trunk curvature refers to the relative straightness of the tree trunk in the lower bole (4.0 feet - 8.0 feet from the ground).

When collected: All live paper birch (0375) ≥5.0″ diameter
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time

Values:
0 – no curvature – The pith of the tree is straight.
1 – moderate curvature – The pith is not straight, but the curvature of the pith does not extend outside the line a straight tree would create.
2 – extreme curvature – The pith extends outside the line a straight tree would create.

Birch Bark Curvature

No Curvature; LTRU = 0 and UTRU = 0
Straight line (pith-to-pith in the section being assessed)
4 to 8′ section or 8 to 16′ section

Pith
Sweep or Crook is less than ½ the distance from the pith to the outside bark of the tree.
Moderate Curvature; LTRU = 1 and UTRU = 1
Sweep or Crook is greater than or equal to ½ the distance from the pith to the outside bark of the tree, but doesn't extend past the outside bark.
4 to 8′ section or 8 to 16' section

Pith
Straight line (pith-to-pith in the section being assessed)
Excessive Curvature; LTRU = 2 and UTRU = 2
Sweep or Crook extends
4 to 8′ beyond the outside bark.
section or 8 to 16′ section

Pith Straight line (pith-to-pith in the section being assessed)
FOR BIRCH WITH MULTIPLE SWEEP AND/OR CROOK IN THE ASSESSED SECTION, EVALUATE ONLY THE MOST EXTREME.

5.29.2NC Lower Bark Harvested (LHAR)

Trees from which bark has been harvested are recorded by using codes defining a range of years since past harvest. For the area on the trunk Lower – 4.0 feet to 8.0 feet from the ground where past harvest has occurred complete only this section. Evaluate what is present if bole is broken.

Less than one year since harvest: The color of the outermost layer of the second growth bark (L1 bark) varies from tan on a freshly peeled tree, aging to a dark brown. Cracks begin to form on the dark brown L1 bark.

One year to less than three years since harvest: L1 bark color is dark brown to blackish. Cracks deepen, with some L1 bark pieces beginning to fall off exposing the next layer of the second growth bark (L2 bark).

Three years to less than six years since harvest: L1 bark color is dark brown to blackish. More L1 bark pieces falling off with over 25% and less than 75% of L2 bark exposed.

Six years to less than ten years since harvest: Over 75% of L2 bark exposed. L2 bark color is brownish-gray to light gray.

Ten years and over since harvest: L1 bark no longer or minimally present. L2 bark color is dark gray to light gray, often cracked and sometimes exfoliating.

Choose the most recent harvest category.

When collected: All live or dead Paper Birch (0375) ≥5.0″ diameter
Field width: 1 digit
Tolerance: No errors
MQO: At least 99% of the time
Values:
0 – No bark harvest
1 – < 1 year
2 – 1 year and <3 years
3 – 3 years and <6 years
4 – 6 years and <10 years
5 – >10 years

5.29.3NC Lower Surface Features (LSUR)

Record any or all of the surface features present in the lower bole (4.0 feet – 8.0 feet from the ground) on all paper birch trees that are at least 5.0 inches in diameter. See each item for more description of the features. Some of the items describe coarseness of the surface bark and some are just features on the bark that are not considered coarseness. Record all that are present on the tree, there are no severity limits.

When collected: All live Paper Birch (0375) ≥5.0” diameter when LOWER BARK HARVESTED = 0

Field width: 6 digits
Tolerance: No errors
MQO: At least 99% of the time
Values:
Bark features:
1 – Lichens and Moss. If any of these are present record this code.

2 – Branching. Branching refers to the presence of lateral stems, regardless if the stems are alive or dead.

Codes 3 – 6: when used will indicate that there is some coarseness to the bark, so use these items when assessing the data entered into the first digit of NC LOWER BARK CHARACTER.

Coarse bark features:

3 – Coarse lenticels. Lenticels are structurally different portions of the bark where gaseous exchange occurs. Dominant lenticels characteristics are determined for those lenticels that comprise the area of rough texture on the bark.

4 – Branch Scars. Branch scars refer to the presence of any characteristic bark texture indicating the former location of branching stems.

5 – Blemishes. Blemishes include any compromises to the integrity of the bark. The blemishes can be formed by the tree itself, animals, attempted bark harvest, or vandalism. Vandalism is any wound that appears to be caused by human that is not attempted bark harvest.

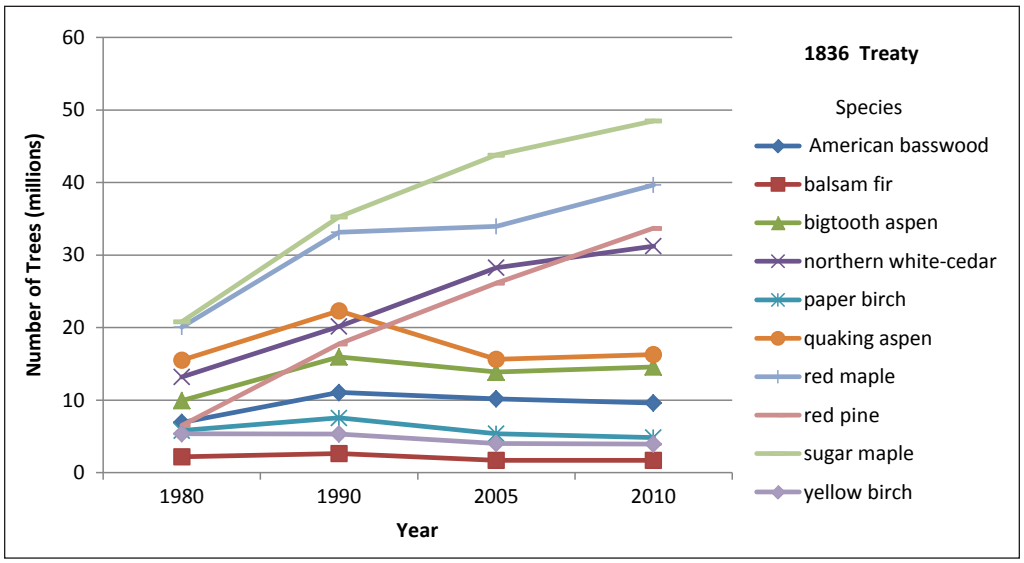
6 – Fungus. Fungus includes all species of stem cankers and conks.

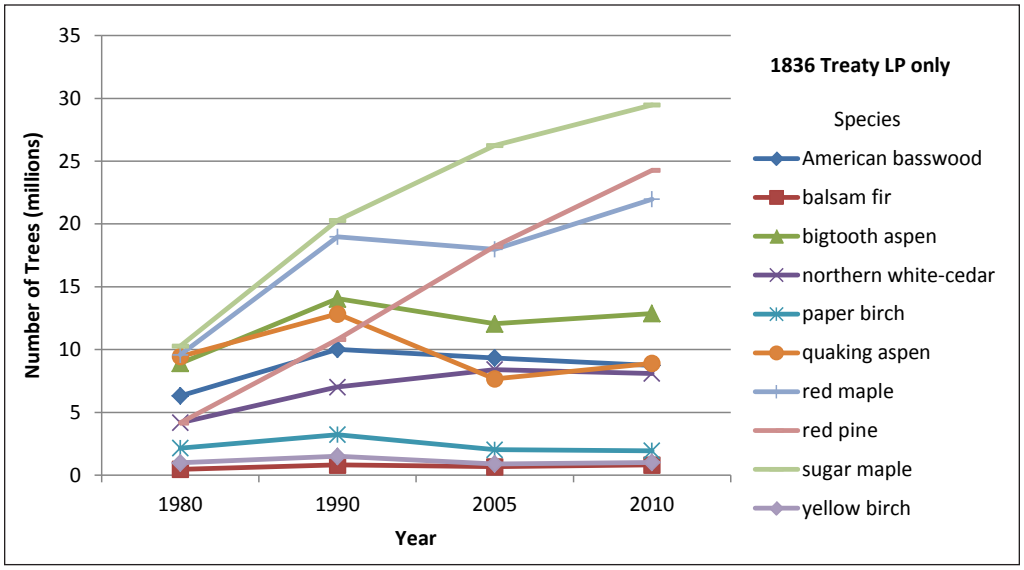
5.29.4NC Lower Bark Character (LCHA)

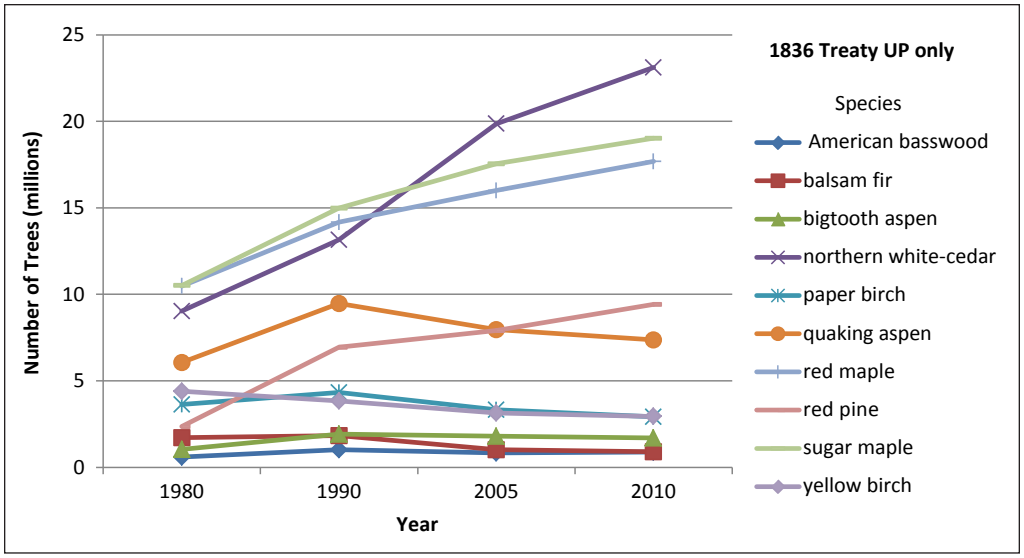
Use the first digit to describe the bark texture and the second digit to describe the amount of exfoliation bark in the lower bole (4.0 feet – 8.0 feet from the ground).

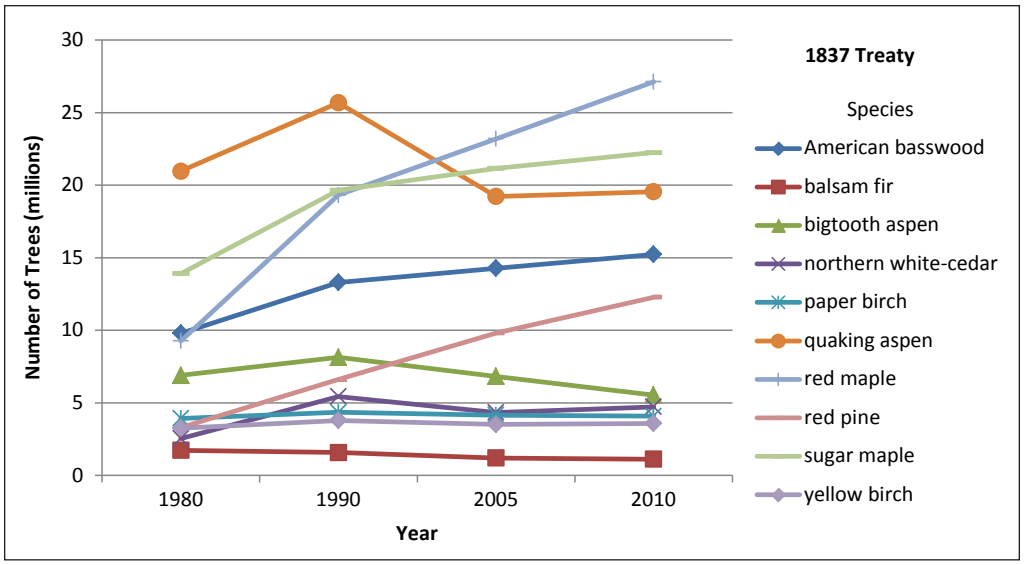
Bark Texture
Bark texture ranges from smooth to rough. Roughness is caused by various bark characteristics including lenticels, branch scars and wounds. Lichens and moss are not included.

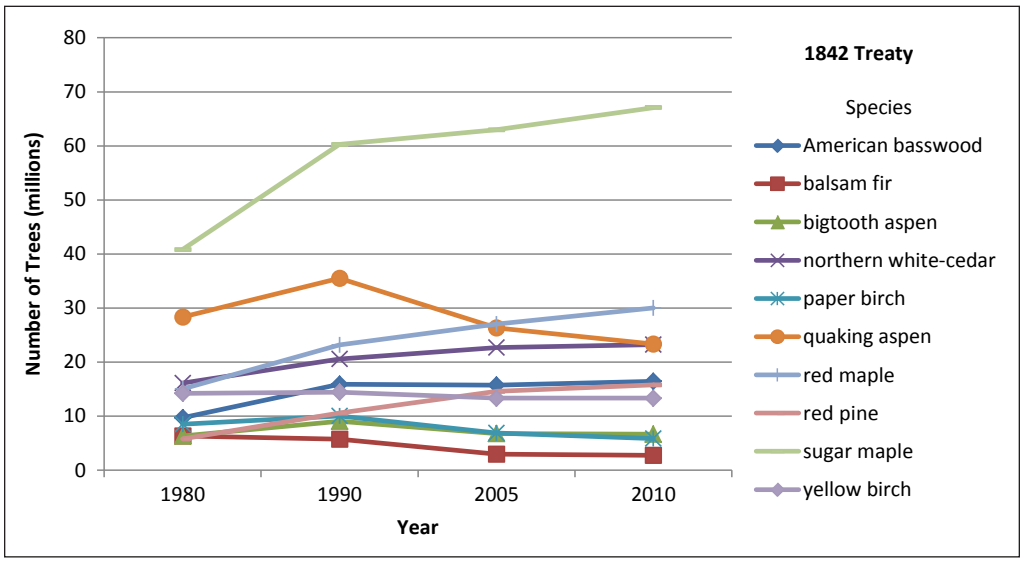
APPENDIX II
Number of Live Trees on Timberland ≥11 Inches d.b.h. by Species, for Each of the Ceded Territories

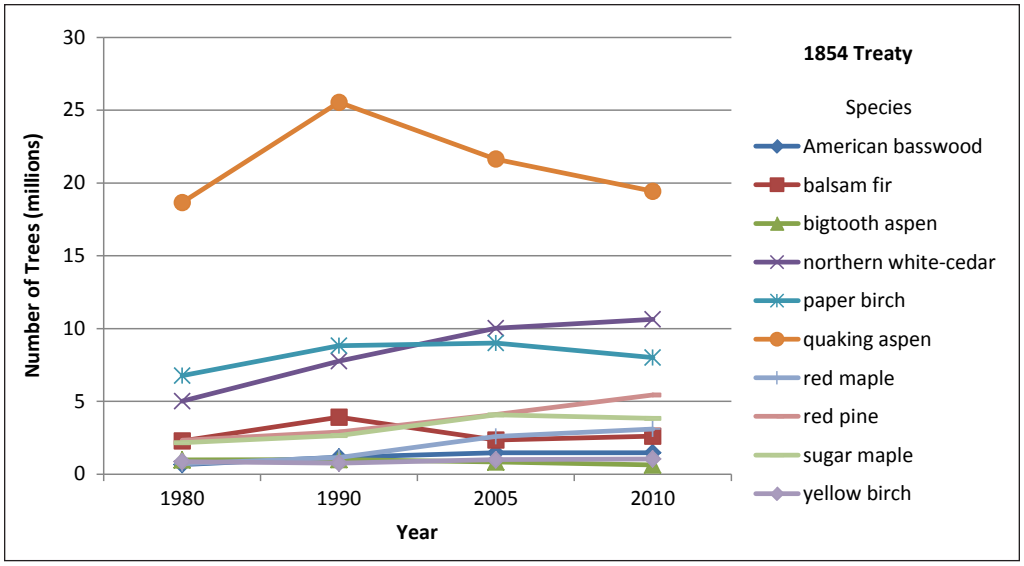




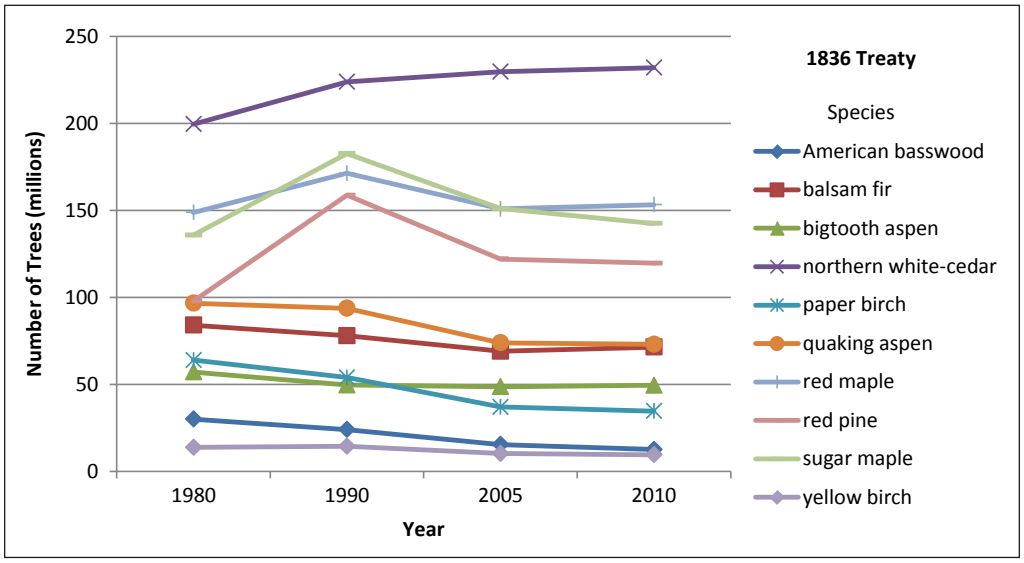


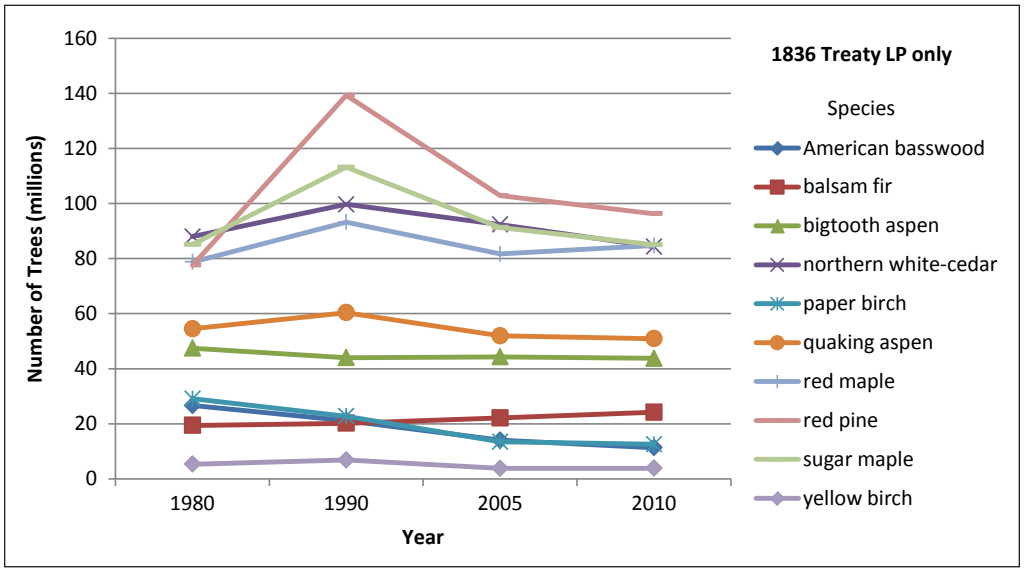

1837 Treaty
Species
American basswood
balsam fir
bigtooth aspen
northern white-cedar
paper birch
quaking aspen
red maple
red pine
sugar maple
yellow birch
Number of Trees (millions)
Year
0
5
10
15
20
25
30
1980
1990
2005
2010

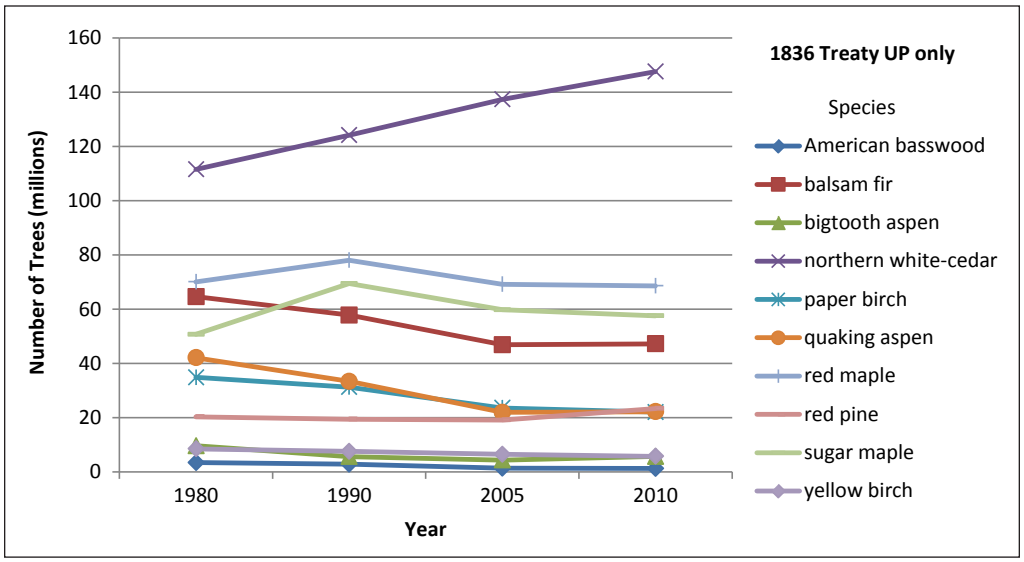

1842 Treaty
Species
American basswood
balsam fir
bigtooth aspen
northern white-cedar
paper birch
quaking aspen
red maple
red pine
sugar maple
yellow birch
Number of Trees (millions)
Year
0
10
20
30
40
50
60
70
80
1980
1990
2005
2010

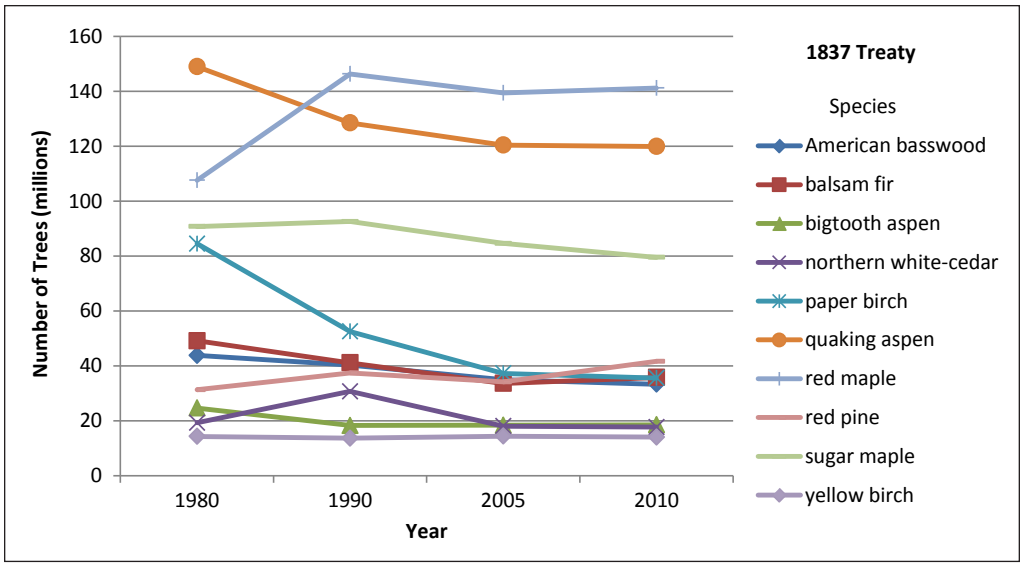

1854 Treaty
Species
American basswood
balsam fir
bigtooth aspen
northern white-cedar
paper birch
quaking aspen
red maple
red pine
sugar maple
yellow birch
Number of Trees (millions)
Year
0
5
10
15
20
25
30
1980
1990
2005
2010

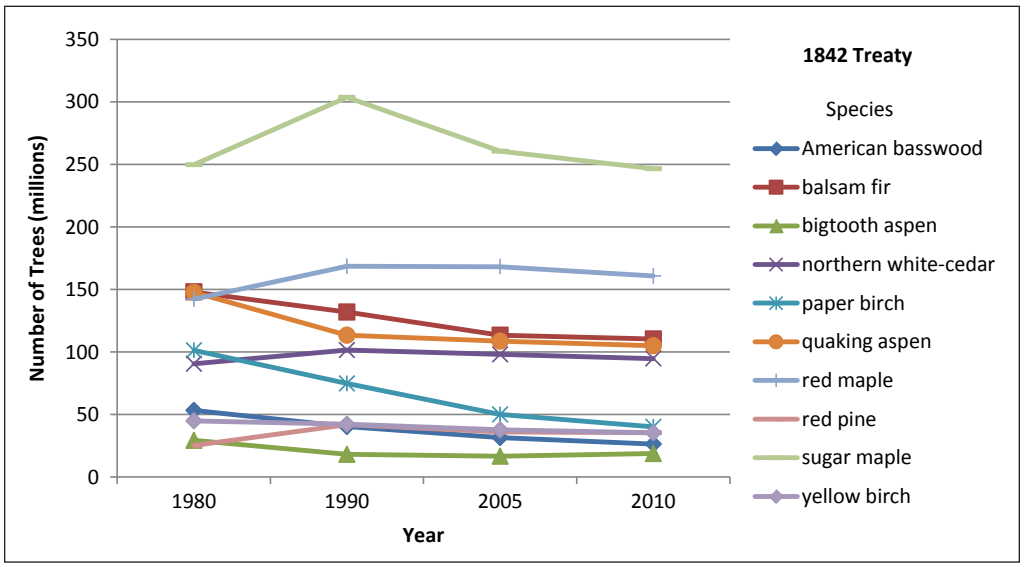
APPENDIX II
Number of Live Trees on Timberland 5-10.9 Inches d.b.h. by Species, for Each of the Ceded Territories

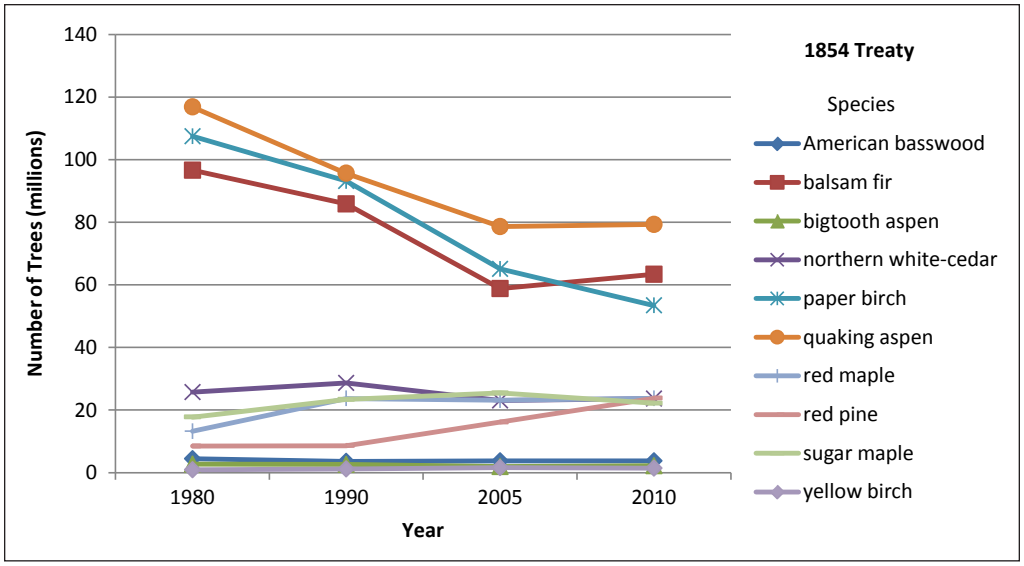







1837 Treaty
Species
American basswood
balsam fir
bigtooth aspen
northern white-cedar
paper birch
quaking aspen
red maple
red pine
sugar maple
yellow birch
Number of Trees (millions)
160
140
120
100
80
60
40
20
0
1980
1990
2005
2010
Year


1842 Treaty
Species
American basswood
balsam fir
bigtooth aspen
northern white-cedar
paper birch
quaking aspen
red maple
red pine
sugar maple
yellow birch
Number of Trees (millions)
350
300
250
200
150
100
50
0
1980
1990
2005
2010
Year


1854 Treaty
Species
American basswood
balsam fir
bigtooth aspen
northern white-cedar
paper birch
quaking aspen
red maple
red pine
sugar maple
yellow birch
Number of Trees (millions)
140
120
100
80
60
40
20
0
1980
1990
2005
2010
Year

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Moser, W. Keith; Hansen, Mark H.; Gormanson, Dale; Gilbert, Jonathan; Wrobel, Alexandra; Emery, Marla R.; Dockry, Michael J. 2015. **Paper birch (Wiigwaas) of the Lake States, 1980-2010.** Gen. Tech. Rep. NRS-149. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 37 p.

Data on paper birch (Betula papyrifera L.; wiigwaas in the Ojibwe language), collected by the Forest Inventory and Analysis (FIA) program of the U.S. Forest Service on forested lands in the Great Lakes region (Michigan, Minnesota, and Wisconsin) from 1980 through 2010, are reported. Also presented are results and analysis of a supplemental inventory designed to identify the characteristics of paper birch bark that influenced Native American harvesters' evaluation of potential uses (e.g., baskets, canoes).

Paper birch has long been an important part of the daily life and culture of the Great Lakes Ojibwe (Anishinaabe) people. The Ojibwe and other Native American tribes of the Upper Midwest signed treaties in 1836, 1837, 1842, and 1854 ceding land ("ceded territories") in northern Michigan, Wisconsin, and Minnesota to the Federal government, but retaining certain rights in the region. To help implement these retained rights on national forests in the ceded territories, member tribes of the Great Lakes Indian Fish and Wildlife Commission and the U.S. Forest Service entered into a memorandum of understanding which, among other things, provides for tribes to regulate their members' harvest of nontimber forest products (including paper birch bark) on national forest lands.

The U.S. Forest Service, GLIFWC, and tribal harvesters created a supplement to the FIA inventory protocol to provide a detailed inventory of birch bark characteristics. These data were collected on FIA plots in 2004, 2005, and 2006 in conjunction with the standard forest inventory annual panels. Forest land in the ceded territories contains 65.9 percent of all paper birch trees ≥5 inches diameter at breast height (d.b.h.) and 66.2 percent of the large (≥11 inches d.b.h.) paper birch trees in the Great Lakes region. The number of birch trees has decreased by 49 percent and total bark supply has decreased by 45.5 percent on forest land in the ceded territories since 1980. The proportion of paper birch bark found in the larger diameter trees has increased. The decline in paper birch, both in number and as a proportion of all trees, across the ceded territories should not materially diminish near-term bark harvest in the region as a whole, but may do so in selected locations. But the long-term trend suggests a lack of regeneration and a continued decrease in the total number of trees across the region.

KEY WORDS: birch bark, nontimber forest products, Ojibwe, FIA

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