North Central Landscape Conditions & Trends Report

A support document to the
2nd Generation MFRC North Central Landscape Plan

May 2017

Minnesota Forest Resources Council

Minnesota Forest Resources Council (MFRC)
Landscape Technical Document #LTxxxx.

This document is online at: http://mn.gov/frc/north-central-committee.html.

Information about the Minnesota Forest Resources Council and the Landscape Program can be found at www.frc.state.mn.us.

This information is available in an alternative format upon request.

Report prepared by: David Henkel-Johnson (MFRC support contractor) and Michael Lynch (former MFRC member).

GIS analysis and map creation by: Jeff Reinhart (MFRC Staff).

Please cite this document as:

Minnesota Forest Resource Council. 2017. *North Central Landscape Conditions & Trends Report.* Landscape Program Document #LTxxxx. Minnesota Forest Resource Council, St. Paul, Minnesota. Available online at www.frc.state.mn.us.

Table of Contents

Executive Summary

The Minnesota Forest Resources Council was established in 1995 by the Minnesota Legislature to provide advice to public and private organizations on forest sustainability issues through the Sustainable Forest Resources Act (SFRA). This legislation provided authorization for establishing regional landscape committees to foster landscape-based forest resource planning and coordination. These regional committees provide an opportunity to involve private citizens, forestry professionals and members of various interest groups in developing and implementing landscape-level plans that promote forest sustainability.

The SFRA defines landscape-level planning as *"long-term or broad based efforts that may require extensive analysis or planning over large areas that may involve or require extensive coordination across all ownerships."* It charges the regional committees to: 1) include representative interests, 2) serve as a forum to discuss issues, 3) identify and implement an open and public process whereby landscape-level strategic planning can occur, 4) identify sustainable forest resource goals for the landscape and strategies to achieve those goals, and 5) provide a regional perspective on forest sustainability to the council.

From 1998 to 2005, landscape plans were prepared for each of the six forested regions in the state following the general planning process of:

- Prepare an assessment of current conditions and trends in the landscape;
- Determine vision, goals, and issues that address existing and potential conditions considered desirable for the region;
- Develop strategies for implementing the vision, goals and/or resolve issues in the region;
- Encourage voluntary implementation of the strategies by coordination between landowners; and
- Conduct an evaluation to determine how well the strategies accomplish the vision and goals and resolve issues.

The purpose of the first part in the general planning process – conducting a landscape assessment – is to provide a common understanding of ecological and socioeconomic conditions in order to further planning and coordination among multiple landowners and interests. This assessment provides a scientific base for goal-setting and collaborative-decision making in the landscape plan development process.

This Conditions and Trends Report gives as accurate a picture of the ten-county North Central Minnesota Landscape (Aitkin, Becker, Cass, Clearwater, Crow Wing, Hubbard, Mahnomen, and Itasca counties, in addition to the southern half of Beltrami County and eastern half of Polk County) as possible given the limitations of available information and resources. It also points to areas where more specific assessments are needed to resolve the primary issue of sustainability in the landscape over time as well as points out gaps where more information is needed. This report is a starting point for addressing forest sustainability in north-central Minnesota, not the end result.

To guide the regional forest resource committees as they carry out landscape-level planning and coordination, the Council established four broad goals that describe overarching strategies for sustaining forests. The MFRC used the Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota and the SFRA to develop these goals. This updated North Central Conditions and Trends report is structured around these four goals. The goals are stated below with the findings, recommendations, and additional data needs concerning that goal.

Note to Reader: Additional regional data can be found in the report, 'North Central Landscape Demographic Data Report', MFRC North Central Planning Committee, 2016.

Goal 1: Forestland Cover. Land area covered by forests within a region's landscape will be the same or larger.

Key Findings

- **Forests are the dominant land cover.** Roughly 61% of the terrestrial area in the North Central Landscape is forested.
- **Historic loss of forests.** The region has lost approximately 728,000 acres of upland forests and over 137,000 acres of lowland vegetation (including lowland forests) to land development, agriculture, upland shrub, and open water since European settlement.
- **Increasing development.** Developed land estimates increased from 0.5 to 3.7% of the North Central Landscape; 15,430 acres per year from 1992 to 2011.
- **Forest cover is constant or decreasing.** There was an estimated 1.2% net loss of forestland between 1977 and 2015 estimates.

Goal 2: Land Ownership. Forests within a region's landscape will be in a variety of ownerships, serving both public and private interests.

Key Findings

- **Abundant public land.** Approximately 39% of the total land and 53% of the forest land is publicly owned.
- **School Trust Lands.** There are nearly 734,000 acres of school trust land in the North Central region, covering 8.1% of the landscape.
- **Uneven distribution of public lands.** The estimated ratio of public forestland to private forestland ranges greatly across the landscape from 0.14:1 in Polk County to 2.28:1 in Cass County, but overall is similar to the statewide estimate of 1.14:1.
- **Reserved forest lands.** Timber harvest is prohibited by statute or administrative regulation on approximately 1.6% of the North Central forestlands.
- **Uneven distribution of family forestlands.** Over half of all family forestland owners in the region have properties less than nine acres, yet about 7.3% of owners have properties greater than 100 acres and account for 47% of the total area of family forestland in North Central Minnesota.
- **Aging private woodland owners.** Approximately 35% of all family forestland by acreage and owners was owned by people greater than 65.
- **Important Forest Resource Areas.** 5.8% of Important Forest Resource Areas in the North Central region are covered by Forest Stewardship Plans.
- **Rising forestland values.** The average per-acre sale price of forestland in the region has increased by over 5.5 times since the early 1990's, but are currently lower than their peak in 2006-2007.
- **Increasing net property taxes from Managed Forestland.** Property tax dollars from Managed Forestland has more than doubled in the region between 2010 and 2014.

Goal 3: Healthy Forests. Within forested landscapes, healthy, resilient, and functioning ecosystems will be maintained within appropriate mixes of forest cover types and age classes to promote timber production, biological diversity, and viable forest dependent fish and wildlife habitats.

Key Findings

- **Forest composition and age has changed since European settlement**. Available data indicates species composition and age structure has changed significantly since the mid to late-1800s. Most noticeably there is an increase in increase in aspen, balsam fir, ash, and red oak, and a significant decrease in jack pine, red pine, white pine, spruce, and tamarack in the North Central Landscape.
- **Climate change vulnerability.** Regional Wet Forest, Forested Rich Peatland, and Acid Peatland Native Plant Community Systems are expected to be most vulnerable to climate change.
- **Recent forest composition change.** Since 2003 the aspen-birch forest type has been reduced by 146,000 acres and several hardwood forest type groups have increased by over 50,000 acres, yet the aspen-birch group remains by far the largest forest type group in the region at 40% of the landscape.
- **Aging forests.** Since 1977 the 41-60 age class in North Central Forests has significantly declined, and large relative gains were observed the 61+ age classes.
- **Regional forests serve as a large biomass and carbon reserve.** North Central Landscape forestlands have an estimated total biomass of 184.6 million short tons of biomass and sequester over 492.3 million short tons of carbon.
- **Removals exceed mortality for marketable species.** Total average annual removals of growing stock trees from timberland exceed mortality by almost 17.4 million cubic feet, but for individual species with little to no market (e.g. white cedar, tamarack, etc) mortality exceeded removals.
- **Changing silvicultural practices.** Survey results suggest clearcutting remains common but is less commonly used in 2008 than previous years, whereas other practices such as thinning and patch clearcut are becoming more common.
- **High plant species richness.** 1,378 plant species are found in the North Central Landscape, 87% of which are native.
- **Healthy bird populations.** 86% of Minnesota's breeding birds and nearly 83% of the state's forest associated breeding birds occur in the North Central Landscape.
- **Variable deer densities.** Deer densities range from a low of 3 deer per square mile in Mahnomen County to 22 in Becker County.
- **Increasing threat of invasive species.** Invasive species pose a significant threat to North Central forests, including the emerald ash borer.
- **High quality water resources.** The North Central Landscape is an area of rich, high quality water resources. Even so, many lakes and streams are designated as impaired – most as a result of mercury in fish tissue.

Goal 4: Economic and Social Values. Forests within a region's landscape will be providing a full range of products, services, and values, including timber products, wildlife and tourism, which are major contributors to economic stability, environmental quality, social satisfaction, and community well-being.

Key Findings

- **Forest products are an important regional employer.** Forest products manufacturing and related sectors directly support an estimated 2,300 jobs within the ten-county North Central Landscape.
- **North Central is a major player in statewide timber harvest.** The North Central Landscape forests account for 41% of the total statewide harvest.
- **Local forest products demand.** Large mills in the North Central Landscape, and those with procurement areas within the ten county area report consumption of over 2.5 million cords annually (approximately 84% of statewide total harvest).

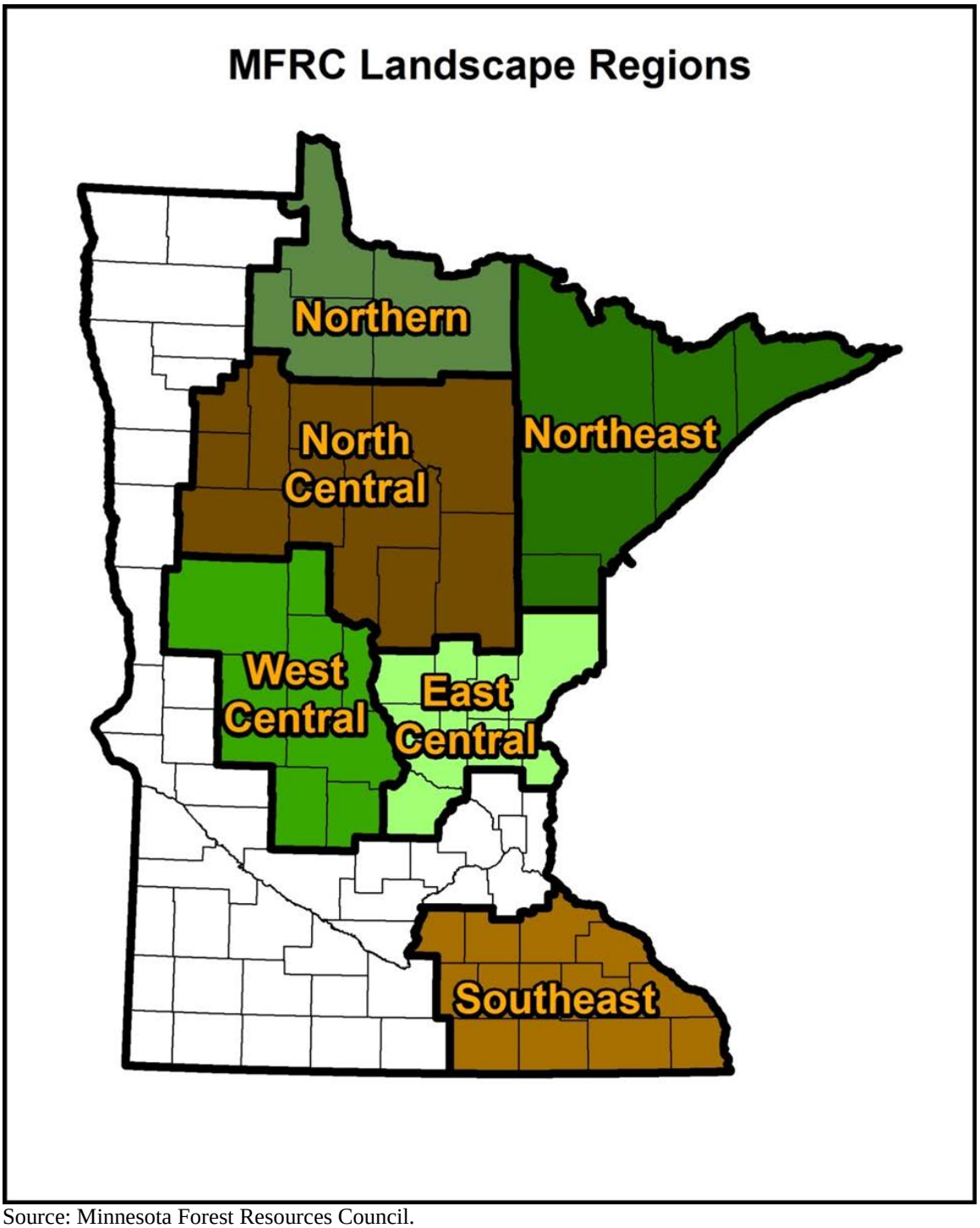
- **Healthy tourism sector.** Tourism is a substantial and growing component of the regional economy with $640 million in gross sales and providing jobs for over 13,000 people.
- **Developed roadway network**. The North Central Landscape roadway network is over 19,000 miles in length and includes US Highways 2, 71, and 169 in addition to state and county highways systems.

List of Tables

List of Figures

Setting

The Minnesota Forest Resources Council defines the North Central Landscape as the following ten county area: Aitkin, Becker, Cass, Clearwater, Crow Wing, Hubbard, Itasca, and Mahnomen counties, in addition to the southern half of Beltrami County and eastern half of Polk County.



Source: Minnesota Forest Resources Council.

Goal 1 – Forest Land Cover

MFRC Goal 1: Land area covered by forests within a region's landscape will be the same or larger.

The MFRC North Central Landscape contains Aitkin, Becker, Cass, Clearwater, Crow Wing, Hubbard, Mahnomen, and Itasca counties, in addition to the southern half of Beltrami County and eastern half of Polk County. These ten counties cover approximately 9.1 million acres, of which over 4.9 million acres (54.3%) are forested. The data in this section shows the extent of forestlands across the region at present and in recent decades.

1.1. Land Cover Data Sources

Presettlement Vegetation of Minnesota: is based on Francis J. Marschner's original analysis done in the 1930's of 19th century of Public Land Survey notes. Marschner compiled his results in map format which has been subsequently captured in digital format.

1990 Census Land Use and Cover: integrates six different source data sets to provide a simplified 8-category view of Minnesota's land use / cover in 30 meter grid cells.

1992 GAP Analysis Project: created land cover datasets as part of its mission to identify habitats that need further protection. This dataset is based on similar satellite imagery to the National Land Cover Database; however it provides a more detailed classification system than the NLCD and places special emphasis on natural plant communities.

2001, 2006, and 2011 National Land Cover Database (NLCD): is a 16-class land cover classification scheme that has been applied consistently across the conterminous United States at a spatial resolution of 30 meters. NLCD is based primarily on Landsat satellite data and a variety of supporting information.

Forest Inventory Analysis (FIA): is the systematic collection of data and forest information by the U.S. Forest Service for assessment or analysis to assess America's forests. This continuous forest census reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. This data is not meant to be represented spatially.

1.2. 1990 Land Cover

Table 1.1 displays the 1990 census land use and cover for the North Central Landscape. Using this analysis, over 4.2 million acres of the North Central Landscape were forested when the data was collected.

Figure 1.1 illustrates the spatial distribution of these land cover classifications and shows the majority of the bog/marsh/fen habitat existing in the eastern portion of the North Central Landscape. Forested cover is spread throughout the landscape with the exception of the far western portion where agriculture is dominant.

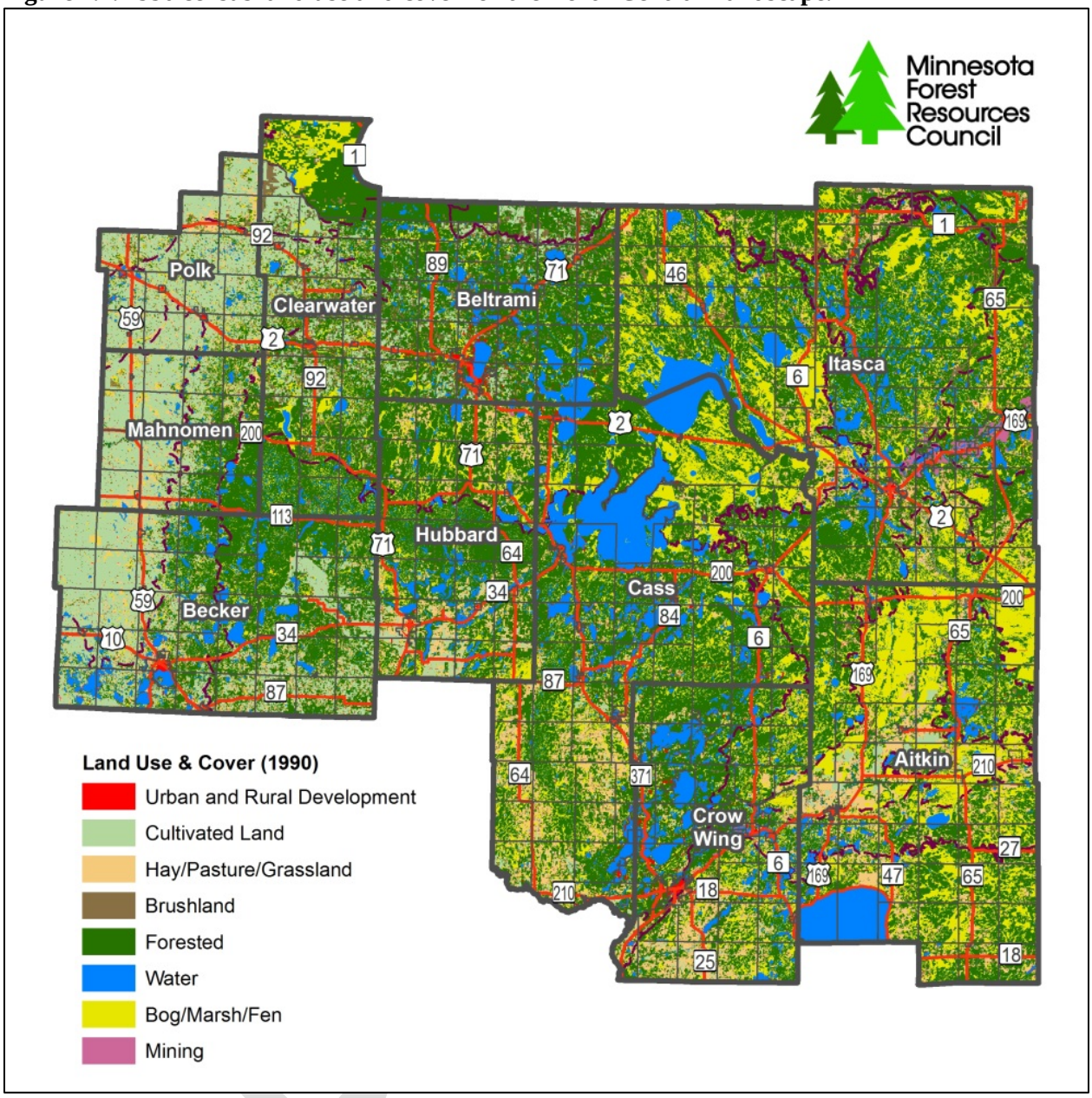
It is important to note, this analysis often placed lowland forests in the 'Bog/Marsh/Fen' category and therefore the combination of this category and 'Forested' of approximately 5.9 million acres, might provide a more accurate estimate.

Table 1.1. 1990 census land use and cover for the North Central Landscape.

Land Use & Cover	Acres	% of Total
Urban and Rural Development	130,137	1.4
Cultivated Land	969,354	10.7
Hay/Pasture/Grassland	823,316	9.1
Brushland	295,537	3.3
Forested	4,243,041	46.8
Water	938,422	10.3
Bog/Marsh/Fen	1,639,433	18.1
Mining	30,465	0.3
Unclassified	8	0.0
Totals	**9,069,715**	**100.0**

Source: MN Geospatial Commons.

Figure 1.1. 1990 census land use and cover for the North Central Landscape.



Source: MN Geospatial Commons.

1.3. Spatial Forestland Cover Analysis (Presettlement, GAP, & NLCD)

Table 1.2 provides an inventory of land cover for five time periods: Presettlement (approximately 150 years ago), 1992, 2001, 2006, and 2011. Figure 1.2 and Figure 1.3 illustrate land cover patterns across the North Central Landscape prior to European settlement and in 2011. As portrayed on the 2011 figure, the North Central continues to be heavily forested. In 2011, more than 3.7 million acres of the North Central Landscape were predicted to be upland forestland (Table 1.2).

It is important to consider sampling scale when comparing modern data sets with presettlement land cover and use caution when drawing conclusions from direct comparisons. With that caveat, estimated upland forestland area decreased by 16.3% (4.46 to 3.74 million acres) and lowland vegetation (includes forested lowlands, shrub lowlands, and emergent herbaceous wetlands) decreased by 5.8% (2.37 to 2.23 million acres) from presettlement to 2011. This change has been less pronounced over recent years with estimated upland forest area decreasing by 2.0% from 2006 to 2011 (3.81 to 3.74 million acres) and lowland vegetation decreasing by 1.1% (2.25 to 2.23 million acres).

Due to challenges in differentiating forested lowlands, shrub lowlands, and emergent herbaceous wetlands using remote sensing, it is difficult to assess the true extent of lowland forests in the 2001, 2006, and 2011 National Land Cover Database (NLCD) data sets.

In 1992, developed lands covered approximately 41,000 acres or 0.5% of the region. In 2011, developed land estimates increased by about 293,000 acres to an area over 334,000 acres (3.7%) of the region. The average annual consumption of rural lands into developed lands from 1992 to 2011 was approximately 15,430 acres per year.

Agricultural land estimates in contrast have decreased from 1.48 million acres (16.3%) in 1992 to less than 667,000 acres (7.4 %) in 2011.

Upland grasslands have also seen a substantial decrease from presettlement (15.1% of total) to 2011 estimates (9.6% of total). Despite this general declining trend, upland grassland estimates have been steadily increasing from 560,550 acres in 1992 to 869,579 acres in 2011.

Table 1.2. Land cover change in the North Central Landscape, Presettlement to 2011.

	Marschner's Presettlement (1895)				GAP Land Cover (1992)			
Comparative Class	**Area (Acres)**	**% of Total**	**NA**	**NA**	**Area (Acres)**	**% of Total**	**Change 1895 to 1992 (Acres)**	**Change 1895 to 1992 (% Cover)**
Upland Forest	4,463,406	49.2	--	--	3,781,916	41.7	-681,490	-7.5
Upland Shrub	168,778	1.9	--	--	295,996	3.3	127,217	1.4
Upland Grass	1,371,596	15.1	--	--	560,550	6.2	-811,047	-8.9
Lowland Vegetation	2,365,973	26.1	--	--	2,015,059	22.2	-350,914	-3.9
Agriculture	0	0.0	--	--	1,480,323	16.3	1,480,323	16.3
Open Water	699,619	7.7	--	--	877,344	9.7	177,725	2.0
Barren	0	0.0	--	--	17,608	0.2	17,608	0.2
Developed	0	0.0	--	--	40,918	0.5	40,918	0.5
Unclassified	342	0.0	--	--	0	0.0	-342	0.0
Total North Central Region	**9,069,715**	**100.0**	**--**	**--**	**9,069,715**	**100.0**	**--**	**--**

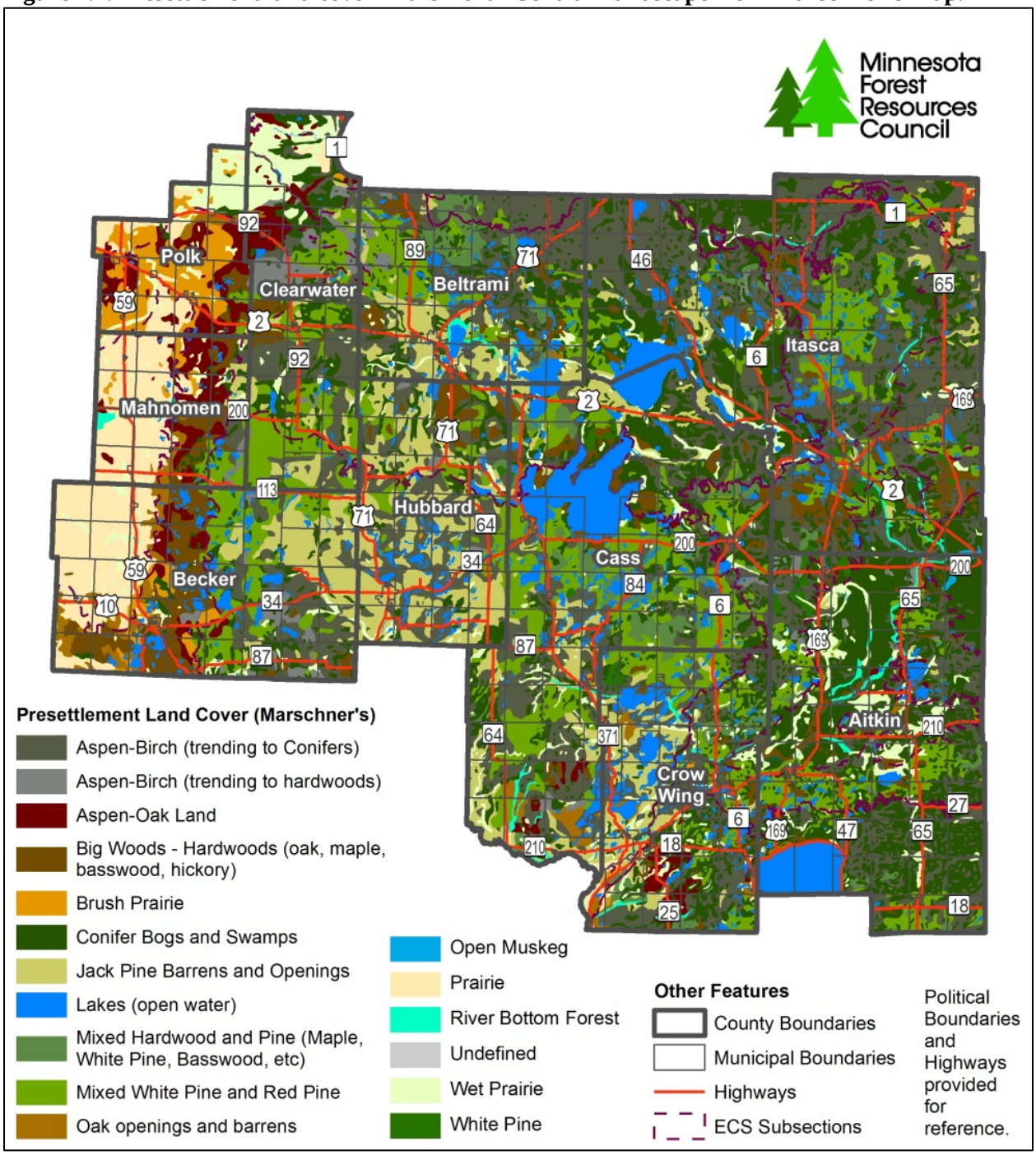
	NLCD (2001)				NLCD (2006)			
Comparative Class	**Area (Acres)**	**% of Total**	**Change 1992 to 2001 (Acres)**	**Change 1992 to 2001 (% Cover)**	**Area (Acres)**	**% of Total**	**Change 2001 to 2006 (Acres)**	**Change 2001 to 2006 (% Cover)**
Upland Forest	3,850,912	42.5	68,996	0.8	3,809,896	42.0	-41,016	-0.5
Upland Shrub	286,327	3.2	-9,669	-0.1	295,566	3.3	9,239	0.1
Upland Grass	841,384	9.3	280,834	3.1	850,947	9.4	9,563	0.1
Lowland Vegetation	2,237,143	24.7	222,083	2.4	2,253,660	24.8	16,518	0.2
Agriculture	667,392	7.4	-812,932	-9.0	667,437	7.4	46	0.0
Open Water	904,191	10.0	26,847	0.3	902,924	10.0	-1,267	0.0
Barren	4,618	0.1	-12,990	-0.1	9,151	0.1	4,533	0.0
Developed	277,748	3.1	236,830	2.6	280,133	3.1	2,384	0.0
Unclassified	0	0.0	0	0.0	0	0.0	0	0.0
Total North Central Region	**9,069,715**	**100.0**	**--**	**--**	**9,069,715**	**100.0**	**--**	**--**

Table 1.2. Continued.

	NLCD (2011)			
Comparative Class	**Area (Acres)**	**% of Total**	**Change 2006 to 2011 (Acres)**	**Change 2006 to 2011 (% Cover)**
Upland Forest	3,735,130	41.2	-74,766	-0.8
Upland Shrub	324,015	3.6	28,449	0.3
Upland Grass	869,579	9.6	18,632	0.2
Lowland Vegetation	2,228,779	24.6	-24,881	-0.3
Agriculture	666,773	7.4	-664	0.0
Open Water	901,124	9.9	-1,801	0.0
Barren	10,250	0.1	1,099	0.0
Developed	334,065	3.7	53,932	0.6
Unclassified	0	0.0	0	0.0
Total North Central Region	**9,069,715**	**100.0**	**--**	**--**

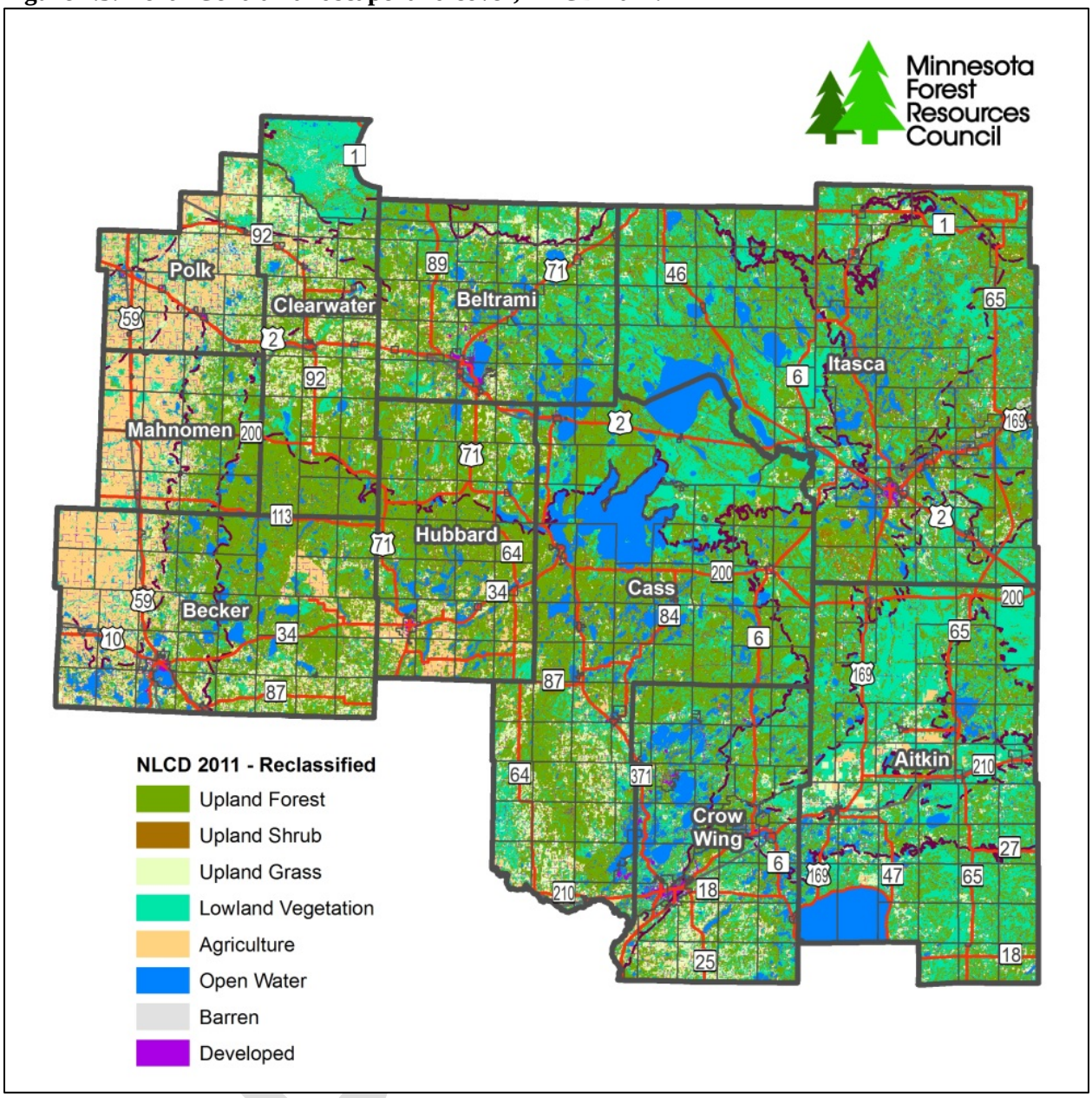
Source: MN Geospatial Commons, Multi-Resolution Land Characteristics Consortium.
Note: Some changes in areas of cover types from one dataset to another may be due to changes in scale and/or classification methodologies used in creation of each dataset. However, the NLCD 2001, 2006, and 2011 datasets are directly comparable.

Figure 1.2. Presettlement land cover in the North Central Landscape from Marschner's Map.



Source: MN Geospatial Commons.

Figure 1.3. North Central landscape land cover, NLCD 2011.



Source: MN Geospatial Commons.

1.4. The Extent of Forestland in Recent Decades

According to United States Forest Service (USFS) Forest Inventory and Analysis (FIA) estimates, between 1977 and 2015, the MFRC North Central Landscape decreased in forested acreage by over 60,000 acres, despite an increase of approximately 94,000 acres between the 2003 and 2015 inventories (Table 1.3). As of 2015, there was over 4.9 million acres of forestland in the North Central Landscape which is approximately 61.3% of the total terrestrial acreage in the region (Table 1.4).

According to 2015 USFS FIA estimates Itasca County contains 27.6% of the North Central Landscape's nearly 5 million forested acres, followed by Cass (17.0%) and Aitkin (16.1%) counties (Figure 1.4). Mahnomen and Polk counties are the least-forested counties with only 2.7% of the regions forested acres between them.

Potential threats to the amount of forestland in the region include agricultural conversions. As previously noted, agriculture declined between the 2006 and 2011 NLCD assessments, but recent increases in commodity crop prices have led to the large scale conversion of pine forests to potato fields. Another treat includes Trust Fund land use. Currently, Trust Fund lands cover over 733,000 acres (8.1% of the region), but only 24% of that land has a Highest and Best Use (HBU) classification of forestry (Table 2.3). About 53% of the Trust Fund lands have a mineral HBU classification, and the real estate HBU classification applies to approximately another 13% of the Trust Fund lands. See section 2.2.1. School Trust Lands for more information about Minnesota's Trust Fund lands.

Table **1.3. Estimated extent of forestland acres in the North Central Landscape, 1977-2015.**

	1977	1990	2003	2015
Aitkin	753,644 (4.22, 534)	754,177 (3.64, 626)	774,658 (2.64, 246)	796,355 (5.32, 299)
Becker	328,886 (6.55, 240)	335,312 (5.76, 278)	348,312 (6.3, 107)	321,694 (9.1, 124)
Beltrami	402,072 (5.79, 263)	400,877 (5.29, 351)	402,944 (7.74, 133)	426,058 (7.96, 154)
Cass	879,357 (3.68, 513)	868,715 (3.45, 708)	826,216 (3.76, 252)	838,193 (5.23, 308)
Clearwater	332,092 (6.54, 225)	317,933 (5.9, 261)	317,698 (6.77, 100)	305,802 (9.34, 116)
Crow Wing	380,486 (6.05, 266)	388,135 (5.21, 306)	355,199 (4.52, 125)	370,561 (8.43, 142)
Hubbard	434,071 (5.66, 309)	401,514 (5.18, 355)	367,769 (6.03, 125)	387,144 (8.26, 145)
Itasca	1,346,925 (2.94, 842)	1,361,403 (2.65, 1,140)	1,310,732 (2.4, 420)	1,363,574 (4.17, 480)
Mahnomen	106,691 (11.62, 76)	121,326 (9.75, 92)	110,409 (10.11, 37)	98,851 (16.53, 41)
Polk	40,821 (18.28, 29)	31,500 (19.31, 29)	36,396 (26.48, 13)	35,959 (25.22, 16)
North Central Landscape	**5,005,046 (1.22, 3,297)**	**4,980,891 (0.98, 4,146)**	**4,850,333 (1.2, 1558)**	**4,944,190 (1.39, 1825)**
Change		-24,155	-130,558	93,857

Source: Forest Inventory and Analysis estimate.
Note: Values are acres followed by the sampling error percent and number of plots.
Note: Area estimates are based on FIA samples and affected by stratification of the sample into categories and by non-sampled rates leading to some artificial variability in area estimates from survey to survey.

Table 1.4. Estimated extent of forestland in the North Central Landscape, 1977-2015.

Land Cover	1977 acres	1990 acres	2003 acres	2015 acres
Forestland[A]	5,005,046	4,980,891	4,850,333	4,944,190
Non-forestland[B*]	3,147,708	3,217,005	3,216,548	3,120,876
Percent Forestland	**61.4%**	**60.8%**	**60.1%**	**61.3%**

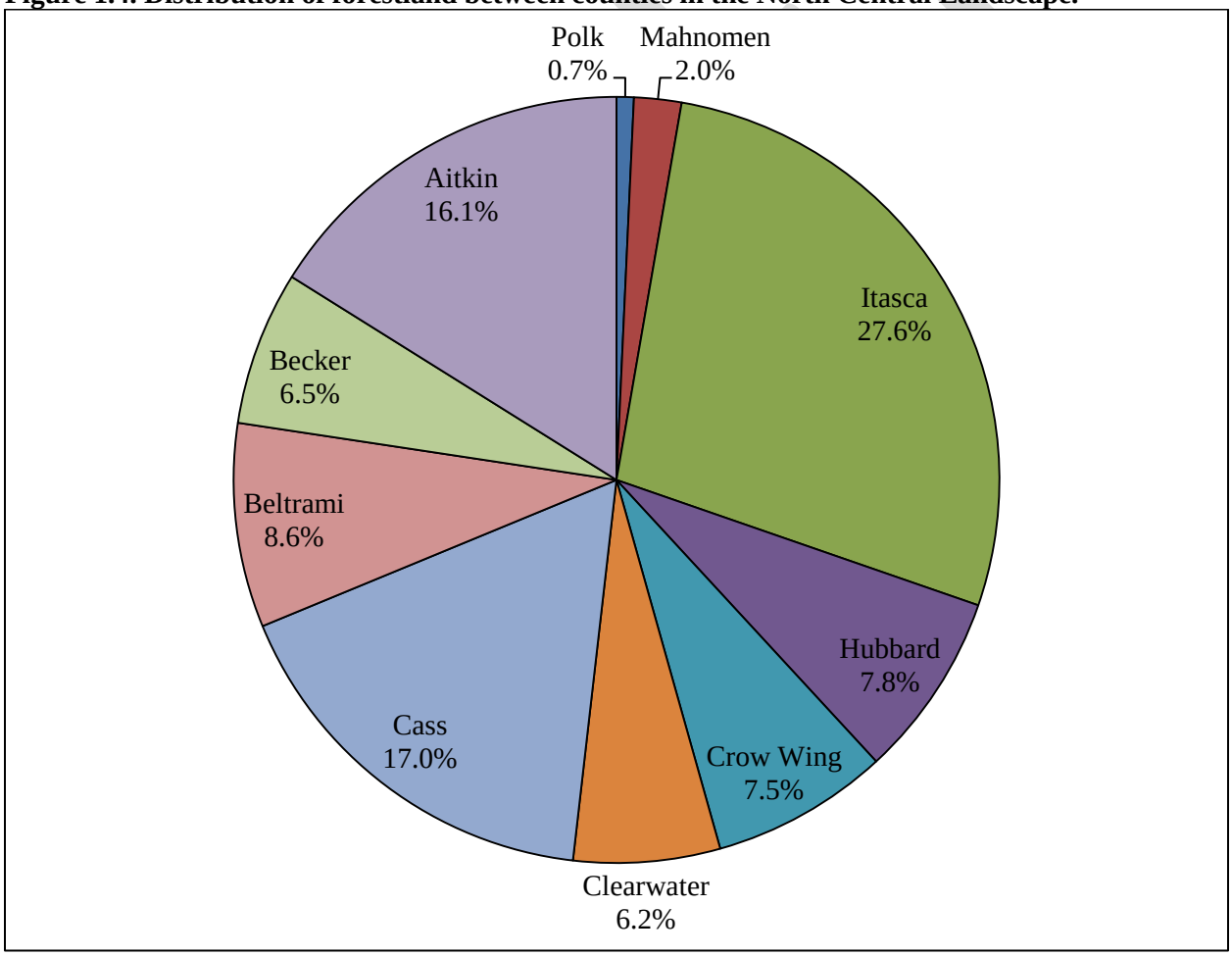
Source: Forest Inventory and Analysis estimate.

[A] FIA defines forestland as: Land that is at least 10 percent stocked by forest trees of any size, or land formerly having such tree cover, and not currently developed for a non-forest use. The minimum area for classification as forest land is one acre. Roadside, stream-side, and shelterbelt strips of timber must be at least 120 feet wide to qualify as forest land. Unimproved roads and trails, streams and other bodies of water, or natural clearings in forested areas are classified as forest, if less than 120 feet in width or one acre in size. Grazed woodlands, reverting fields, and pastures that are not actively maintained are included if the above qualifications are satisfied. Forest land includes three sub-categories: timberland, reserved forestland, and other forestland.

[B] All terrestrial acres not designated as forestland.

Note: Area estimates are based on FIA samples and affected by stratification of the sample into categories and by non-sampled rates leading to some artificial variability in area estimates from survey to survey.

Figure 1.4. Distribution of forestland between counties in the North Central Landscape.



Source: Forest Inventory and Analysis estimate.

Goal 2 – Land Ownership

MFRC Goal 2: Forests within a region's landscape will be in a variety of ownerships, serving both public and private interests.

Data presented in this section show recent trends in forestland ownership in the North Central Landscape.

2.1. Land Ownership Data Sources

GAP Stewardship 2008: created land ownership information for the entire state of Minnesota. These data were created specifically to support the GAP Analysis Project. The base cartography is derived from mathematically subdivided PLS quarter-quarter sections and the 40 acre polygons have been dissolved on the ownership values in the attribute table. Ownership reflects surface features only. Ownership is only as current as the source information and should not be considered comprehensive for the entire state. Land interest is expressed only when some organization owns or administers more than 50 percent of a forty except where sub-forty accuracy stewardship polygons were created.

Forest Inventory Analysis (FIA): is the systematic collection of data and forest information by the U.S. Forest Service for assessment or analysis to assess America's forests. This continuous forest census reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. This data is not meant to be represented spatially but breaks forestland and timberland estimates down by ownership class.

MN DNR Private Forest Management Program, Forest Stewardship Program

- (FSP 2013): The Forest Stewardship program "provides technical advice and long-range forest management planning to interested landowners." More information available at: http://www.dnr.state.mn.us/grants/forestmgmt/stewardship.html
- (Arends et al. 2009): Arends, Andrew, Gary Michael, and the Forest Stewardship Council. Nov. 23, 2009. "Charging for stewardship plans." Available at: http://files-intranet.dnr.state.mn.us/user_files/1865/changingstewardshipplans.pdf?ticket=ST-2616560-Oz8c867MPmLKUtuuOR24
- (USFS 2009): U.S. Forest Service. 2009. Spatial Analysis Program. More information available at: http://www.fs.fed.us/na/sap/products/mn.shtml

MN DNR Data Deli: The internet-based spatial data acquisition site hosted by the Minnesota Department of Natural Resources. http://deli.dnr.state.mn.us/index.html

National Woodland Owner Survey (NWOS): is the official census of forest owners in the United States. On an annual basis, the NWOS contacts forest-land owners from across the county to ask them questions about: The forest land they own, their reasons for owning it, how they use it, if and how they manage it, sources of information about their forests, their concerns and issues related to their forests, their intentions for the future of their forests, and their demographics.

2.2. Land Ownership – Administration.

Ownership in the North Central Landscape is split between many different public and private entities. Table 2.1 and Figure 2.1 were developed using GAP Stewardship 2008 data. This area is dominated by public lands with 38.6% of the total land area in public ownership, of which 99.0% is owned by the State of Minnesota or the US Forest Service. There is just over 5.4 million acres of private land in the North Central Landscape.

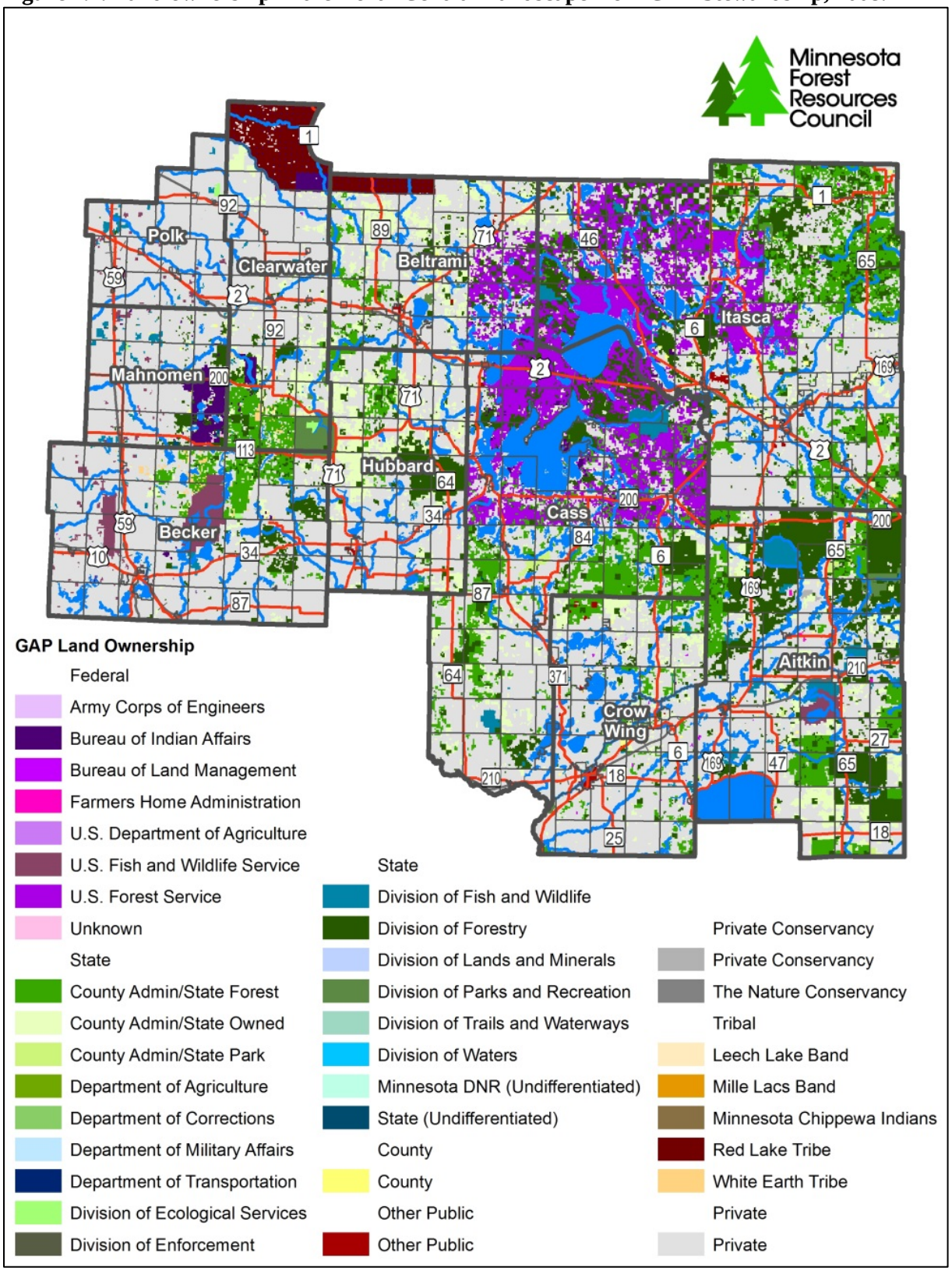
In many cases land ownership and management or administration are the same; however there are several situations where this distinction can make a dramatic difference in understanding trends on the landscape. For instance 'County Administered State Owned' tax forfeit land is owned by the State of Minnesota, however, it is managed by the counties changing the relative importance of counties in the North Central Landscape from 0.2 % to 14.8 % of the total land area (Table 2.1 and Table 2.2, Figure 2.1and Figure 2.2).

Table 2.1. Land ownership in the North Central Landscape from GAP Stewardship, 2008.

Ownership Type	Land Ownership	Acres	% of Total
Federal	Army Corps of Engineers	5,088	0.1
	Bureau of Indian Affairs	89,548	1.0
	Bureau of Land Management	5,744	0.1
	Farmers Home Administration	1,193	0.0
	U.S. Fish and Wildlife Service	99,922	1.1
	U.S. Forest Service	662,762	7.3
	Unknown	15,264	0.2
Total Federal		**879,521**	**9.7**
State	County Admin/State Forest	780,124	8.6
	County Admin/State Owned	526,698	5.8
	County Admin/State Park	16,063	0.2
	Department of Military Affairs	41	0.0
	Department of Transportation	449	0.0
	Division of Ecological Services	5,679	0.1
	Division of Fish and Wildlife	139,337	1.5
	Division of Forestry	1,053,080	11.6
	Division of Lands and Minerals	1,264	0.0
	Division of Parks and Recreation	53,640	0.6
	Division of Trails and Waterways	658	0.0
	Division of Waters	541	0.0
	Minnesota DNR (Undifferentiated)	672	0.0
	State (Undifferentiated)	3,498	0.0
Total State		**2,581,744**	**28.5**
County	County	20,135	0.2
Total County		**20,135**	**0.2**
Other Public	Other Public	15,480	0.2
Total Other Public		**15,480**	**0.2**
Private Conservancy	Private Conservancy	2,105	0.0
	The Nature Conservancy	246	0.0
Total Private Conservancy		**2,351**	**0.0**
Total Public and Private Conservancy		**3,499,230**	**38.6**
Tribal	Leech Lake Band	4,954	0.1
	Mille Lacs Band	116	0.0
	Minnesota Chippewa Indians	1,988	0.0
	Red Lake Tribe	135,243	1.5
	White Earth Tribe	13,386	0.1
Total Tribal		**155,688**	**1.7**
Total Private	**Private**	**5,414,797**	**59.7**
Total North Central Region		**9,069,715**	**100.0**

Source: MN Geospatial Commons.

Figure 2.1. Land ownership in the North Central Landscape from GAP Stewardship, 2008.



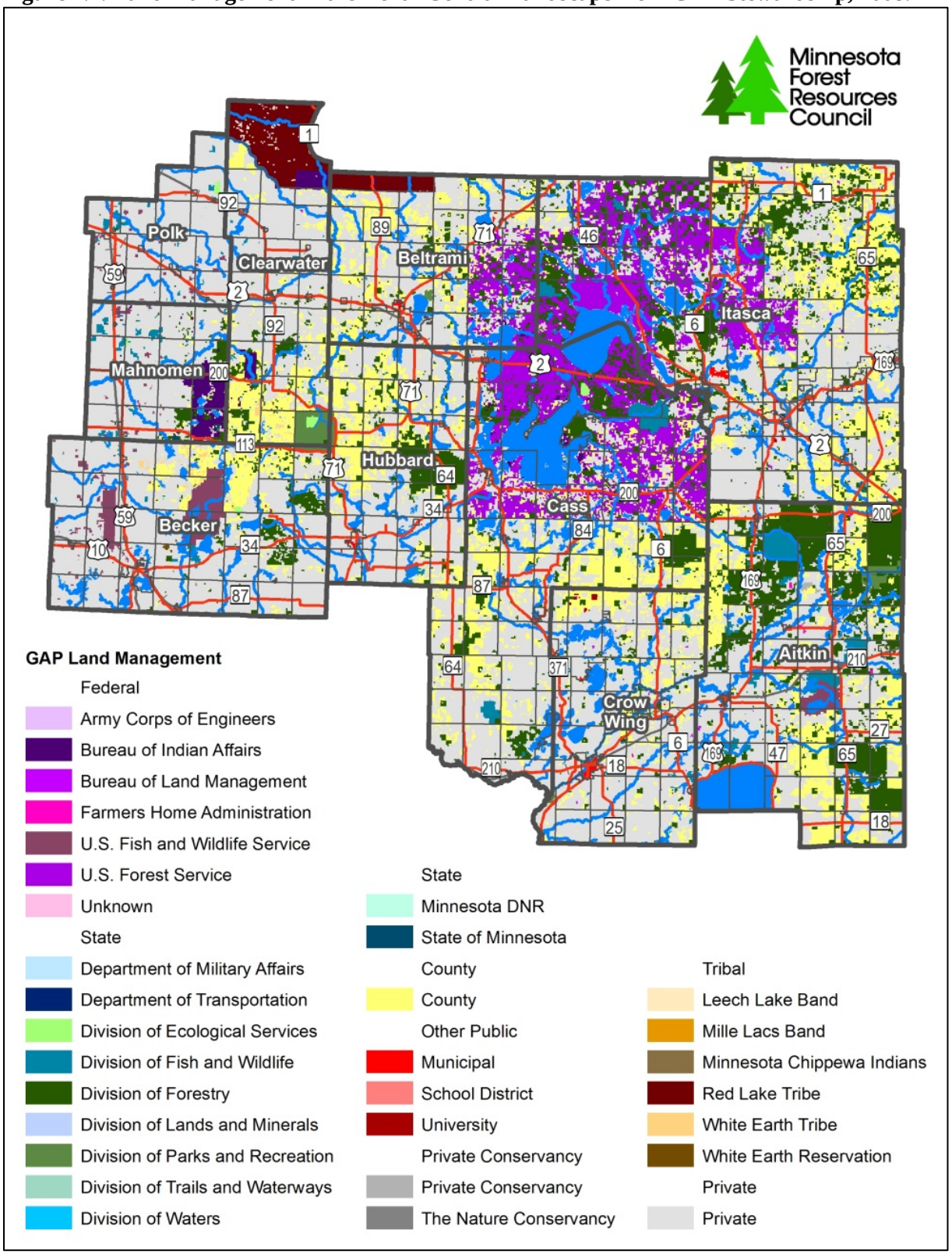
Source: MN Geospatial Commons.

Table 2.2. Land management in North Central Landscape from GAP Stewardship 2008.

Management Type	Land Management	Acres	% of Total
Federal	Army Corps of Engineers	5,088	0.1
	Bureau of Indian Affairs	80,578	0.9
	Bureau of Land Management	5,744	0.1
	Farmers Home Administration	1,193	0.0
	U.S. Fish and Wildlife Service	99,922	1.1
	U.S. Forest Service	662,617	7.3
	Unknown	15,264	0.2
Total Federal		**870,405**	**9.6**
State	Department of Military Affairs	41	0.0
	Department of Transportation	449	0.0
	Division of Ecological Services	7,852	0.1
	Division of Fish and Wildlife	139,337	1.5
	Division of Forestry	1,051,584	11.6
	Division of Lands and Minerals	1,264	0.0
	Division of Parks and Recreation	53,109	0.6
	Division of Trails and Waterways	658	0.0
	Division of Waters	541	0.0
	Minnesota DNR	672	0.0
	State of Minnesota	3,498	0.0
Total State		**1,259,003**	**13.9**
County	County	1,343,021	14.8
Total County		**1,343,021**	**14.8**
Other Public	Municipal	12,235	0.1
	School District	902	0.0
	University	2,343	0.0
Total Other Public		**15,480**	**0.2**
Private Conservancy	Private Conservancy	2,105	0.0
	The Nature Conservancy	246	0.0
Total Private Conservancy		**2,351**	**0.0**
Total Public and Private Conservancy		**3,490,261**	**38.5**
Tribal	Leech Lake Band	11,006	0.1
	Mille Lacs Band	979	0.0
	Minnesota Chippewa Indians	1,486	0.0
	Red Lake Tribe	135,243	1.5
	White Earth Reservation	2,557	0.0
	White Earth Tribe	13,386	0.1
Total Tribal		**164,658**	**1.8**
Total Private	**Private**	**5,414,797**	**59.7**
Total North Central Region		**9,069,715**	**100.0**

Source: MN Geospatial Commons.

Figure 2.2. Land management in the North Central Landscape from GAP Stewardship, 2008.



Source: MN Geospatial Commons.

2.2.1. School Trust Lands

When Minnesota became a state in 1858, sections 16 and 36 of every township were granted to Minnesota from the federal government to support schools. Alternative sections, referred to as Indemnity Lands, were granted when sections 16 and 36 had already been claimed, were reserved for an Indian reservation, or were under water. The grant ultimately resulted in 2.9 million acres being given to the state for the use of the public schools and the Minnesota Constitution established the Permanent School Fund (PSF) to ensure long-term funding would be generated from accumulated revenues from the land for public education. As a result, these lands are owned by the state in trust for all public schools of Minnesota, they are not owned by the local school district. Also included in school trust lands today are remaining lands from two other federal land grants: the Swampland grant of about 4.7 million acres in 1860, and the Internal Improvement grant of 500,000 acres in 1866.

By 1900, much of this land had been sold to support public schools. Today roughly 2.4 million acres (31% of the original 8.1 million acres) of school trust lands and an additional 1 million acres of mineral rights remain and are managed by the DNR. The vast majority of these lands are located in the northern forested portion of the state with nearly 734,000 acres found in the North Central Landscape, accounting for almost 8.1% of the regional land cover (Table 2.3) and Figure 2.3).

In 2013, the Minnesota Legislature established the 12 member Legislative Permanent School Fund Commission to advise the Department of Natural Resources and the school trust lands director on the management of permanent school fund land and review legislation affecting permanent school fund land. The commission is required to review statutes and recommend any changes necessary for provident utilization of school trust lands, and to report annually to the legislature with recommendations for management of school trust fund lands to secure long-term economic return for the permanent school fund. The impact of this new commission on management of school trust lands in North Central Minnesota is unknown but there may be changes in ownership and/or management of these lands in the near future.

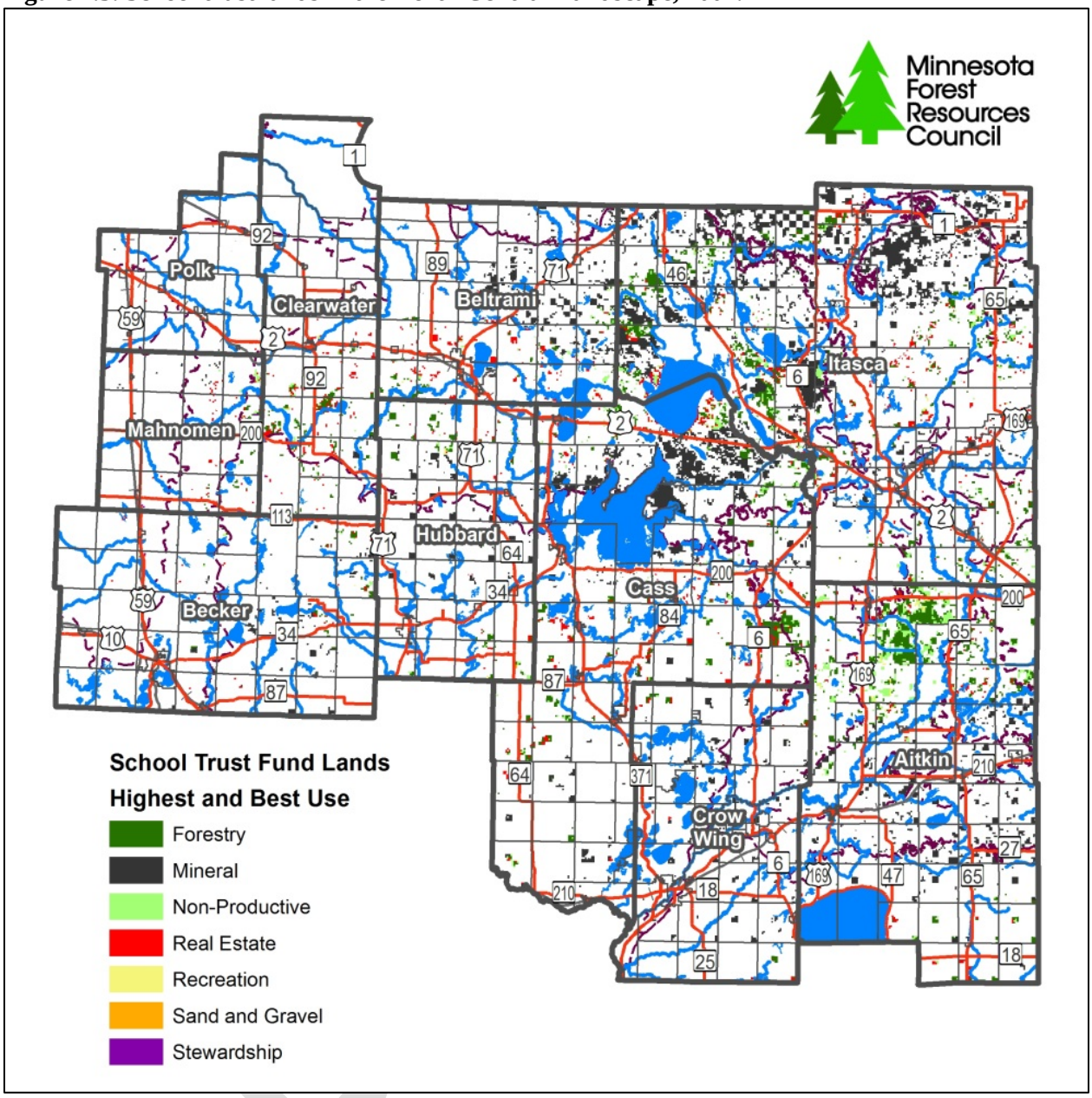
For more information visit: www.dnr.state.mn.us/aboutdnr/school_lands/index.html

Table 2.3. School trust lands in the North Central Landscape.

School Trust Fund Lands Highest and Best Use	Acres	% of Region
Forestry	176,467	1.9
Mineral	387,446	4.3
Non-Productive	69,146	0.8
Real Estate	91,850	1.0
Recreation	7,052	0.1
Sand and Gravel	359	0.0
Stewardship	1,522	0.0
Total School Trust Fund Lands	**733,842**	**8.1**
Total North Central Region	**9,069,715**	

Source: MN DNR Forestry.

Figure 2.3. School trust lands in the North Central Landscape, 2007.



Source: MN DNR Forestry.

2.3. Forestland Management/Administration

According to FIA estimates over 53% of the 4.9 million acres of forestland in the North Central Landscape is publicly owned (Figure 2.4 and Table 2.4). This public land is split relatively evenly between Federal (13%), State (18%), and County/Municipal (21%) ownerships. The region-wide ratio of public to private land (1.14:1) is identical to the statewide estimate, although the public land is not spread evenly throughout the region with the ratio ranging from 0.14 in Polk County to 2.28 in Cass County (Table 2.4). The federal land is primarily restricted to Cass and Itasca Counties with over 250,000 acres of federal land (primarily the Chippewa National Forest) in each county while some other counties have zero acres of estimated federal forestland. Over 31% of the total forest land in Cass County is owned by the US Forest Service. State land is a little more evenly distributed with the highest estimated totals in Aitkin (273,406 acres) and Itasca (268,030 acres) counties. Beltrami County (32%) has the highest percentage of total forestland in local-government ownership.

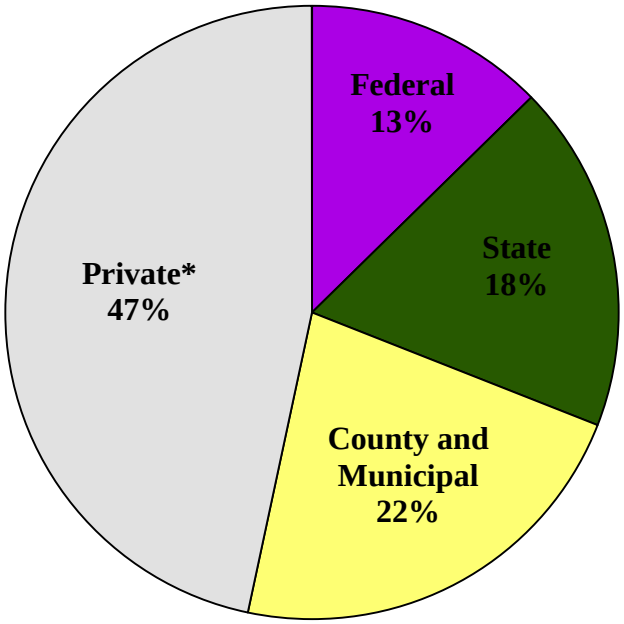
The remaining 47% of the region's forestland is split between Tribal, Industrial Private, and Non-Industrial Private land ownership (Figure 2.4 and Table 2.5). Due to data disclosure issues these three categories are lumped together under the general heading of 'Private' for the counties. The highest total private forestland estimates in the region are in Itasca (571,682 acres) and Aitkin (325,057 acres) counties while the highest percentage of total forestland is in Polk (87.7%) and Mahnomen counties (80.4%).

FIA further splits forestland into three administration classes as shown in Table 2.6. The three classes of forestlands are defined as follows:

- Reserved forestlands – Lands on which timber production is prohibited by statute or administrative regulation. See Figure 2.5 for a map of reserved timberlands in the North Central Landscape.
- Timberlands – Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)
- Other forestlands – Lands not capable of producing industrial wood at a sufficient rate. Relatively little of the forestland in the North Central Landscape (1.6%) is 'other forestland'.

Figure 2.5 and Table 2.6 show the acreage of state and federal areas in which timber harvesting is prohibited or highly restricted. These reserved lands account for an estimated 80,000 acres or 1.6% of the North Central Landscape. Most of the reserved land is found in Becker (28,706 acres), Clearwater (20,463 acres), and Aitkin (17,700 acres) counties.

Figure 2.4. Distribution of forestland in the North Central Landscape by owner / administrator, 2015.



Source: Forest Inventory Analysis estimate.
* The FIA database combines Tribal, Forest Industry, and Non-industrial Private as 'Private'. For some analysis these categories cannot be separated due to disclosure laws.

Table 2.4. Estimated forestland area by ownership type in the North Central Landscape, 2015. (Values are acres.)

County	Public			Private*	Ratio (Public : Private)
	Federal	State	County & Municipal		
Aitkin	10,110	273,406	187,782	325,057	1.45:1
Becker	29,288	47,707	66,145	178,553	0.80:1
Beltrami	62,726	29,685	134,977	198,670	1.14:1
Cass	261,104	129,268	192,260	255,561	2.28:1
Clearwater	866	48,126	65,279	191,530	0.60:1
Crow Wing	--	16,438	79,307	274,815	0.35:1
Hubbard	--	72,677	114,871	199,596	0.94:1
Itasca	261,056	268,030	262,807	571,682	1.39:1
Mahnomen	--	16,611	2,736	79,504	0.24:1
Polk	179	4,233	--	31,546	0.14:1
North Central Landscape	**625,329**	**906,181**	**1,106,165**	**2,306,515**	**1.14:1**
Minnesota	2,839,199	3,848,587	2,569,083	8,150,381	1.14:1

Source: Forest Inventory Analysis estimate.
* The FIA database combines Tribal, Forest Industry, and Non-industrial Private as 'Private'. For some analysis these categories cannot be separated due to disclosure laws.

Table 2.5. Estimated acres of private forestland and timberland in the North Central Landscape, 2015.

County	Forestland	Timberland	% of All-ownership Forestland
Aitkin	325,057	323,817	40.8%
Becker	178,553	177,687	55.5%
Beltrami	198,670	196,278	46.6%
Cass	255,561	250,728	30.5%
Clearwater	191,530	191,530	62.6%
Crow Wing	274,815	274,815	74.2%
Hubbard	199,596	198,625	51.6%
Itasca	571,682	550,447	41.9%
Mahnomen	79,504	79,504	80.4%
Polk	31,546	31,546	87.7%
North Central Landscape	**2,306,515**	**2,274,977**	**46.7%**

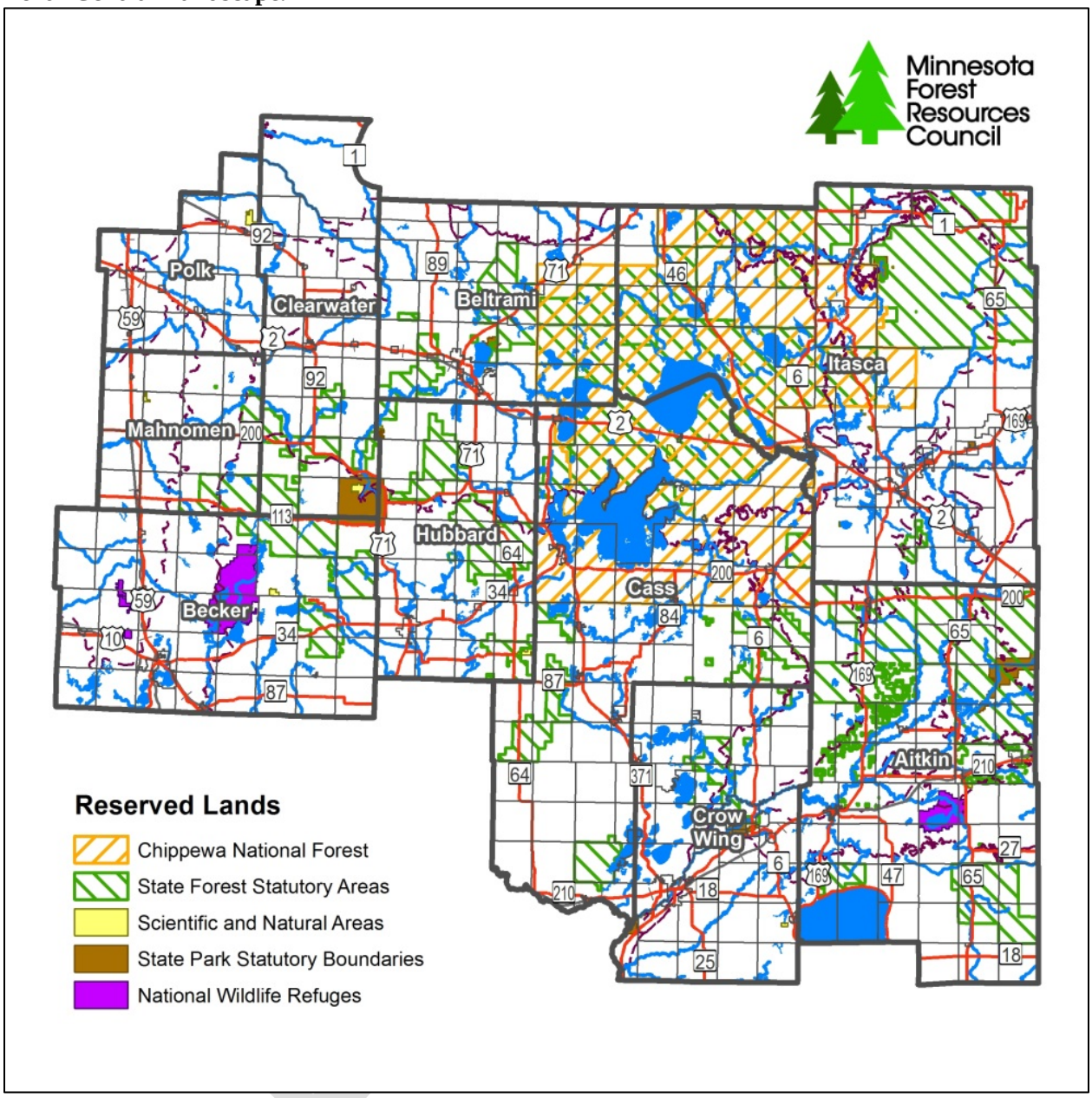
Source: Forest Inventory Analysis estimate.

Table 2.6. Estimated forestland ownership in the North Central Landscape by county, 2015. (Values are acres.)

County	Forestland	Type of Forestland		
		Timberland	Reserved Forestland	Other Forestland
Aitkin	796,355	763,373	17,700	15,282
Becker	321,694	292,121	28,706	866
Beltrami	426,058	420,617	--	5,441
Cass	838,193	816,163	6,238	15,792
Clearwater	305,802	285,339	20,463	--
Crow Wing	370,561	366,759	3,802	--
Hubbard	387,144	386,173	--	971
Itasca	1,363,574	1,323,933	--	39,641
Mahnomen	98,851	98,851	--	--
Polk	35,959	34,402	1,557	--
North Central Landscape	**4,944,190**	**4,787,731**	**78,466**	**77,993**
Minnesota	17,412,528	15,702,250	1,267,619	442,659

Source: Forest Inventory Analysis estimate.
Note: Area estimates are based on FIA samples and affected by stratification of the sample into categories and by non-sampled rates leading to some artificial variability in area estimates from survey to survey.
Note: In October 2013 the Beltrami County Board approved the creation of 397 “Legacy” acres, lands which will have no harvest, lands are located in the Movil Maze Recreation area and in Three Island County Park.

Figure 2.5. State Parks and other forestlands legislatively reserved from timber harvesting in the North Central Landscape.



Source: MN Geospatial Commons.

2.4. Ownership Fragmentation

2.4.1. Parcel sizes of non-industrial private family forest lands

Data on parcel size of family forestland was collected by the USDA Forest Service through the National Woodland Owner Survey between 2002 and 2006 (Table 2.7).

For this survey, the US Forest Service defined *'Family Forestland'* as: families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals that own forest land; where forest land is defined as land at least 10 percent stocked by forest trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. The minimum area for classification of forest land was 1 acre. More information on the NWOS can be found at: www.fia.fs.fed.us/nwos/

In 2006 (survey publish year), total family forestland acreage was estimated at nearly 1.9 million acres in the region of north central Minnesota which includes all of the MFRC North Central Landscape except the eastern half of Polk County. The survey area also included Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties which could not be removed for this analysis. Survey respondents indicated that two thirds of this family forestland is held in parcel sizes of at least 50 acres (Table 2.7 and Figure 2.6). Figure 2.6 shows that more acres of family forestland statewide and in the North Central Landscape are owned in the 100-499 size class than any other ownership size class.

Figure 2.7 shows the estimated distribution of family forestland owners by ownership size class statewide and in the North Central Landscape from National Woodland Owner Survey respondents. Over half (56.7%) of all family forestland owner respondents in the region have properties less than nine acres which is higher than the state average (49.8%). Over 47% of the total family forestland acres in the region are in held by owners which have over 100 acres; however, this represents less than 7.3% of the survey respondents in the region.

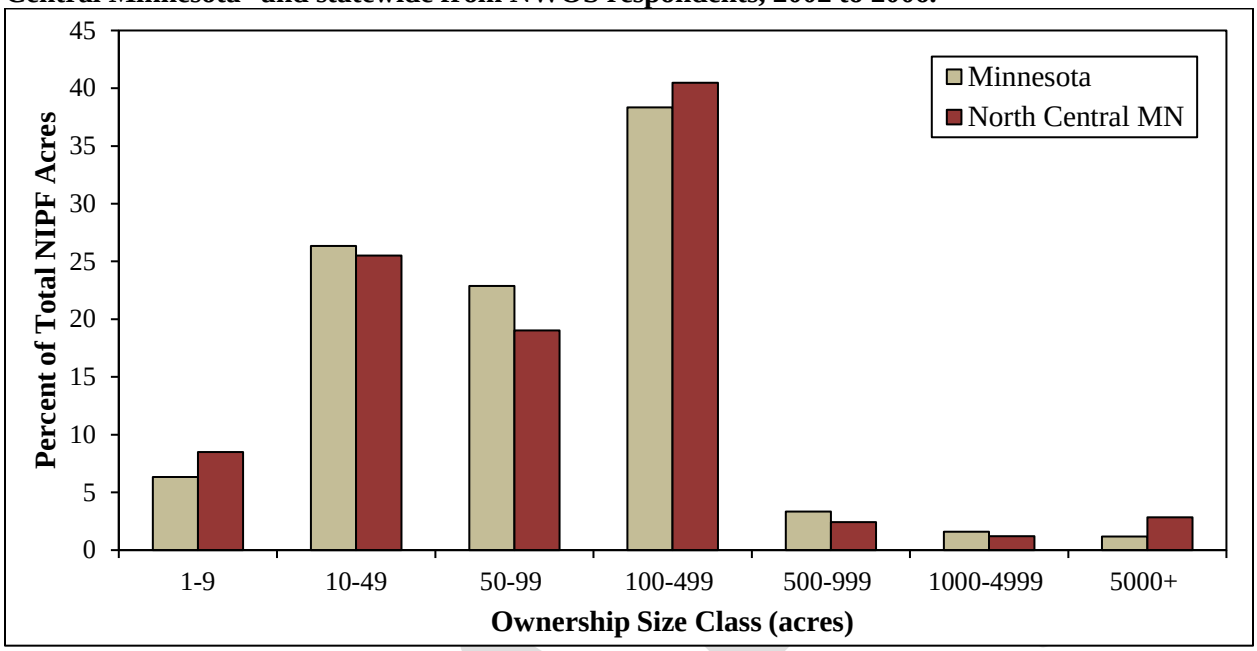
Table 2.7. Estimated area of family forestland acres by ownership size class in North Central Minnesota [A], 2002 to 2006.

	Ownership size class (in acres)							
	1-9	**10-49**	**50-99**	**100-499**	**500-999**	**1000-4999**	**5000+**	**Total**
Acres	159,347	478,041	356,634	758,796	45,528	22,764	53,116	1,874,226
% of total	8.5	25.5	19.0	40.5	2.4	1.2	2.8	--

Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

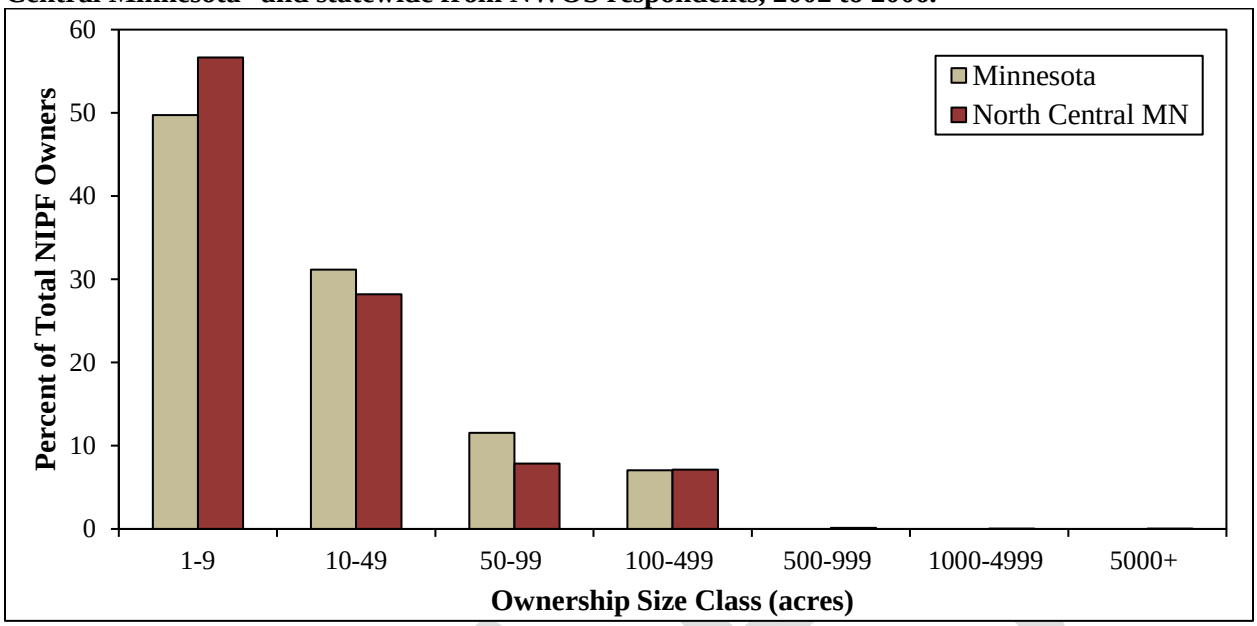
Figure 2.6. Estimated distribution of family forestland acres by ownership size class in North Central Minnesota[A] and statewide from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

Figure 2.7. Estimated distribution of family forestland owners by ownership size class in North Central Minnesota[A] and statewide from NWOS respondents, 2002 to 2006.



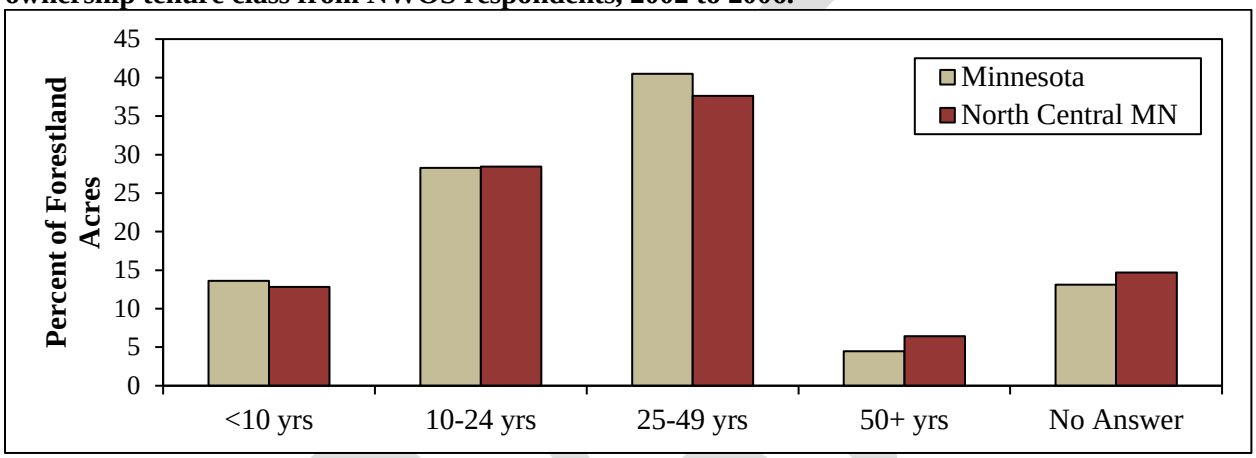
Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

2.4.3. Private land ownership tenure.

Data on private family forestland ownership tenure in North Central Minnesota (includes Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties) was collected by the USDA Forest Service in 2006 (publish year) through the National Woodland Owner Survey (Figure 2.8 and Figure 2.9). Based on survey response in 2006, approximately 37.6% of family forestland acres had been owned by the same owner for 25-49 years, while 12.8% of the total family forestland -acres were owned for less than 10 years. Figure 2.9 shows a little more than 30% of the family forestland owner respondents have held their property for 10-24 years.

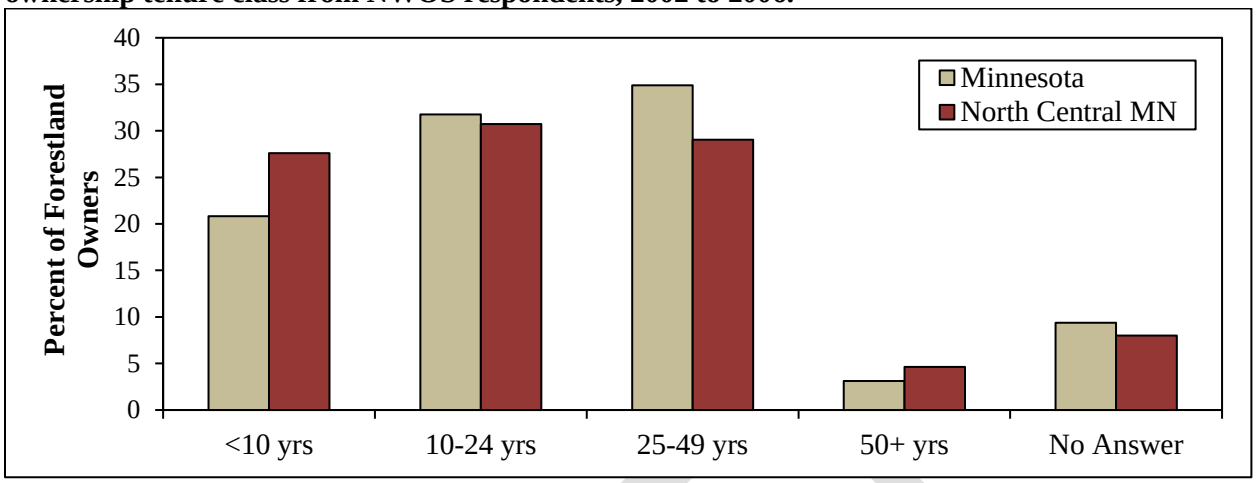
Figure 2.8. Estimated distribution of family forestland acres in North Central Minnesota[A] by ownership tenure class from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

Figure 2.9. Estimated distribution of family forestland owners in North Central Minnesota[A] by ownership tenure class from NWOS respondents, 2002 to 2006.



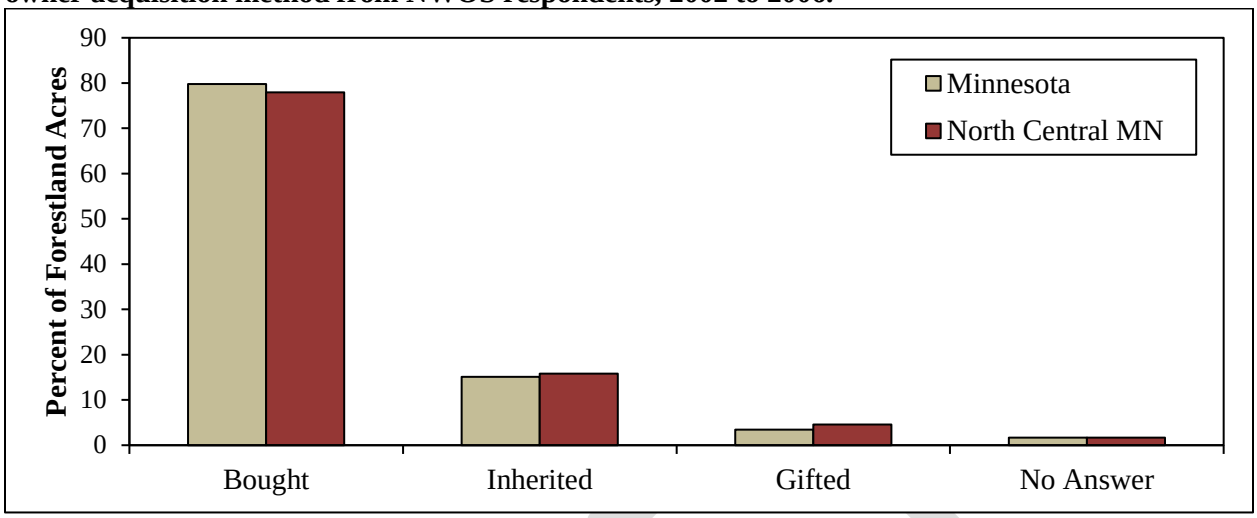
Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

2.4.4. Private land acquisition method.

Data on family forest land acquisition method in North Central Minnesota (includes Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties) was collected by the USDA Forest Service in 2006 (publish year) through the National Woodland Owner Survey (Figure 2.10 and Figure 2.11). Around 80% of family forestland acreage and properties were acquired via purchase based on NWOS response.

Figure 2.10. Estimated distribution of family forestland acres in North Central Minnesota[A] by owner acquisition method from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

Figure 2.11. Estimated distribution of family forestland owners in North Central Minnesota[A] by owner acquisition method from NWOS respondents, 2002 to 2006.

Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

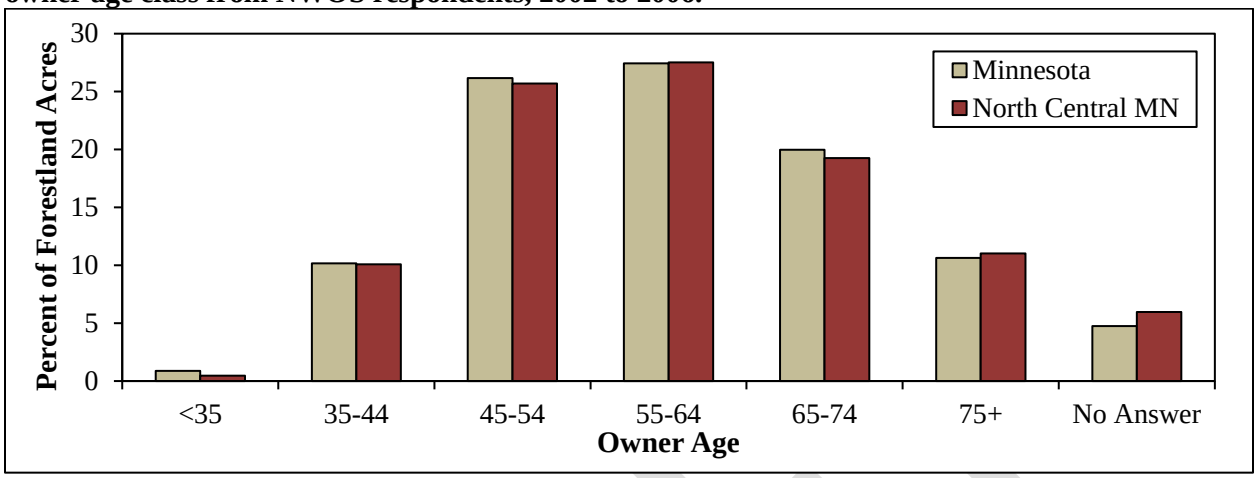
[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

2.4.5. Private landowner age.

Data on family forest landowner age in North Central Minnesota (includes Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties) was collected by the USDA Forest Service in 2006 (publish year) through the National Woodland Owner Survey (Figure 2.12 and Figure 2.13). Based on survey response in 2006, approximately 35% of all family forestland by acreage and owners was owned by

people greater than 65. This is in stark contrast to the less than one percent of private land owned by individuals less than 35 years of age.

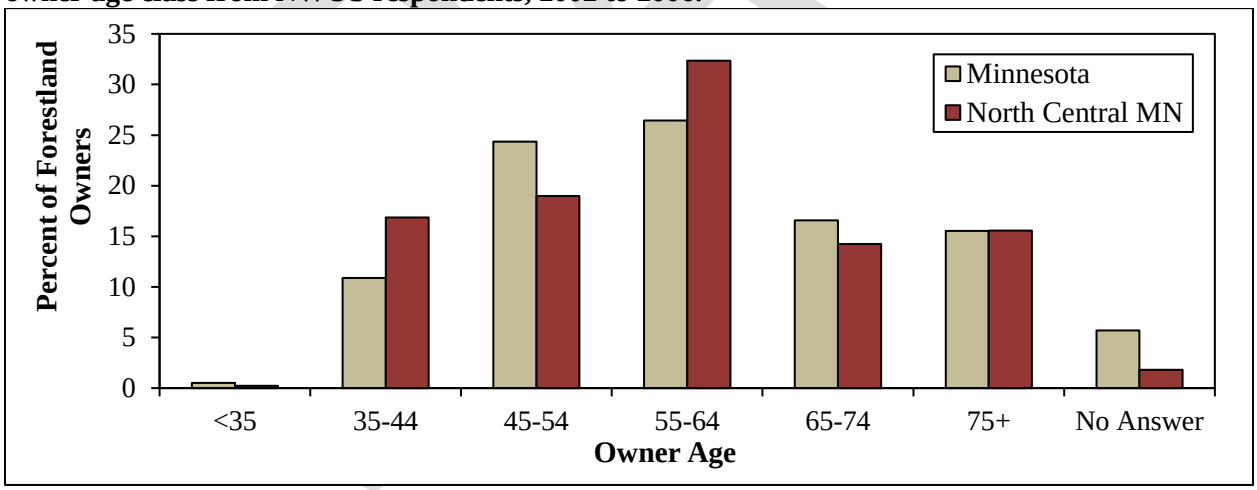
Figure 2.12. Estimated distribution of family forestland acres in North Central Minnesota[A] by owner age class from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

Figure 2.13 Estimated distribution of family forestland owners in North Central Minnesota[A] by owner age class from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

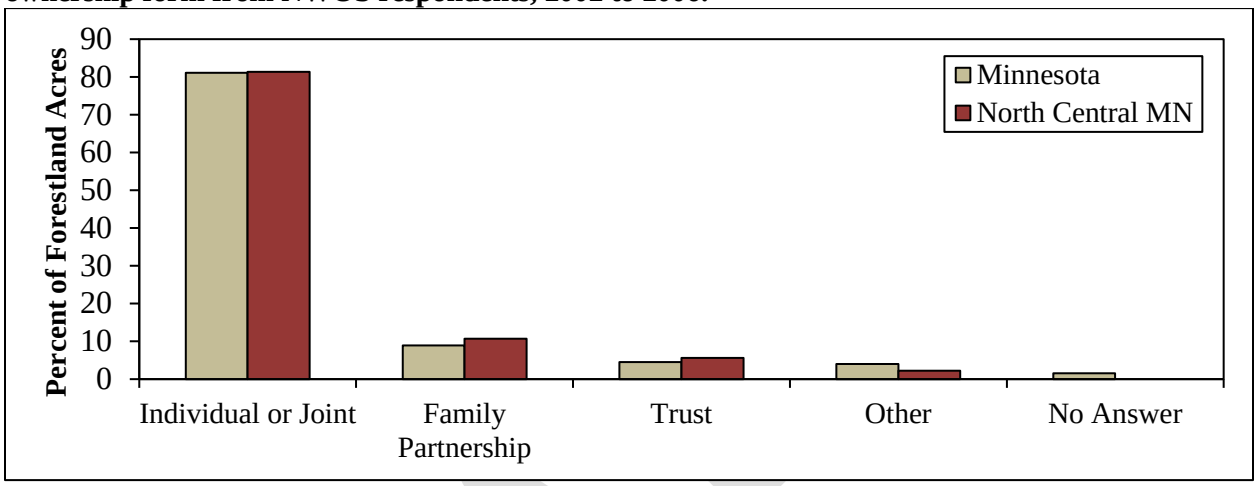
[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included

2.4.6. Private land ownership form.

Data on family forestland ownership form in North Central Minnesota (includes Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties) was collected by the USDA Forest Service

in 2006 (publish year) through the National Woodland Owner Survey (Figure 2.14 and Figure 2.15). Based on survey response in 2006, approximately 84% of all family forestland was owned individually or jointly. This trend was even higher for forestland owners where nearly 93% of the forestland owners were individual or joint.

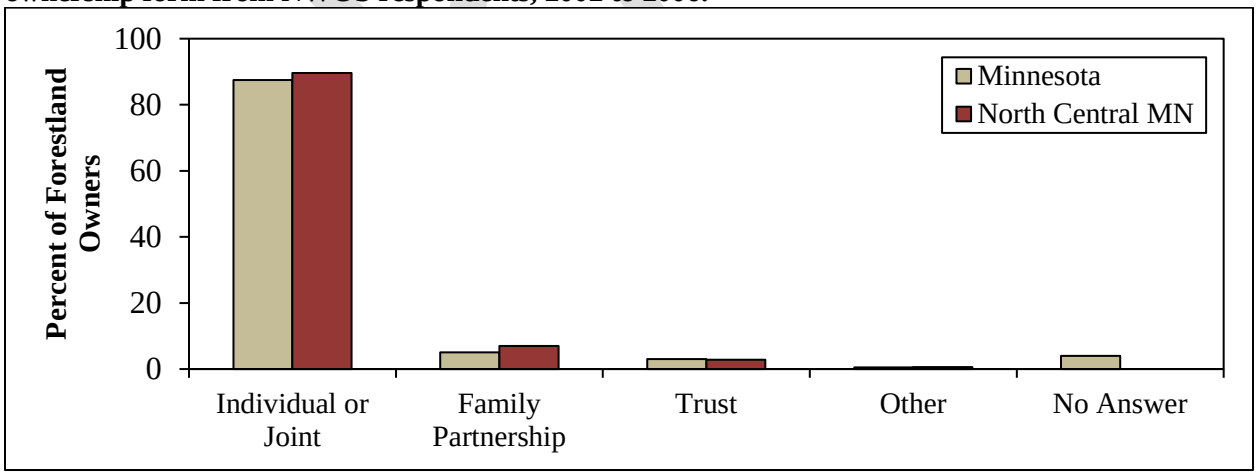
Figure 2.14. Estimated distribution of family forestland acres in North Central Minnesota[A] by ownership form from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

Figure 2.15. Estimated distribution of family forestland owners in North Central Minnesota[A] by ownership form from NWOS respondents, 2002 to 2006.



Source: National Woodland Owner Survey conducted from 2002 to 2006 – USFS Forest Inventory and Analysis database.

[A] Lake of the Woods, Roseau, Wadena, and the northern portion of Beltrami Counties were included in North Central Minnesota for the National Woodland Owner Survey and could not be removed for this analysis. Polk County was not included.

2.5. Forest Stewardship Plans

According to the Minnesota Department of Natural Resources' Forest Stewardship Program, "The DNR Forest Stewardship Program provides technical advice and long-range forest management planning to interested landowners. All aspects of the program are voluntary. Plans are designed to meet landowner goals while maintaining the sustainability of the land. The entire property except active farming areas, is covered by the plan." (FSP 2013)

It should be noted that not all private forest land is eligible for a Forest Stewardship Plan; for example, a landowner must have at least 20 eligible acres to enroll. Non-forested land that meets certain criteria is eligible for the program as well; examples include agricultural land that will be converted to forest and non-forested wetlands (Arends et al. 2009).

The Spatial Analysis Project (SAP) was conducted by the Minnesota DNR Forestry Private Lands Program in 2006. The purpose of the SAP was to create "a GIS layer representing the level of "benefit" gained from potential forest stewardship work." Several factors that were determined to "contribute to the overall benefits gained by active forest stewardship" were mapped, overlaid, and scored, and then scores were weighted by the importance of the factor. The resulting scores were then classified into low, medium and high potential benefit gained by active forest stewardship. Similar to Forest Stewardship Plan eligibility, the SAP process considered other factors in addition to areas of existing forest; therefore non-forested areas may have also been identified as gaining potential benefit from forest stewardship. More information on this process can be found at http://www.fs.fed.us/na/sap/products/mn.shtml (USFS 2009).

To quantify Forest Stewardship Plan accomplishments, the USFS asked the states to designate Important Forest Resource Areas (IFRA). Accomplishments would then be based on how much of those areas are covered by current forest stewardship plans (plans are current for 10 years in Minnesota). For the IFRAs in Minnesota, the medium and high areas delineated in the SAP were used.

Forest stewardship plan areas in Minnesota were compared against the IFRAs. Table 2.8 lists the accomplishments for Minnesota state-wide and within the North Central Landscape for forest stewardship plans current as of the end of the Federal Fiscal Year (Sept. 30, 2015). IFRAs across the State were at 4.4% coverage. In the North Central Landscape, IFRAs were at 5.8% coverage (Table 2.8).

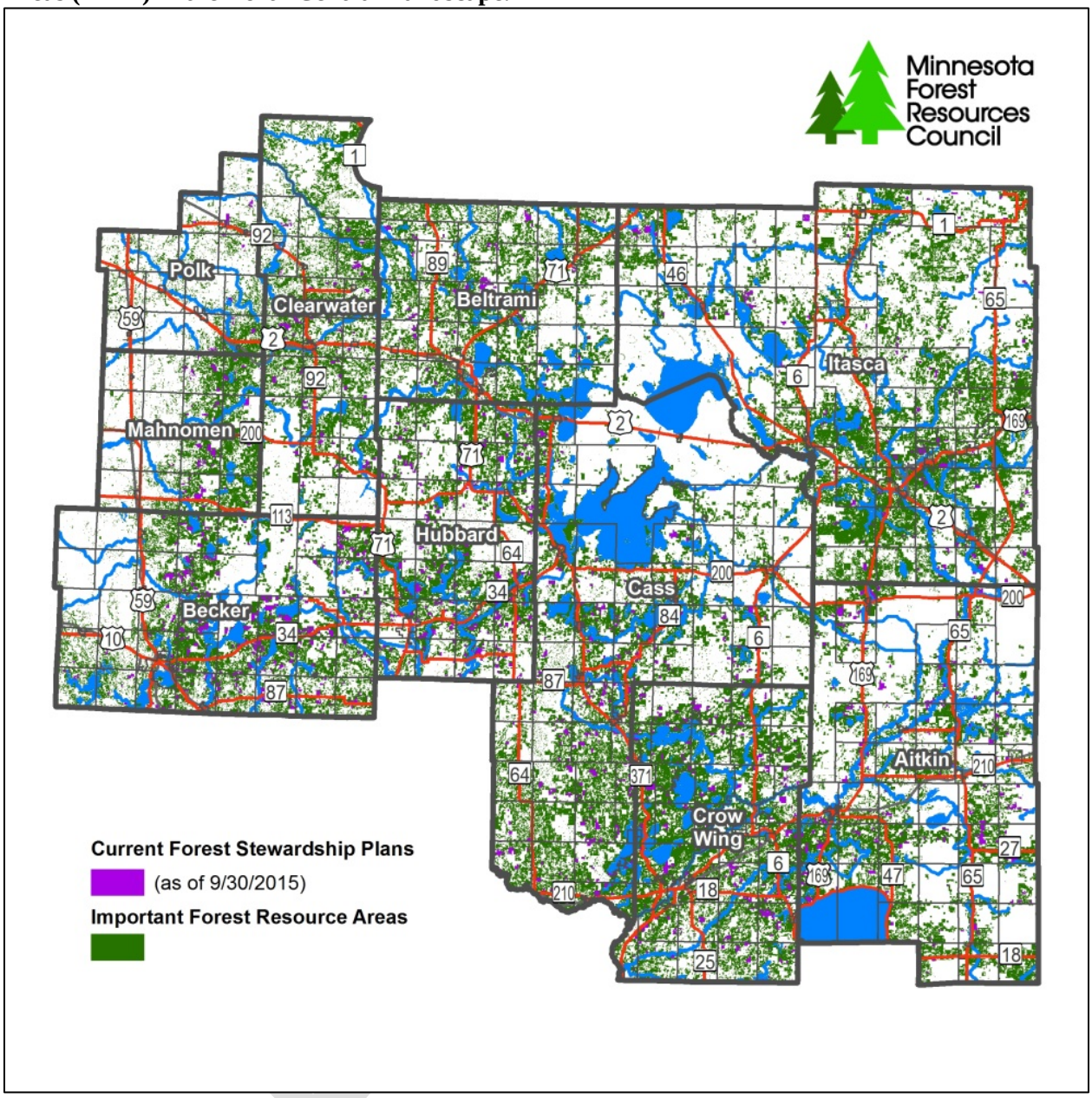
Table 2.8. Areas covered by Forest Stewardship Plans compared to Important Forest Resource Areas (IFRA) in the North Central Landscape.

Study Area	Metric	Acres
North Central	Acres covered by current forest stewardship plans	204,173
North Central	Acres of Important Forest Resource Areas	2,670,943
North Central	Acres in Important Forest Resource Areas covered by current Forest Stewardship Plans	155,908
Minnesota	Acres covered by current forest stewardship plans	623,038
Minnesota	Acres of Important Forest Resource Areas	9,898,192
Minnesota	Acres in Important Forest Resource Areas covered by current Forest Stewardship Plans	434,910

Source: Spatial Analysis Project (SAP), Minnesota DNR Forestry Community and Private Lands Program (2006). For further information on this data, contact the MN DNR Private Forest Management Program.

Notes: The SAP that created the IFRA used GAP Land Cover (1992) data to determine forested acres. IFRA acres exceed 1992 forested acres because the SAP process considered areas of potential forest gain and areas that could have significant effect on forests as well. Acres covered by forest stewardship plans only include forest stewardship plans submitted to the DNR; other plans may exist that were not submitted to the DNR.

Figure 2.16 Areas covered by Forest Stewardship Plans compared to Important Forest Resource Areas (IFRA) in the North Central Landscape.



Source: Spatial Analysis Project (SAP), Minnesota DNR Forestry Community and Private Lands Program (2006).

2.6. Forestland Value

According to timberland sales data available on the Minnesota Land Economics website, which is maintained by the Department of Applied Economics at the University of Minnesota, forestland prices in the North Central Landscape have increased dramatically since the early 1990's (Table 2.9). The average per-acre sale price of forestland in the region has increased by over 6 times for the entire region from $230/acre in 1990 to $1,454 in 2014. Becker, Cass, and Hubbard counties have increased at the most rapid rate (919%, 854%, and 847%, respectively), although the highest land values were in Polk County ($1,913 per-acre). Despite the overall increase from 1990 to 2014, the current per-acre sale prices are significantly lower than they were in 2006-07 when forestland was selling for an average of nearly $2,000 per-acre over the entire region and close to $3,000 in certain counties.

Table 2.9. Average per-acre sale prices ($) for forestland in the North Central Minnesota counties, 1990-2014.

Year	Aitkin	Becker	Beltrami	Cass	Clearwater	Crow Wing	Hubbard	Itasca	Mahnomen	Polk	10 County Area
1990	185	--	204	203	143	287	219	257	132	--	230
1991	264	161	182	226	105	288	240	261	141	--	237
1992	215	180	228	226	232	246	194	249	111	--	225
1993	212	173	240	220	250	309	294	262	137	--	242
1994	224	260	328	250	184	353	328	262	124	--	269
1995	256	251	348	348	152	429	421	245	145	--	278
1996	275	238	324	410	199	507	448	341	186	--	318
1997	344	341	168	544	178	577	500	343	225	--	407
1998	407	412	585	576	240	531	909	348	280	--	477
1999	378	414	366	860	325	631	929	372	231	--	501
2000	564	694	451	962	315	1,335	818	578	210	--	713
2001	652	777	746	873	386	1,219	1,171	463	140	--	789
2002	679	740	459	1,131	582	1,273	1,093	617	225	--	841
2003	1,012	1,340	579	975	769	1,181	1,098	1,039	248	--	1,032
2004	831	1,041	780	1,303	981	1,955	1,892	1,358	401	--	1,225
2005	1,441	1,531	1,294	1,849	1,268	1,729	2,176	1,291	973	--	1,510
2006	1,350	1821*	1638*	2841*	1,313	2927*	2951*	1,390	1644*	--	1,824
2007	1572*	1,407	1,403	1,766	1464*	2,640	1,923	1,274	987	--	1,678
2008	1,426	1,661	1,300	2,559	1,098	2,302	2,065	1548*	1,083	689	1,692
2009	1,380	1,578	1,253	2,271	1,032	2,899	1,875	1,223	1,312	1,053	1,630
2010	1,314	1,591	1,311	1,741	1,087	1,904	1,751	1,345	1,114	1,442	1,463
2011	1,169	1,216	1,020	1,705	873	2,303	1,856	1,125	719	--	1,392
2012	1,181	1,608	842	1,385	938	1,800	1,531	1,155	1,192	1,064	1,301
2013	1,217	1,401	1,366	1,808	981	1,737	1,718	1,376	911	1,033	1,500
2014	1,219	1,479	867	1,734	1,023	1,842	1,855	1,195	955	1913*	1,454

Source: Minnesota Land Economics; University of Minnesota. Available at: www.landeconomics.umn.edu

* Highest estimated per-acre land value during the study period.

2.7. Property Taxes

Property taxes in the North Central Landscape exceeded $423 million in 2013 (Table 2.10). Only 0.2% ($708,810) of the total property tax dollars was from Managed Forestland in the North Central Landscape. This was true across the counties with the highest percentage of total dollars from Managed Forestland in Hubbard County (0.4%). Property tax dollars from Managed Forestland has more than doubled in the region between 2010 and 2014 (Figure 2.17).

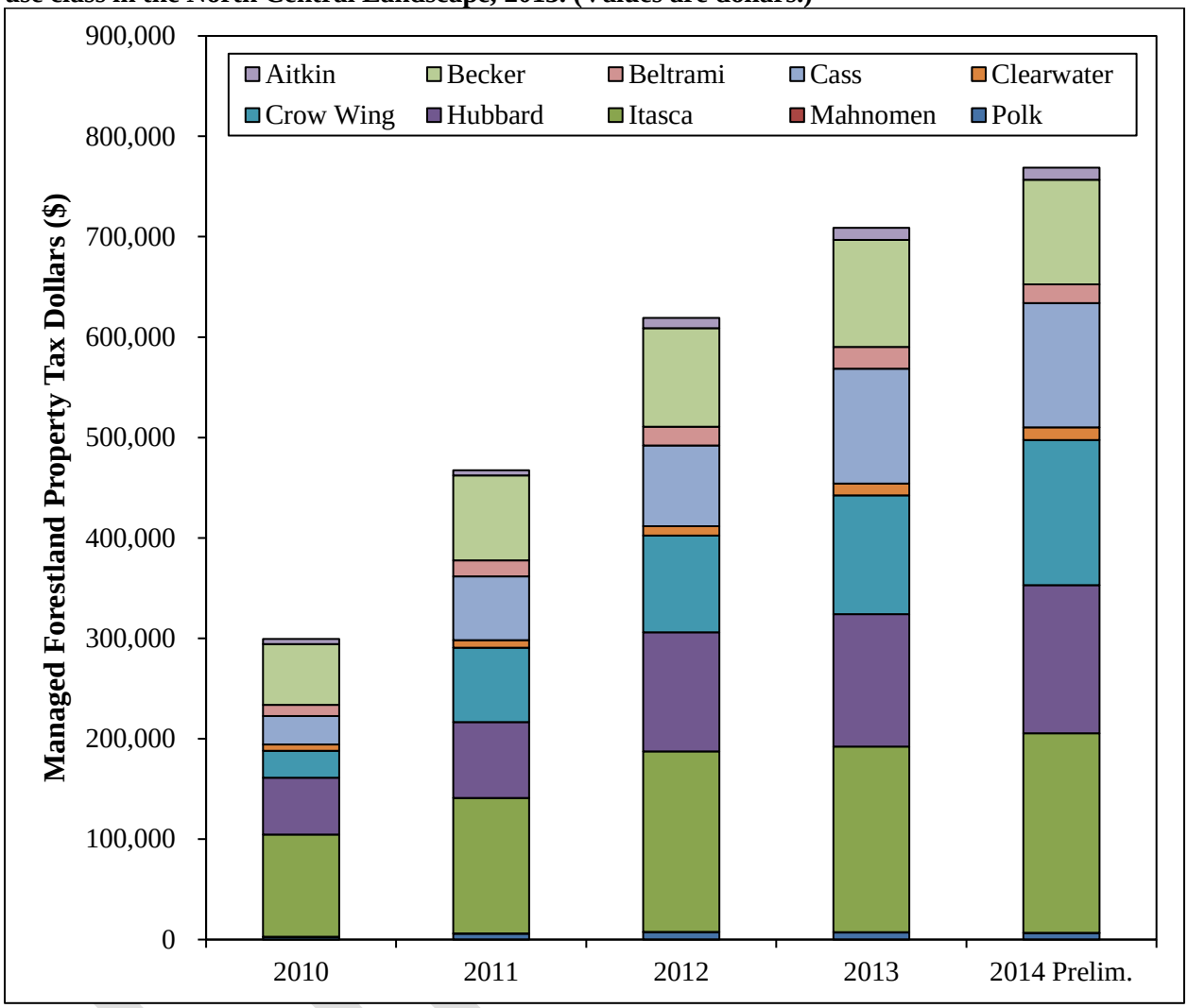
Aitkin, Cass, and Hubbard counties had more property tax dollars coming from Seasonal Recreational Residential than Residential properties which highlight the recreational nature of the region (Table 2.10). Over 24% of the total property tax dollars in the region were from Crow Wing County, which was followed by Itasca (16.6%) and Cass (11.6%) counties.

Table 2.10. Total net property tax and estimated distribution among selected use classes in the North Central Landscape, 2013. (Values are dollars.)

County	Farm	Managed Forest Land	Seasonal Recreational Residential	Residential (Homestead and Non-)	Total*
Aitkin	3,597,723	11,941	9,538,822	5,767,540	22,134,878
Becker	7,142,953	106,590	11,378,834	16,076,755	43,780,335
Beltrami	3,714,942	21,689	4,216,251	16,970,992	41,568,120
Cass	3,891,237	114,384	21,576,306	12,673,334	49,299,834
Clearwater	2,286,754	11,718	511,570	1,921,649	13,310,558
Crow Wing	3,897,030	118,491	33,053,239	35,287,108	102,610,698
Hubbard	3,119,705	131,935	10,221,257	9,993,901	31,581,958
Itasca	7,254,194	184,623	11,103,937	20,807,257	70,510,517
Mahnomen	3,538,552	363	781,747	1,097,605	6,342,778
Polk	16,778,376	7,076	1,979,642	13,065,582	42,464,073
North Central Landscape	**$55,221,466**	**$708,810**	**$104,361,605**	**$133,661,723**	**$423,603,749**

Source: MN Department of Revenue; supplied by Lisa Erickson.
* There are classes besides those listed; however, the 'Total' includes all property types.

Figure 2.17. Net property taxes by county and year designated under the Managed Forest Lands use class in the North Central Landscape, 2013. (Values are dollars.)



Source: MN Department of Revenue; supplied by Lisa Erickson.

Goal 3 – Healthy Forests

MFRC Goal 3: Within forested landscapes, healthy, resilient, and functioning ecosystems will be maintained within appropriate mixes of forest cover types and age classes to promote timber production, biological diversity, and viable forest dependent fish and wildlife habitats.

This report includes the best ecological data on the North Central Landscape available at this time. It includes data on pre-settlement forest patterns; climate change; tree species; forest composition and age structure; growth and removals on timberland; silvicultural and harvesting practices; species at risk; wildlife furbearer and game species; invasive species; and lake and stream water quality.

3.1. Healthy Forest Data Sources

Minnesota Ecological Classification System (ECS): The Minnesota Department of Natural Resources and the U.S. Forest Service developed an Ecological Classification System for ecological mapping and landscape classification in Minnesota following the National Hierarchical Framework of Ecological Units (ECOMAP 1993). For more information on this system see Section 3.2.

- Minnesota Department of Natural Resources (MN DNR). 2003. *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MNDNR St. Paul, MN.
- Minnesota Department of Natural Resources (MN DNR). 2013 (1). "Native Plant Community Classification." Available at: www.dnr.state.mn.us/npc/classification.html.

Native Plant Communities (NPC): This is a classification system of the native vegetation of Minnesota developed by the Minnesota DNR. This system is intended to provide a framework and common language for improving vegetation management, surveys of natural areas, identifying research needs, and promoting the study and appreciation of native vegetation in Minnesota. For more information on this system see Section 3.3.

Minnesota Biological Survey (MBS): The MBS is a systematic survey of rare biological features. The goal of the MBS is to identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and natural communities. More information on this system can be found in Section 3.4. Available at: http://www.dnr.state.mn.us/mbs/index.html.

Presettlement Vegetation of Minnesota: The Public Land Survey of Minnesota started in 1847 and by 1908 the entire state of Minnesota had been surveyed. As an essential part of the survey process, surveyors notched or blazed bearing trees to facilitate the relocation of survey corners. They also noted the species, diameter, and distance and azimuth from the corner for each bearing tree. This data has been used to estimate tree species abundance across the state prior to European settlement. Further information at: http://files.dnr.state.mn.us/eco/nhnrp/brgtree.pdf

Forest Inventory Analysis (FIA): The FIA is a systematic collection of data and forest information by the U.S. Forest Service for assessment or analysis to assess America's forests. This continuous forest census is designed to provide reliable estimates on the type, extent, growth, mortality, and removals of forestland. This data is not meant to be represented spatially but breaks forestland and timberland estimates down by ownership class. More information available at: www.fia.fs.fed.us/

Current Status and Long-term Trends of Silvicultural Practices in Minnesota: This was developed by Anthony W. D'Amato, Nicholas W. Bolton, Charles R. Blinn, and Alan R. Ek of the University of Minnesota, Department of Forest Resources in 2008. This technical report characterized the status of silvicultural practices within Minnesota in 2008 and used results from past surveys (1991 and 1996) to describe general trends in Silviculture across ownerships and over time. More information on this data source can be found in Section 3.14.

MN DNR Rare Plants and Animals: Data available through the MN DNR Division of Ecological and Water Resources and the Minnesota Natural Heritage System.

MNTaxa: A list of vascular plant species that reflect vouchered specimens present in herbarium collections at the University of Minnesota and University of Minnesota Duluth herbariums. More information available at: www.dnr.state.mn.us/eco/mcbs/plant_lists.html

MN DNR Forest Wildlife Populations and Research Group: Develops annual summaries of forest wildlife populations.

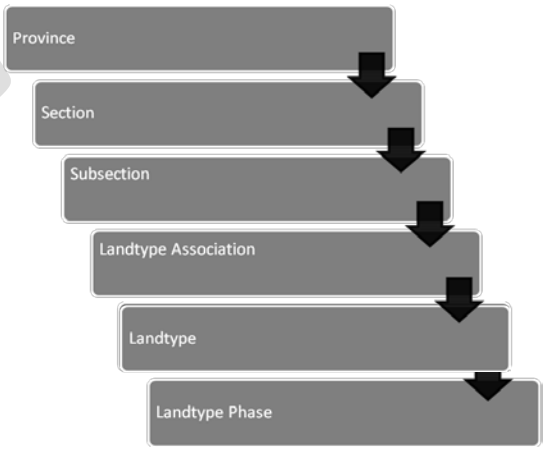
Invasive Species: Minnesota DNR invasive species information on the GIS Data Deli

Water Health data: Minnesota DNR water quality data on the GIS Data Deli

Forest Ecosystem Vulnerability Assessment and Synthesis (FEVAS): A climate change vulnerability assessment for forest ecosystems in northern Minnesota developed by forest managers and researchers from across the State of Minnesota and Great Lakes Region.

3.2. Minnesota Ecological Classification System (ECS)

The Minnesota Department of Natural Resources and the U.S. Forest Service have developed an Ecological Classification System (ECS) for ecological mapping and landscape classification in Minnesota following the National Hierarchical Framework of Ecological Units (ECOMAP 1993).



Ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The system uses associations of biotic and environmental factors including: 1) climate, 2) geology, 3) topography, 4) soils, 5) hydrology, and 6) vegetation. There are eight levels of ECS units in the United States. Map units for six of these levels occur in Minnesota: Provinces, Sections, Subsections, Land Type Associations, Land Types, and Land Type Phases. The first three levels are described below:

- **Provinces** are units of land defined using major climate zones, native vegetation, and biomes such as prairies, deciduous forests, or boreal forests. There are four ecological provinces in Minnesota.
- **Sections** are units within Provinces that are defined by origin of glacial deposits, regional elevation, distribution of plants, and regional climate. Minnesota has ten ecological sections.

- **Subsections** are units within Sections that are defined using glacial deposition processes, surface bedrock formations, local climate, topographic relief, and the distribution of plants, especially trees. Minnesota has 26 ecological subsections.
- **Land Type Associations** (LTAs) are divisions within Subsections that are delineated using glacial landforms, bedrock types, topographic roughness, lake and stream distributions, wetland patterns, depths to groundwater table, soil parent material and pre-European settlement vegetation. There are 291 LTAs in the state, 160 of which occur in the Laurentian Province.

Source: Field Guide to Native Plant Communities of Minnesota, MN DNR 2003. More information is available at: www.dnr.state.mn.us/ecs/index.html

3.2.1. ECS Geography of the North Central Landscape

The North Central Landscape is primarily located within the Laurentian Mixed Forest Province; however, it contains portions of the Tallgrass Aspen Parklands, Eastern Broadleaf Forest, and Prairie Parkland. There are seven ecological sections that cover the region and a total of 12 subsections within those sections (Figure 3.1 and Figure 3.2). Table 3.1 summarizes the acreages of ECS Sections with the North Central Landscape. The maps below illustrate the hierarchical or scaled nature of the various ECS geographic units as they relate to the state and the North Central Landscape.

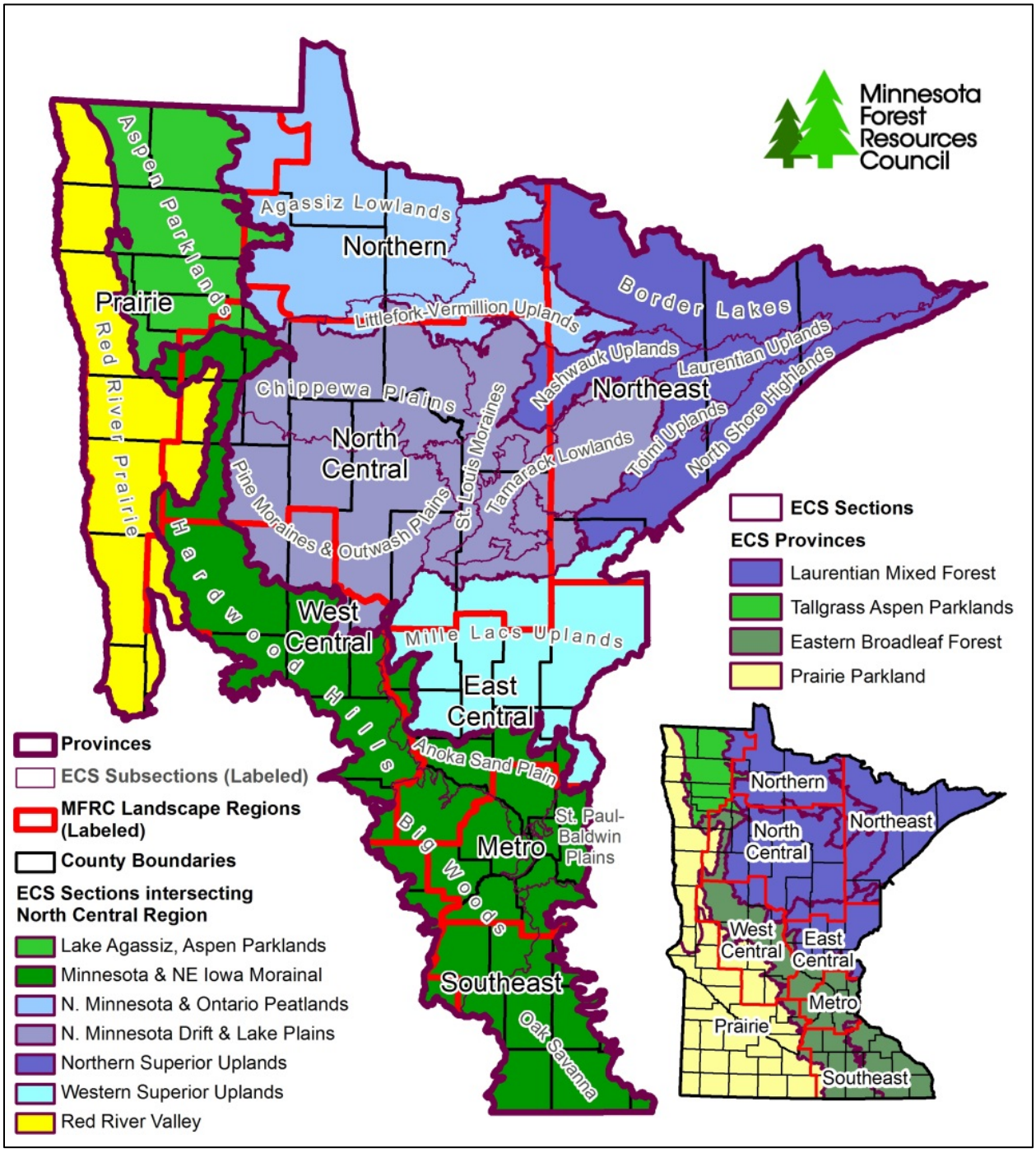
Within the 12 subsections, there are 90 LTAs. The average area of a land type association across the region is approximately 101,000 acres. Table 3.2 summarizes the areas of each subsection and provides the number of LTAs in each section and subsection.

Table 3.1. Ecological Classification System Section (ESC) Areas in the North Central Landscape.

ECS Sections	Code	Acres in Region	% of Region
Lake Agassiz, Aspen Parklands	LAP	147,531	1.6
Minnesota & NE Iowa Morainal	MIM	745,722	8.2
N. Minnesota & Ontario Peatlands	MOP	408,607	4.5
N. Minnesota Drift & Lake Plains	MDL	6,483,253	71.5
Northern Superior Uplands	NSU	211,922	2.3
Red River Valley	RRV	415,270	4.6
Western Superior Uplands	WSU	657,410	7.2
Total		**9,069,715**	**100.0**

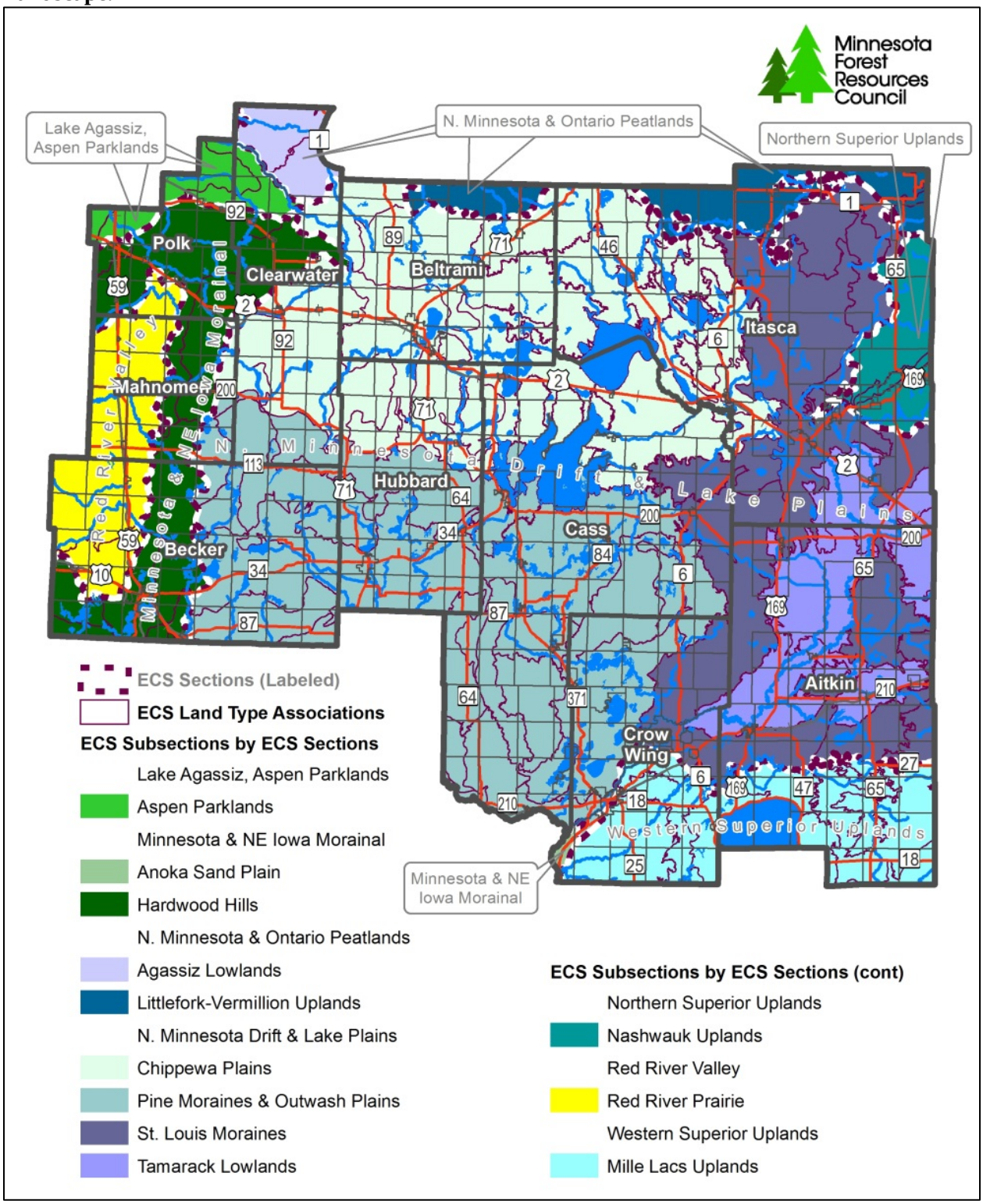
Source: MN Geospatial Commons.

Figure 3.1. Ecological Classification System (ESC) Section areas in the Laurentian Mixed Forest Province.



Source: MN Geospatial Commons.

Figure 3.2. Ecological Classification System (ESC) Subsection areas in the North Central Landscape.



Source: MN Geospatial Commons.

Table 3.2. Ecological Classification System (ECS) Subsection Areas in the North Central Landscape.

ECS Provinces	ECS Sections	ECS Subsections	Acres in Region	% of Region	# of LTAs
Eastern Broadleaf Forest Province	Minnesota & NE Iowa Morainal	Anoka Sand Plain	12,718	0.1	1
		Hardwood Hills	733,004	8.1	9
	Subtotal (Section)		**745,722**	**8.2**	**10**
Subtotal (Province)			**745,722**	**8.2**	**10**
Laurentian Mixed Forest Province	N. Minnesota & Ontario Peatlands	Agassiz Lowlands	119,858	1.3	4
		Littlefork-Vermillion Uplands	288,748	3.2	4
	Subtotal (Section)		**408,607**	**4.5**	**8**
	N. Minnesota Drift & Lake Plains	Chippewa Plains	2,142,176	23.6	13
		Pine Moraines & Outwash Plains	2,311,101	25.5	20
		St. Louis Moraines	1,456,897	16.1	12
		Tamarack Lowlands	573,079	6.3	5
	Subtotal (Section)		**6,483,253**	**71.5**	**50**
	Northern Superior Uplands	Nashwauk Uplands	211,922	2.3	3
	Subtotal (Section)		**211,922**	**2.3**	**3**
	Western Superior Uplands	Mille Lacs Uplands	657,410	7.2	12
	Subtotal (Section)		**657,410**	**7.2**	**12**
Subtotal (Province)			**7,761,191**	**85.6**	**73**
Prairie Parkland Province	Red River Valley	Red River Prairie	415,270	4.6	3
	Subtotal (Section)		**415,270**	**4.6**	**3**
Subtotal (Province)			**415,270**	**4.6**	**3**
Tallgrass Aspen Parklands	Lake Agassiz, Aspen Parklands	Aspen Parklands	147,531	1.6	4
	Subtotal (Section)		**147,531**	**1.6**	**4**
Subtotal (Province)			**147,531**	**1.6**	**4**
Total North Central Region			**9,069,715**	**100.0**	**90**

Source: MN Geospatial Commons.

3.3. Native Plant Communities (NPC)

A **native plant community** is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as oak savannas, pine forests, or marshes, that tend to repeat over space and time. Native plant communities are classified and described by considering 1) vegetation, 2) hydrology, 3) landforms, 4) soils, and 5) natural disturbance regimes. Examples of natural disturbances include: wildfires, severe droughts, windstorms, and floods.

Sometimes referred to as native habitats or natural communities, native plant communities are named for the characteristic plant species within them or for characteristic environmental features. Examples of native plant communities in Minnesota include Dry Barrens Oak Savanna, Red Pine-White Pine Forest, Bulrush Marsh, Sedge Meadow, and Mesic Sandstone Cliff. There are many kinds of vegetated areas that are not native plant communities. These include places where native species have largely been replaced by exotic or invasive species such as smooth brome grass, buckthorn, and purple loosestrife, and planted areas such as orchards, pine plantations, golf courses, and lawns. Other areas not considered to be native plant communities include areas where modern human activities such as farming, overgrazing, non-sustainable logging, and development have destroyed or greatly altered the vegetation.

More information on NPC Classes can be found in the *'Field Guide to the Native Plant Communities of Minnesota'* or at www.dnr.state.mn.us/npc/classification.html

3.3.1. Native Plant Community Classification

In 2003, researchers in the Minnesota Department of Natural Resources (DNR) completed a new classification of the native vegetation of Minnesota, Minnesota's Native Plant Community Classification (Version 2.0). The DNR's new classification is intended to provide a framework and common language for improving our ability to manage vegetation, to survey natural areas for biodiversity conservation, to identify research needs, and to promote study and appreciation of native vegetation in Minnesota. Version 2.0 of the DNR's native plant community classification is based strongly on plant species composition and was developed through analysis of extensive field data collected from sample plots in forests, prairies, wetlands, and other habitats. The classification is hierarchical, with vegetation units described at levels ranging from broad landscape-level ecological systems to local communities (Table 3.3). One of the most important features of the new classification is the inclusion of ecological processes as an organizing principle.

The NPC classification has six levels (Table 3.3). **System Groups**, the highest level, were created to allow development of manageable field keys for lower levels of the classification. System Groups were formed by combining lower levels of the classification along major physiognomic and hydrologic splits in vegetation. **Ecological Systems** are groups of native plant communities that are unified by strong influence from a major ecological process or set of processes, especially nutrient cycling and natural disturbances. **Floristic Regions** are divisions within Ecological Systems that reflect the distribution of Minnesota's plant species into characteristically northern, northwestern, central, and southern groups, or floras. The important influences on these species distributions appear to be climate and paleohistory. **Native Plant Community Classes** are units of vegetation that generally have uniform soil texture, soil moisture, soil nutrients, topography, and disturbance regimes. For wooded vegetation, Native Plant Community Classes were developed by emphasizing understory vegetation more than canopy trees, under the hypothesis that in much of Minnesota understory plants are often more strongly tied to specific habitat conditions (such as levels of nutrients and moisture) than are canopy trees. **Native Plant Community Types** are defined by dominant canopy trees, variation in substrate, or fine-scale differences in environmental factors such as moisture or nutrients. Type distinctions were also made to describe geographic patterns within a Class. **Native Plant**

Community Subtypes are based on finer distinctions in canopy composition, substrates, or other environmental factors. In some instances, Subtypes represent apparent trends within a Type for which more study and collection of data are needed. In other instances Subtypes are well-documented, fine-scale units of vegetation that are useful for work such as rare plant habitat surveys.

Table 3.3. Native Plant Community (NPC) classification hierarchy.

Classification Level	Dominant Factors	Example
System Group	Vegetation structure & geology	Upland Forest & Woodland Systems
Ecological System	Ecological processes	Fire-Dependent Forest/Woodland
Floristic Region	Climate & paleohistory	Central
NPC Class	Local environmental conditions	Central Dry Pine Woodland
NPC Type	Canopy dominants, substrate, or finer environmental conditions	Jack Pine-(Yarrow) Woodland
NPC Subtype	Finer distinctions in canopy dominants, substrate, or environmental conditions	Ericaceous Shrub

Source: Field Guide to the Native Plant Communities of Minnesota www.dnr.state.mn.us/npc/classification.html

3.3.2. NPC Systems in the North Central Landscape

Upland/Lowland Characteristics

The North Central Landscape Region covers approximately 9.1 million acres. Within this region there are five forested NPC systems (Table 3.5 and Figure 3.3); three of which are generally represented in lowland areas and two systems that are in upland terrain areas. Upland systems cover almost half of the region. The Natural Resources Research Institute has integrated soil series, plant relevee, geomorphic, topographic, and other relevant geospatial data layers to create native plant community maps of the Northern Minnesota and Ontario Peatlands, Drift and Lake Plains, Northern Superior Uplands, and Western Superior Uplands ecological sections to estimate acreages of native plant communities at the system and class level by ownership. These NPC system area estimates are listed below in Table 3.4 and Table 3.5.

Upland Systems
- Fire Dependent
- Mesic Hardwood

Lowland Systems
- Acid Peatland
- Forested Rich Peatland
- Wet Forest

Table 3.4. Native Plant Community (NPC) System area estimates by lowland and upland systems

Potential NPC Systems	Acres	% of Region
Upland NPC Systems	4,489,023	49.5
Lowland NPC Systems	3,272,127	36.1
Not classified (not in LMF)	1,308,565	14.4
Total North Central Region	**9,069,715**	**100.0**

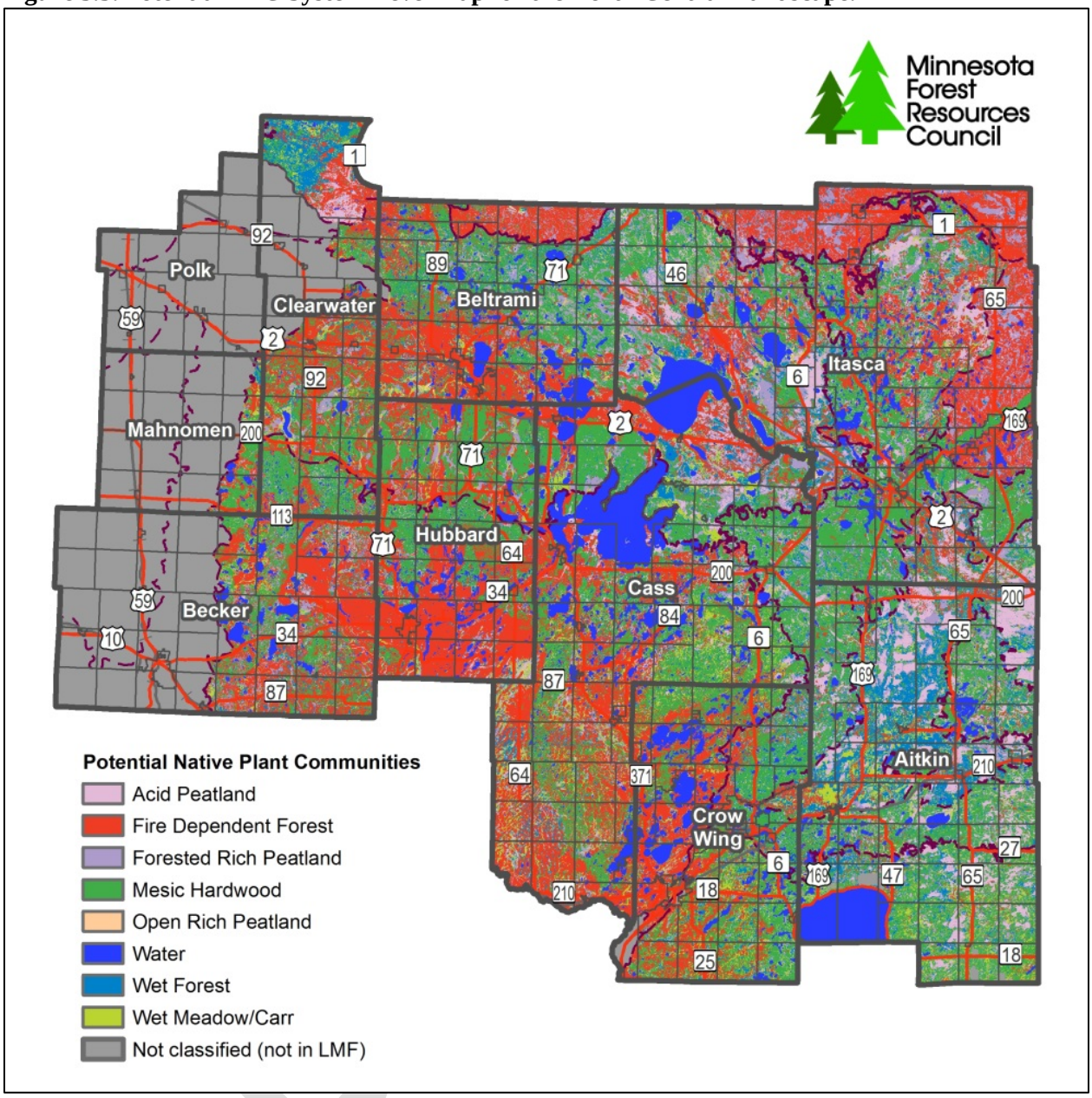
Source: George Host, Natural Resources Research Institute.

Table 3.5. North Central Landscape Native Plant Community (NPC) system area estimates.

Code	Potential NPC Systems	Acres	% of Subtotal	% of Region
FD	Fire-Dependent Forest/Woodland	2,217,379	49.4	24.4
MH	Mesic Hardwood Forest	2,271,643	50.6	25.0
	Subtotal - Upland Systems	**4,489,023**	**100.0**	**49.5**
AP	Acid Peatland	497,070	15.2	5.5
FP	Forested Rich Peatland	657,527	20.1	7.2
OP	Open Rich Peatland	27,483	0.8	0.3
Water	Water	806,568	24.6	8.9
WF	Wet Forest	722,300	22.1	8.0
WM	Wet Meadow/Carr	561,178	17.2	6.2
	Subtotal - Lowland Systems	**3,272,127**	**100.0**	**36.1**
	Not classified (not in LMF)	1,308,565	--	14.4
	Total North Central Region	**9,069,715**	--	**100.0**

Source: George Host, Natural Resources Research Institute.

Figure 3.3. Potential NPC System Level map for the North Central Landscape.



Source: George Host, Natural Resources Research Institute.

3.3.3. NPC Landownership Characteristics

Land ownership varies greatly across the five NPC systems. Table 3.6 illustrates the diverse ownership patterns by NPC system. Individual private landowners are the largest ownership block of forests classified in the Mesic Hardwoods, Fire Dependent, and Wet Forest NPC systems. The state government is the largest owner of lands classified as Forested Peatland as well as the Acid Peatland systems.

Land ownership also varies greatly across the North Central Landscape at the NPC class level. Table 3.7 summarizes the NPC classes by the landownership categories.

Table 3.6. NPC System area estimates by land ownership

Code	NPC Systems	Federal	State	County	Tribal	Industrial	Private	Other	Total
Upland Systems									
FD	Fire Dependent	230,742	511,411	4,721	48,245	148,762	1,266,084	7,413	2,217,379
MH	Mesic Hardwoods	285,831	801,762	5,774	22,540	124,379	1,026,845	4,513	2,271,643
	Subtotal	**516,574**	**1,313,173**	**10,495**	**70,785**	**273,141**	**2,292,928**	**11,926**	**4,489,023**
Lowland Systems									
AP	Acid Peatland	50,880	307,819	1,449	10,587	17,392	108,407	536	497,070
FP	Forested Peatland	80,442	339,807	2,052	2,935	37,456	193,982	854	657,527
OP	Open Rich Peatland	4,601	12,120	167	305	525	9,736	29	27,483
WF	Wet Forest	64,250	262,539	1,771	45,746	22,972	324,277	746	722,300
WM	Wet Meadow	52,505	217,649	1,802	16,250	14,697	257,254	1,022	561,178
Wa	Water	46,101	55,630	1,111	2,665	5,970	694,740	351	806,568
	Subtotal	**298,780**	**1,195,563**	**8,351**	**78,487**	**99,011**	**1,588,396**	**3,539**	**3,272,127**
	Total	**815,354**	**2,508,736**	**18,846**	**149,272**	**372,152**	**3,881,324**	**15,465**	**7,761,149**

Source: George Host, Natural Resources Research Institute.

Table 3.7. NPC class level area estimates by land ownership in the North Central Landscape.

Code	NPC Class	Federal	State	County	Tribal	Industrial	Private	Other	Total
FD	Fire Dependent	0	2	0	0	0	19	0	20
FDc23	Central Dry Pine Woodland	8,321	26,531	292	493	10,914	171,008	1,139	218,697
FDc24	Central Rich Dry Pine Woodland	32,917	74,183	952	8,183	31,092	382,368	2,708	532,404
FDc34	Central Dry-Mesic Pine-Hardwood Forest	43,083	151,006	261	1,950	23,478	350,523	1,310	571,610
FDn12	Northern Dry-Sand Pine Woodland	1,301	8,085	45	120	1,437	8,411	32	19,431
FDn33	Northern Dry-Mesic Mixed Woodland	124,924	123,667	1,754	3,959	20,965	219,725	1,520	496,513
FDn43	Northern Mesic Mixed Forest	20,197	127,939	1,417	33,540	60,877	134,029	705	378,704
MH	Mesic Hardwoods	5,619	17,646	111	6,010	2,806	20,491	219	52,902
MHc26	Central Dry-Mesic Oak-Aspen Forest	21,229	230,214	352	2,678	8,264	216,396	1,219	480,353
MHc36	Central Mesic Hardwood Forest (Eastern)	48	7,327	48	0	749	59,810	269	68,251
MHc47	Central Wet-Mesic Hardwood Forest	332	1,898	13	9	20	3,909	2	6,183
MHn35	Northern Mesic Hardwood Forest	166,645	346,173	2,421	1,817	53,802	405,071	1,210	977,138
MHn44	Northern Wet-Mesic Boreal Hardwood-Conifer Forest	64,467	160,422	2,298	4,285	45,355	246,888	1,068	524,785
MHn45	Northern Mesic Hardwood (Cedar) Forest	0	1,561	142	0	5,147	2,023	0	8,872
MHn46	Northern Wet-Mesic Hardwood Forest	21,965	31,232	307	7,739	4,667	61,359	351	127,619
MHn47	Northern Rich Mesic Hardwood Forest	5,525	5,290	82	2	3,567	10,898	174	25,540
	Upland Subtotal	**516,574**	**1,313,173**	**10,495**	**70,785**	**273,141**	**2,292,928**	**11,926**	**4,489,023**
AP	Acid Peatland	45,249	306,993	1,449	842	17,386	106,682	536	479,136
APn80	Northern Spruce Bog	5,632	826	0	9,745	7	1,725	0	17,934
FP	Forested Peatland	73,581	298,831	1,891	1,661	32,730	174,317	832	583,843
FPn63	Northern Cedar Swamp	6,861	37,789	160	1,274	4,389	17,669	22	68,164
FPn71	Northern Rich Spruce Swamp (Water Track)	0	3,102	0	0	336	1,996	0	5,435
FPn81	Northern Rich Tamarack Swamp (Water Track)	0	85	0	0	0	1	0	85
OP	Open Rich Peatland	4,601	12,120	167	305	525	9,736	29	27,483
WF	Wet Forest	61,919	261,090	1,730	2,798	22,864	321,691	746	672,838
WFn55	Northern Wet Ash Swamp	1,807	0	0	42,882	0	1,931	0	46,620
WFn64	Northern Very Wet Ash Swamp	524	1,449	41	67	108	655	0	2,842
WM	Wet Meadow	52,505	217,649	1,802	16,250	14,697	257,254	1,022	561,178
Water	Water	46,101	55,630	1,111	2,665	5,970	694,740	351	806,568
	Lowland Subtotal	**298,780**	**1,195,563**	**8,351**	**78,487**	**99,011**	**1,588,396**	**3,539**	**3,272,127**
	Total	**815,354**	**2,508,736**	**18,846**	**149,272**	**372,152**	**3,881,324**	**15,465**	**7,761,149**

Source: George Host, Natural Resources Research Institute.

Note: More information on NPC Classes can be found in the *'Field Guide to the Native Plant Communities of Minnesota'* or at: www.dnr.state.mn.us/npc/classification.html

3.4. Minnesota County Biological Survey (MCBS)

The Minnesota Biological Survey (MBS) began in 1987 as a systematic survey of rare biological features. The goal of the MBS is to identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals, and natural communities. To accomplish this goal the MBS uses a multi-level procedure, beginning with evaluation of existing inventory data and followed by an assessment of the quality and condition of selected areas using air photos, classified satellite imagery, and ground survey. This is supplemented by specialized field surveys of selected rare species or groups of species. Through this process the MBS systematically collects, interprets, and delivers baseline data on the distribution and ecology of rare plants, rare animals, native plant communities, and functional landscapes needed to guide decision making. To date MBS has completed survey work in 81 of Minnesota's 87 counties, with surveys underway in 6 other counties. The Chippewa Plains, Littlefork-Vermilion Uplands, Hardwood Hills, Agassiz Lowlands, and Aspen Parklands ECS units are currently being surveyed in Beltrami and Clearwater counties.

In the completed survey area, the MBS has added over 15,000 new records of rare plants and animals to the DNR's Natural Heritage Information System (NHIS), added over 8,800 vegetation plots to the Relevé Database, recorded 20 native plant species and 3 native amphibians not previously documented in Minnesota, conducted aquatic plant surveys in over 1,500 lakes, produced printed and digital maps of native plant communities and rare species for 38 counties, and digital maps for an additional 18 counties and 3 Ecological subsections.

In the completed portion of the North Central Landscape the Biological Survey has identified 527,188 acres as areas of biological significance (Figure 3.4 and Table 3.8). These areas of biological significance are distributed between several Native Plant Community classes.

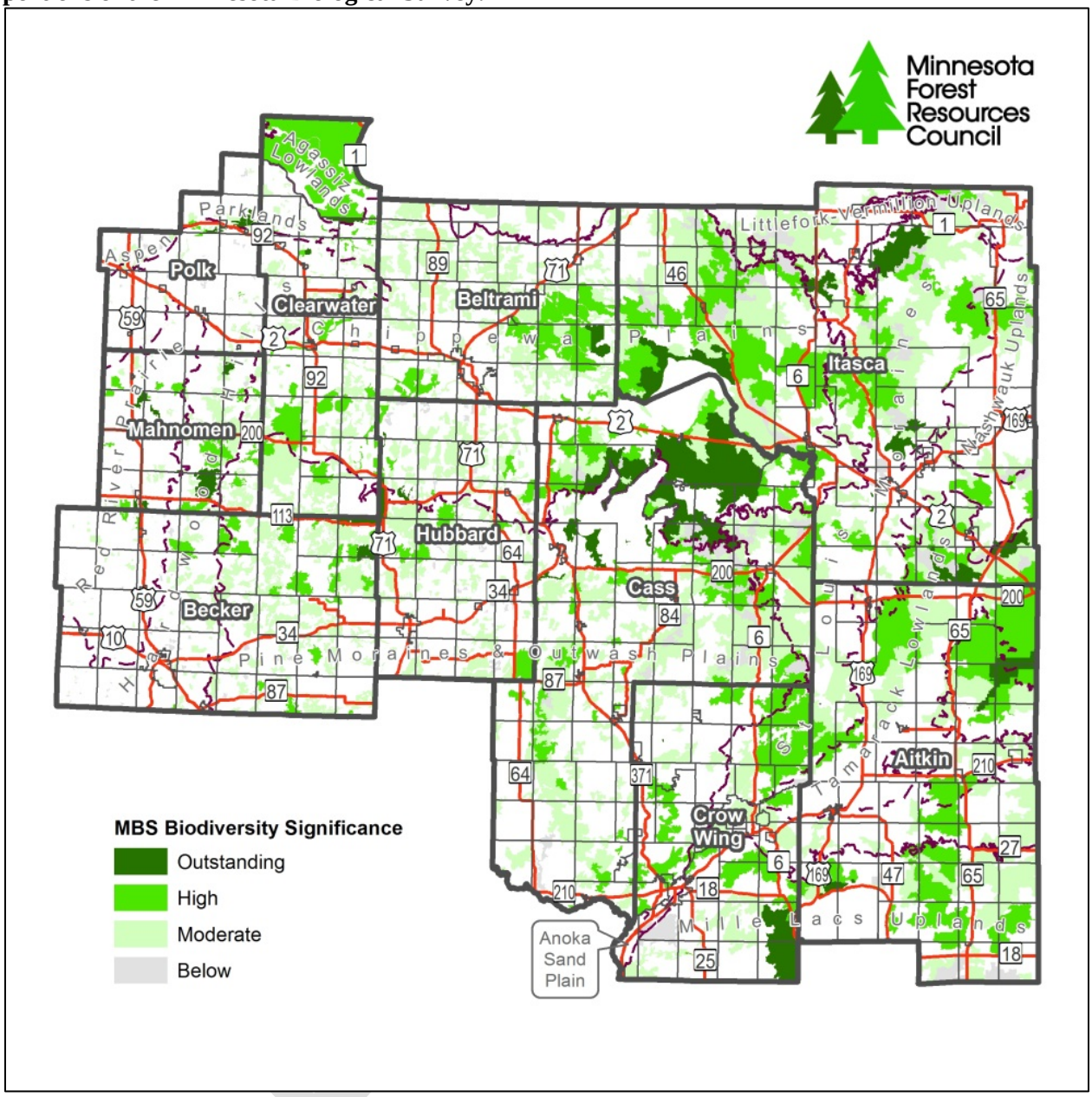
Table 3.8. Areas of biological significance in the North Central Landscape by NPC class.

DNR Mapped Native Plant Communities	Acres	% of Region	No. Polygons
Fire-Dependent Forest/Woodland	49,811	0.5	2,031
Mesic Hardwood Forest	199,453	2.2	5,163
Complex community	26,131	0.3	1,129
Acid Peatland	57,466	0.6	1,526
Floodplain Forest	2,982	0.0	33
Forested Rich Peatland	62,627	0.7	1,882
Lakeshore	17	0.0	8
Marsh	3,798	0.0	812
Open Rich Peatland	34,740	0.4	1,034
River Shore	15	0.0	2
Upland Prairie	6,754	0.1	269
Wet Forest	35,246	0.4	1,769
Wet Meadow/Carr	47,494	0.5	4,156
Wetland Prairie	654	0.0	30
Total DNR Mapped Native Plant Communities	**527,188**	**5.8**	**19,844**
Total North Central Region	**9,069,715**		

Source: MN Geospatial Commons.

Note: The Biological Survey has not been completed for all of the North Central Landscape; however the percentages listed represent the percent of the total area and not the completed area. Once the survey is complete these numbers are likely to increase.

Figure 3.4. Areas of biological significance in the North Central Landscape from the completed portions of the Minnesota Biological Survey.



Source: MN Geospatial Commons.

3.5. Comparison of pre-settlement vegetation to current vegetation

The North Central Landscape was heavily forested prior to European settlement and continues to be today. A quantitative comparison of cover type change from presettlement to 2006 is provided in Section 1.3 using data from Francis J. Marschner's analysis of 19th century of Public Land Survey notes and the 2006 National Land Cover Database.

The Public Land Survey of Minnesota started in 1847 and by 1908 the entire state of Minnesota had been mapped. As an essential part of the survey process, surveyors notched or blazed bearing trees to facilitate the relocation of survey corners. They also noted the species, diameter, and distance and azimuth from the corner for each bearing tree. The Minnesota Department of Natural Resources Ecological Classification System Program analyzed bearing tree data and compared it to FIA 1990 plot-level data. Tree records were selected from the 1990 FIA plot data to reproduce as nearly as possible the procedure that the surveyors used to select bearing trees. For a more detailed description of the methodology used, see "Minnesota's Bearing Tree Database" at http://files.dnr.state.mn.us/eco/nhnrp/brgtree.pdf.

Table 3.9 summarizes the results of the analysis for the Northern Minnesota Drift and Lake Plains, which has a similar boundary to the North Central Landscape. The table compares abundance of bearing trees to abundance of FIA possible bearing trees. The "difference" column shows the percentage point difference between the bearing tree abundance values and the FIA values. The final column shows the proportional difference for each species. For example, ash was 17% more abundant among the selected FIA trees than among the bearing trees. In general there is an increase in aspen, balsam fir, ash, and red oak, and a significant decrease in jack pine, red pine, white pine, spruce, and tamarack from the bearing tree data to the FIA data.

The MN DNR Division of Forestry, Resource Assessment program has also done comparisons between pre-settlement (ca. 1846-1908) and modern (ca. 1990) NPC communities. Table 3.10 shows a decline of the young growth stage (0 – 55 year) and an increase in the mature growth stage (95 - 205 year) forests in the MHn35 forest community; a class which accounts for nearly 980,000 acres in the North Central Landscape. In comparison, Table 3.11 shows an increase in the young growth stage (0-55 year) and an decline in the mature (95-135 year) and old (<175 year) growth stage in the FDc34 forest community, which accounts for over 570,000 acres in the North Central Landscape. Table 3.12 and Table 3.13 shows changes in the relative abundance of different species in different growth stages between pre-settlement and modern MHn35 and FDc34 forests, respectively. In MHn35 forests, paper birch was a relatively abundant species in the young and mature growth stages prior to European settlement, and after settlement its relative abundance has decreased in those growth stages while sugar maple has increased. In FDc34 forests, aspen has increased significantly across the young and mature growth stages, whereas all pine species have decreased across all growth stages. More information can be found at: www.dnr.state.mn.us/forestry/ecs_silv/npcTables_Figures.html

More information on the comparison of pre-settlement and current vegetation can be found in the following resources:

- Friedman, S. K., and Reich, P.B. (2005). "Regional legacies of logging: departure from presettlement forest conditions in northeastern Minnesota." Ecological Applications **15**: 726-744. (This summarizes change for % density and basal area by subsection.)
- Schulte, L. A., D. J. Mladenoff, et al. (2007). "Homogenization of northern U.S. Great Lakes forests due to land use." Landscape Ecology **22**(7): 1089-1103. (This includes northern MN and shows changes in species composition as well as tree size.)

- White, M. A. and G. E. Host (2008). "Forest disturbance frequency and patch structure from pre-European settlement to present in the Mixed Forest Province of Minnesota, USA." Canadian Journal of Forest Research **38**(8): 2212-2226.

Table 3.9. Relative difference in abundance of tree species estimated from the Public Land Survey of the late 1800s[A] and the 1990 Forest Inventory and Analysis[B] for the Northern Minnesota Drift and Lake Plains.

Tree Species (from bearing tree metadata)	Difference	Proportional difference
Ash - *Fraxinus nigra, F. pennsylvanica, F. americana*	17.35	15.14
Aspen - *Populus tremuloides, P. grandidentata, P. balsamifera* (in lesser part)	67.36	9.54
Balm-of-Gilead - *Populus balsamifera* (in greater part)	12.65	54.27
Birch - *Betula papyrifera, B. cordifolia*	0.14	0.49
Bur Oak - *Quercus macrocarpa*	7.86	13.26
Butternut - *Juglans cinerea*	0.03	2.53
Box-Elder - *Acer negundo*	0.24	9.44
Cherry - *Prunus serotina, P. pennsylvanica*	0.24	27.3
Cottonwood - *Populus deltoides*	-0.27	-13.54
Elm - *Ulmus americana, U. rubra, U. thomasii*	3.96	6.53
Fir - *Abies balsamea*	14.23	8.34
Ironwood - *Ostrya virginiana*	-0.76	-9.57
Jack Oak - *Quercus ellipsoidalis*	0.25	2.02
Jack Pine - *Pinus banksiana*	-13.35	-1.21
Linden or Basswood - *Tilia americana*	8.89	13.13
Maple - *Acer rubrum, A. saccharum, A. saccharinum*	3.39	3.01
Oak - *Quercus rubra, Q. macrocarpa, Q. ellipsoidalis, Q. velutina, Q. alba, Q. bicolor*	-6.51	0
Pine - *Pinus strobus, P. resinosa, P. banksiana*	-9.51	0
Red Elm - *Ulmus rubra*	0.1	-1.29
Red Oak - *Quercus rubra, Q. ellipsoidalis* (in part or as hybrid)	13.86	30.41
Red, Norway, or Yellow Pine - *Pinus resinosa*	-15.57	-7.98
Spruce - Picea mariana, P. glauca	-15.14	-7.34
Sugar Maple - *Acer saccharum*	6.16	9.94
Tamarack - *Larix laricina*	-69.92	-21.67
White Cedar - *Thuja occidentalis*	-3.3	-2.39
Willow - *Salix spp.*	-0.62	-30.86
White Pine - *Pinus strobus*	-21.41	-25.52
Yellow Birch - *Betula alleghaniensis*	-0.21	-6.35

Source: DNR Division of Forestry, Resource Assessment.
[A] Public Land Survey Bearing Tree Data, late 1800s.
[B] Forest Inventory and Analysis, 1990.

Table 3.10. Growth-stage distribution in pre-settlement[A] and modern[B] MHn45 forests.

Growth Stage (Years)	Pre-settlement[A] (ca. 1846-1908)	Modern[B] (ca. 1990)
Young (0 - 55)	39%	29%
Transition (55 - 95)	51%	52%
Mature (95 - 205)	8%	18%
2nd Transition (205 - 295)	1%	1%
Old (> 295)	1%	0%

Source: DNR Division of Forestry, Resource Assessment.
http://files.dnr.state.mn.us/forestry/ecssilviculture/plantcommunities/MHn35.pdf
Note: Values based on 5,887 Public Land Survey corners and 3,470 FIA subplots modeled to represent the MHn35 community and estimated to fall within the young, mature, and old growth-stages.
[A]Public Land Survey Bearing Tree Data, late 1800s.
[B]United States Forest Service Forest Inventory and Analysis, 1990.

Table 3.11. Growth-stage distribution in pre-settlement[A] and modern[B] FDc34 forests.

Growth Stage (Years)	Pre-settlement[A] (ca. 1846-1908)	Modern[B] (ca. 1990)
Young (0 - 55)	47%	58%
Transition (55 - 95)	31%	40%
Mature (95 - 135)	13%	2%
2nd Transition (135 - 175)	3%	0%
Old (> 175)	6%	0%

Source: DNR Division of Forestry, Resource Assessment.
http://files.dnr.state.mn.us/forestry/ecssilviculture/plantcommunities/FDc34.pdf
Note: Values based on 4,684 Public Land Survey corners and 1,969 FIA subplots modeled to represent the FDc34 community and estimated to fall within the young, mature, and old growth-stages.
[A]Public Land Survey Bearing Tree Data, late 1800s.
[B]United States Forest Service Forest Inventory and Analysis, 1990.

Table 3.12. Relative abundance (%) of tree species in young, mature, and old growth-stages in pre-settlement[A] and modern[B] MHn45 forests.

Dominant Trees	Forest Growth Stages in Years					
	Young (0-55)		Mature (95-205)		Old[2] (> 295)	
	Pre-settlement[A]	Modern[B]	Pre-settlement[A]	Modern[B]	Pre-settlement[A]	Modern[B]
Paper Birch	38%	9%	28%	7%	12%	0%
Quaking Aspen	20%	22%	6%	4%	4%	0%
Red Oak	10%	6%	5%	11%	1%	0%
Balsam Fir	5%	4%	3%	2%	1%	0%
Basswood	6%	9%	9%	19%	6%	0%
White Spruce[1]	1%	1%	13%	0%	--	0%
Sugar Maple	11%	24%	14%	32%	29%	50%?
White Pine	1%	0%	7%	1%	31%	0%
American Elm	3%	2%	2%	3%	0%	0%
Red Maple	--	9%	--	4%	0%	0%

Table 3.12. Continued.

Dominant Trees	Forest Growth Stages in Years					
	Young (0-55)		Mature (95-205)		Old[2] (> 295)	
	Pre-settlement[A]	Modern[B]	Pre-settlement[A]	Modern[B]	Pre-settlement[A]	Modern[B]
Ironwood	1%	7%	1%	7%	1%	0%
Bur Oak	1%	1%	2%	3%	0%	50%?
Miscellaneous	39%	29%	8%	18%	1%	0%

Source: DNR Division of Forestry, Resource Assessment.
http://files.dnr.state.mn.us/forestry/ecssilviculture/plantcommunities/MHn35.pdf
Note: Values based on 5,887 Public Land Survey corners and 3,470 FIA subplots modeled to represent the MHn35 community and estimated to fall within the young, mature, and old growth-stages.
[A]Public Land Survey Bearing Tree Data, late 1800s.
[B]United States Forest Service Forest Inventory and Analysis, 1990.
[1]Important historically, white spruce is no longer a significant component of MHn35 forests and is not covered in the accounts of potential crop species.
[2]Just 4 FIA trees contributed to the old growth-stage and the results are unreliable.

Table 3.13. Relative abundance (%) of tree species in young, mature, and old growth-stages in pre-settlement[A] and modern[B] FDc34 forests.

Dominant Trees	Forest Growth Stages in Years					
	Young (0-55)		Mature (95-205)		Old[2] (> 295)	
	Pre-settlement[A]	Modern[B]	Pre-settlement[A]	Modern[B]	Pre-settlement[A]	Modern[B]
Quaking Aspen (incl. Bigtooth)	31%	71%	5%	29%	7%	0%
Jack Pine	11%	1%	9%	1%	1%	0%
Red Oak	7%	2%	3%	12%	4%	0%
Red Pine	25%	0%	50%	10%	15%	0%
Paper Birch	6%	10%	4%	7%	6%	0%
White Spruce	1%	0%	3%	1%	3%	0%
White Pine	14%	0%	22%	2%	54%	0%
Red Maple	1%	8%	1%	8%	2%	0%
Bur Oak	1%	2%	1%	25%	2%	0%
Miscellaneous	3%	6%	2%	5%	6%	0%

Source: DNR Division of Forestry, Resource Assessment.
http://files.dnr.state.mn.us/forestry/ecssilviculture/plantcommunities/FDc34.pdf
Note: Values based on 4,684 Public Land Survey corners and 1,969 FIA subplots modeled to represent the FDc34 community and estimated to fall within the young, mature, and old growth-stages.
[A]Public Land Survey Bearing Tree Data, late 1800s.
[B]United States Forest Service Forest Inventory and Analysis, 1990.

3.6. Forests in a changing climate

Future forest management discussions need to consider climate change considerations in addition to the pre-settlement conditions. Forest managers and researchers from across the State of Minnesota and Great Lakes Region developed a climate change vulnerability assessment for the forest ecosystems of the Laurentian Mixed Forest Province in northern Minnesota (Handler et al. 2014). Contributors to the assessment included private forestry companies; academic institutions; and federal, state, and tribal agencies. This collaboration led to the development of the Forest Ecosystem Vulnerability Assessment and Synthesis (FEVAS) which pulls together information about the current condition of forests and land-use in northern Minnesota, observed and projected climate trends, ecosystem modeling results, and published scientific literature to describe the potential impacts of climate change. The assessment included a deliberate process to incorporate local knowledge and manager experience before reaching conclusions about the vulnerability of different forest systems. This assessment serves as an information baseline for managers to consider and refine based on local information. The particular climate change risks for a specific location will be influenced by variety of factors, including site conditions, forest health, and past management.

The FEVAS summarizes major drivers and stressors related to climate change (Table 3.14) and vulnerability determinations for all six forested Native Plant Community Systems, in addition to two key managed forest systems. Overall vulnerability determinations ranged from low-moderate (Floodplain Forests) to high (Wet Forests, Forested Rich Peatlands, and Acid Peatlands) (Table 3.15). These vulnerability determinations were made by a group of local forest managers and researchers, after considering the full array of information described above.

To assist in formulating vulnerability determinations, researchers affiliated with the FEVAS used two climate impact models (Tree Atlas and LANDIS) to describe potential change to tree species by the end of the century in the Northern Minnesota Drift and Lake Plains Ecological Section (212N), which has a similar boundary to the North Central Landscape. More information about these forest impact models can be found in chapters 2 and 5 of Handler et al. 2014. Results for the Tree Atlas model are summarized directly from this assessment in Table 3.16 and cover the entire Laurentian Mixed Forest Province in Minnesota. Tree Atlas results are divided into "low" (PCM B1) and "high" (GFDL A1F1) climate scenarios so the range of potential outcomes can be compared side-by-side. The LANDIS model results are summarized from a new set of projections from Portland State University and the USFS Northern Research Station. They're draft results as of December 2015, and consider only the Ecological Section 212N landscape. Also, for LANDIS only one average result for each tree species is presented rather than results for low and high scenarios.

The vulnerability determinations for NPC Systems and Managed Forests are broad expectations across the entire Laurentian Mixed Forest Province. Within smaller landscapes and individual stands, local site conditions will have a big influence on climate change risk and vulnerability. Forest health issues, species and age class diversity, and soils and landscape position can all influence how a site might respond to climate change. For example, a mesic hardwood stand might have increased risk from climate change if it contains few species, is infested with garlic mustard, and exists on relatively nutrient-poor or drought-prone soils. Therefore, managers and planners should modify the general vulnerability determinations with their own knowledge and experience.

For more complete information on climate change in North Central Minnesota, please refer to the full FEVAS document. This document is available at www.nrs.fs.fed.us/pubs/45939.

Table 3.14. Summary of current major drivers and stressors for each forest system analyzed in the Forest Ecosystem Vulnerability Assessment and Synthesis.

Community Type	Major Drivers	Major Stressors
Fire-Dependent Forest	Coarse-textured soils or shallow soils over bedrock, fire return intervals 20 to 150 yrs.	Fire suppression, insect pests and diseases, understory hazel competition, deer herbivory
Mesic Hardwood Forest	Mesic soils or deep impermeable layers, consistent moisture and nutrients, gap-phase disturbances with stand-replacing events every 400 to 2000 yrs.	Exotic earthworms, invasive plants, insect pests, diseases, freeze-thaw cycles, drought, deer herbivory
Floodplain Forest	Alluvial soils, annual or occasional floods, connectivity to river and water table	Changes to flood regime, buckthorn and reed canarygrass, drought, deer herbivory
Wet Forest	Wet-mesic soils, saturated in spring and dry in summer, periodic flooding	Changes to soil moisture regime, ongoing ash decline, invasive species, insect pests, drought
Forested Rich Peatland	Peat soils, saturated throughout growing season, moisture through precipitation and groundwater, pH greater than 5.5	Changes to water table, roads and beaver dams, insect pests and diseases, winterburn, drought, deer herbivory, changes in pH
Acid Peatland	Peat soils, saturated throughout growing season, moisture through only precipitation, pH less than 5.5, nutrient-poor environments	Changes to water table, roads and beaver dams, insect pests and diseases, winterburn, drought
Managed Aspen	Gradient of soil types and landforms, frequent disturbance, even-aged management on 35 to 60 yr. rotation	Forest tent caterpillar and gypsy moth, drought, deer herbivory, hypoxylon canker, exotic earthworms
Managed Red Pine	Sandy to mesic soils, limited by high summer temperatures, dependent on planting for regeneration, even-aged management on 60 to 120 yr. rotation	Armillaria, red pine shoot blight, understory hazel competition, deer herbivory, bark beetles, drought stress in dense stands

Source: Handler et al. 2014; Forest Ecosystem Vulnerability Assessment and Synthesis (FEVAS).
Note: More information on native plant communities can be found at: www.dnr.state.mn.us/npc/classification.html

Table 3.15. Vulnerability determination summaries for the forest systems analyzed in the Forest Ecosystem Vulnerability Assessment and Synthesis.

Forest System	Potential Impacts	Adaptive Capacity	Vulnerability	Evidence	Agreement
Fire-Dependent Forest	Negative	Moderate-High	Moderate	Medium	Medium
Mesic Hardwood Forest	Moderate	Moderate-High	Moderate	Medium	Medium
Floodplain Forest	Moderate-Positive	Moderate	Low-Moderate	Limited-Medium	Medium
Wet Forest	Negative	Low	High	Limited-Medium	Medium
Forested Rich Peatland	Negative	Low	High	Medium	Medium-High
Acid Peatland	Negative	Low	High	Medium	Medium-High
Managed Aspen	Moderate-Negative	Moderate	Moderate-High	Medium	High
Managed Red Pine	Moderate-Negative	Moderate-Low	Moderate-High	Medium	Medium

Source: Handler et al. 2014; Forest Ecosystem Vulnerability Assessment and Synthesis (FEVAS).
Note: More information on native plant communities can be found at: www.dnr.state.mn.us/npc/classification.html

Table 3.16. Climate Change Projections for Individual Tree Species Landscape: Northern Minnesota Drift & Lake Plains (Ecological Section 212 N).

Common Name	PCM B1	GFDL A1FI	LANDIS (Lucash et al)
American basswood	No Change	Increase	
American beech	New Habitat	New Habitat	
American elm	Increase	Large Increase	Increase
American hornbeam	Increase	Large Increase	
Balsam fir (-)	Decrease	Large Decrease	
Balsam poplar	Large Decrease	Large Decrease	Decrease
Bigtooth aspen	No Change	Decrease	Decrease
Bitternut hickory (+)	Large Increase	Large Increase	
Black ash (-)	No Change	Decrease	Increase
Black cherry (-)	Large Increase	Large Increase	Mixed
Black hickory	NA	New Habitat	
Black locust	New Habitat	New Habitat	
Black oak	Large Increase	Large Increase	
Black spruce	Large Decrease	Large Decrease	Decrease
Black walnut	Large Increase	Large Increase	
Black willow (-)	Large Increase	Large Increase	
Blackgum (+)	NA	New Habitat	
Blackjack oak (+)	NA	New Habitat	
Boxelder (+)	Increase	Large Increase	
Bur oak (+)	No Change	Increase	Increase
Butternut (-)	No Change	Large Decrease	
Chestnut oak (+)	NA	New Habitat	
Chinkapin oak	New Habitat	New Habitat	
Chokecherry	No Change	No Change	
Eastern cottonwood	Increase	Large Increase	
Eastern hemlock (-)	New Habitat	New Habitat	
Eastern hophornbeam (+)	Increase	Increase	Increase
Eastern red cedar	Increase	Large Increase	
Eastern redbud	NA	New Habitat	
Eastern white pine	Increase	Increase	Increase
Flowering dogwood	NA	New Habitat	
Green ash	No Change	Large Increase	
Hackberry (+)	Large Increase	Large Increase	
Honeylocust (+)	New Habitat	New Habitat	
Jack pine	No Change	Decrease	Decrease
Mockernut hickory (+)	NA	New Habitat	
Mountain maple (+)	Large Decrease	Large Decrease	
Northern catalpa	NA	New Habitat	
Northern pin oak (+)	Large Increase	Large Increase	Increase
Northern red oak (+)	Increase	No Change	Mixed
Northern white-cedar	Decrease	Large Decrease	Increase
Ohio buckeye	NA	New Habitat	
Osage-orange (+)	New Habitat	New Habitat	
Paper birch	No Change	Large Decrease	Decrease
Peachleaf willow	Large Decrease	Large Increase	
Pignut hickory	New Habitat	New Habitat	
Pin cherry	Decrease	No Change	
Pin oak (-)	New Habitat	New Habitat	

Table 3.16. Continued.

Common Name	PCM B1	GFDL A1FI	LANDIS (Lucash et al)
Post oak (+)	NA	New Habitat	
Quaking aspen	Decrease	Large Decrease	Decrease
Red maple (+)	Increase	Increase	Increase
Red mulberry	New Habitat	New Habitat	
Red pine	No Change	Increase	Increase
River birch	Increase	Increase	
Rock elm (-)	No Change	Increase	
Sassafras	New Habitat	New Habitat	
Scarlet oak	New Habitat	New Habitat	
Shagbark hickory	New Habitat	New Habitat	
Shingle oak	NA	New Habitat	
Silver maple (+)	Large Increase	Large Increase	
Slippery elm	Large Increase	Large Increase	
Striped maple	No Change	No Change	
Sugar maple (+)	Large Increase	Increase	Mixed
Sugarberry	NA	New Habitat	
Swamp white oak	Increase	Large Increase	
Sweet birch (-)	NA	New Habitat	
Sweetgum	NA	New Habitat	
Tamarack (-)	Decrease	Decrease	Mixed
White ash (-)	Large Increase	Large Increase	Mixed
White oak (+)	Large Increase	Large Increase	Increase
White spruce	Decrease	Decrease	Decrease
Wild plum	Increase	Increase	
Yellow birch	Large Increase	Decrease	Increase
Yellow-poplar (+)	NA	New Habitat	

Sources: Handler et al. 2014; Forest Ecosystem Vulnerability Assessment and Synthesis (FEVAS).
Draft LANDIS results from Melissa Lucash, Portland State University, 12/4/15
Note: (-) and (+) = this species has particularly low or high modification factors according to the Tree Atlas model, which are natural history traits that might make them less or more adaptable to future change.

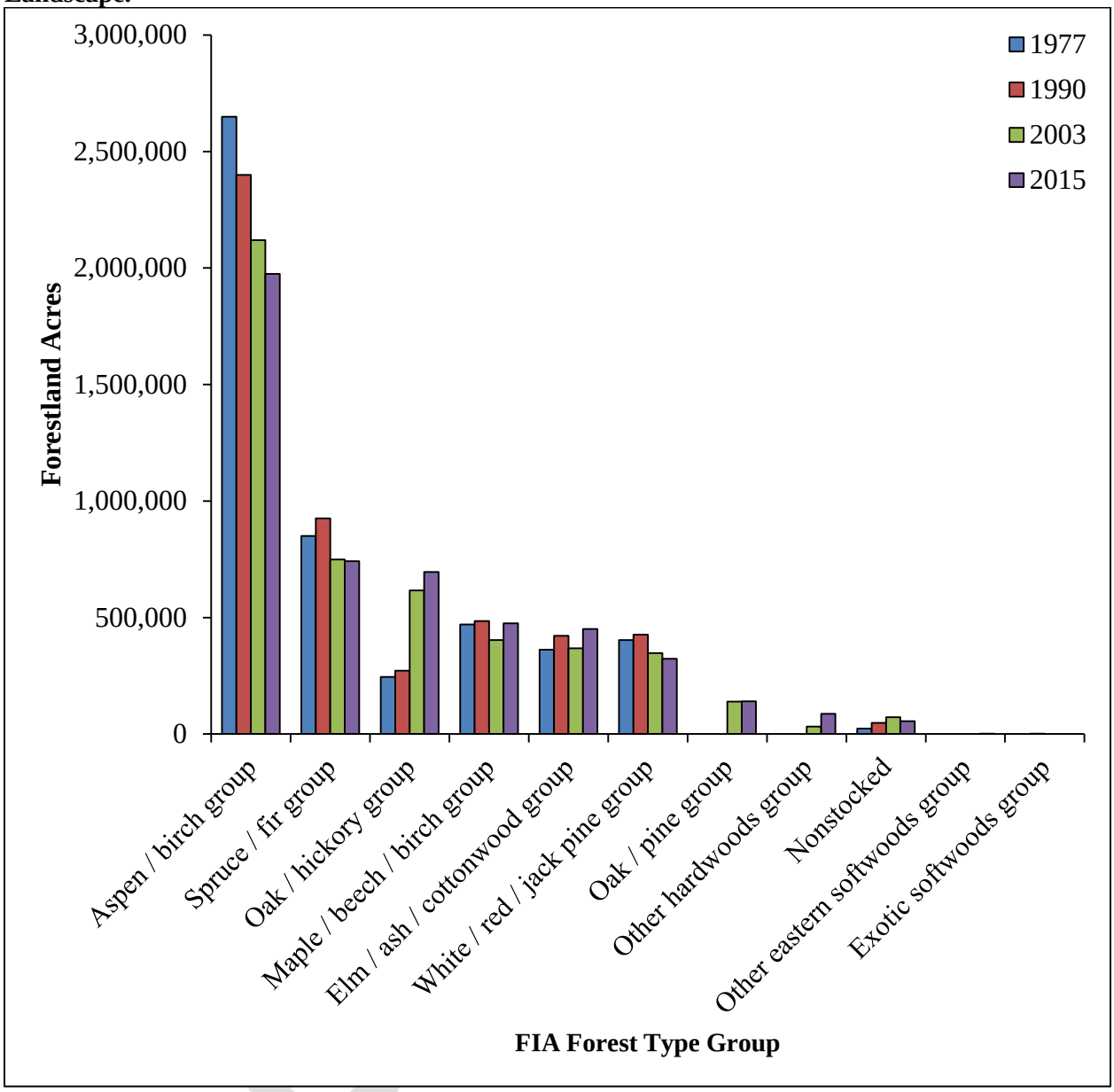
3.7. Forest type groups

Forest Inventory and Analysis (FIA) is a periodic survey of the state's forestland coordinated by the US Forest Service. Survey procedures are designed to provide reliable estimates on the type, extent, growth, mortality, and removals of forestland. FIA was not conceived or designed to provide information on ecological potential, plant diversity, forest fragmentation, or any number of other variables that may be necessary to fully assess the diversity of our forests. FIA alone provides an incomplete picture of forest diversity.

FIA classifies forestlands into types based on the predominant tree species in a stand (Figure 3.5). Forest types exhibit broad ranges of species composition and structure. For example, the aspen forest type will include areas of pure aspen and also areas with multiple species such as aspen, birch and fir. Forest type groups are collections of one or more forest types. For example, the aspen-birch group includes aspen, birch, and balsam poplar forest types.

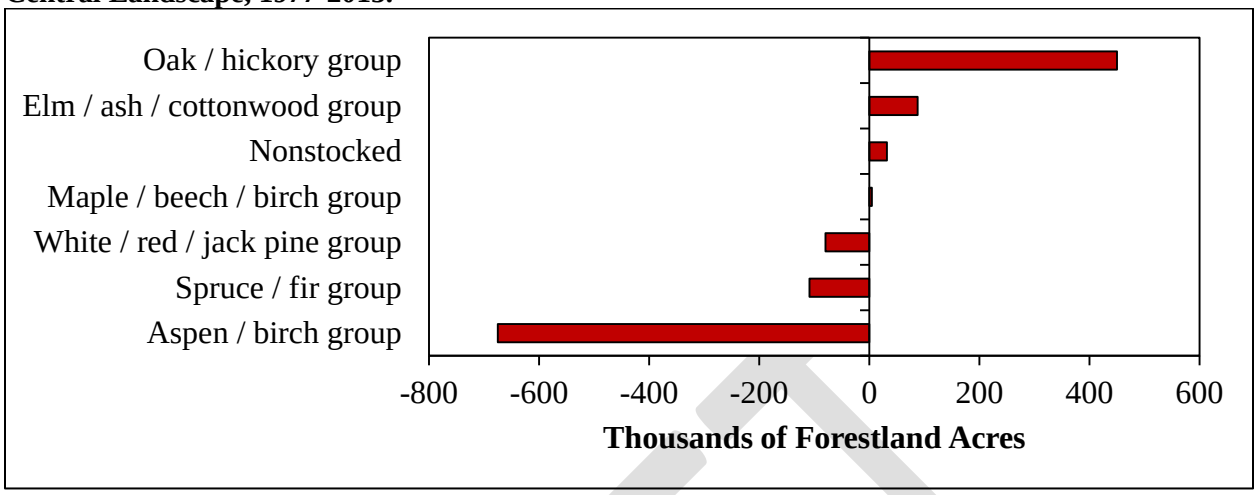
Figure 3.5 shows the FIA estimated distribution of forest type groups in the North Central Landscape in 1977, 1990, 2003, and 2015. In each of these survey years the aspen-birch group has been by far the largest forest type group in the region, ranging from a high of 53% in 1977 to a low of 40% in the 2015 survey. According to FIA analysis there has been a decline of over 675,000 acres of forestland in the aspen-birch group between 1977 and 2015 estimates (Figure 3.6). The spruce-fir group also declined during this time period and was nearly passed by the oak-hickory group as the second most abundant forest type group in the region. Comparison between the 2003 and 2015 surveys shows a decline in the aspen-birch group by nearly 146,000 acres while several of the hardwood forest type groups have increased by over 50,000 acres (Figure 3.7), yet the aspen-birch group remains by far the largest forest type group in the region (Figure 3.5).

Figure 3.5. Forestland acres by FIA Forest Type Group for forestland in the North Central Landscape.



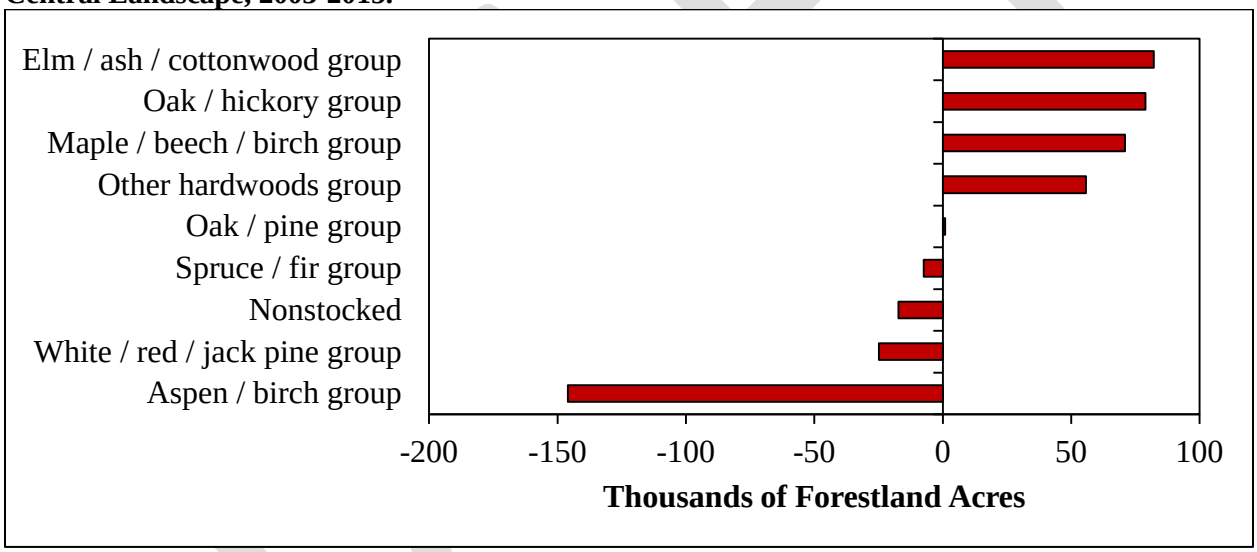
Source: Forest Inventory and Analysis estimate.
Note: Oak/pine, Other Hardwoods, Other eastern softwoods, and Exotic softwoods groups were not available for all time periods.

Figure 3.6. Estimated change in FIA Forest Type Group acreage for forestland in the North Central Landscape, 1977-2015.



Source: Forest Inventory and Analysis estimate.

Figure 3.7. Estimated change in FIA Forest Type Group acreage for forestland in the North Central Landscape, 2003-2015.



Source: Forest Inventory and Analysis estimate.

3.9. Age class structure of forestland

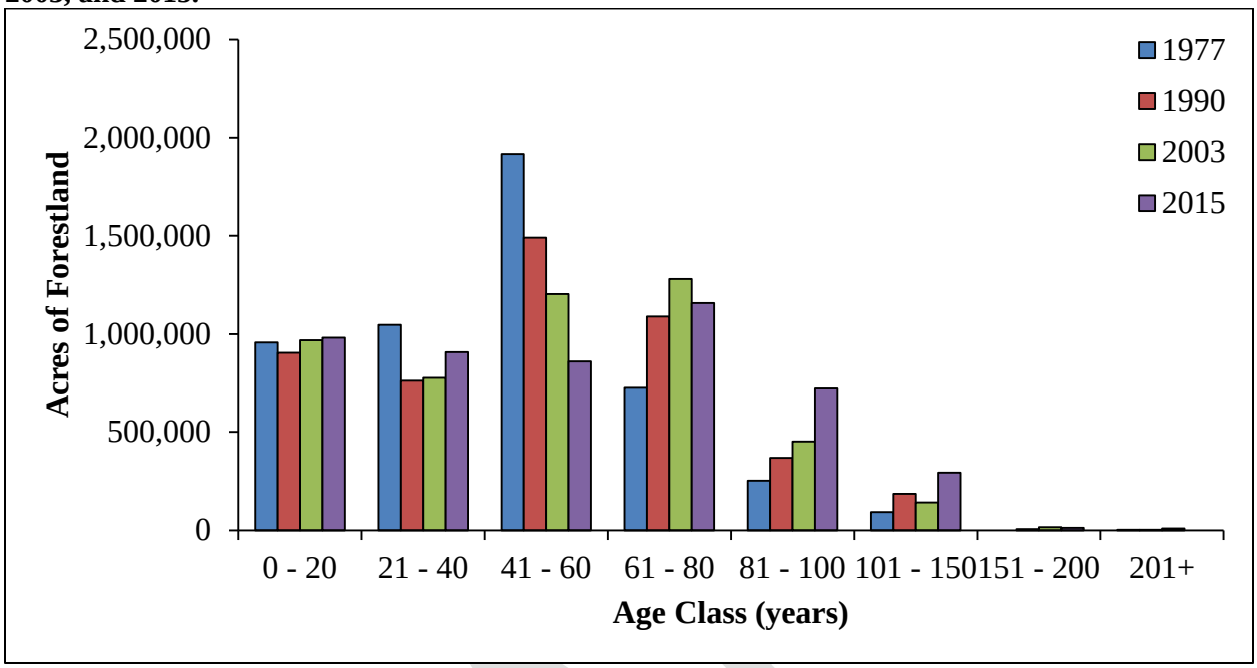
Figure 3.8 shows the FIA estimated age class structure of forestlands in the North Central Landscape in 1977, 1990, 2003, and 2015 FIA datasets. The FIA estimated age class structure for 1977 shows an abundance of forestland in the 41-60 year age class (1.9 million acres; 38.3% of all forestland). This marked peak in the 41-60 age class in 1977 was somewhat reduced by 1990 (1.5 million acres; 29.9% of total) and continued to decrease though the 2003 and 2015 estimates. By the 2015 estimate the 0-20, 21-40, and 61-80 age classes had all surpassed the 41-60 age class in abundance.

The FIA estimated amount of forestland in the 21-40 and 41-60 year age classes was reduced between 1977 and 2015 (Figure 3.9). Gains were observed in the younger (<20 years) and older (61+ years) age classes with the greatest increases occurring in the 61-80 (430,000 acres) and 81-100 (473,000 acres) age class. This pattern was somewhat continued between 2003 and 2015 when the greatest decrease was in the 41-60 age class while the greatest increase was in the 81-100 age class (Figure 3.10).

The aspen-birch forest type group is the largest group in the region and seen significant declines across the region. For the aspen forest type on forestland most of this decline has been in the 41-60 age class (653,000 acres) (Figure 3.11).

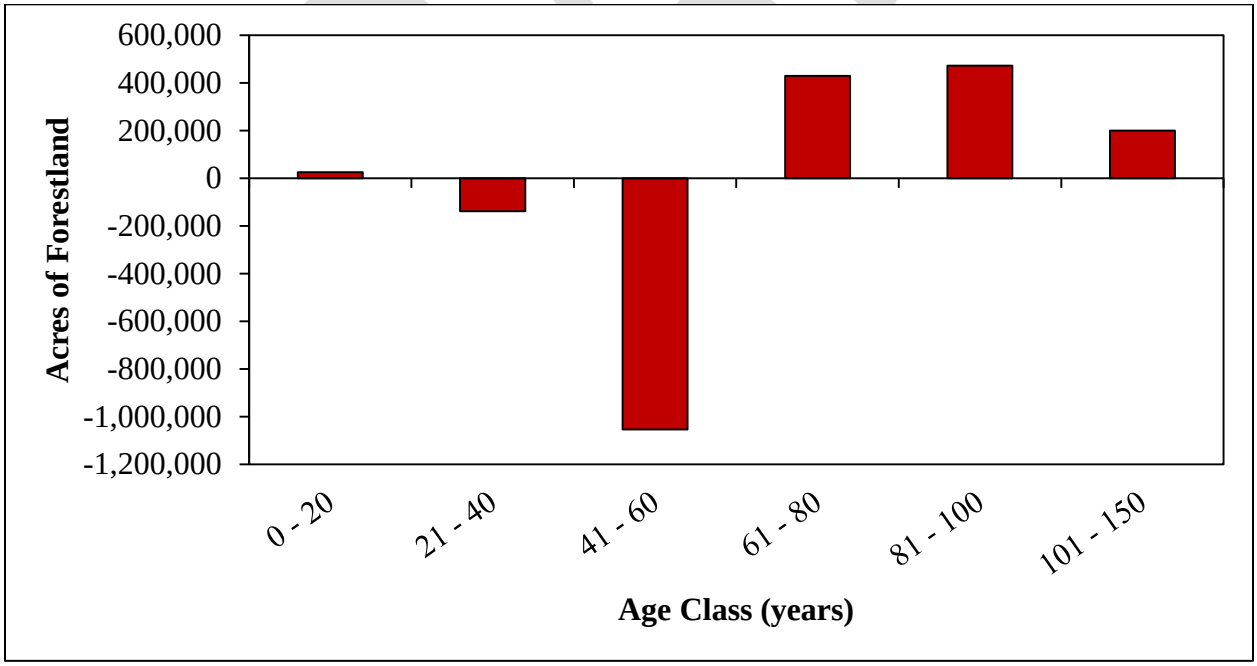
Figure 3.12 and Figure 3.13 summarize FIA estimates of forest age structure data for 1977, 1990, 2003, and 2015. This analysis shows the highest total acreage (1,158,000 acres) in 2015 was in the 61-80 year age class but also shows variation between forest types (Table 3.20, Figure 3.12). For example the majority of aspen-birch group is in the 21-40 age class while the most frequent oak-hickory and spruce-fir forest type group are in the 61-80 year age class (Figure 3.13).

Figure 3.8. Estimated age class structure of forestland in the North Central Landscape, 1977, 1990, 2003, and 2015.



Source: Forest Inventory and Analysis estimate.

Figure 3.9. Estimated change in age class structure on forestland in the North Central Landscape, 1977 to 2015.



Source: Forest Inventory and Analysis estimate.

Figure 3.10. Estimated change in age class structure on forestland in the North Central Landscape, 2003 to 2015.

Source: Forest Inventory and Analysis estimate.

Figure 3.11. Estimated change in age class structure of the aspen forest type on forestland in the North Central Landscape, 1977 to 2015.

Source: Forest Inventory and Analysis estimate.

Table 3.17. Estimated age class structure of forestland in the North Central Landscape (acres) by forest type group, 1977.

Forest Type Group	Age Class									Total
	0-20	21-40	41-60	61-80	81-100	101-150	151-200	201+	Not Collected	
Aspen / birch	483,220	660,298	1,184,320	261,932	54,428	5,199	--	--	--	2,649,398
Spruce / fir	245,145	150,512	193,618	131,445	74,485	45,007	--	3,100	6,999	850,312
Maple / beech / birch	23,511	64,095	197,399	119,695	45,007	20,438	--	--	--	470,145
White / red / jack pine	80,393	97,813	133,735	70,615	15,598	5,009	--	--	--	403,163
Elm / ash / cottonwood	79,262	47,499	93,396	87,393	43,197	11,799	--	--	--	362,547
Oak / hickory	22,498	27,502	113,827	56,600	19,618	5,499	--	--	--	245,545
Non-stocked	23,938	--	--	--	--	--	--	--	--	23,938
Exotic softwoods	--	--	--	--	--	--	--	--	--	--
Total	**957,967**	**1,047,719**	**1,916,295**	**727,679**	**252,334**	**92,952**	**--**	**3,100**	**6,999**	**5,005,046**

Source: Forest Inventory and Analysis estimate.

Table 3.18. Estimated age class structure of forestland in the North Central Landscape (acres) by forest type group, 1990.

Forest Type Group	Age Class									Total
	0-20	21-40	41-60	61-80	81-100	101-150	151-200	201+	Not Collected	
Aspen / birch	585,118	376,086	811,681	491,483	79,298	16,899	--	--	38,545	2,399,109
Spruce / fir	91,799	201,003	194,564	159,700	101,501	80,101	5,799	3,201	87,801	925,468
Maple / beech / birch	28,398	33,409	154,910	160,670	81,201	26,398	--	--	--	484,985
White / red / jack pine	98,409	80,204	134,397	76,698	21,598	15,200	--	--	--	426,505
Elm / ash / cottonwood	63,807	51,500	87,901	118,102	51,207	35,802	1,100	--	12,799	422,218
Oak / hickory	17,699	20,098	106,903	82,302	33,903	10,500	--	--	1,000	272,405
Non-stocked	19,699	1,100	--	1,200	--	--	--	--	26,402	48,400
Exotic softwoods	500	--	--	--	--	--	--	--	1,300	1,800
Total	**905,428**	**763,401**	**1,490,356**	**1,090,154**	**368,707**	**184,900**	**6,899**	**3,201**	**167,845**	**4,980,891**

Source: Forest Inventory and Analysis estimate.

Table 3.19. Estimated age class structure of forestland in the North Central Landscape (acres) by forest type group, 2003.

Forest Type Group	Age Class								Total
	0-20	21-40	41-60	61-80	81-100	101-150	151-200	201+	
Aspen / birch	658,161	423,284	516,975	448,647	69,967	3,361	--	3,055	2,123,449
Spruce / fir	49,400	104,578	199,763	186,861	126,636	68,875	12,921	3,055	752,088
Oak / hickory	72,858	42,062	174,651	238,100	83,178	5,881	--	--	616,730
Maple / beech / birch	23,320	13,576	103,815	185,902	70,458	6,886	--	--	403,957
Elm / ash / cottonwood	20,851	33,532	70,945	119,299	72,505	48,778	3,082	--	368,993
White / red / jack pine	55,122	109,751	97,079	65,898	11,727	5,041	--	3,360	347,979
Oak / pine	10,560	45,645	38,005	33,265	12,129	--	--	--	139,604
Non-stocked	72,853	--	--	--	--	--	--	--	72,853
Other hardwoods	9,303	5,881	4,082	5,202	3,916	3,381	--	--	31,765
Total	**972,428**	**778,310**	**1,205,315**	**1,283,174**	**450,515**	**142,203**	**16,003**	**9,469**	**4,857,417**

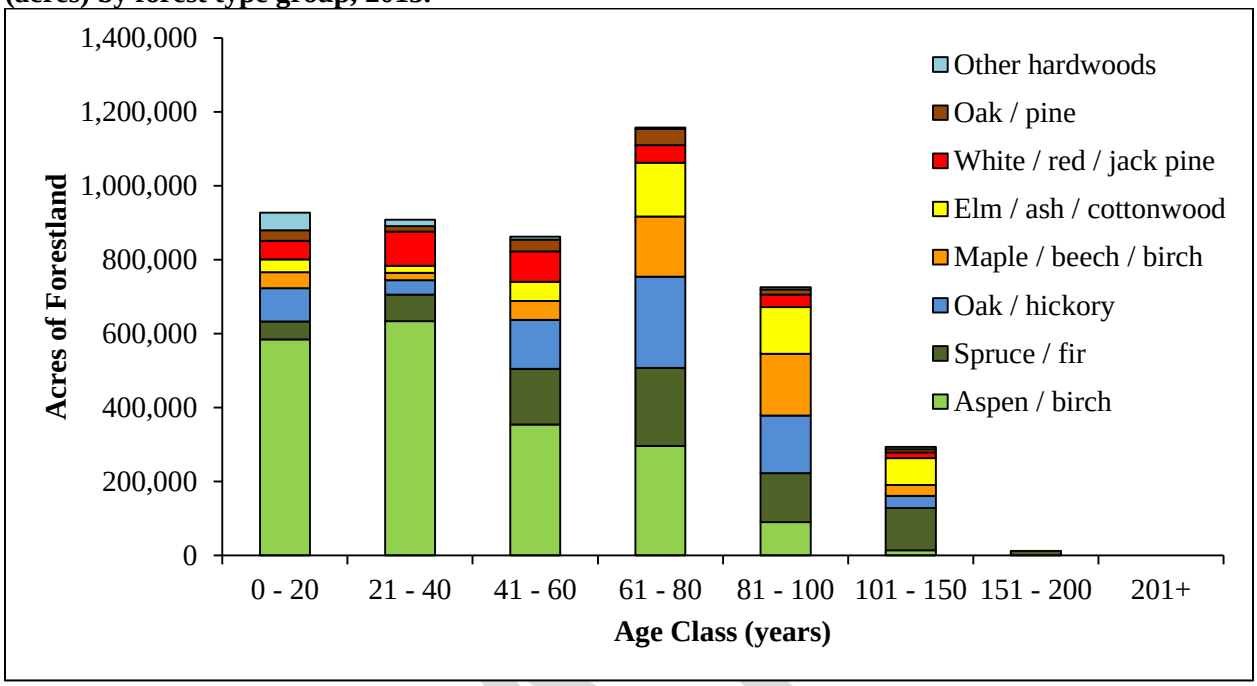
Source: Forest Inventory and Analysis estimate.

Table 3.20. Estimated age class structure of forestland in the North Central Landscape (acres) by forest type group, 2015.

Forest Type Group	Age Class								Total
	0-20	21-40	41-60	61-80	81-100	101-150	151-200	201+	
Aspen / birch	584,400	633,918	354,376	296,788	90,510	14,346	--	--	1,974,339
Spruce / fir	49,133	71,785	150,633	210,876	132,173	114,187	12,696	--	741,483
Oak / hickory	89,412	38,755	132,403	246,655	155,858	32,535	--	--	695,617
Maple / beech / birch	43,310	20,465	51,058	162,903	167,175	29,944	--	--	474,857
Elm / ash / cottonwood	35,061	18,899	52,083	145,312	126,469	72,513	--	--	450,336
White / red / jack pine	50,030	93,034	82,489	47,840	33,890	15,780	--	--	323,063
Oak / pine	28,956	14,078	31,600	43,747	14,057	8,144	--	--	140,582
Other hardwoods	47,388	17,322	7,572	3,997	5,219	5,937	--	--	87,435
Non-stocked	55,594	--	--	--	--	--	--	--	55,594
Other eastern softwoods	--	885	--	--	--	--	--	--	885
Total	**983,284**	**909,140**	**862,215**	**1,158,118**	**725,351**	**293,386**	**12,696**	**--**	**4,944,190**

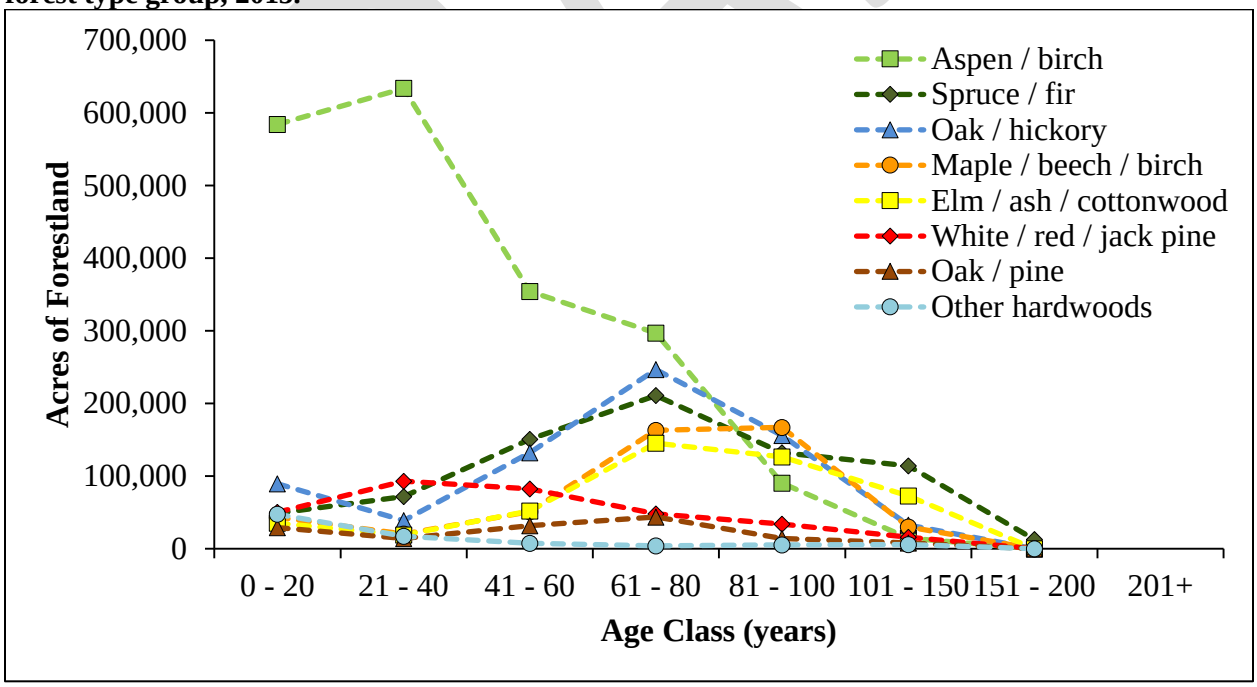
Source: Forest Inventory and Analysis estimate.

Figure 3.12. Total estimated age class structure of forestland in the North Central Landscape (acres) by forest type group, 2015.



Source: Forest Inventory and Analysis estimate.

Figure 3.13. Estimated age class structure of forestland in the North Central Landscape (acres) by forest type group, 2015.

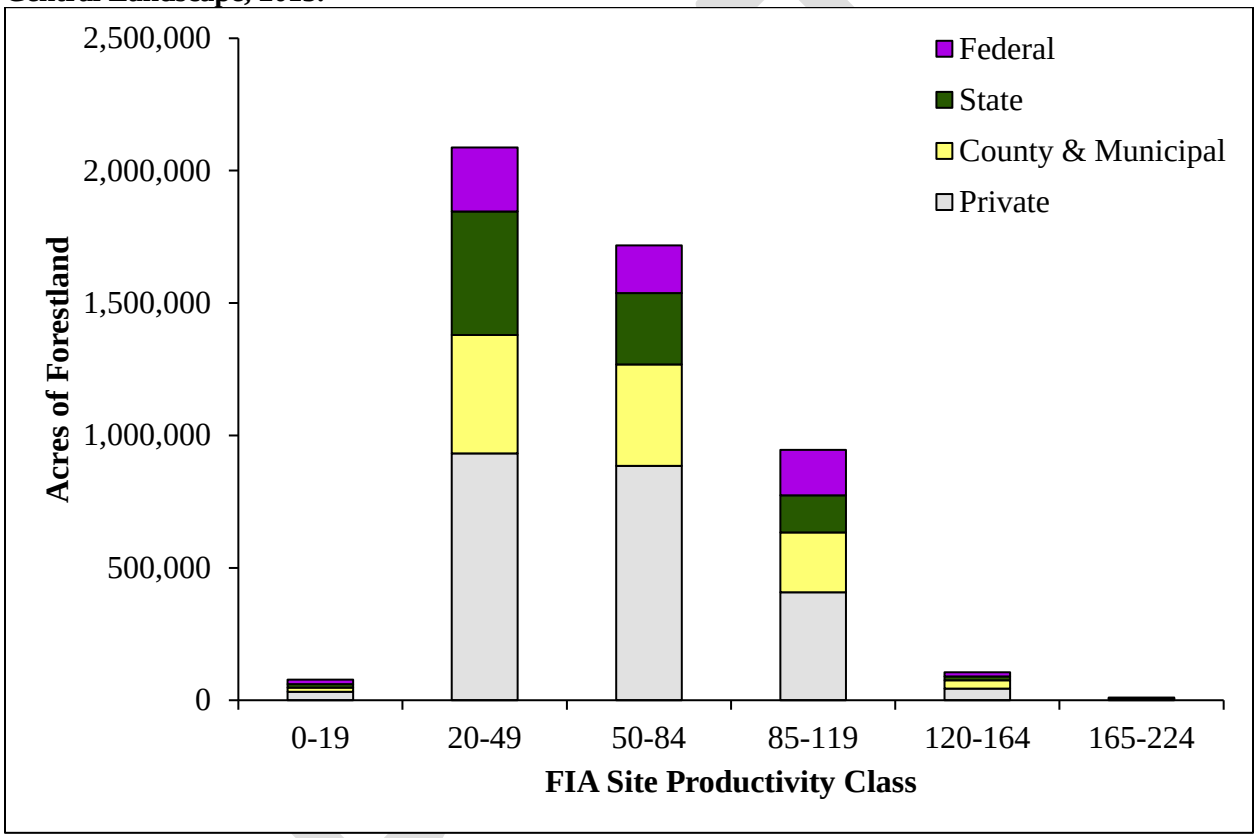


Source: Forest Inventory and Analysis estimate.

3.10. Productivity of the North Central's forestland

The site productivity class in the Forest Inventory and Analysis (FIA) database is a classification of forest land in terms of inherent capacity to grow crops of industrial wood. This class identifies the potential growth in cubic feet/acre/year and is based on the culmination of mean annual increment of fully stocked natural stands. In the North Central Landscape about 2.1 million acres (42.2%) of forestlands is estimated to have a site productivity class of 20-49 cubic feet per acre per year, which is the dominant productivity class for each landowner group. Only 2.3% of the forestland area in the region is estimated to have site productivity over 120 cubic feet per acre per year, and 1.6% of the area is estimated to have a site productivity of less than 20. The estimated distribution of forestland by owner and site productivity class is displayed in Figure 3.14.

Figure 3.14. Estimated distribution of forestland by owner and site productivity class for the North Central Landscape, 2015.



Source: Forest Inventory and Analysis estimate.
Note: The FIA database combines Tribal, Forest Industry, and Non-industrial Private as 'Private'. For some analysis these categories cannot be separated due to disclosure laws.
Note: Site productivity class is a classification of forest land in terms of inherent capacity to grow crops of industrial wood. Identifies the potential growth in cubic feet/acre/year and is based on the culmination of mean annual increment of fully stocked natural stands.

3.11. Forestland biomass

Forest biomass is an estimate of the total dry weight of live trees (at least 1 inch d.b.h.) on the landscape including bark but excluding foliage. Biomass has five components for most tree species (bole, tops and limbs, saplings, stump, and belowground).

- Bole - Biomass of a tree at least 5 inches d.b.h. from 1 foot above the ground to a 4-inch top outside bark or to a point where the central stem breaks into limbs.
- Tops and limbs - Total biomass of a tree at least 5 inches d.b.h. from a 1-foot stump minus the bole.
- Saplings - Total aboveground biomass of a tree from 1 to 5 inches in d.b.h.
- Stump - Biomass of a tree 5 inches d.b.h. and larger from the ground to a height of 1 foot.
- Belowground biomass - Biomass of coarse roots with a root diameter ≥ 0.1 inch. This is a modeled estimate, calculated on live trees with a diameter of ≥ 1 inch and dead trees with a diameter ≥ 5 inches.

Forestland in the North Central Landscape has an estimated total biomass of 184.6 million short tons (one short ton equals 2,000 lbs.) with aboveground biomass accounting for over 153.0 million short tons (Table 3.21). Nearly 25% of the region's total aboveground biomass is aspen and cottonwood. The second highest total aboveground biomass was ash (10.3%) which is under increasing threats from Emerald Ash Borer. These estimates do not include dead trees, foliage, or trees on non-forestlands but highlight the volume of chemical resources sequestered in the woody species of North Central Minnesota's forests.

Table 3.21. Estimated biomass in dry weight (short tons) of live trees on forestland in the North Central Landscape, 2015.

Species Group	Merchantable bole	Tops and limbs	Saplings	Stumps	Total aboveground biomass	Belowground biomass	Total biomass
Other yellow pines	14,434	2,670	--	1,025	18,129	4,204	22,333
Eastern white and red pine	10,747,739	1,850,721	339,666	525,357	13,463,483	3,069,850	16,533,333
Jack pine	1,412,821	254,377	121,922	84,515	1,873,635	432,692	2,306,327
Spruce and balsam fir	4,837,038	901,721	2,529,430	307,907	8,576,096	2,039,434	10,615,530
Other eastern softwoods	7,318,974	1,214,310	1,172,226	566,604	10,272,113	2,388,892	12,661,005
Select white oaks	8,580,141	2,352,032	874,612	518,558	12,325,342	2,405,203	14,730,545
Select red oaks	7,076,472	1,715,143	435,081	380,773	9,607,469	1,860,619	11,468,089
Other red oaks	1,306,855	349,081	111,654	79,366	1,846,956	359,830	2,206,786
Hickory	7,271	2,880	-	642	10,793	2,138	12,931
Yellow birch	265,497	74,026	115,597	17,245	472,365	93,795	566,160
Hard maple	6,689,924	1,982,413	1,360,313	418,041	10,450,691	2,066,228	12,516,919
Soft maple	5,287,802	1,558,672	1,215,758	313,759	8,375,991	1,653,957	10,029,948
Ash	9,638,821	2,899,807	2,572,957	715,015	15,826,599	3,138,277	18,964,876
Cottonwood and aspen	21,230,069	6,714,143	8,675,324	1,132,783	37,752,318	7,526,670	45,278,989
Basswood	5,413,758	1,529,420	526,333	260,274	7,729,784	1,507,641	9,237,425
Black walnut	5,476	1,456	--	383	7,314	1,417	8,732
Other eastern soft hardwoods	7,778,881	2,431,956	2,303,436	489,801	13,004,073	2,579,043	15,583,116
Other eastern hard hardwoods	--	--	396	--	396	101	496
Eastern noncommercial hardwoods	225,657	87,060	1,200,606	28,575	1,541,899	339,536	1,881,435
Total	**97,837,629**	**25,921,886**	**23,555,312**	**5,840,621**	**153,155,447**	**31,469,526**	**184,624,973**

Source: Forest Inventory and Analysis estimate.

3.12. Forestland carbon stock

Interest in terrestrial carbon sequestration has increased in an effort to explore opportunities for climate change mitigation. Carbon sequestration is the process by which atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage, and roots) and soils. The sink of carbon sequestration in forests and wood products helps to offset sources of carbon dioxide to the atmosphere, such as deforestation, forest fires, and fossil fuel emissions.

Sustainable forestry practices can increase the ability of forests to sequester atmospheric carbon while enhancing other ecosystem services, such as improved soil and water quality. Planting new trees and improving forest health through thinning and prescribed burning are some of the ways to increase forest carbon in the long run. Harvesting and regenerating forests can also result in net carbon sequestration in wood products and new forest growth.

In response to government, business, and individual commitments to reduce carbon dioxide emissions, carbon is now a priced environmental commodity in the global marketplace. The United States carbon market is in its formative stages. States and regions are developing climate change strategies and policy for reducing carbon dioxide emissions, and mandatory markets are forming at the regional and state levels. The Voluntary Reporting of Greenhouse Gases Program, established by Section 1605(b) of the Energy Policy Act of 1992, provides a means for organizations and individuals - including forest landowners and other land managers - to record their baseline emissions and emission reductions. More information on carbon sequestration can be found at: www.fs.fed.us/ecosystemservices/carbon.shtml

According to FIA estimates, forests in the North Central Landscape currently sequester over 492.3 million short tons of carbon which represents over 27% of the state-wide total (Table 3.22). About 70% of this carbon is sequestered in the organic soil (defined as the fine organic material below the soil surface to a depth of 1 meter). Over 51% of the non-organic soil carbon storage is in live trees at least 1 inch d.b.h.

Table 3.22. Estimated carbon storage in North Central Landscape forestland, 2015 (Values are short tons).

	Minnesota	North Central Landscape	% of State Category Total	% of Total Carbon	% of Non-Organic Soil Carbon
Aboveground in live trees*	249,782,391	76,577,724	30.7%	15.6%	51.1%
Belowground in live trees*	51,872,714	15,734,763	30.3%	3.2%	10.5%
Above and belowground standing-dead trees*	31,063,635	9,238,404	29.7%	1.9%	6.2%
Aboveground live seedlings, shrubs, and bushes	13,321,904	3,782,643	28.4%	0.8%	2.5%
Belowground live seedlings, shrubs, and bushes	1,480,212	420,294	28.4%	0.1%	0.3%
Stumps, coarse roots, and coarse woody debris	39,611,586	11,860,611	29.9%	2.4%	7.9%
Litter	125,457,659	32,307,828	25.8%	6.6%	21.5%
Organic soil	1,297,504,617	342,418,196	26.4%	69.5%	--
Total carbon	**1,810,094,717**	**492,340,463**	**27.2%**	**100.0%**	**--**

Source: Forest Inventory and Analysis estimate.
* At least 1 inch d.b.h./d.r.c

3.13. Annual growth, mortality, and removals of growing stock on timberland

These data are for Timberland

Forest Inventory and Analysis Definitions:

- Growing stock. All live trees of commercial species that meet minimum merchantability standards (at least 5 inches d.b.h.). In general, these trees have at least one solid 8-foot section, are reasonably free from defect on the merchantable bole, and at least 34% or more of the volume is merchantable. Excludes rough or rotten cull trees.
- Net cubic-foot volume. For timber species, this is the net volume of wood in the central stem of a sample tree ≥ 5.0 inches in diameter, from a 1-foot stump to a minimum 4-inch top diameter, or to where the central stem breaks into limbs all of which are <4.0 inches in diameter.
- Average annual net growth**.** The average annual change in the volume of trees during the period between inventories. Components include the change in volume of trees that have met the minimum size requirements over the inventory period, plus the volume of trees reaching the minimum size (≥ 5.0 inches dbh) during the period (ingrowth), minus the volume of trees that died during the period, minus the volume of cull during the period. Mortality removals (trees killed in the harvesting process and left on site) and diversion removals (trees removed from the forest-land base due to a change from forest to non-forest land) are not included.
- Average annual removals of growing stock. Trees that were growing-stock trees on timberland at the time of the previous inventory and were removed from timberland by the time of the current inventory. Removals are cut and utilized trees, trees killed as a result of harvest operations but not utilized and live trees associated with land-use reclassifications.
- Average annual harvest removals. Trees that were growing-stock tress on timberland at the time of the previous inventory and were either cut or removed by direct human activity related to harvesting or died as a result of silvicultural or land-clearing activity (death caused by harvesting or other silvicultural activity, including girdling, chaining, etc., or to land-clearing activity).
- Average annual mortality of growing stock. Volume of growing stock trees that were alive at the time of the previous inventory and are dead in the current inventory. Tree death associated with insects, disease, fire, animals, weather, and other factors are included.
- Sampling error percent. Equals 100 multiplied by the square root of the variance divided by the sample estimate. Since sampling error is given in percent of the estimate, a large sampling error indicates that there is considerable uncertainty associated with the estimate.

There were 5.27 billion cubic feet (66.7 million cords) of growing stock on timberland in the North Central Landscape in the 2015 FIA survey dataset (Table 3.23). Average annual net growth in this dataset was 143.6 million cubic feet. Quaking aspen and red pine had both the highest net volumes and average annual net growth rates; together they made up about 32.7% of the total growing stock volume and 46.8% of the total average annual net growth.

The total average annual removals (82.4 million cubic feet) exceeded the total average annual mortality (65.0 million cubic feet) by almost 17.4 million cubic feet. This was not true for all species, particularly those species for which there is little to no market (e.g., white cedar, tamarack, etc). Additionally, for some species average annual removals were greater than their average annual net growth. This was most noticeable with jack pine and paper birch, which experienced average annual removals over twice as large as average annual net growth, ultimately resulting in a negative net change for those species.

Between 2003 and 2015, net volume and annual net growth increased by 2.2% and 13.3%, respectively (Table 3.24). Annual removals decreased by 24.4% and mortality decreased by 35.8%. Among individual

species, paper birch growth decreased by 253%, red pine and black spruce removals increased by 243% and 185% respectively, and white pine mortality increased by 738%.

Overall relative mortality rates increased from 1.0% of growing stock volume in 1977 to 1.2% in 2015 (Table 3.25) with a six fold increase in paper birch and white pine, although 2015 mortality rates were highest for balsam fir, balsam poplar, and jack pine. Data collection methods changed significantly over this period and we do not know how much those changes may have influenced the estimates.

More recent trends can be detected by comparing FIA data from 2003 to 2015. Relative mortality rates increased between 2003 and 2015 for white pine, tamarack, jack pine, sugar maple, and black ash, decreased for elm, paper birch, white cedar, red maple, white spruce, quaking aspen, basswood, balsam fir, black spruce, green ash, balsam poplar, red pine, and bigtooth aspen, and did not change for bur oak or northern red oak.

Mortality is strongly related to age class structure. Overall, mortality volume is higher in the 41-60 and 61-80 age classes, but relative mortality rates are highest in the 0-20 age class (Table 3.26). Notable exceptions to this trend include longer lived species (e.g. black ash, white cedar) whose mortality volume is highest in the 81-100, and 101-150 age classes. Other species such as northern red oak, green ash, balsam poplar, and American elm had higher relative mortality rates in older age classes.

Relative mortality rates were generally similar across ownerships (Table 3.27), although they were particularly high for balsam poplar on private timberlands.

Total relative removal rates were highest from county and state timberlands and lower from private and national forest timberlands (Table 3.28). The relative removal rate of individual species varied widely across ownerships. The most striking difference was the high removal rates of quaking aspen, bigtooth aspen, and paper birch on county timberlands and jack pine and black spruce on state timberlands.

Over the period from 2004 to 2015, average annual growing stock mortality did not drastically change for most species (Figure 3.15). Jack pine mortality fell by over 7 million cubic feet from a high of nearly 10 million cubic feet in 2004 to less than 3 million cubic feet in 2015. Furthermore, the relative mortality rate for elm dropped drastically from 16.3% of growing stock volume in 2004 to 2.6% in 2015 (Figure 3.16).

Table 3.23. Net volume, average annual net growth, average annual removals, and average annual mortality of growing stock trees, in cubic feet, on timberlands in the North Central Landscape, 2015.

Species	Net Volume			Average Annual Net Growth			Average Annual Removals			Average Annual Mortality		
	Volume (ft^3)	Sampling error %	% of total volume	Growth (ft^3)	Sampling error %	% of total growth	Removals (ft^3)	Sampling error %	% of total removals	Mortality (ft^3)	Sampling error %	% of total mortality
Quaking aspen	1,150,172,481	4.4	21.8	47,785,805	6.2	33.3	37,173,611	13.6	45.1	23,856,705	8.0	36.7
Red pine	572,051,568	9.2	10.9	19,453,361	10.5	13.5	9,261,909	22.2	11.2	787,320	39.6	1.2
American basswood	409,174,292	7.9	7.8	7,391,096	12.6	5.1	3,191,258	33.5	3.9	2,057,416	33.7	3.2
Black ash	382,379,902	7.7	7.3	8,819,439	12.2	6.1	1,565,787	33.8	1.9	1,988,310	31.5	3.1
Paper birch	311,996,211	6.0	5.9	2,912,258	24.2	2.0	6,493,128	20.4	7.9	5,906,338	11.2	9.1
Bur oak	308,632,830	7.2	5.9	6,895,566	6.8	4.8	1,291,599	28.9	1.6	787,808	28.3	1.2
Northern red oak	248,750,128	9.2	4.7	5,169,640	15.4	3.6	3,154,028	28.7	3.8	2,555,636	25.1	3.9
Northern white-cedar	216,656,647	14.6	4.1	4,307,932	20.7	3.0	131,639	75.0	0.2	410,516	29.4	0.6
Sugar maple	213,696,420	9.0	4.1	4,733,264	10.4	3.3	1,173,380	28.2	1.4	882,864	27.1	1.4
Tamarack (native)	207,313,901	10.3	3.9	4,377,966	25.7	3.0	1,940,882	59.8	2.4	3,764,248	28.1	5.8
Balsam fir	180,957,762	7.2	3.4	3,282,687	25.2	2.3	3,335,220	30.5	4.0	7,044,573	11.5	10.8
Eastern white pine	157,614,329	14.1	3.0	4,173,335	33.3	2.9	383,215	81.7	0.5	1,954,831	54.9	3.0
Bigtooth aspen	156,983,660	12.9	3.0	5,368,619	19.3	3.7	2,675,124	38.6	3.2	1,868,360	39.6	2.9
Red maple	153,863,439	6.8	2.9	4,774,524	8.2	3.3	2,049,834	27.1	2.5	992,472	20.7	1.5
Green ash	108,231,443	11.3	2.1	3,305,114	11.5	2.3	269,199	38.6	0.3	320,482	40.3	0.5
Balsam poplar	95,806,273	10.8	1.8	1,782,136	38.7	1.2	1,541,532	44.0	1.9	2,875,657	20.3	4.4
Jack pine	93,017,433	13.0	1.8	496,364	117.7	0.3	2,863,935	36.0	3.5	2,732,517	19.9	4.2
Black spruce	92,411,472	12.2	1.8	1,837,990	25.0	1.3	2,522,016	56.0	3.1	1,588,874	20.1	2.4
White spruce	82,973,289	13.5	1.6	2,438,838	21.9	1.7	754,197	54.9	0.9	1,010,927	35.2	1.6
Northern pin oak	42,557,434	19.7	0.8	1,208,436	19.9	0.8	374,598	96.3	0.5	235,469	47.6	0.4
American elm	39,077,613	9.0	0.7	1,724,914	17.2	1.2	202,758	43.7	0.2	985,757	20.8	1.5
Silver maple	26,789,146	50.1	0.5	356,353	60.9	0.2	--	--	--	9,579	101.5	0.0
Yellow birch	6,713,262	23.6	0.1	171,979	29.9	0.1	--	--	--	37,864	51.1	0.1
Eastern cottonwood	4,478,293	87.6	0.1	731,176	97.7	0.5	--	--	--	--	--	--
Boxelder	3,363,984	49.0	0.1	163,292	32.5	0.1	--	--	--	6,609	102.1	0.0
Butternut	2,328,596	71.3	0.0	26,821	178.4	0.0	--	--	--	37,137	101.9	0.1
Black cherry	1,414,956	34.7	0.0	33,225	108.2	0.0	--	--	--	40,947	61.4	0.1
Scotch pine	771,865	101.5	0.0	136,790	101.9	0.1	--	--	--	--	--	--
Bitternut hickory	320,592	84.1	0.0	40,894	77.8	0.0	--	--	--	--	--	--
White oak	318,309	84.9	0.0	-231,258	-104.0	-0.2	58,850	95.7	0.1	251,980	98.4	0.4
Black walnut	294,366	102.4	0.0	23,610	102.1	0.0	--	--	--	--	--	--
Slippery elm	104,249	57.8	0.0	-2,408	-433.9	0.0	--	--	--	17,222	101.9	0.0
Total	**5,271,216,145**	**2.2**	**100.0**	**143,652,725**	**3.7**	**100.0**	**82,407,701**	**10.1**	**100.0**	**65,049,598**	**5.4**	**100.0**

Source: Forest Inventory and Analysis estimates.

Note: Sampling error is based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

Table 3.24. Net volume, average annual net growth, average annual removals, and average annual mortality of growing stock trees, in cubic feet, on timberlands in the North Central Landscape, 2003.

Species	Net Volume			Average Annual Net Growth			Average Annual Removals			Average Annual Mortality		
	Volume (ft^3)	Sampling error %	% of total volume	Growth (ft^3)	Sampling error %	% of total growth	Removals (ft^3)	Sampling error %	% of total removals	Mortality (ft^3)	Sampling error %	% of total mortality
Quaking aspen	1,160,456,796	5.1	22.5	32,650,759	15.3	25.8	54,096,015	11.6	49.6	33,889,740	9.3	33.4
Paper birch	420,863,037	5.6	8.2	-1,903,587	-110.2	-1.5	8,181,779	19.8	7.5	19,172,017	11.2	18.9
Red pine	406,285,904	11.0	7.9	12,586,465	22.4	9.9	2,770,767	29.8	2.5	1,259,681	37.3	1.2
American basswood	359,490,541	8.3	7.0	9,570,574	17.8	7.6	3,022,825	34.4	2.8	3,895,330	25.9	3.8
Black ash	340,156,370	8.3	6.6	11,407,267	12.8	9.0	2,546,617	30.2	2.3	1,210,579	45.5	1.2
Northern red oak	320,495,879	8.1	6.2	6,288,684	20.9	5.0	4,309,239	30.5	4.0	3,159,660	23.2	3.1
Bur oak	262,737,393	7.6	5.1	11,913,963	23.5	9.4	832,419	32.2	0.8	847,232	37.0	0.8
Sugar maple	213,767,565	8.8	4.1	5,941,820	19.3	4.7	1,062,772	54.9	1.0	684,053	35.0	0.7
Northern white-cedar	206,023,150	13.5	4.0	4,886,445	59.8	3.9	941,945	77.1	0.9	2,807,644	47.9	2.8
Balsam fir	195,001,227	7.8	3.8	3,891,462	40.1	3.1	6,279,084	22.3	5.8	8,408,895	15.4	8.3
Jack pine	192,308,549	11.4	3.7	2,375,303	70.4	1.9	9,884,028	24.8	9.1	4,923,710	29.1	4.9
Tamarack (native)	190,141,806	10.8	3.7	4,902,551	27.3	3.9	1,632,598	50.0	1.5	3,143,818	32.4	3.1
Bigtooth aspen	163,660,093	14.9	3.2	2,934,103	45.1	2.3	2,891,418	37.7	2.7	2,192,249	34.8	2.2
Red maple	162,435,570	7.8	3.1	7,228,960	19.3	5.7	1,194,752	37.5	1.1	2,767,355	27.4	2.7
Balsam poplar	136,811,448	11.6	2.7	1,860,020	81.0	1.5	4,126,184	27.4	3.8	4,914,332	19.5	4.8
Eastern white pine	109,539,592	15.7	2.1	3,462,806	27.9	2.7	1,553,572	60.7	1.4	233,221	51.1	0.2
Black spruce	91,642,406	13.1	1.8	2,133,429	47.3	1.7	884,763	48.9	0.8	2,536,744	22.8	2.5
Green ash	76,891,801	13.3	1.5	1,956,868	32.9	1.5	505,201	49.0	0.5	333,365	45.3	0.3
White spruce	55,895,863	15.5	1.1	1,807,741	65.9	1.4	1,492,471	42.4	1.4	1,254,939	39.7	1.2
American elm	33,785,280	10.7	0.7	-446,649	-181.0	-0.4	443,313	50.3	0.4	2,939,574	25.1	2.9
Silver maple	31,065,366	50.6	0.6	1,009,092	98.1	0.8	--	--	--	--	--	--
White oak	11,093,991	34.6	0.2	56,754	110.4	0.0	--	--	--	--	--	--
Yellow birch	6,208,326	25.9	0.1	12,818	714.6	0.0	86,448	100.1	0.1	99,300	71.4	0.1
Boxelder	4,959,049	44.5	0.1	2,291	5006.9	0.0	--	--	--	--	--	--
Northern pin oak	3,537,153	40.3	0.1	237,880	75.9	0.2	--	--	--	--	--	--
Butternut	863,752	81.3	0.0	-287,578	-112.8	-0.2	218,023	100.2	0.2	401,077	99.7	0.4
Black cherry	583,850	45.2	0.0	45,841	574.6	0.0	--	--	--	284,294	59.7	0.3
Black oak	410,954	76.2	0.0	71,351	97.0	0.1	--	--	--	--	--	--
Rock elm	220,684	93.2	0.0	86,274	98.6	0.1	--	--	--	--	--	--
Slippery elm	200,887	59.7	0.0	--	--	--	--	--	--	--	--	--
Eastern cottonwood	44,944	102.2	0.0	--	--	--	--	--	--	--	--	--
Siberian elm	34,473	106.2	0.0	--	--	--	--	--	--	--	--	--
Other	33,827	103.0	0.0	--	--	--	--	--	--	--	--	--
Total	**5,157,647,523**	**2.4**	**100.0**	**126,741,128**	**7.9**	**100.0**	**108,956,233**	**8.9**	**100.0**	**101,358,810**	**5.9**	**100.0**

Source: Forest Inventory and Analysis estimates.

Note: Sampling error is based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

Table 3.25. Average annual growing stock mortality, in percent of growing stock volume, on timberlands in the North Central Landscape, 1977, 1990, 2003, and 2015.

Tree species	1977		1990		2003		2015	
	% of volume	Sampling error %	% of volume	Sampling error %	% of volume	Sampling error %	% of volume	Sampling error %
Balsam fir	1.0	9.5	3.1	5.4	4.4	15.0	3.9	10.3
Balsam poplar	1.8	1.7	2.7	5.6	3.3	22.8	3.0	20.0
Jack pine	0.6	12.6	1.7	6.4	2.8	30.2	3.0	17.7
American elm	0.5	4.2	7.6	7.6	8.1	28.6	2.6	21.9
Quaking aspen	1.9	1.0	1.8	2.3	2.9	9.6	2.1	7.3
Paper birch	0.3	8.6	1.4	3.8	4.7	11.2	1.9	11.2
Tamarack (native)	2.3	3.5	1.1	11.3	1.5	33.1	1.8	27.0
Black spruce	0.7	11.8	2.0	7.7	2.2	23.9	1.7	19.7
White spruce	0.5	24.1	0.8	14.5	2.3	45.7	1.3	35.7
Bigtooth aspen	1.4	1.6	0.8	10.6	1.3	30.8	1.2	39.0
Eastern white pine	0.2	17.6	0.3	19.3	0.2	51.9	1.2	55.3
Northern red oak	0.5	1.3	0.7	7.3	1.0	23.3	1.0	24.9
Red maple	0.2	3.7	0.7	10.8	1.7	27.4	0.6	20.5
American basswood	0.3	2.3	0.4	7.4	1.1	26.9	0.5	32.2
Black ash	1.0	10.0	0.5	8.4	0.4	45.4	0.5	30.9
Sugar maple	0.4	2.8	0.3	10.9	0.3	31.4	0.4	27.1
Bur oak	0.3	3.3	0.1	18.2	0.3	37.7	0.3	28.2
Green ash	0.8	3.2	0.3	25.8	0.6	47.4	0.3	39.6
Northern white-cedar	0.4	11.9	0.2	12.6	1.5	50.5	0.2	25.7
Red pine	0.1	83.0	0.1	20.0	0.3	38.1	0.1	39.4
Total	**1.0**	**1.5**	**1.4**	**1.7**	**2.0**	**5.9**	**1.2**	**5.3**

Source: Forest Inventory and Analysis.

Note: Sampling error is based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

Note: Estimates are based on the plot area that was timberland at both the beginning and end of the remeasurement period. This provides a more realistic estimate of the actual change component (growth, removals, mortality) that has occurred on lands that remain in the timberland base.

Note: Data collection procedures and plot design have changed over the course of the Forest Inventory Analysis program history which may lead to issues comparing between years. FIA data collected in 1977 and 1990 (*) were collected as a periodic survey while 2003 and 2015 are part of the annual survey (5 year running average). Comparisons between similarly collected survey data are stronger than between the two methods.

Table 3.26. Average annual growing stock mortality by age class on timberlands in the North Central Landscape, 2015.

Stand age class	All species				Quaking aspen				Red pine			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	261,759,153	6,497,825	2.5	26.2	35,762,163	2,392,323	6.7	25.6	31,679,152	99,416	0.3	88.3
21 to 40 years	764,820,670	7,684,467	1.0	10.2	339,266,241	4,896,759	1.4	10.8	139,291,272	28,553	0.0	68.4
41 to 60 years	1,059,172,940	14,290,189	1.3	10.8	370,700,107	7,203,249	1.9	13.5	142,424,323	277,375	0.2	79.7
61 to 80 years	1,598,138,385	21,286,507	1.3	8.8	291,867,417	6,977,505	2.4	14.7	117,747,001	30,867	0.0	70.1
81 to 100 years	1,127,437,966	11,211,475	1.0	11.0	91,910,630	2,083,485	2.3	25.2	101,415,041	318,384	0.3	62.5
101 to 150 years	398,122,996	3,523,682	0.9	19.2	7,595,866	220,960	2.9	105.3	42,648,782	32,726	0.1	80.3
151 to 200 years	23,642,775	122,947	0.5	25.4	--	--	--	--	--	--	--	--
Not collected	--	432,506	--	--	--	82,424	--	--	--	--	--	--
Total	**5,233,094,886**	**65,049,598**	**1.2**	**5.3**	**1,137,102,423**	**23,856,705**	**2.1**	**7.3**	**575,205,571**	**787,320**	**0.1**	**39.4**

Stand age class	American basswood				Black ash				Paper birch			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	35,912,122	488,571	1.4	89.7	13,661,159	200,791	1.5	74.6	18,706,704	317,730	1.7	42.4
21 to 40 years	17,152,728	--	--	--	19,005,574	8,614	0.0	99.6	22,048,708	419,141	1.9	34.4
41 to 60 years	39,138,978	74,177	0.2	58.3	33,282,712	28,404	0.1	97.1	51,244,539	1,052,229	2.1	26.3
61 to 80 years	152,770,429	469,715	0.3	30.4	116,178,274	231,060	0.2	39.2	133,584,214	2,222,869	1.7	18.7
81 to 100 years	131,083,279	902,800	0.7	50.0	118,750,934	963,574	0.8	51.0	73,951,015	1,415,675	1.9	20.9
101 to 150 years	30,889,276	122,154	0.4	83.3	70,870,494	555,867	0.8	58.5	13,144,608	235,911	1.8	43.1
151 to 200 years	--	--	--	--	39,277	--	--	--	1,700,328	--	--	--
Not collected	--	--	--	--	--	--	--	--	--	242,783	--	--
Total	**406,946,812**	**2,057,416**	**0.5**	**32.2**	**371,788,425**	**1,988,310**	**0.5**	**30.9**	**314,380,117**	**5,906,338**	**1.9**	**11.2**

Stand age class	Bur oak				Northern red oak				Northern white-cedar			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	31,072,598	78,161	0.3	92.5	14,713,928	67,308	0.5	67.3	2,464,227	--	--	--
21 to 40 years	21,406,704	84,568	0.4	79.8	9,804,089	181,450	1.9	87.3	1,259,767	--	--	--
41 to 60 years	56,097,799	82,764	0.1	59.9	27,156,580	8,544	0.0	100.7	8,961,593	7,190	0.1	97.3
61 to 80 years	88,627,094	334,443	0.4	42.6	99,302,510	1,482,221	1.5	39.2	26,353,508	12,019	0.0	74.0
81 to 100 years	84,685,294	166,007	0.2	77.8	90,956,396	762,247	0.8	26.2	63,907,930	134,025	0.2	41.9
101 to 150 years	22,195,729	41,865	0.2	45.7	5,706,146	53,865	0.9	90.8	95,802,371	185,564	0.2	43.7
151 to 200 years	--	--	--	--	--	--	--	--	20,493,904	71,719	0.3	23.2
Not collected	--	--	--	--	--	--	--	--	--	--	--	--
Total	**304,085,217**	**787,808**	**0.3**	**28.2**	**247,639,648**	**2,555,636**	**1.0**	**24.9**	**219,243,299**	**410,516**	**0.2**	**25.7**

Table 3.26. Continued.

Stand age class	Tamarack (native)				Sugar maple				Balsam fir			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	5,687,448	256,166	4.5	89.0	12,086,132	80,901	0.7	67.6	10,140,634	715,467	7.1	39.8
21 to 40 years	8,331,179	--	--	--	5,146,001	--	--	--	30,474,390	761,967	2.5	30.0
41 to 60 years	31,582,561	1,182,061	3.7	63.0	8,331,261	8,523	0.1	84.1	42,002,718	1,317,987	3.1	21.1
61 to 80 years	64,590,051	620,283	1.0	37.3	91,545,304	314,042	0.3	34.9	55,470,985	2,809,006	5.1	16.6
81 to 100 years	58,340,038	804,744	1.4	54.2	82,542,068	337,312	0.4	46.9	27,201,392	757,608	2.8	26.3
101 to 150 years	36,125,727	866,773	2.4	45.7	14,596,112	142,086	1.0	88.6	12,800,490	628,545	4.9	28.9
151 to 200 years	823,194	27,092	3.3	0.0	--	--	--	--	415,919	11,006	2.6	75.0
Not collected	--	7,129	--	--	--	--	--	--	--	42,987	--	--
Total	**205,480,198**	**3,764,248**	**1.8**	**27.0**	**214,246,876**	**882,864**	**0.4**	**27.1**	**178,506,529**	**7,044,573**	**3.9**	**10.3**

Stand age class	Bigtooth aspen				Red maple				Eastern white pine			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	3,167,128	523,531	16.5	77.5	9,667,327	111,639	1.2	54.5	9,923,121	851,899	8.6	93.1
21 to 40 years	27,893,804	193,315	0.7	81.8	6,940,045	36,820	0.5	96.2	16,979,930	--	--	--
41 to 60 years	35,365,597	145,371	0.4	74.2	34,084,139	224,088	0.7	44.4	33,265,188	61,784	0.2	75.6
61 to 80 years	53,459,978	726,128	1.4	62.3	66,183,212	394,659	0.6	34.6	53,387,588	792,853	1.5	90.6
81 to 100 years	34,174,907	280,015	0.8	56.8	31,547,394	215,959	0.7	41.9	38,784,427	248,296	0.6	77.4
101 to 150 years	3,851,415	--	--	--	4,424,371	--	--	--	5,607,315	--	--	--
151 to 200 years	--	--	--	--	--	--	--	--	--	--	--	--
Not collected	--	--	--	--	--	9,306	--	--	--	--	--	--
Total	**157,912,830**	**1,868,360**	**1.2**	**39.0**	**152,846,487**	**992,472**	**0.6**	**20.5**	**157,947,568**	**1,954,831**	**1.2**	**55.3**

Stand age class	Green ash				Balsam poplar				Jack pine			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	6,449,757	27,011	0.4	98.5	3,206,602	66,140	2.1	73.3	2,536,958	102,280	4.0	109.3
21 to 40 years	5,836,965	32,913	0.6	65.2	32,542,502	463,157	1.4	51.1	25,549,884	354,785	1.4	36.8
41 to 60 years	24,297,865	--	--	--	26,680,559	1,142,215	4.3	25.1	30,518,750	612,385	2.0	31.3
61 to 80 years	33,941,735	78,107	0.2	59.7	18,865,719	865,170	4.6	44.3	25,009,039	1,264,003	5.1	31.5
81 to 100 years	30,741,837	101,633	0.3	90.0	11,332,347	227,741	2.0	61.0	7,055,811	344,710	4.9	35.3
101 to 150 years	3,610,137	80,817	2.2	76.0	2,275,673	111,234	4.9	89.6	1,610,001	54,353	3.4	28.6
151 to 200 years	--	--	--	--	--	--	--	--	--	--	--	--
Not collected	--	--	--	--	--	--	--	--	--	--	--	--
Total	**104,878,297**	**320,482**	**0.3**	**39.6**	**94,903,402**	**2,875,657**	**3.0**	**20.0**	**92,280,443**	**2,732,517**	**3.0**	**17.7**

Table 3.26. Continued.

Stand age class	Black spruce				White spruce				American elm			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error %
0 to 20 years	1,386,083	75,150	5.4	93.1	5,502,327	--	--	--	3,662,980	43,342	1.2	60.7
21 to 40 years	3,011,592	--	--	--	21,188,038	--	--	--	5,577,604	213,408	3.8	55.7
41 to 60 years	15,791,950	87,301	0.6	34.9	23,762,717	427,121	1.8	64.0	8,467,174	231,859	2.7	49.7
61 to 80 years	44,971,716	804,965	1.8	30.6	16,529,885	243,618	1.5	56.1	13,776,213	328,899	2.4	36.1
81 to 100 years	18,536,924	516,878	2.8	31.9	7,369,116	267,208	3.6	82.3	4,744,881	110,192	2.3	51.7
101 to 150 years	9,547,292	91,450	1.0	46.0	6,289,570	72,981	1.2	50.4	1,921,519	10,181	0.5	101.6
151 to 200 years	--	13,131	--	--	--	--	--	--	170,152	--	--	--
Not collected	--	--	--	--	--	--	--	--	--	47,876	--	--
Total	**93,245,557**	**1,588,874**	**1.7**	**19.7**	**80,641,654**	**1,010,927**	**1.3**	**35.7**	**38,320,523**	**985,757**	**2.6**	**21.9**

Source: Forest Inventory and Analysis.

Note: Sampling error is based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

Note: Estimates are based on the plot area that was timberland at both the beginning and end of the remeasurement period. This provides a more realistic estimate of the actual change component (growth, removals, mortality) that has occurred on lands that remain in the timberland base.

Table 3.27. Average annual growing stock mortality by timberland ownership in the North Central Landscape, 2015.

Species	National Forest				State			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error (%)	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error (%)
Quaking aspen	211,432,823	3,485,346	1.6	17.5	150,649,685	3,404,168	2.3	16.0
Red pine	204,445,233	276,041	0.1	68.6	56,675,612	152,900	0.3	57.9
American basswood	70,023,900	686,706	1.0	67.0	41,311,936	69,417	0.2	65.5
Black ash	45,389,410	47,548	0.1	50.0	67,163,174	350,190	0.5	57.3
Paper birch	61,169,773	788,390	1.3	33.4	30,674,640	608,576	2.0	28.6
Bur oak	20,685,076	203,504	1.0	64.6	32,019,099	5,967	0.0	97.0
Northern red oak	12,890,270	--	--	--	35,598,831	197,335	0.6	42.0
Northern white-cedar	59,516,815	107,492	0.2	44.8	46,373,862	151,268	0.3	43.9
Tamarack (native)	30,563,434	663,670	2.2	65.2	80,599,297	1,153,002	1.4	35.3
Sugar maple	26,736,517	217,852	0.8	51.3	24,515,225	54,918	0.2	88.7
Balsam fir	27,085,829	886,178	3.3	23.2	21,785,629	734,739	3.4	24.1
Bigtooth aspen	23,867,936	732,356	3.1	75.0	21,138,740	167,515	0.8	67.8
Red maple	15,088,674	242,885	1.6	39.2	23,987,665	85,421	0.4	58.4
Eastern white pine	43,204,929	1,027,349	2.4	78.9	11,201,799	60,055	0.5	88.4
Green ash	4,653,771	--	--	--	9,290,114	25,409	0.3	82.4
Balsam poplar	13,076,603	217,312	1.7	53.8	20,672,073	597,417	2.9	34.7
Jack pine	9,573,871	304,369	3.2	38.8	7,676,243	322,853	4.2	40.7
Black spruce	15,698,883	321,159	2.0	52.2	32,018,685	440,117	1.4	28.5
White spruce	9,578,633	23,775	0.2	91.1	10,843,165	253,023	2.3	103.4
American elm	2,924,104	20,721	0.7	103.1	4,347,257	140,324	3.2	48.1
Total	**911,336,883**	**10,511,797**	**1.2**	**18.4**	**732,097,482**	**8,999,334**	**1.2**	**10.7**

Table 3.27 Continued.

Species	County and Municipal				Private			
	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error (%)	Volume (ft^3)	Mortality (ft^3)	% of volume	Sampling error (%)
Quaking aspen	252,983,458	5,561,509	2.2	16.4	522,036,457	11,323,258	2.2	10.6
Red pine	94,376,061	82,276	0.1	81.3	219,708,665	276,103	0.1	79.3
American basswood	69,807,053	120,602	0.2	46.6	225,803,923	1,180,691	0.5	40.7
Black ash	76,672,450	255,588	0.3	58.5	182,563,390	1,334,984	0.7	38.8
Paper birch	70,719,691	1,483,642	2.1	19.4	151,816,013	2,782,948	1.8	15.4
Bur oak	44,086,598	197,353	0.4	41.9	207,294,443	380,984	0.2	43.1
Northern red oak	60,530,462	217,276	0.4	75.5	138,620,085	2,141,025	1.5	28.6
Northern white-cedar	52,341,110	30,034	0.1	71.9	61,011,512	121,722	0.2	45.9
Tamarack (native)	40,649,771	330,610	0.8	66.8	53,667,697	1,609,836	3.0	48.9
Sugar maple	41,700,587	95,328	0.2	39.4	121,294,547	514,766	0.4	39.7
Balsam fir	44,827,353	1,872,043	4.2	21.9	84,807,718	3,508,626	4.1	15.4
Bigtooth aspen	27,209,765	438,052	1.6	94.8	85,696,388	530,437	0.6	44.6
Red maple	38,911,500	242,635	0.6	40.3	74,858,648	412,224	0.6	34.5
Eastern white pine	37,437,825	--	--	--	66,103,015	867,427	1.3	83.4
Green ash	18,856,812	62,737	0.3	60.6	72,077,600	232,335	0.3	51.4
Balsam poplar	20,105,818	283,431	1.4	32.9	41,048,909	1,777,497	4.3	29.3
Jack pine	20,451,699	616,095	3.0	47.5	54,578,630	1,489,200	2.7	22.6
Black spruce	20,965,969	407,116	1.9	47.0	24,562,021	420,482	1.7	33.1
White spruce	15,869,321	194,072	1.2	62.5	44,350,535	540,058	1.2	42.2
American elm	9,211,051	159,061	1.7	54.3	21,838,111	617,776	2.8	29.2
Total	**1,074,614,755**	**12,736,781**	**1.2**	**10.5**	**2,515,045,766**	**32,369,181**	**1.3**	**7.0**

Source: Forest Inventory and Analysis.

Note: Sampling error is based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

Note: Estimates are based on the plot area that was timberland at both the beginning and end of the remeasurement period. This provides a more realistic estimate of the actual change component (growth, removals, mortality) that has occurred on lands that remain in the timberland base.

Table 3.28. Average annual growing stock removals by timberland ownership in the North Central Landscape, 2015.

Species	National Forest				State			
	Volume (ft^3)	Removals (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Removals (ft^3)	% of volume	Sampling error %
Quaking aspen	211,432,823	2,604,771	1.2	47.6	150,649,685	3,978,818	2.6	49.1
Red pine	204,445,233	2,651,196	1.3	48.8	56,675,612	1,480,319	2.6	38.5
American basswood	70,023,900	120,872	0.2	75.1	41,311,936	809,784	2.0	85
Black ash	45,389,410	--	--	--	67,163,174	155,187	0.2	73.3
Paper birch	61,169,773	70,534	0.1	100.3	30,674,640	1,035,405	3.4	56.5
Bur oak	20,685,076	--	--	--	32,019,099	7,232	0.0	95.9
Northern red oak	12,890,270	7,086	0.1	104.4	35,598,831	618,817	1.7	74.4
Northern white-cedar	59,516,815	--	--	--	46,373,862	--	--	--
Tamarack (native)	30,563,434	--	--	--	80,599,297	833,287	1.0	75
Sugar maple	26,736,517	--	--	--	24,515,225	430,570	1.8	59.2
Balsam fir	27,085,829	96,463	0.4	94.2	21,785,629	232,305	1.1	58.6
Bigtooth aspen	23,867,936	54,271	0.2	107.3	21,138,740	318,040	1.5	77.2
Red maple	15,088,674	--	--	--	23,987,665	673,049	2.8	47.9
Eastern white pine	43,204,929	--	--	--	11,201,799	--	--	--
Green ash	4,653,771	--	--	--	9,290,114	19,447	0.2	105.3
Balsam poplar	13,076,603	--	--	--	20,672,073	7,426	0.0	100.7
Jack pine	9,573,871	--	--	--	7,676,243	488,738	6.4	64
Black spruce	15,698,883	--	--	--	32,018,685	1,774,174	5.5	73.1
White spruce	9,578,633	13,918	0.1	95.7	10,843,165	181,337	1.7	80.5
American elm	2,924,104	--	--	--	4,347,257	38,174	0.9	94.5
Total	**911,336,883**	**5,619,111**	**0.6**	**33.4**	**732,097,482**	**13,082,110**	**1.8**	**25.2**

Table 3.28. Continued.

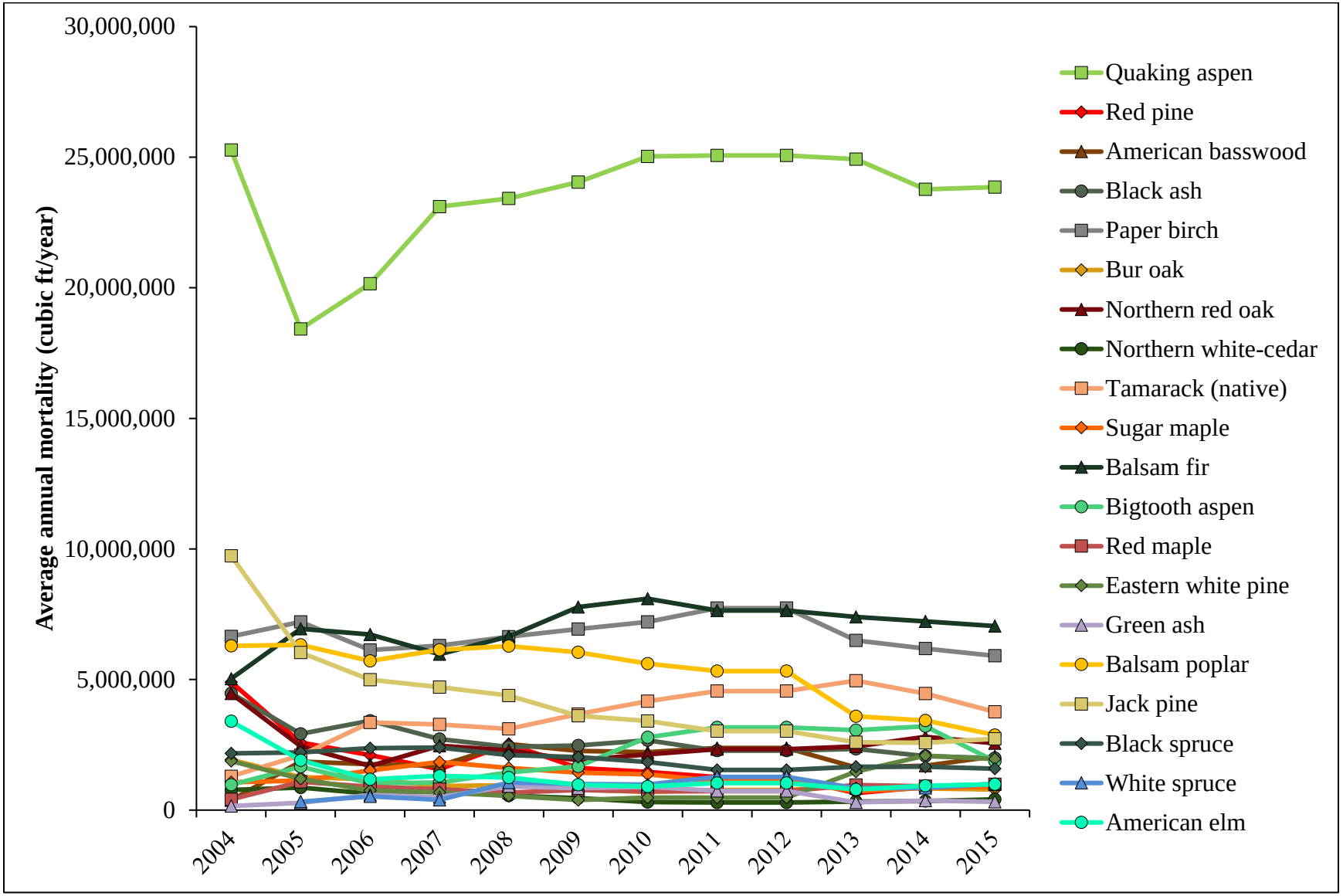
Species	County and Municipal				Private			
	Volume (ft^3)	Removals (ft^3)	% of volume	Sampling error %	Volume (ft^3)	Removals (ft^3)	% of volume	Sampling error %
Quaking aspen	252,983,458	15,897,787	6.3	23.1	522,036,457	14,144,133	2.7	22
Red pine	94,376,061	778,274	0.8	72.7	219,708,665	3,233,492	1.5	33.5
American basswood	69,807,053	707,048	1.0	43	225,803,923	1,197,192	0.5	60
Black ash	76,672,450	604,488	0.8	61.2	182,563,390	681,418	0.4	54
Paper birch	70,719,691	2,883,554	4.1	29.5	151,816,013	1,184,459	0.8	44.2
Bur oak	44,086,598	410,656	0.9	50.7	207,294,443	389,800	0.2	51.4
Northern red oak	60,530,462	1,466,339	2.4	44.4	138,620,085	381,076	0.3	75.7
Northern white-cedar	52,341,110	--	--	--	61,011,512	95,930	0.2	98.2
Tamarack (native)	40,649,771	1,099,869	2.7	92.4	53,667,697	--	--	--
Sugar maple	41,700,587	444,608	1.1	43.1	121,294,547	291,592	0.2	43.9
Balsam fir	44,827,353	1,538,283	3.4	54.8	84,807,718	825,371	1.0	51.7
Bigtooth aspen	27,209,765	1,811,596	6.7	58	85,696,388	491,217	0.6	67.3
Red maple	38,911,500	1,085,226	2.8	40.5	74,858,648	291,559	0.4	72.9
Eastern white pine	37,437,825	15,312	0.0	105.1	66,103,015	68,623	0.1	104.5
Green ash	18,856,812	71,935	0.4	65.2	72,077,600	81,397	0.1	77.5
Balsam poplar	20,105,818	123,236	0.6	102.6	41,048,909	1,130,843	2.8	58
Jack pine	20,451,699	102,885	0.5	75.9	54,578,630	1,976,648	3.6	49.5
Black spruce	20,965,969	747,842	3.6	88.8	24,562,021	--	--	--
White spruce	15,869,321	112,895	0.7	57.7	44,350,535	446,047	1.0	88.3
American elm	9,211,051	7,057	0.1	98.3	21,838,111	87,245	0.4	50.9
Total	**1,074,614,755**	**30,263,463**	**2.8**	**19**	**2,515,045,766**	**27,018,066**	**1.1**	**16.7**

Source: Forest Inventory and Analysis.

Note: Sampling error is based on one standard error, that is, the chances are two in three that the results would have been within the limits indicated had a 100-percent inventory been conducted using these methods.

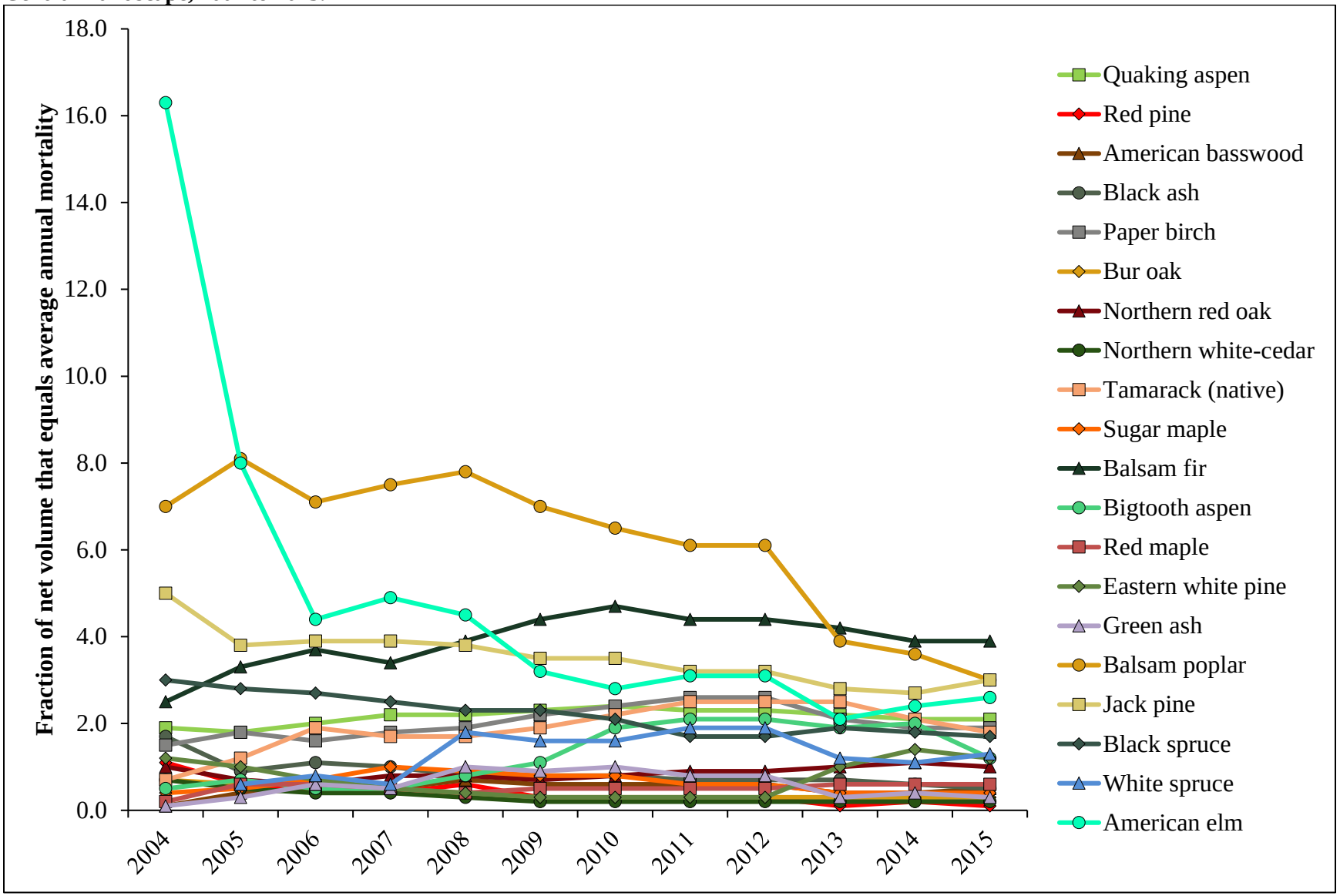
Note: Estimates are based on the plot area that was timberland at both the beginning and end of the remeasurement period. This provides a more realistic estimate of the actual change component (growth, removals, mortality) that has occurred on lands that remain in the timberland base.

Figure 3.15. Average annual growing stock mortality volume estimate of selected species on timberland in the North Central Landscape, 2004 to 2015.



Source: Forest Inventroy Analysis.

Figure 3.16. Average annual growing stock mortality, in percent of growing stock volume, of selected species on timberland in the North Central Landscape, 2004 to 2015.



Source: Forest Inventroy Analysis.

3.14. Silvicultural and harvesting practices

In 2008 Anthony W. D'Amato, Nicholas W. Bolton, Charles R. Blinn, and Alan R. Ek of the University of Minnesota Department of Forest Resources published a Technical Report looking at silvicultural practices in the state of Minnesota titled: *"Current Status and Long-term Trends of Silvicultural Practices in Minnesota: A 2008 Assessment"* The following text and tables are summarized from this document. The full report can be found at:
http://iic.umn.edu/prod/groups/cfans/@pub/@cfans/@forestry/documents/asset/cfans_asset_184742.pdf

This study characterized the status of silvicultural practices within Minnesota in 2008 and used results from past surveys (1991 and 1996) to describe general trends in Silviculture across ownerships and over time. A questionnaire regarding silvicultural practices applied in fiscal year 2008 was administered to all state, county, federal, industry, and Native American ownerships. Non-industrial private landowners were not surveyed. The data presented are for the entire state. Surveys included questions on silvicultural and harvesting practices such as regeneration practices used, extent and type of biofuels harvesting, use of site-level guidelines, and approaches to insect and disease issues. In addition, open-ended responses were collected on questions relating to general constraints most affecting the implementation of silvicultural practices.

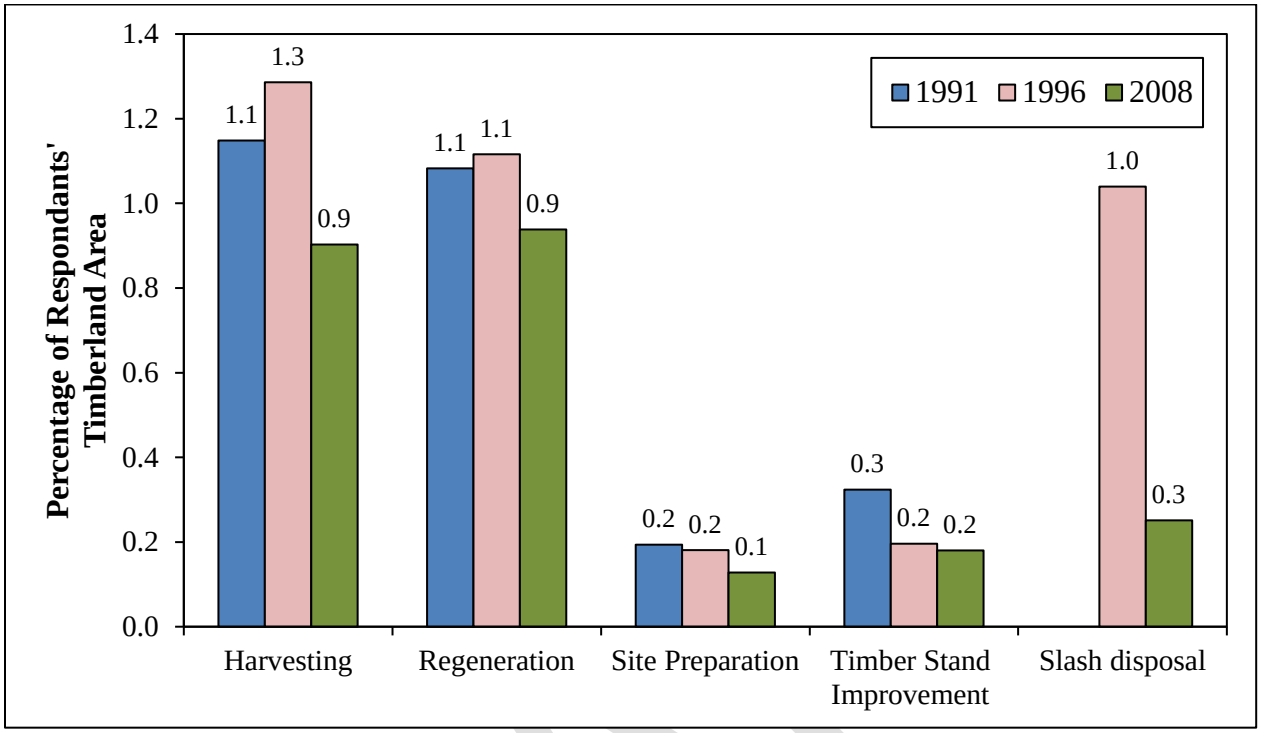
Twenty-six respondents completed the survey with the respondent pool including 2 state, 2 federal, 14 county, 3 industrial, and 5 Native American ownerships. In addition, one non-governmental organization involved with forest management also completed the survey. Collectively, the respondent pool ownerships covered 64% of the timberland in the state (9,865,694 out of 15,414,200 acres) and accounted for 67% of the estimated 2008 statewide harvest (1.97 million out of 2.92 million cords). The respondent harvest levels were similar to those reported during the 1996 survey; however, the statewide harvest levels were less than in 1996 (3.81 million cords). In addition, the harvest volume removed per acre of timberland in 2008 (0.20 cords) was lower than the harvest volumes in 1996 (0.25 cords).

Silvicultural practices are the ways in which forests are managed. The total amount of timberland on which silvicultural practices are carried out is small with roughly one percent of respondents' timberland area harvested in each of the study years (Figure 3.17).

Managers used clearcutting more than any other silvicultural system in 1991, 1996, and 2008 (Figure 3.18), however, the data suggest managers planned less clearcutting between each sampling interval. Patch clearcut, selection, seed tree, shelterwood cutting, and thinning were each used more in 2008 than in 1991 or 1996. Strip clearcutting was less common in 2008 than 1996.

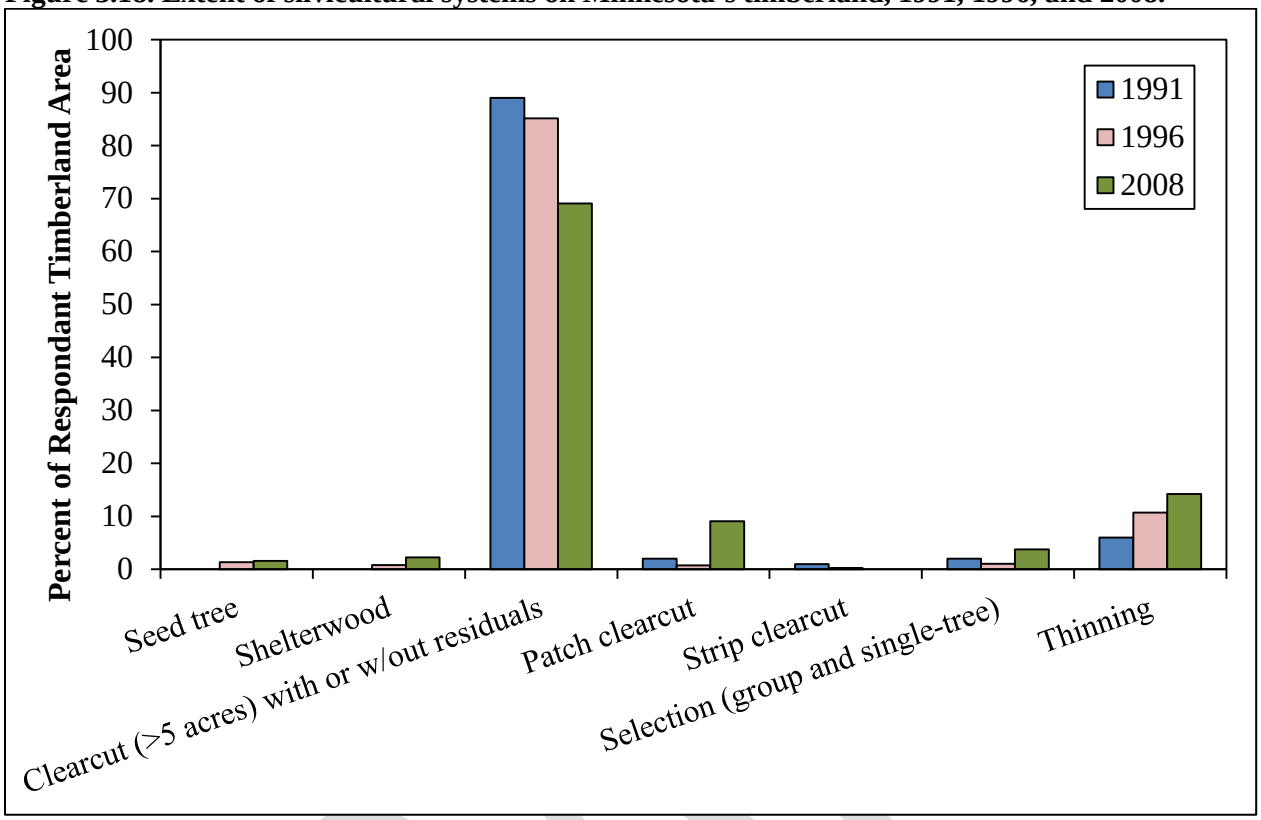
Managers use natural regeneration more often than artificial regeneration (Figure 3.19). This fact is not unexpected, since aspen and many other Minnesota forest species regenerate well on their own. Use of natural regeneration increased between 1991 and 1996 from 75.8% to 80.7% of total regenerated area, while use of artificial regeneration declined correspondingly from 24.2% to 19.3%. This trend was reversed in 2008 when natural regeneration dropped to 60.9% and artificial regeneration acres nearly doubled to 39.1%. Most natural regeneration was of vegetative origin (sprouts or root suckers), whereas artificial regeneration was primarily conifer species that were containerized planting stock.

Figure 3.17. Type and extent of silvicultural practices on Minnesota's timberland, 1991, 1996, and 2008.



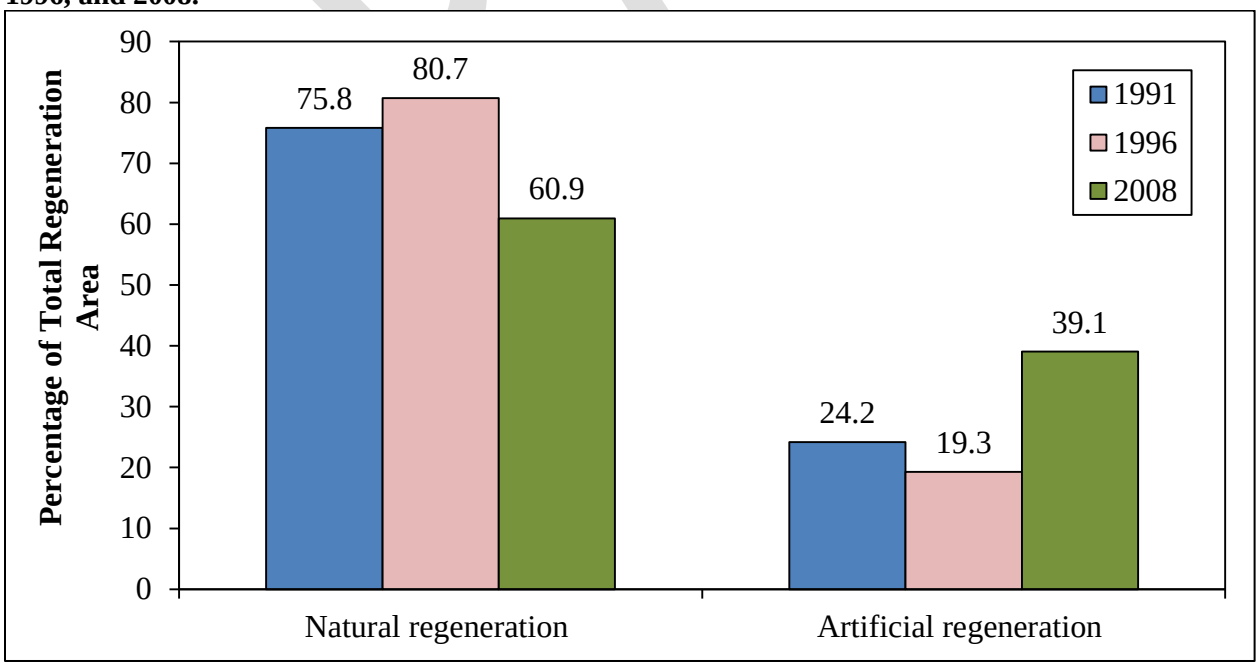
Source: D'Amato et al., 2009.
Note: Slash disposal was not a category for the 1991 survey.

Figure 3.18. Extent of silvicultural systems on Minnesota's timberland, 1991, 1996, and 2008.



Source: D'Amato et al., 2009.

Figure 3.19. Type and relative extent of regeneration activities on Minnesota's timberland, 1991, 1996, and 2008.



Source: D'Amato et al., 2009.

3.15. North Central vascular plants

The Minnesota DNR maintains a list of vascular plant species called MNTaxa that reflect vouchered specimens present in herbarium collections at the University of Minnesota Herbarium, a division of the Bell Museum of Natural History on the St. Paul campus, and select plant families (Cyperaceae, Orchidaceae, and ferns) from the Olga Lakela Herbarium at University of Minnesota Duluth. This database provides the species full scientific name, including family, genus, species, and variety or subspecies (when applicable). Other attributes available include: whether the species is introduced to Minnesota; current status according to Minnesota's Endangered Species Statute and associated Rules; physiognomy; and the counties and subcounties where it has been documented. For further information on this data set visit: www.dnr.state.mn.us/eco/mcbs/plant_lists.html

According to the MNTaxa dataset total vascular plant species richness in Minnesota is 2,250 with 1,378 documented in the North Central Landscape (Table 3.29). Over 87% of these vascular plant species are native to the region and seven of the species are found only in the North Central Landscape. This is a much lower level of endemicity than other regions of the state; for example 80 of the species found in the Northeast Landscape are found nowhere else in the state including 19 which are found only in Cook County.

Table 3.29. Vascular plant species richness in the North Central Landscape.

County	Native	Introduced	Unknown	Total	Endemic
Aitkin	749	74	2	825	--
Becker	795	78	2	875	1
Beltrami	647	65	2	714	1
Cass	847	102	2	951	--
Clearwater	789	102	3	894	--
Crow Wing	769	83	2	854	2
Hubbard	626	71	1	698	--
Itasca	798	111	3	912	--
Mahnomen	513	36	3	552	1
Polk	693	76	2	771	2
North Central Landscape	**1,202**	**172**	**4**	**1,378**	**7**
Minnesota	1,874	362	14	2,250	--

Source: MNTaxa Database. Available at: www.dnr.state.mn.us/eco/mcbs/plant_lists.html
Note: The number of species with recorded occurrences in a given landscape reflects herbarium records and not necessarily the richness of the landscape. Regions with significant amounts of remote areas may not be as well represented as those landscapes with easier access.

3.16. North Central forest associated vertebrate species

The North Central Landscape provides habitat for many of the state's amphibians, reptiles, birds, and mammals. Comprehensive data on the range of individual species is hard to develop. One of the best available datasets on species richness in the state of Minnesota was compiled in 2003 by the MN DNR Wildlife Resource Assessment Program from various species distribution sources following consultation with species group experts. The data was collected as part of Minnesota's contribution to the national GAP data system and has more validity than most single sources due to the variety of sources it considered as well as the use of expert panel reviewers at the time. Species distributions are based on the state's ECS subsections and report 19 of the state's 21 amphibian, 14 of 29 reptile, and 70 of 78 mammal species occur in ECS subsections completely or partial within the North Central Landscape (Table 3.30). Table 3.31 displays species presents by county using an alternative data source.

Birds are the most taxonomically rich vertebrate group in the region and can often be used as indicator species on the health of forested systems and associated ecological functions. The DNR's 2003 GAP data indicates 274 of 315 bird species occur in ECS subsections completely or partially within the North Central Landscape. This data reports all species observed in a region, including species moving through on migration. Ensuring healthy forests for migrating birds is important but perhaps more pertinent is data relating to species which breed in Minnesota. The Minnesota Breeding Bird Atlas (MNBBA) is critical bird conservation project designed to document every species that currently breeds in Minnesota and where in the state each species breeds. From 2009 through 2013 volunteers and project partners covered the state to report evidence of breeding species. This atlas found 84% (200/239) of the state's breeding birds and nearly 83% (85/103) of the state's forest associated breeding birds occur in the ten-county North Central Landscape. Additionally, 85 of the region's 200 breeding bird species (43%) are forest associated species. Breeding bird estimates include species that had either confirmed or probable breeding evidence during the 5 year MNBBA (more information at www.mnbba.org).

Since 1995, the Natural Resources Research Institute at the University of Minnesota Duluth has monitored the populations of forest-breeding birds in the Chippewa National Forest. In general, this study found population trends appear stable or increasing with 3 species showing significant declines, 20 species showing significant increases, and 40 species showing stable trends over the 1995-2013 period. This study selected forest stands in a stratified-random manner based on dominant tree species and suggest the positive results correlate to changes in forest age-class structure and silvicultural practices observed over the last 35 years. Study results indicate older forests, especially those with diverse structural elements, support a broad range of species including species that normally use early-successional forests. Aspen forests provide an excellent example of how this structural diversity develops; stands >60 years old have 2-3 times higher natural mortality than those that are 41-60 years old, thus providing a variety of habitat elements from snags that increase nest-cavities to tree-fall gaps that endorse the shrubby growth utilized by many species. Further information can be found in:

Zlonis, E.J., G.J. Niemi, A. Grinde, J. Bednar. 2013. Summary of breeding bird trends in the Chippewa and Superior National Forests of Minnesota – 1995-2013. NRRI technical report NRRI/TR-2012/39, University of Minnesota Duluth.

Table 3.30. Richness of amphibians, reptiles, birds, and mammals in North Central Minnesota, 2003.

MN DNR Subsection	Amphibian	Reptile	Bird	Mammal
Red River Prairie	9	8	173	45
Hardwood Hills	12	8	185	53
Aspen Parkland	8	7	184	46
Mille Lacs Uplands	15	14	196	53
Pine Moraine & Outwash Plains	13	10	195	55
St. Louis Moraine	12	4	200	50
Chippewa Plain	11	6	210	52
Tamarack Lowlands	12	5	201	49
Agassiz Lowlands	8	4	212	43
Nashwauk Uplands	12	4	176	40
Littlefork-Vermillion Uplands	12	4	180	39
Total North Central Subsections	**19**	**14**	**274**	**70**
Minnesota	21	29	315	78

Source: 2003 National GAP Analysis Program – from MN DNR Wildlife Resource Assessment Program. Provided by Tim Quincer, MN DNR – Wildlife.

Table 3.31. Total species richness and richness of small and incidental mammals*, amphibians and reptiles, and breeding birds in Minnesota and the North Central Landscape.

	Small/incidental mammals[a]	Amphibians and reptiles[b]	Breeding Birds[a]
Aitkin	18	18	154
Becker	27	18	169
Beltrami	4	15	162
Cass	22	21	129
Clearwater	19	19	158
Crow Wing	9	24	125
Hubbard	15	22	142
Itasca	33	18	161
Mahnomen	14	13	125
Polk	15	17	114
North Central Landscape	**46**	**28**	**209**
Minnesota	71	52	247

Note: These data are still preliminary at this time, as the Minnesota Biological Survey has not been completed for all counties in the region.
Note: "Incidental" mammals are larger mammals whose presence was observed during grid trapping sessions for small mammals.
Source: Minnesota Biological Survey, MN DNR Division of Ecological and Water Resources, 2013.
[a] Data provided by Karen Cieminski and Steve Stucker, MN DNR Division of Ecological and Water Resources
[b] Distribution maps: http://files.dnr.state.mn.us/eco/mcbs/herp_maps/reptile_and_amphibian_maps_2ecs.pdf. Note: the following types of recordings were included for amphibians/reptiles : *vouchered record, post-1960*, specimen or photo collected after 1960; *vouchered record, pre-1960*, specimen or photo collected prior to 1960; *sighting or literature record*, description of species lacking a photo or specimen.

3.17. Species at risk

Minnesota law requires the Department of Natural Resources to maintain a list of species that are at risk of disappearing from the state. Listed species are placed into one of three categories: endangered, threatened and special concern. The list is based on scientific field studies, such as those conducted by the Minnesota Biological Survey. The state's List of Endangered, Threatened and Special Concern Species was first established in 1984, updated in 1996, and updated again in 2013 (Table 3.32). Additional information on species at risk and the process of developing the list can be found at: www.dnr.state.mn.us/ets/index.html

Minnesota designates species as:

- Endangered, if the species is threatened with extinction throughout all or a significant portion of its range
- Threatened, if the species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range
- Species of Special Concern, if although the species is not endangered or threatened, it is extremely uncommon in this state, or has unique or highly specific habitat requirements and deserves careful monitoring of its status. Species on the periphery of their range that are not listed as threatened may be included in this category along with those species that were once threatened or endangered but now have increasing or protected, stable populations

Table 3.33 displays the taxonomic break down of updates to the 1996 Endangered, Threatened and Special Concern List for Minnesota. A current regional list of Endangered, Threatened and Special Concern species or updates is not available.

Table 3.32. Numbers of endangered, threatened, and special concern species for Minnesota, 2013.

	Endangered	Threatened	Special Concern	Total
Mammals	0	2	19	21
Birds	9	2	21	32
Amphibians and Reptiles	2	4	10	16
Fish	4	5	25	34
Mollusks	13	11	9	33
Jumping Spiders	0	1	9	10
Leafhoppers	0	0	3	3
Dragonflies	0	1	7	8
Butterflies and Moths	8	1	10	19
Caddisflies	5	11	8	24
Tiger Beetles	3	2	4	9
Vascular Plants	86	93	130	309
Fungi	3	0	5	8
Lichens	7	9	21	37
Mosses and Liverworts	3	7	17	27
Total	**143**	**149**	**298**	**590**

Source: Minnesota's List of Endangered, Threatened, and Special Concern Species, 2013. MN DNR Division of Ecological and Water Resources.

Table 3.33. Changes to the endangered, threatened and special concern list for the state of Minnesota between the 1996 and 2013 listing.

	Add	Remove	Status increase	Status decrease
Mammals	7	1	1	0
Breeding birds	5	1	2	2
Amphibians and reptiles	3	1	1	0
Fishes	13	0	8	0
Mollusks	8	5	8	2
Spiders and Insects	30	6	9	2
Vascular Plants	66	13	42	12
Lichens	21	1	0	1
Mosses and Liverworts	25	1	1	0
Fungi	2	0	0	0
Total	**180**	**29**	**72**	**19**

Source: Amendments to Minnesota Rules, Chapter 6134 (Endangered, Threatened and Special Concern Species). MN DNR Division of Ecological and Water Resources.

3.18. Trends in wildlife species populations

The North Central Landscape is well known for its wildlife populations and the following figures show population trends for ruffed grouse, otter, martin, fisher, bobcat, white-tailed deer, and timber wolves.

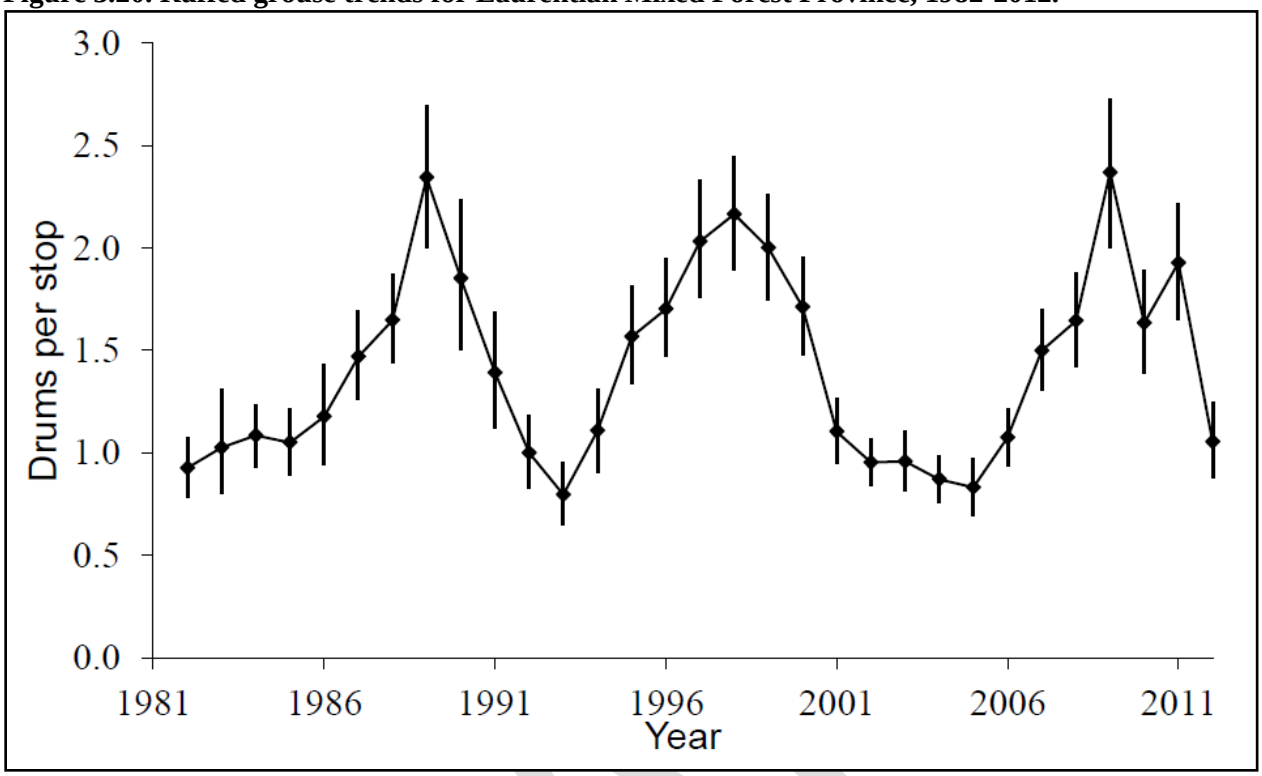
Minnesota frequently is the nation's top ruffed grouse producer. On average, 115,000 hunters harvest 545,000 ruffed grouse in the state each year, making it the state's most popular game bird. During the peak years of 1971 and 1989, hunters harvested more than 1 million ruffed grouse. One reason for the Minnesota's status as a top grouse producer is an abundance of aspen and other ruffed grouse habitat, much of it located on county, state, and national forests where public hunting is allowed. An estimated 11.5 million of the state's 16.3 million acres of forest are grouse habitat (MN DNR – Division of Wildlife). For the past 64 years, DNR biologists have monitored ruffed grouse populations using a drum count index. Ruffed grouse drum count index values in the Laurentian Mixed Forest Province (Figure 3.20) highlight the roughly ten year cycle ruffed grouse populations follow in Minnesota.

The Minnesota DNR Forest Wildlife Research Group annually monitors furbearer populations using a variety of indices. The statewide bobcat spring (pre-birth) population estimate has increased to a mean of approximately 5,000 in the last 15 years from an average of just under 2,000 individuals from 1977 to 1997 (Figure 3.21). Statewide fisher spring population estimates have decreased from approximately 10,000 individuals in the mid 1990's to just under 6,000 in 2013 (Figure 3.22). American marten population estimates have similarly decreased recently from peak estimates in excess of 14,000 in the early 2000's to an estimate of just under 9,000 in 2013 (Figure 3.23). Otter population estimates in Minnesota increased from 1977 to the mid 1990's and have remained relatively steady around 12,000 individuals since then (Figure 3.24).

The DNR Section of Wildlife publishes spring white-tailed deer densities annually. Deer densities are stated as an average yearly density across the permit area, and portions of some permit areas may have local and/or seasonal densities higher or lower than the average. Estimates for permit areas existing mostly or entirely within the North Central Landscape (Figure 3.25) are displayed in Table 3.34. In 2015, deer densities were highest in permit areas 172 (Cass County), 258 (Becker County), and 259 (Hubbard County) with densities of 21, 22, and 21 deer per square mile respectively. Permit area 297 (Mahnomen County) and 210 (eastern Polk and western Clearwater counties) had the lowest densities in 2015 with densities of 3 and 7 deer per square mile respectively.

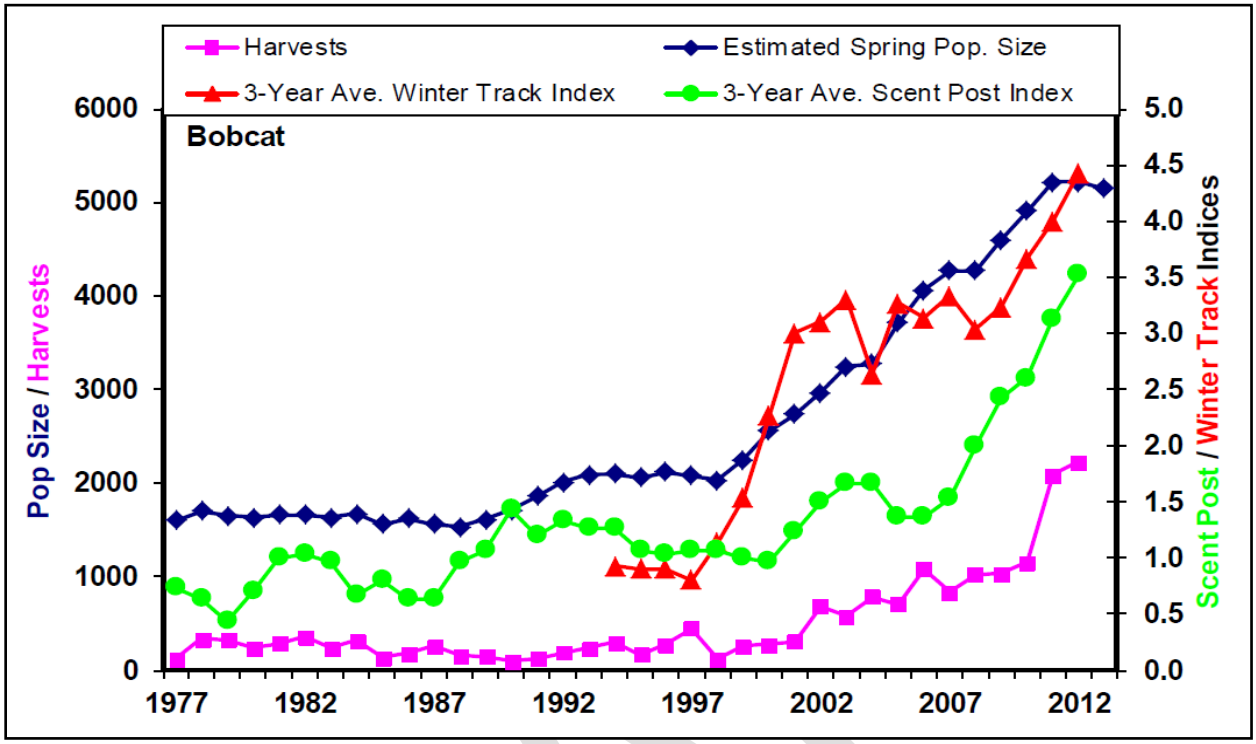
The Minnesota DNR monitors the mid-winter timber wolf population before the pups are born using a combination of visual, track, scat, and other methods. The winter of 2012-13 survey results estimate that within Minnesota's wolf range there were 438 packs and 2,211 wolves (Table 3.35). More information about wolves in Minnesota can be found at the DNR website: www.mndnr.gov/wolves.

Figure 3.20. Ruffed grouse trends for Laurentian Mixed Forest Province, 1982-2012.



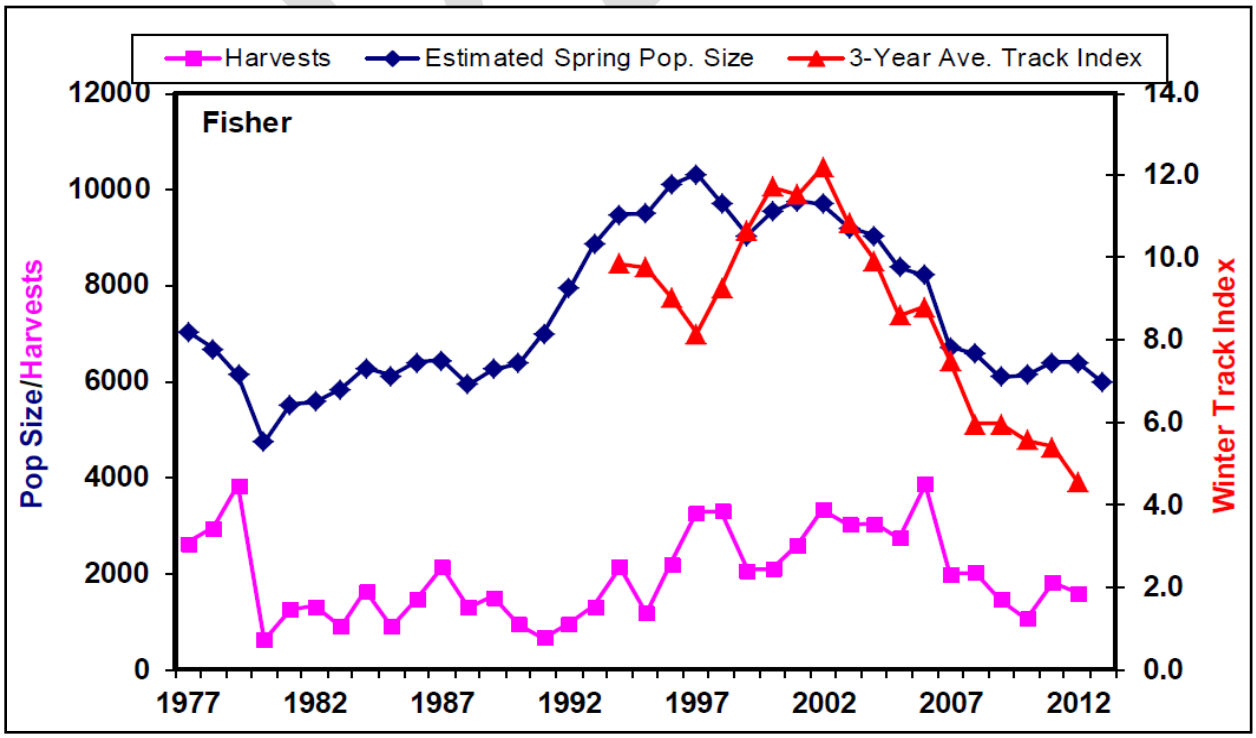
Source: MN DNR Forest Wildlife Populations and Research Group.
Note: Vertical error bars represent 95% confidence intervals based on bootstrap samples.

Figure 3.21. Minnesota bobcat spring (pre-birth) population estimate, harvest, and survey indices, 1977-2013.



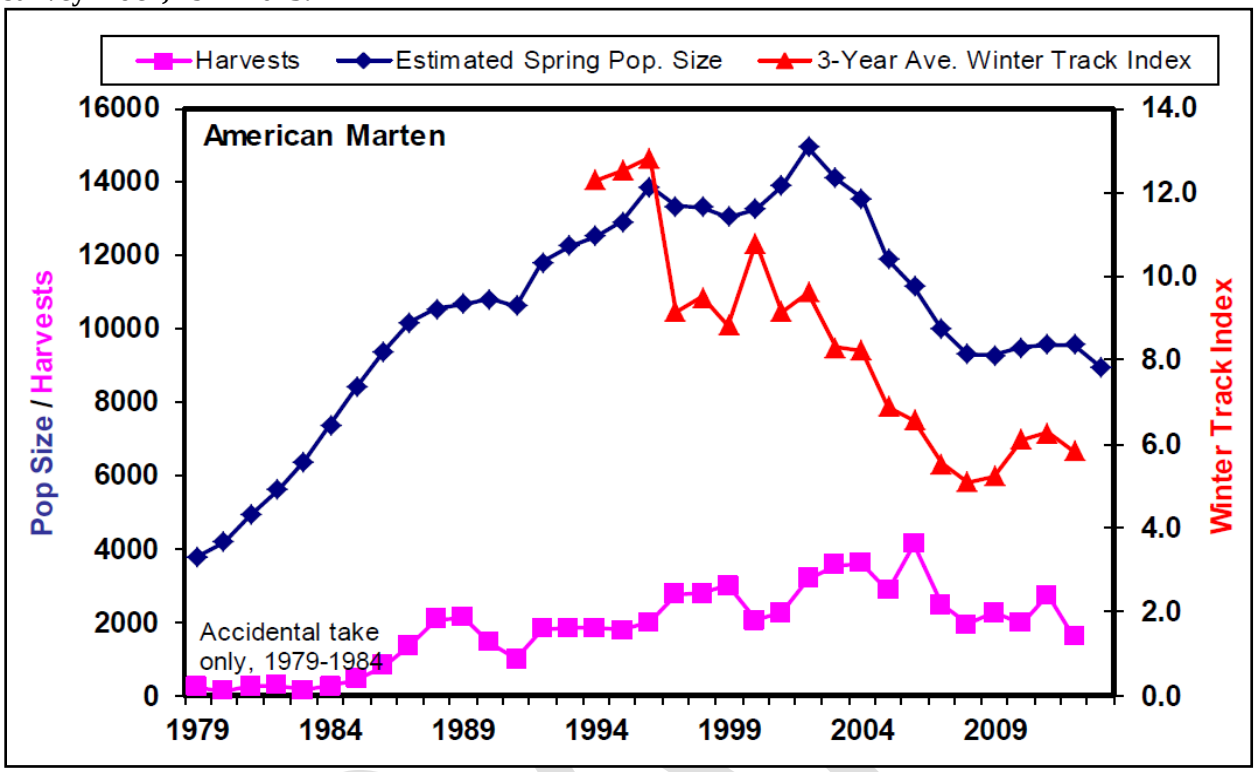
Note: Harvests include an estimate of non-reported take.

Figure 3.22. Minnesota fisher spring (pre-birth) population estimate, harvest, and survey index, 1977-2013.



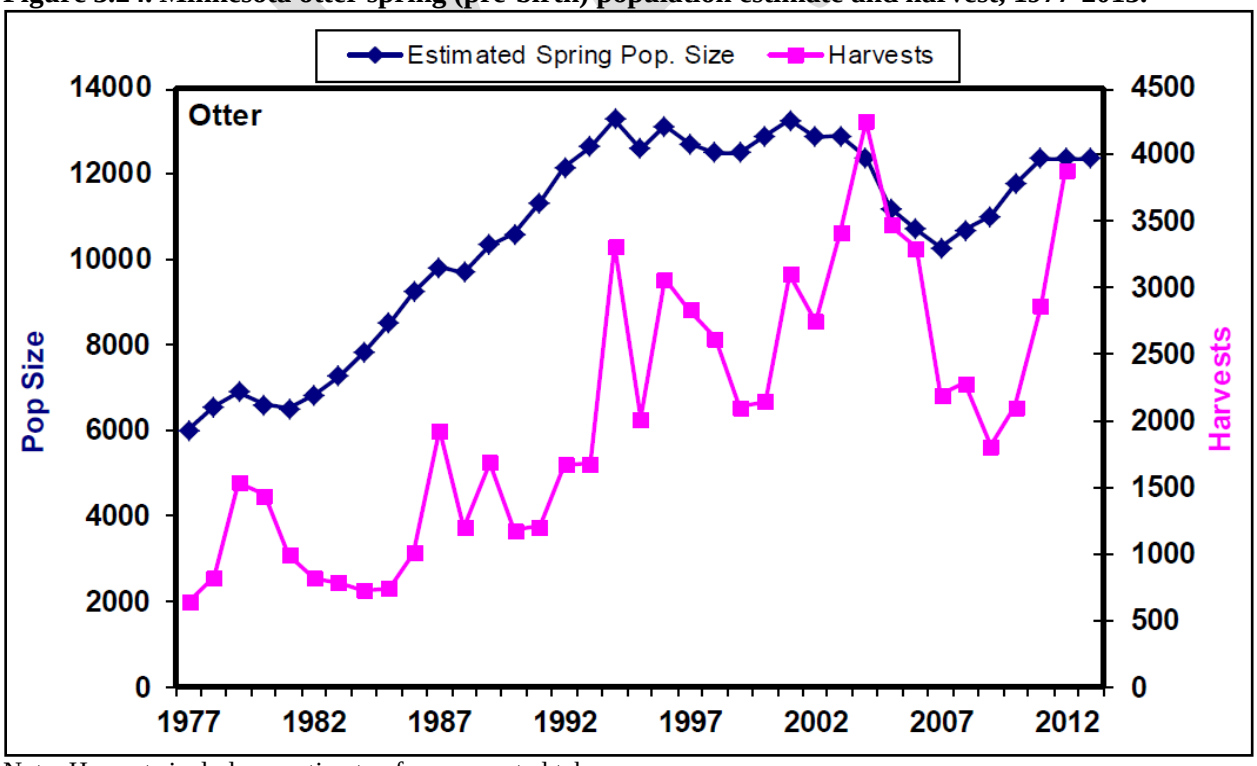
Note: Harvests include an estimate of non-reported take.

Figure 3.23. Minnesota American marten spring (pre-birth) population estimate, harvest, and survey index, 1977-2013.



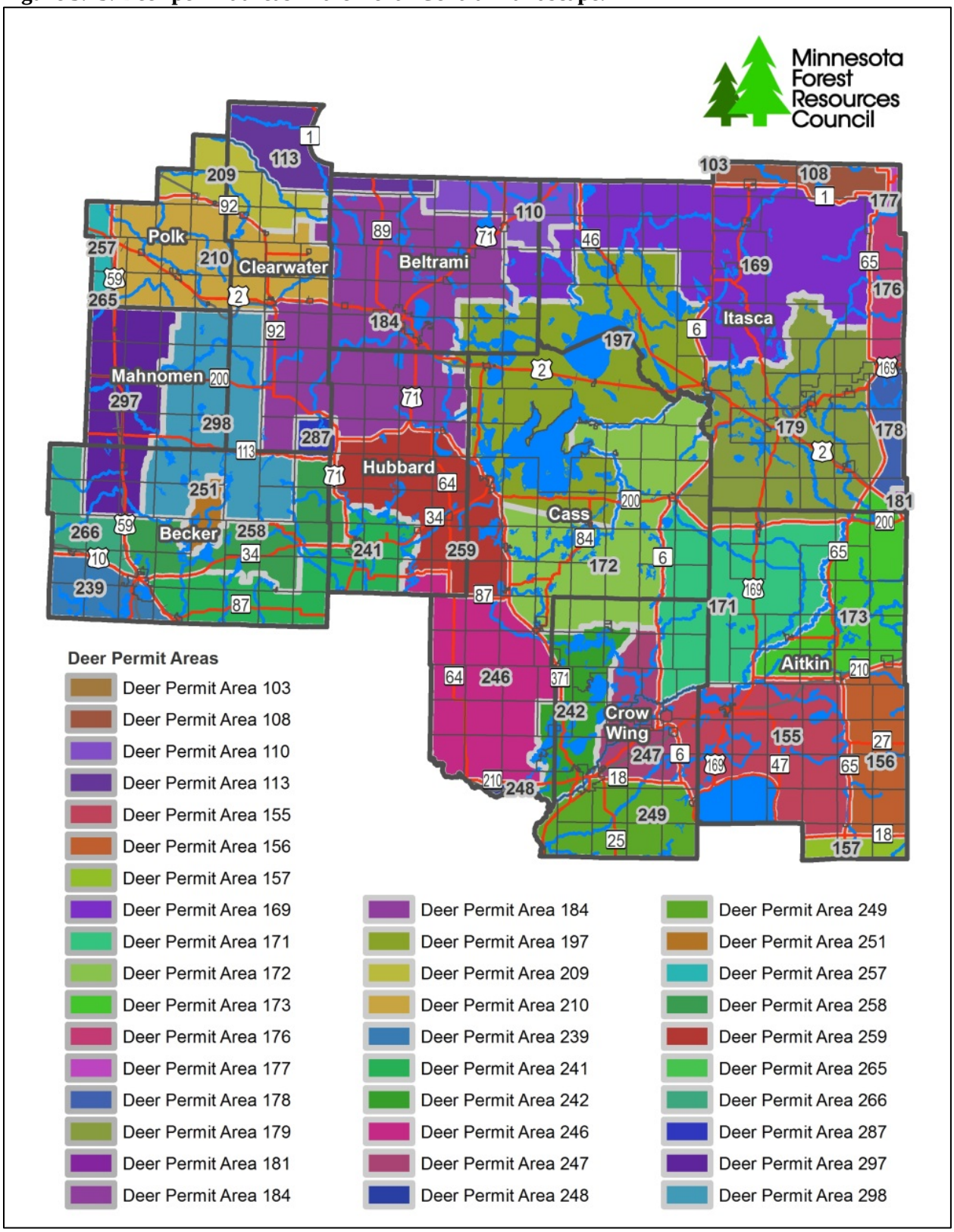
Note: Harvests include an estimate of non-reported take.

Figure 3.24. Minnesota otter spring (pre-birth) population estimate and harvest, 1977-2013.



Note: Harvests include an estimate of non-reported take.

Figure 3.25. Deer permit areas in the North Central Landscape.



Source: MN Geospatial Commons.

Table 3.34. Estimated deer population trends in north central deer permit areas, 2010-2015

Permit area	Area (mi^3)	Deer per square mile					
		2010	2011	2012	2013	2014	2015
155	593	18	18	19	19	16	19
169	1,124	13	12	13	12	8	9
171	701	12	12	13	13	10	11
172	687	21	21	22	23	18	21
173	584	10	10	10	10	7	8
179	862	20	18	18	17	11	10
184	1,229	22	21	22	21	16	18
197	955	13	12	12	12	9	10
210	615	14	12	11	10	7	7
242	214	24	23	22	20	15	17
246	840	16	16	17	17	15	17
247	228	20	20	21	22	19	20
251	55	--	--	--	--	--	--
258	343	21	20	22	22	19	22
259	490	25	24	24	23	18	21
297	438	3	3	3	3	3	3
298	618	10	9	10	10	9	12

Source: MN DNR Farmland Wildlife Populations and Research Group.
Note: "-" indicates deer permit area was not modeled.
Permit areas listed exist mostly or entirely within the North Central Landscape.

Table 3.35. Winter timber wolf population trends, 1988-2013.

	Winter Wolf Survey Year				
	1988/89	**1997/98**	**2003/04**	**2007/08**	**2012/13**
Total # observations	1,244	3,659	1,719	2,710	2,898
Total Wolf Range (km^2)	60,229	88,325	88,325	88,325	95,098
Occupied Range (km^2)	53,100	73,920	67,852	71,514	70,579
% Occupied Range confirmed by pack detection in township	55	84	54	68	70
% occupied area with pack detection that exceeds human/road density thresholds [a]	11	17	19	20	31
# Radio-Marked Packs	108[b]	36	24	32	36
Average mid-winter pack size	5.55	5.4	5.3	4.9	4.3
Average Territory Size [c] (km^2)	227	192	140	142	161
Estimated # packs	233	385	485	503	438
Population Estimate (90% CI)	1521 (1,338, 1,762)	2445 (1,995, 2,905)	3020 (2,301, 3,708)	2921 (2,192, 3,525)	2211 (1,652, 2,641)
Population Density (wolves/100 km^2)	2.86	3.31	4.45	4.08	3.13
Questionnaire: % respondents that perceive that the local wolf population (increased, stable, decreased) since last survey	--	(71, 29, 0)	(40, 42, 18)	(40, 58, 2)	(28, 56, 16)

Source: MN DNR Forest Wildlife Populations and Research Group.

[a] Thresholds from Fuller et al. (1992)

[b] Included packs marked in years prior to the survey

[c] Adjusted using scaling factors to account for interstitial spaces/territory underestimation

3.19. Invasive Species

Non-native invasive species pose a significant threat to Minnesota's forests, lakes, and associated economies. Figure 3.26 shows the distribution of invasive plants listed on Minnesota's Prohibited Noxious Weeds List. The Department of Agriculture is responsible for maintaining and updating this list which includes annual, biennial, or perennial plants that are designated as having the potential or are known to be detrimental to human or animal health, the environment, public roads, crops, livestock or other property. Plants on this list designated as:

- Eradicate List: plants that are not currently known to be present in Minnesota or are not widely established. These species must be eradicated, meaning all of the above and below ground parts of the plant must be destroyed, as required by Minnesota Statutes, Section 18.78. Additionally, no transportation, propagation, or sale of these plants is allowed. Measures must also be taken to prevent and exclude these species from being introduced into Minnesota.
- Control List: plants established throughout Minnesota or regions of the state. Species on this list must be controlled, meaning efforts must be made to prevent the spread, maturation and dispersal of any propagating parts, thereby reducing established populations and preventing reproduction and spread as required by Minnesota Statutes, Section 18.78. Additionally, transportation, propagation, or sale of these plants is prohibited.

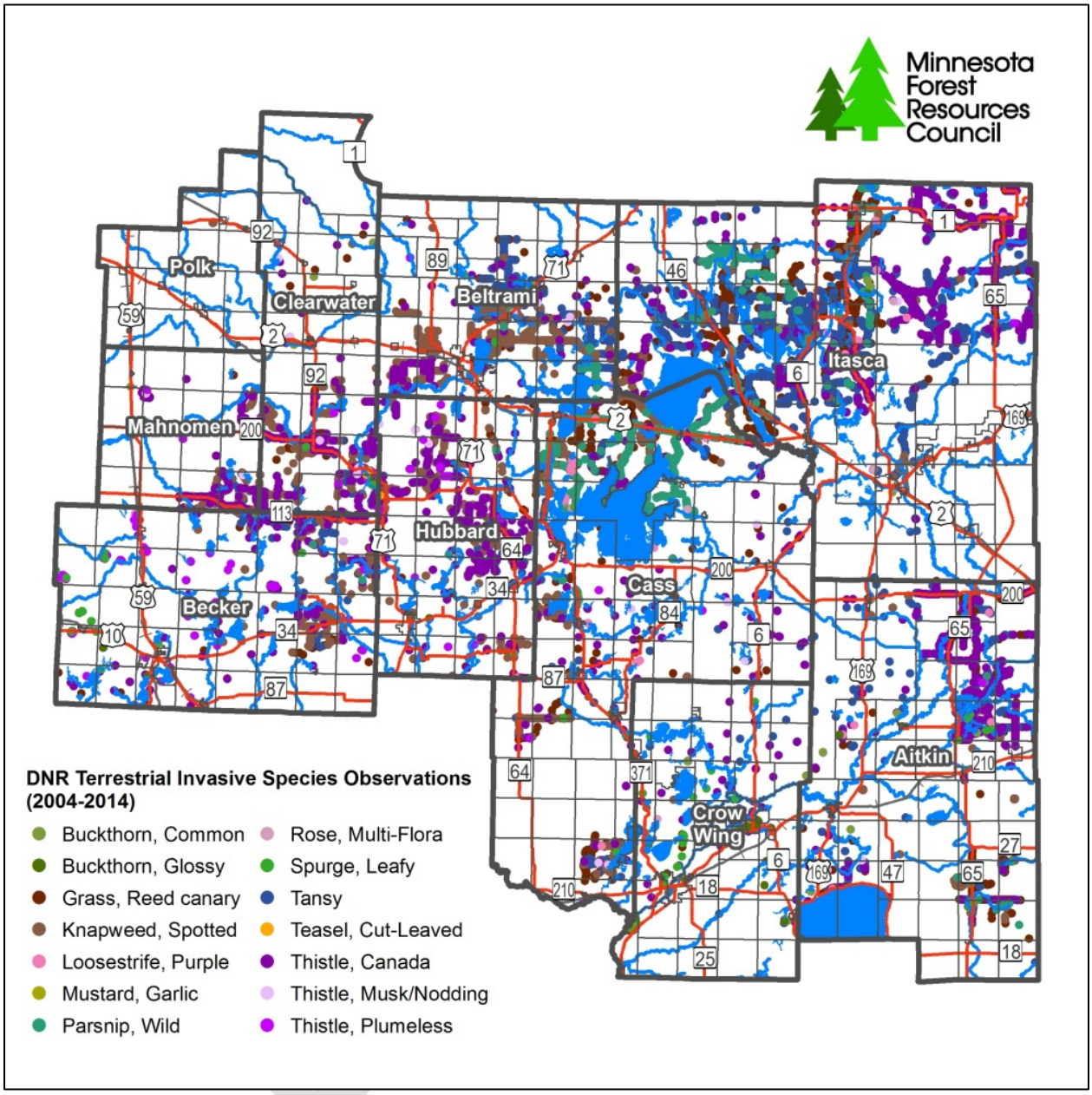
- Restricted Noxious Weeds: plants that are widely distributed in Minnesota and are detrimental to human or animal health, the environment, public roads, crops, livestock or other property, but whose only feasible means of control is to prevent their spread by prohibiting the importation, sale, and transportation of their propagating parts in the state except as allowed by Minnesota Statutes, Section 18.82. Plants designated as Restricted Noxious Weeds may be reclassified if effective means of control are developed.

More information on terrestrial invasive plants in Minnesota can be found at www.mda.state.mn.us/plants/badplants/noxiouslist.aspx or www.dnr.state.mn.us/invasives/terrestrial/index.html

Emerald ash borer (EAB) is a nonnative invasive insect that kills ash trees. EAB has currently been identified in the Twin Cities Metro and Southeastern regions of the state and quarantine has been placed on Ramsey, Hennepin, Houston, and Winona counties to help slow the spread of EAB. EAB was also confirmed in Superior, WI in August 2013. EAB poses a significant threat to the black ash communities in the North Central Landscape and Figure 3.27 shows the areas with the highest introduction risk.

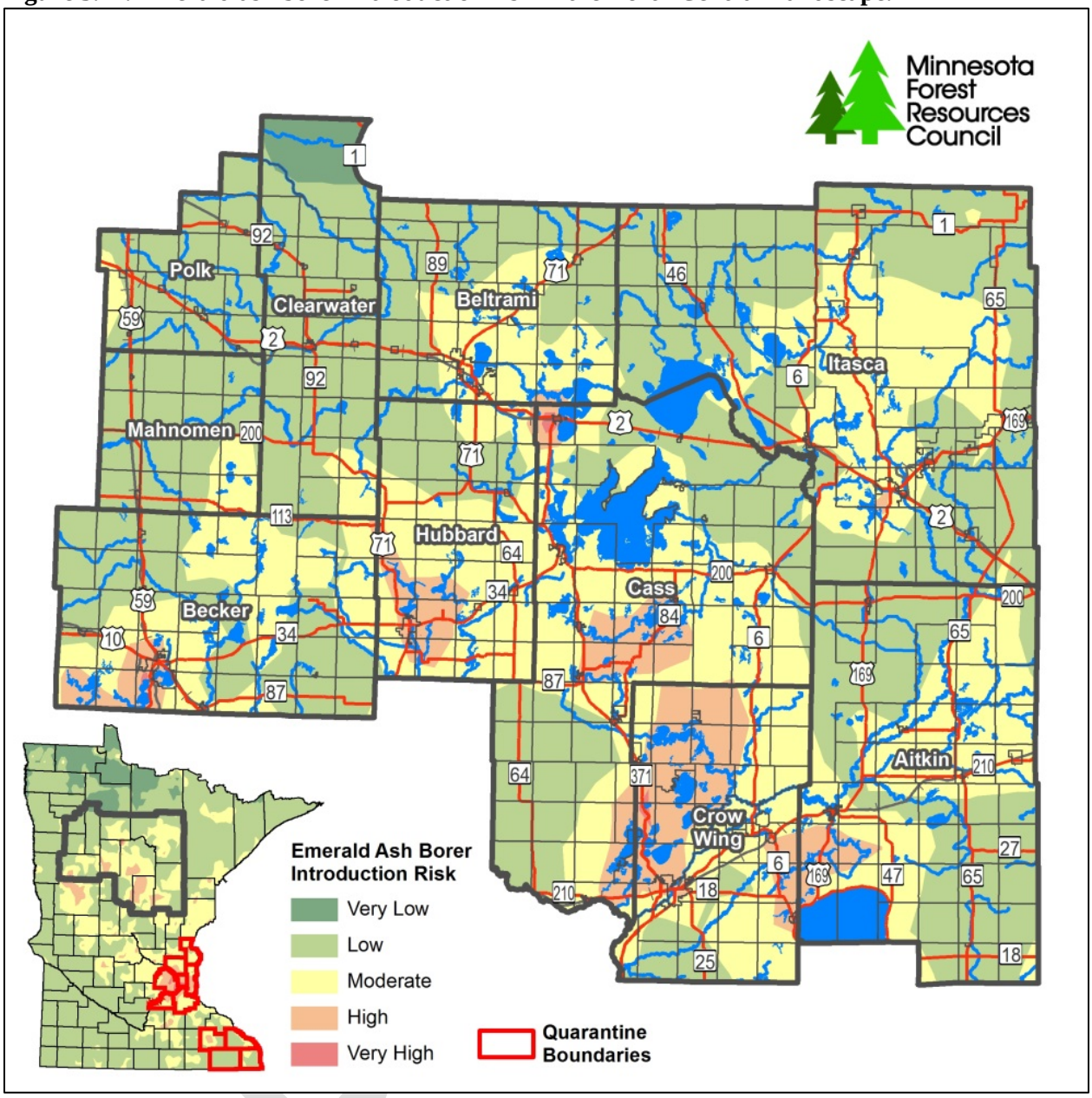
Figure 3.28 shows the distribution of lakes and rivers containing aquatic invasive species in the North Central Landscape. More information on aquatic invasive species in Minnesota can be found at www.dnr.state.mn.us/invasives/index_aquatic.html and the complete list of infested waters can be found at http://files.dnr.state.mn.us/eco/invasives/infested_waters.pdf.

Figure 3.26. MN DNR terrestrial invasive species observations in the North Central Landscape, 2004 to 2012.



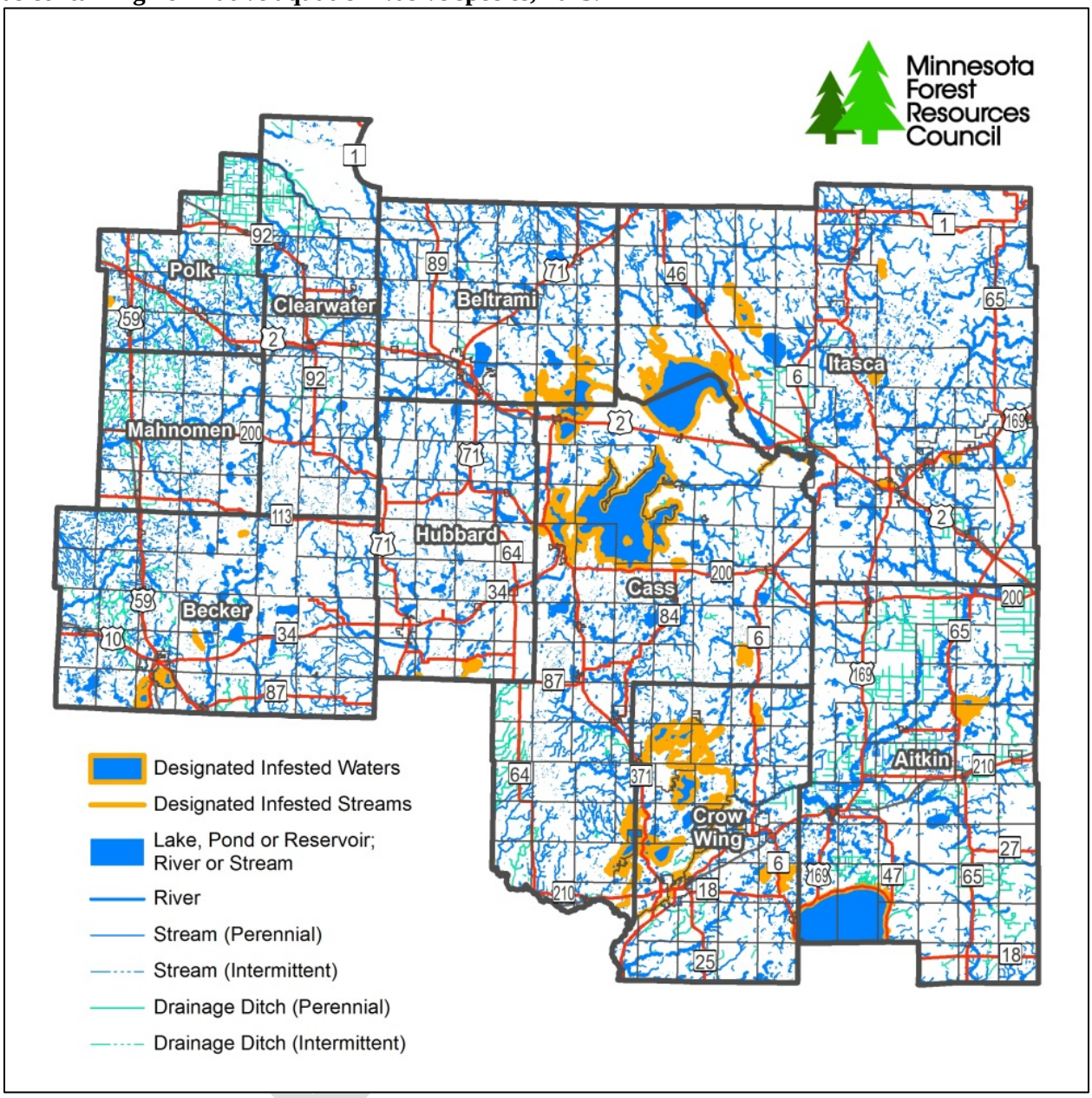
Source: MN Geospatial Commons.
Note: Species represented in this figure are those designated by the MN Department of Agriculture as 'Noxious Weeds' and therefore falling under the Noxious Weed Law (www.mda.state.mn.us/plants/badplants/noxiouslist.aspx). Other non-native species, not on the noxious weed list, are present in the region.

Figure 3.27. Emerald ash borer introduction risk in the North Central Landscape.



Source: MN Geospatial Commons.

Figure 3.28. Lakes and streams in the North Central Landscape designated by the Minnesota DNR as containing non-native aquatic invasive species, 2013.



Source: MN Geospatial Commons.

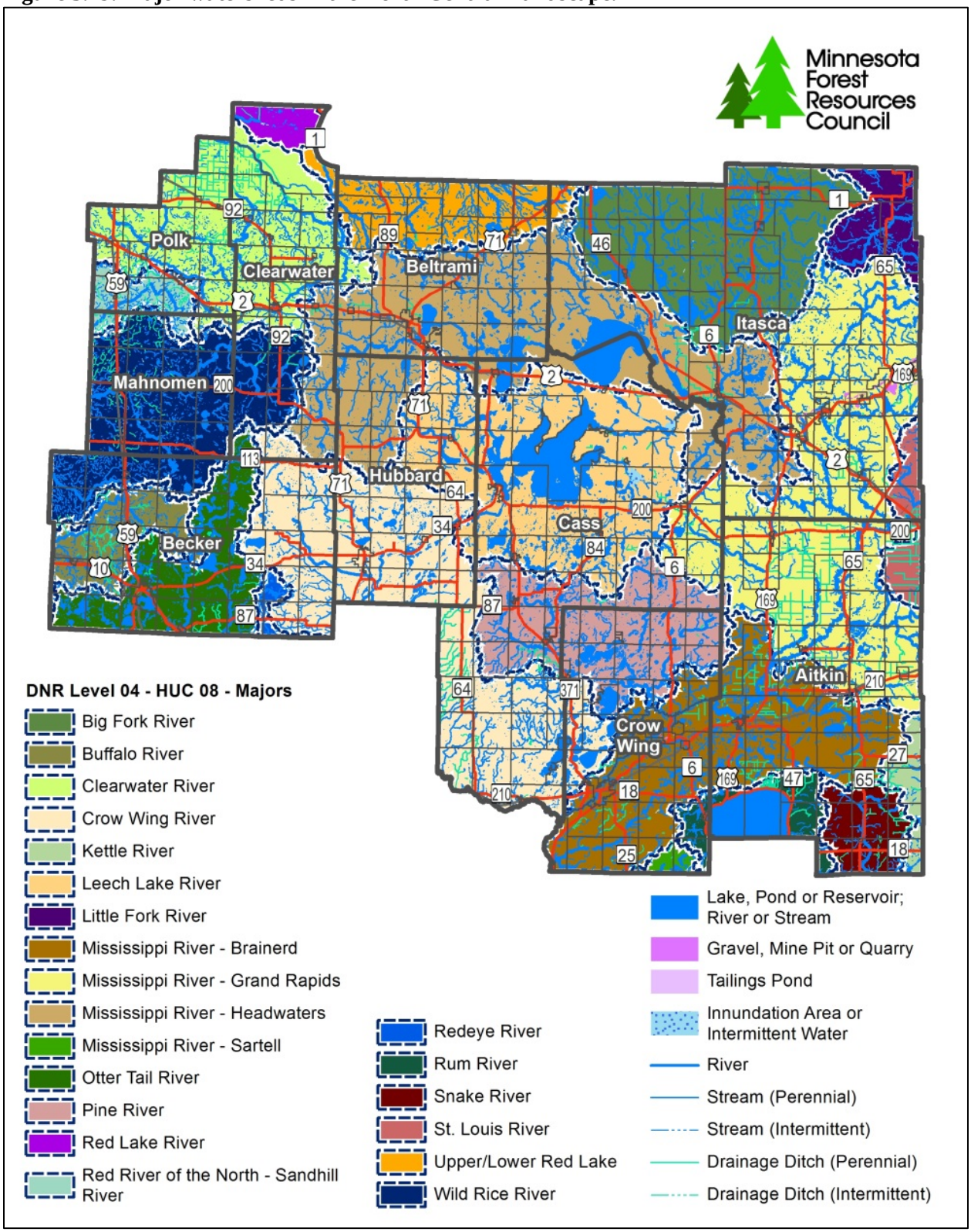
3.20. Water quality in lakes and streams

The North Central Landscape is an area of rich water resources. Most of this region is drained through the Upper Mississippi River Basin, Red River of the North Basin, or Rainy River Basin (Figure 3.29). The region also contains small portions of the Lake Superior Basin and St Croix River Basin. Water in this region forms the headwaters to the Mississippi River and forestry practices within the region can directly affect stream and lake health.

The Minnesota DNR developed the Watershed Health Assessment Framework (WHAF) to provide a comprehensive overview of the ecological health of Minnesota's watersheds. By applying a consistent statewide approach, the WHAF expands understanding of processes and interactions that create healthy and unhealthy responses in Minnesota's watersheds. Health scores are used to provide a baseline for exploring patterns and relationships in emerging health trends. The western watersheds of the Red River Basin – namely the Red Lake River, Clearwater River, Red River of the North Sandhill River, Wild Rice River, Buffalo River, and Otter Tail River Watersheds – in addition to the St. Louis River watershed in the east, scored lower than the other watersheds in the region (Figure 3.30).

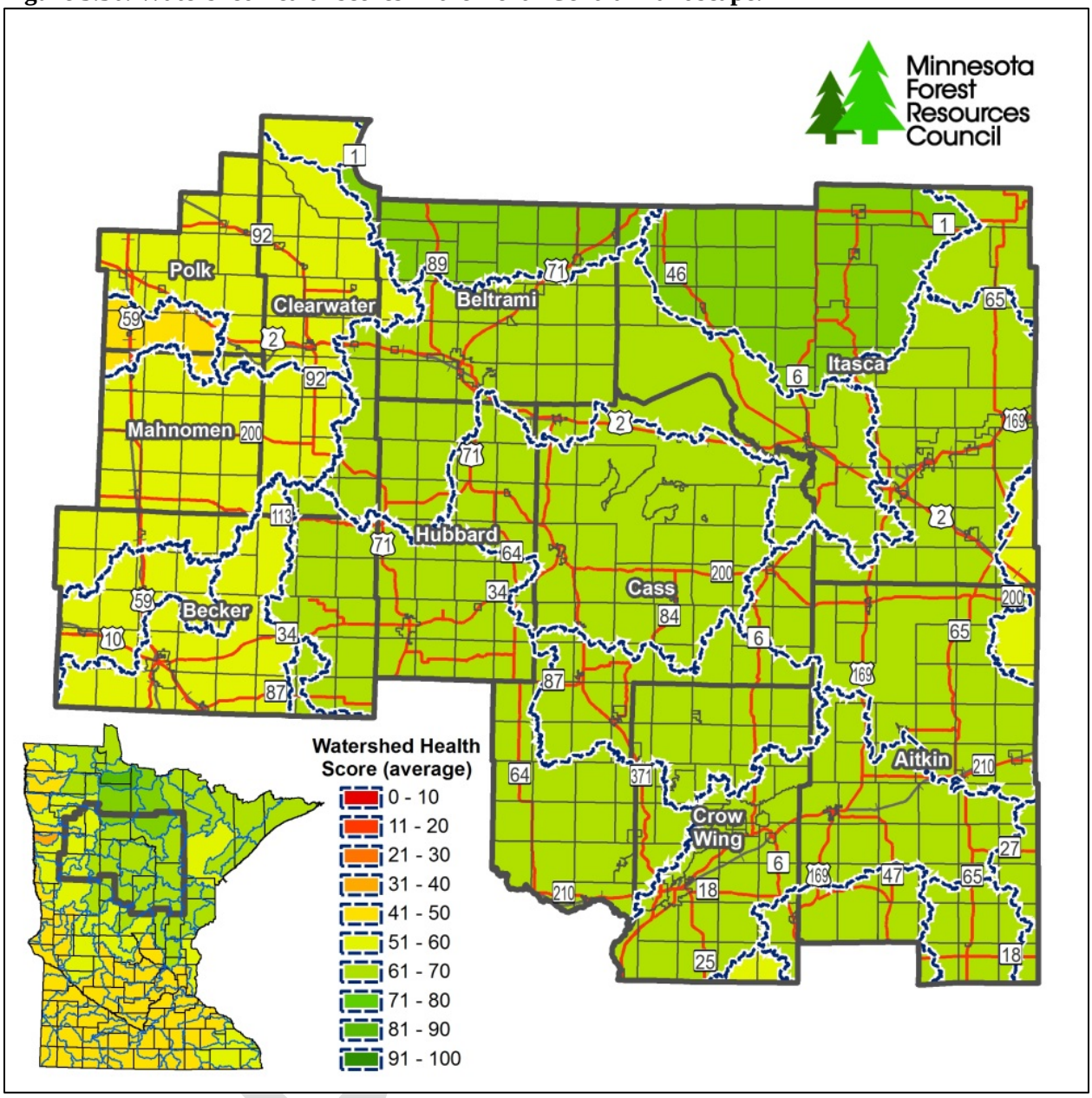
The Minnesota Pollution Control Agency (MPCA) is the state agency responsible for protecting Minnesota's water quality. Water quality standards are fundamental tools that help protect Minnesota's abundant and valuable water resources from pollution. "*Beneficial uses*" are the uses that water resources and their associated aquatic communities provide. Under the federal Clean Water Act, states are required to monitor and assess their waters to determine if they meet water quality standards and thereby support the beneficial uses they are intended to provide. Waters that do not meet their designated uses because of water quality standard violations are impaired. States are then required to develop a list of impaired waters that require Total Maximum Daily Loads (TMDL) studies, and to submit an updated list to the U.S. Environmental Protection Agency every even-numbered year for approval. These studies identify both point and nonpoint sources of each pollutant that fails to meet water quality standards and define how much of the pollutant can be in the surface and/or ground water while still allowing the waterbody to meet its designated uses, such as drinking water, fishing, swimming, irrigation or industrial purposes. Rivers and streams may have several TMDLs, each one determining the limit for a different pollutant. Most of the impaired lakes and streams in the North Central Landscape result of mercury in fish tissue (Table 3.36 and Figure 3.31). More information about impaired waters in Minnesota can be found at www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/minnesotas-impaired-waters-and-total-maximum-daily-loads-tmdls.html.

Figure 3.29. Major watersheds in the North Central Landscape.



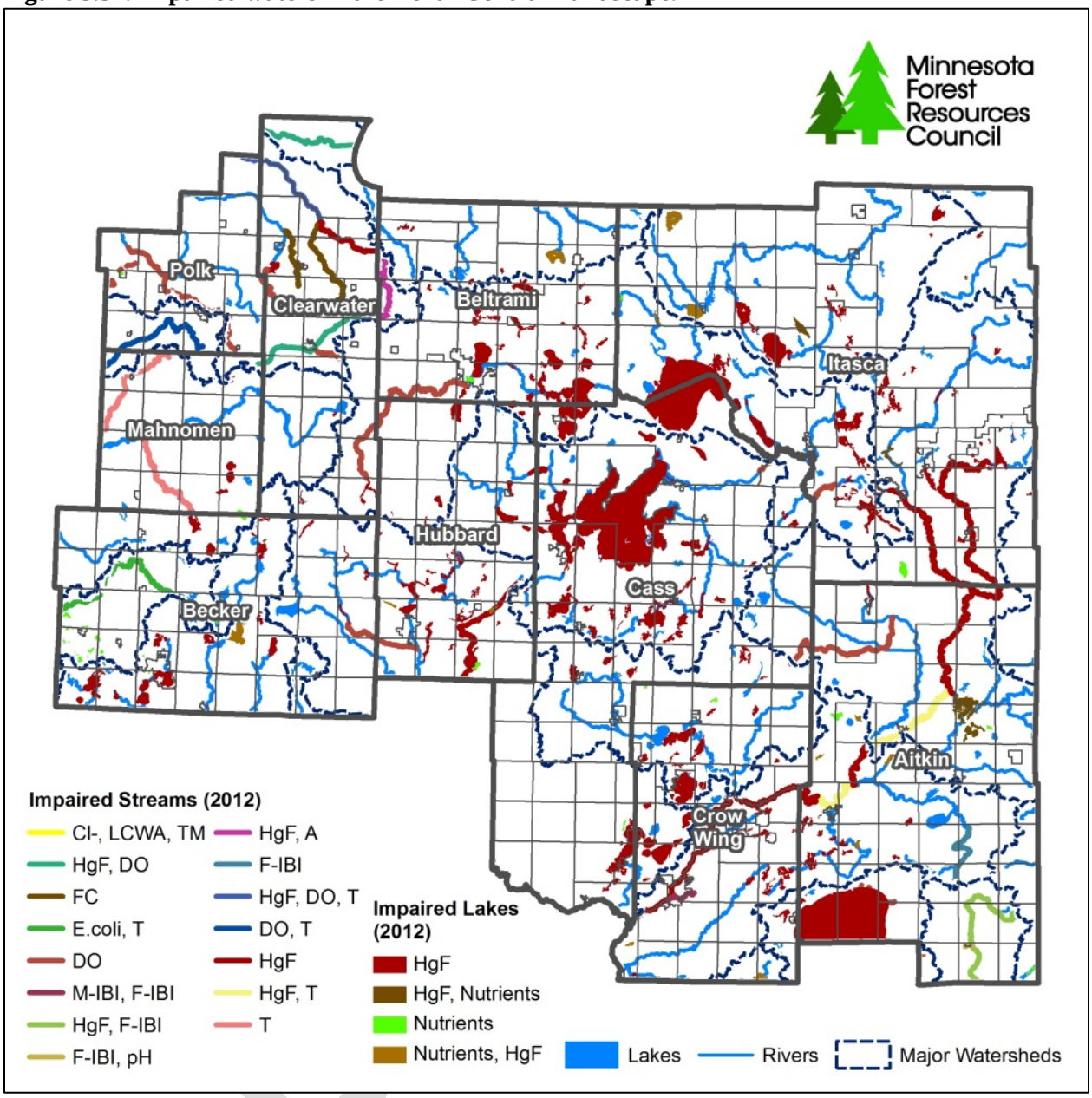
Source: MN Geospatial Commons.

Figure 3.30. Watershed health scores in the North Central Landscape.



Source: MN Geospatial Commons.

Figure 3.31. Impaired waters in the North Central Landscape.



Source: MN Geospatial Commons.

Table 3.36. Area of lakes and length of rivers and streams in the North Central Landscape by affected use and impairment, 2010.

Stream Impairments	Affected Use	Miles
DO	AQL	179.5
DO, T	AQL	28.3
E.coli, T	AQL, AQR	35.2
F-IBI	AQL	13.3
F-IBI, pH	AQL	1.4
FC	AQR	42.1
HgF	AQC	299.5
HgF, A	AQC, AQL	17.6
HgF, DO	AQC, AQL	48.1
HgF, DO, T	AQC, AQL	20.0
HgF, F-IBI	AQC, AQL	29.4
HgF, T	AQC, AQL	44.2
M-IBI, F-IBI	AQL	5.6
T	AQL	47.9
Total Length		**812.2**

Lake Impairments	Affected Use	Area (Acres)
HgF	AQC	482,672
HgF, Nutrients	AQC, AQR	11,668
Nutrients	AQR	10,943
Nutrients, HgF	AQC, AQR	17,511
Total Area		**522,794**

Source: Minnesota DNR Data Deli; Minnesota Pollution Control Agency.

Impairment Abbreviations	
A	Ammonia
Cl-	Chloride
DDT	Dichloro-diphenyl-trichloroethane
DO	Dissolved oxygen
FC	Fecal coliform
F-IBI	Fish Index of Biotic Integrity
HgF	Mercury in fish tissue
HgW	Mercury in water column
LCWA	Lack of a coldwater assemblage
PCBF	PCB in fish tissue
PCBW	PCB in water column
pH	Acidity
T	Turbidity
TM	Temperature

Affected Use Abbreviations	
AQC	Aquatic consumption
AQL	Aquatic life
AQR	Aquatic recreation

Goal 4 – Economic and Social Values

MFRC Goal 4: Economic and Social Values. Forests within a region's landscape will be providing a full range of products, services, and values, including timber products, wildlife, and tourism that are major contributors to economic stability, environmental quality, social satisfaction, and community well-being.

In general Goal 4 refers to both economic and social issues. This report includes the best economic data available at this time. It focuses on the regional forest products industry, tourism, and the regional road network. Social components relating to recreation and tourism are found in this report; for a review of regional demographic trends and projections relating to population, households, employment, earnings and income see the "North Central Landscape Demographic Data Report" at http://mn.gov/frc/initiatives_llm_committees_North Central.html

4.1. Economic and Social Value Data Sources

Minnesota DNR: The MN DNR Division of Forestry updates a series of annual and semi-annual forest products industry documents. These were referred to in the development of the following document. Some data was collected directly from MN DNR staff while other data was extracted from Division of Forestry documents. Many of these documents can be found at: www.dnr.state.mn.us/publications/forestry/index.html The MN DNR Division of Parks and Trails provided data on recreational infrastructure in the region and use data directly from their database.

US Forest Service: The USFS Northern Research Station updates a series of annual and semi-annual forest products industry documents. These were referred to in the development of the following document. Some data was collected directly from USFS staff while other data was extracted from USFS documents. Many of these documents can be found at: www.nrs.fs.fed.us/pubs/ Additional data on forestry, wilderness, and recreation trends was collected directly from USFS Superior National Forest Staff.

Explore Minnesota: Compiles and shares data on trends in regional tourism. More information on this Minnesota state agency can be found at: www.exploreminnesota.com/index.aspx

Minnesota Department of Revenue: Compiles and shares data on trends in the regional economy. More information can be found at: www.revenue.state.mn.us/Pages/default.aspx

US Department of Commerce: Compiles and shares data on trends in the regional economy. More information can be found at: www.commerce.gov/

Additional Resource Documents:

"Economic Contribution of Minnesota's Forest Products Industry – 2011 edition" by Donald Deckard (MN Forestry) and James Skurla (University of Minnesota – Duluth) provides an excellent overview of the forest products industry in Minnesota.
http://files.dnr.state.mn.us/forestry/um/economiccontributionMNforestproductsindustry2011.pdf

"Status of the Minnesota Logging Sector in 2011"; 2014; C. Blinn, T. O'Hara, D. Chura, and M. Russell - University of Minnesota, Department of Forest Resources.

"Current Status and Long-term Trends of Silvicultural Practices in Minnesota"; 2008; A. D'Amato, N. Bolton, C. Blinn, and A. Ek - University of Minnesota, Department of Forest Resources.

"Northern Minnesota Forestry Analysis"; by J. Skurla et al. 2011; Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth.

http://mn.gov/frc/initiatives_llm_committees_North Central.html

4.2. Forest products industry

(*Note: Much of this information is relates to statewide estimates and many of these have been taken directly from the Northeast Conditions and Trends Report*)

This section summarizes historical and current trends in the forest products industry from statewide to management agency level. The first section provides an overview of the forest products industry, and the following sections detail harvesting, imports-exports, mill consumptions, stumpage prices, and logging operation trends. Data in this section is often presented as primary and secondary forest products. Primary forest products manufacturers procure and utilize wood fiber directly from the forest while secondary forest products manufacturers purchase and utilize primary forest products in their manufacturing process.

4.2.1. Economic impact of the forest products industry

Forest products manufacturing and related sectors is a significant economic driver in Minnesota, directly contributing $9.7 billion in industry output and $3 billion in value added while employing about 40,370 people with a $1.8 billion payroll (Table 4.1). Including direct, indirect, and induced economic effects, Minnesota's forestry-related sectors have a total economic impact of $17.1 billion in industry output, $6.9 billion in value added (contribution to gross state product), and support 86,775 jobs (Table 4.1).

Nationally, Minnesota is ranked 8th in forest industry gross state product per capita (Figure 4.1), with 66% coming from pulp and paper and the remaining 33% from wood products (Table 4.1). Within the state, forest products manufacturing is the fifth largest manufacturing sector by employment in Minnesota (Figure 4.2), contributing approximately $3 billion or 10 percent of the state's total manufacturing value added sector and 1.7 percent of gross state product. Based on IMPLAN modeling results, the total economic impact of forest products manufacturing is $6.9 billion in value added including direct, indirect, and induced effects.

According to data collected by Deckard and Skurla (2011) in 2008, there were more than 2,300 forestry-related jobs (includes jobs related to manufacturing of forest products) in the ten county North Central Landscape (note this includes portions of Polk and Beltrami counties which are in different MFRC Landscape Regions) (Table 4.2). Hubbard County had the most forestry-related jobs (461), followed by Itasca (446), Beltrami (408), and Crow Wing (406) counties (Figure 4.3).
This industry has seen declines in recent years and the remaining regional forest products employers include: SAPPI Fine Papers and Jarden Home Brands, Inc. in Carlton County, Hedstrom Lumber in Cook County, UPM Blandin in Itasca County, Packaging Corp of America (formerly Boise, Inc.) in Koochiching County, Louisiana-Pacific Corp. in Lake County and NewPage in St. Louis County.

Based on IMPLAN modeling results by Skurla et al. 2011, paper mills produce a higher output (> $492,000,000) than all of the other forest products sectors in the North Central Landscape combined (Table 4.3, Figure 4.4). Paper mills also have the highest value (> $130,000,000) added in the forest products

sector; however, commercial logging has the highest employment in the region with 813 jobs followed by paper mills employing 695 workers.

Skurla et al. 2011 used IMPLAN modeling to compare the 1998 North Central Landscape forest products industry to the 2009 industry in current dollars and dollars deflated to 1998 value to provide insight into industry shifts (Table 4.4). Only commercial logging and wood kitchen cabinet and countertop manufacturing showed an increase in both value added and output over this time when comparing equivalent dollars. Paper mills showed a decline in deflated dollar output of nearly $72 million. Some of the hardest hit sectors included engineered wood member and truss manufacturing, and sawmills and wood preservation. Showcase, partition shelving and locker manufacturing, and veneer and plywood manufacturing disappeared from the region between 1998 and 2009. Employment changes between 1998 and 2009 show that only commercial logging, and wood kitchen cabinets and countertops had added workers. All the other forest products sectors lost jobs.

Location quotients indicate the degree of concentration for an identified industry. A location quotient over one identifies that industry as being over-represented in the region and classifies that industry as being a part of the region's economic base or a driver of the regional economy. Table 4.5 shows the North Central location quotients in the forest products sectors. Reconstituted wood products value added and output show LQ values of over 56 and 53, and were the highest values observed by Skurla et al. 2011 in their study of all regions of northern Minnesota. The North Central Landscape had the largest number of forestry sectors in the exporting economic base of any of the regions analyzed by Skurla et al. 2011, with only wood container and pallet manufacturing, non-upholstered wood household furniture and forestry, forest products and timber tract production being part of the importing economy with an LQ of less than one.

Table 4.1. Direct contribution and total economic impact of Minnesota forest products manufacturing and related sectors.

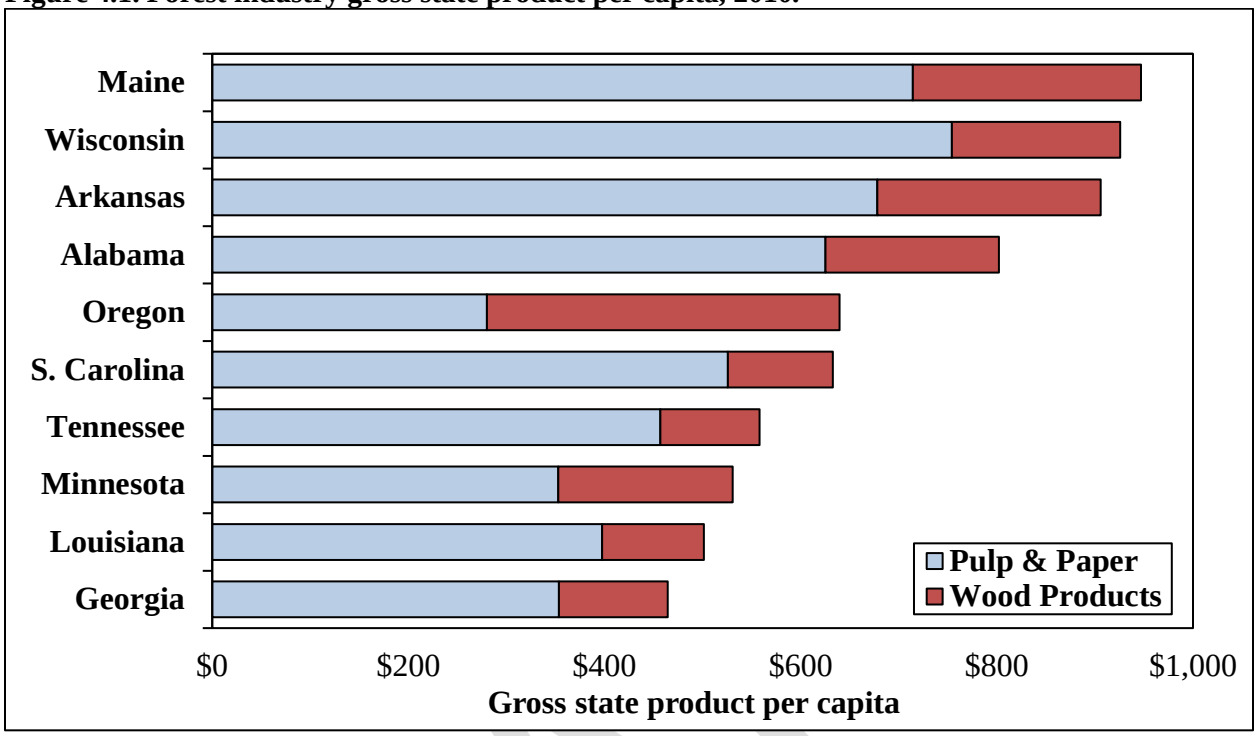
	Employment		Output (Billion $)		Value Added (Billion $)	
IMPLAN [1] Sector	**Direct Contribution**	**Total Impact**	**Direct Contribution**	**Total Impact**	**Direct Contribution**	**Total Impact**
Primary Forest Products Mfg.	5,353	19,153	$2.90	$5.20	$0.80	$1.90
Secondary Forest Products Mfg.	31,743	68,541	$6.80	$12.40	$2.20	$5.20
Forestry and Logging	3,273	6,231	$0.70	$1.10	$0.20	$0.40
Totals [2]	**40,369**	**86,775**	**$9.70**	**$17.10**	**$3.00**	**$6.90**

Source: Deckard, D. and J. Skurla. 2011. "Economic Contribution of Minnesota's Forest Products Industry – 2011 edition." Available at: http://files.dnr.state.mn.us/forestry/um/economiccontributionMNforestproductsindustry2011.pdf

[1] IMPLAN – (**IM**pact analysis for **PLAN**ning) software and data combines classic economic input-output analysis with regional specific social accounting matrices and multiplier models.

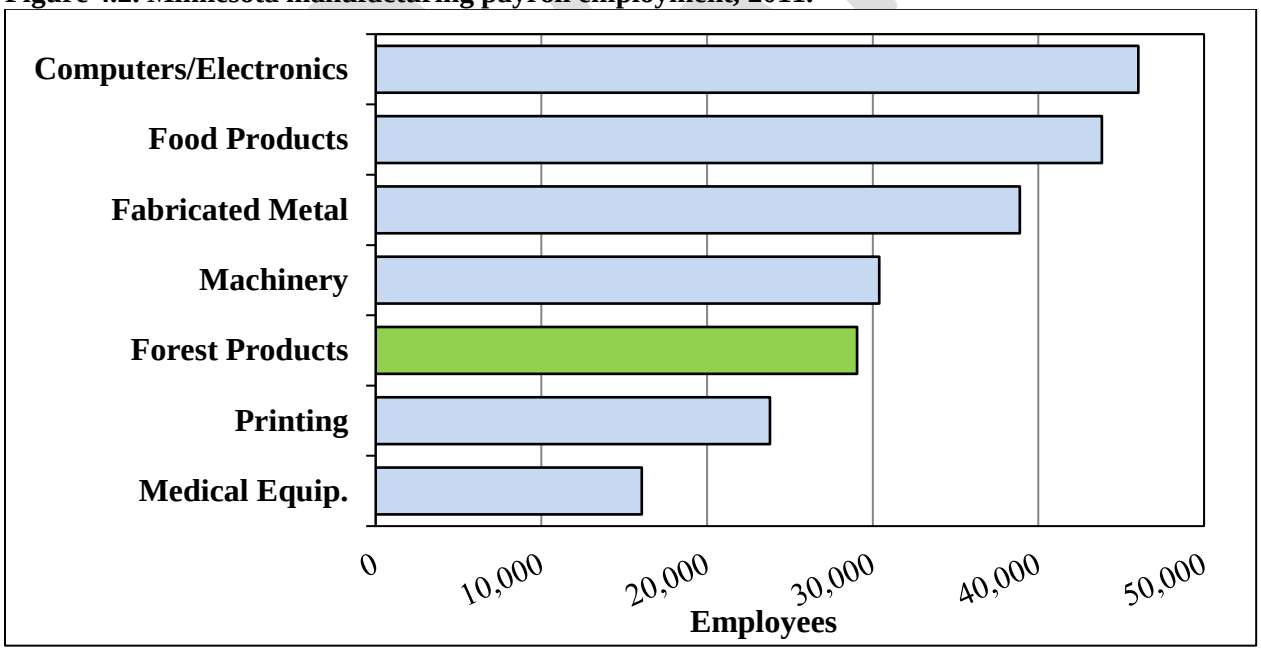
[2] To avoid the appearance of double counting, forestry and logging were discounted from primary manufacturing estimates of output and value added.

Figure 4.1. Forest industry gross state product per capita, 2010.



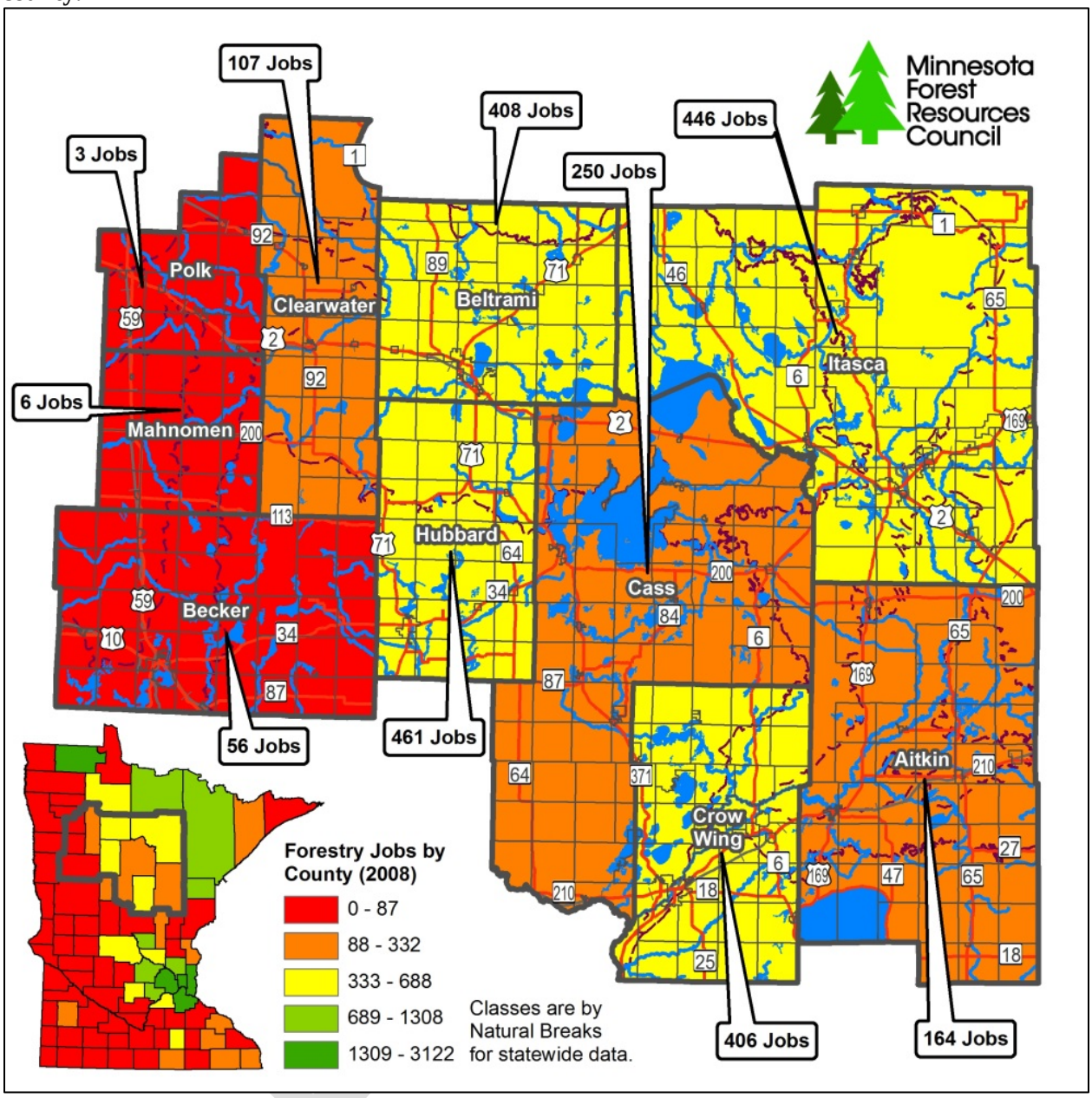
Source: Don Deckard, Minnesota DNR, Division of Forestry.

Figure 4.2. Minnesota manufacturing payroll employment, 2011.



Source: Don Deckard, Minnesota DNR, Division of Forestry.
Note: Forest products employment value includes Forestry and Logging (Industry Code; 113), Support Activities for Forestry (Industry Code; 1153), Wood Product Manufacturing (Industry Code; 321), Paper Manufacturing (Industry Code; 322), 50% of Furniture and Related Product Manufacturing total (Industry Code; 337), and Forest Products Non-employer values.

Figure 4.3. Estimated forest products manufacturing and related sectors direct employment by county.



Source: Minnesota Department of Employment and Economic Development 2008 county employment data and U.S. Census Economic Census 2007, Geographic Series: Non-Employer Statistics data. Originally compiled for Deckard and Skurla 2011.

Table 4.2. Forestry related jobs by County in the North Central Landscape, 2008.

State Rank	County	Jobs
18	Hubbard	461
19	Itasca	446
20	Beltrami	408
21	Crow Wing	406
25	Cass	250
28	Aitkin	164
34	Clearwater	107
40	Becker	56
58	Mahnomen	6
66	Polk	3
North Central Landscape		**2,307**

Source: Deckard, D. and J. Skurla. 2011. "Economic Contribution of Minnesota's Forest Products Industry – 2011 edition." Available at: http://files.dnr.state.mn.us/forestry/um/economiccontributionMNforestproductsindustry2011.pdf

Table 4.3. Forest products sectors in the North Central Landscape based on value added, output, and employment according to IMPLAN modeling, 2009.

Description	Value Added	Output	Employment
Commercial logging	$32,742,038	$95,371,400	813
Paper mills	$130,214,352	$492,071,904	695
Reconstituted wood product manufacturing	$98,464,032	$154,963,136	354
Wood windows and doors and millwork manufacturing	$10,330,532	$33,068,466	224
Wood kitchen cabinet and countertop manufacturing	$6,049,513	$23,808,152	214
Sawmills and wood preservation	$8,445,609	$38,599,428	181
All other miscellaneous wood product manufacturing	$6,798,205	$13,911,453	87
Engineered wood member and truss manufacturing	$2,678,355	$6,284,816	45
Wood container and pallet manufacturing	$2,951,056	$5,492,152	35
Non-upholstered wood household furniture mfg	$1,287,685	$2,807,575	22
Forestry, forest products, and timber tract production	$506,323	$891,757	1

Note: IMPLAN – (**IM**pact analysis for **PLAN**ning) software and data combines classic economic input-output analysis with regional specific social accounting matrices and multiplier models.
Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

Table 4.4. Forest products sectors in the North Central Landscape based on value added, output, and employment according to IMPLAN modeling trends from 1998 to 2009.

Value Added	1998	2009	2009 (Deflated to 1998 $)
Paper Mills	$164,844,000	$130,214,352	$101,567,195
Reconstituted wood product mfg	$70,105,000	$98,464,032	$80,838,970
Commercial logging	$18,634,000	$32,742,038	$30,875,742
Engineered wood member and truss mfg	$13,261,000	$2,678,355	$2,316,777
Sawmills and wood preservation	$12,079,000	$8,445,609	$8,758,097
Forestry, forest products, and timber tract production	$6,166,000	$506,323	$478,476
All other miscellaneous wood product mfg	$5,715,000	$6,798,205	$5,125,847
Non-upholstered wood household furniture mfg	$876,000	$1,287,685	$1,034,011
Wood kitchen cabinet and countertop mfg	$755,000	$6,049,513	$4,936,402
Showcase, partition, shelving, and locker mfg	$263,000	$0	$0
Veneer and plywood mfg	$69,000	$0	$0
Output			
Paper Mills	$455,683,000	$492,071,904	$383,816,085
Reconstituted wood product mfg	$189,119,000	$154,963,136	$127,224,735
Sawmills and wood preservation	$56,436,000	$38,599,428	$40,027,607
Commercial logging	$53,914,000	$95,371,400	$89,935,230
Engineered wood member and truss mfg	$32,326,000	$6,284,816	$5,436,365
Forestry, forest products, and timber tract production	$16,288,000	$891,757	$842,711
All other miscellaneous wood product mfg	$12,106,000	$13,911,453	$10,489,236
Non-upholstered wood household furniture mfg	$3,130,000	$2,807,575	$2,254,483
Wood kitchen cabinet and countertop mfg	$1,344,000	$23,808,152	$19,427,452
Showcase, partition, shelving, and locker mfg	$636,000	$0	$0
Veneer and plywood mfg	$241,000	$0	$0
Employment			
Paper Mills	1,800	694.91	
Reconstituted wood product mfg	719	353.56	
Sawmills and wood preservation	374	181.39	
Commercial logging	339	812.97	
Engineered wood member and truss mfg	254	44.7	
Forestry, forest products, and timber tract production	214	1.18	
All other miscellaneous wood product mfg	136	86.91	
Non-upholstered wood household furniture mfg	45	21.51	
Wood kitchen cabinet and countertop mfg	13	213.51	
Showcase, partition, shelving, and locker mfg	6	0	
Veneer and plywood mfg	2	0	

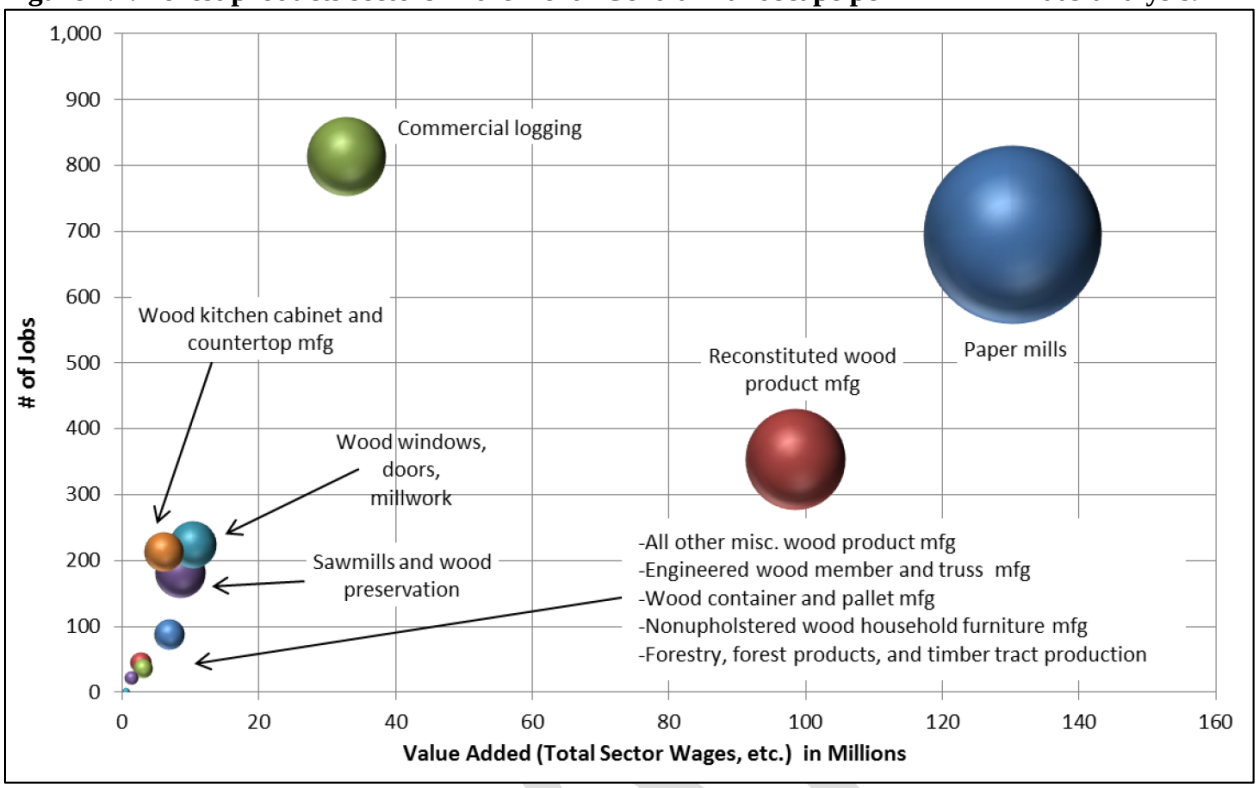
Note: IMPLAN – (**IM**pact analysis for **PLAN**ning) software and data combines classic economic input-output analysis with regional specific social accounting matrices and multiplier models.
Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

Table 4.5. Location quotients for forest products sectors in the North Central Landscape vs. the United States.

	Value Added	Output	Employment
Exporting Industries in Economic Base:			
Reconstituted wood product manufacturing	56.44	53.47	29.48
Paper mills	12.74	13.85	10.66
Commercial logging	11.06	11.52	8.92
All other miscellaneous wood product manufacturing	7.93	7.31	5.01
Wood windows and doors and millwork manufacturing	2.75	3.03	2.4
Sawmills and wood preservation	2.7	3.03	2.3
Engineered wood member and truss manufacturing	2.36	2.4	1.87
Wood kitchen cabinet and countertop manufacturing	2.24	2.72	2.16
Wood container and pallet manufacturing *	1.43	1.25	
Importing Industries to the Economic Base:			
Wood container and pallet manufacturing *			0.75
Non-upholstered wood household furniture manufacturing	0.7	0.72	0.58
Forestry, forest products, and timber tract production	0.36	0.26	0.1

* Exporting industry for value added and output but importing for employment.
Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

Figure 4.4. Forest products sectors in the North Central Landscape per IMPLAN 2009 analysis.



Note: Size of bubble = Industry output in 2009 dollars
Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

4.2.1. Harvesting trends

Minnesota's all-ownership annual timber harvest volume last peaked in 2005 at 3.7 million cords (Figure 4.5). As a result of recession induced mill closures, harvest volume declined to about 2.6 million cords in 2012, of which approximately 72% was used as pulp wood and the remaining 28% being used for sawlogs, specialty products, and fuel wood (Table 4.6). The decline of roughly 1 million cords over a relatively short time period was largely due to the significant decline in harvest of private and tribal forests. Since 2005, harvest volume from private and tribal ownership decreased from 55% of total all-ownership harvest volume to 34% of total all-ownership harvest volume in 2012. Meanwhile the volume of timber harvested from public land has stayed relatively constant over this time period but has increased from 45% to 66% of total all-ownership harvest volume (Figure 4.6). Data averaged from 2008-2010 indicates the statewide public land harvest is broken down roughly 47% state, 43% county, and 10% federal ownership (Table 4.7).

In 2008, eight of the ten counties in the North Central Landscape ranked in the top fifteen counties in the state for harvested cords (Table 4.8). The ten counties combined accounted for over 1,237,000 cords or 41% of the roughly 3 million cord statewide all-ownership timber harvest in 2008 (Table 4.8, Figure 4.7). Itasca (361,457), Beltrami (208,049), Cass (194,043), Aitkin (178,416), and Hubbard (114,842) each harvested over 100,000 cords in 2008.
Pulpwood harvest in the North Central Landscape peaked at nearly 1.3 million cords in 2005 and has dropped to about 881,000 following the recession and regional mill closures (Figure 4.8). Itasca County is the largest pulpwood producer in the region, accounting for approximately a quarter to a third of the total pulpwood harvest in any given year. Despite the change in pulpwood harvest from 2005 to 2010, the percent

of the statewide pulpwood harvest coming from the North Central Landscape has remained relatively steady at approximately 40 to 47%.

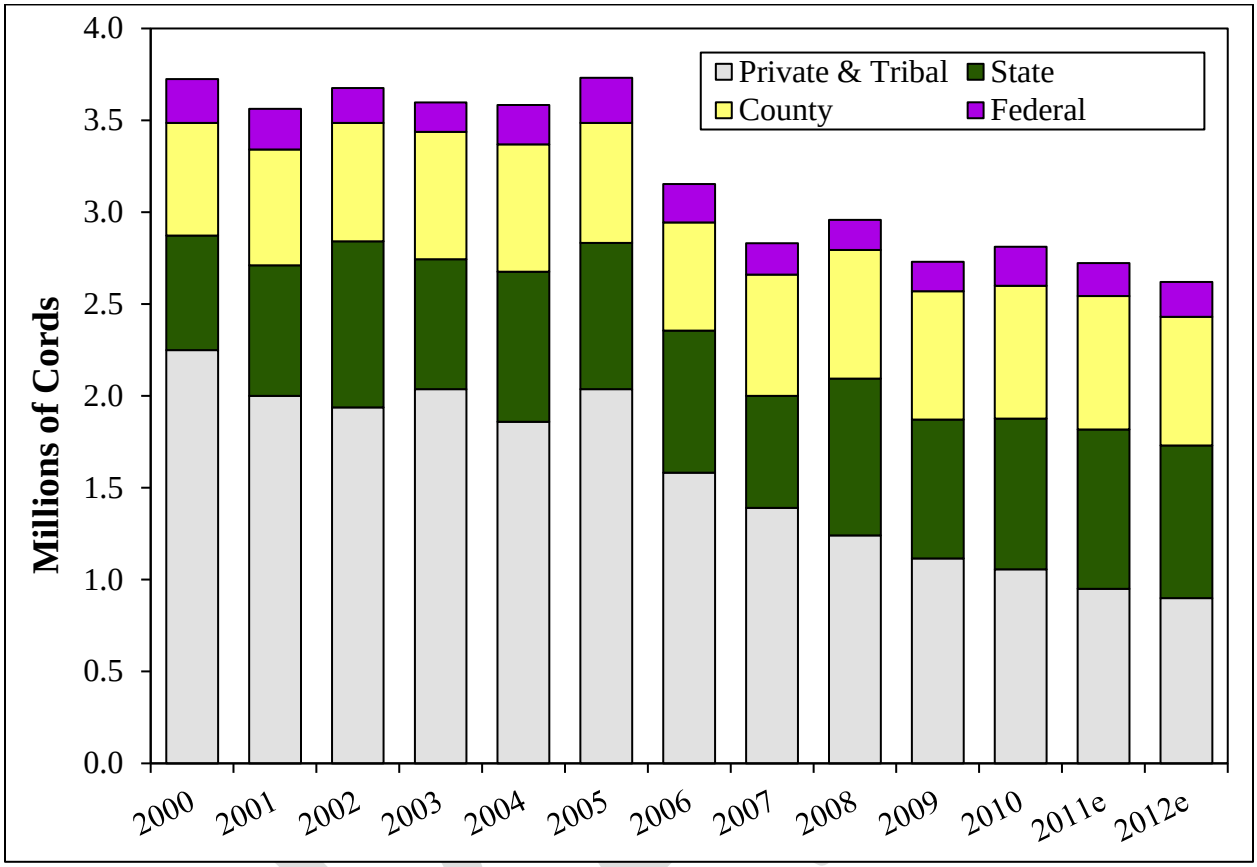
Sawlog harvest in the North Central Landscape has decreased from 1990 to 2004, but from 2004 to 2010 has since stayed relatively steady at roughly 123,000 thousand board feet (Figure 4.9). The percentage from individual counties varies by year, but on average approximately 50% of the sawlogs come from Itasca and Cass counties, and the remaining is split among the other eight counties.

According to the 2015 FIA survey quaking aspen had by far the highest total harvested volume (37.1 million ft^3) in the region which accounted for over 47% of the total harvest volume in the region (Table 4.9). Red pine and paper birch had the next highest harvested volume (Figure 4.10). Other species, such as northern white cedar, with relatively large volumes experienced little or no harvest (Table 4.9).

The highest average annual harvest removal estimates by ownership were on county forestlands in the North Central Landscape (Figure 4.11, Table 4.10). As a percentage of the total volume owned the county also harvested the most (2.8%) according to the 2015 FIA survey.

As a specific example, the Chippewa National Forest sold timber contracts on 6,434 acres of timberland and had a harvest volume of 49.1 million board feet with an additional 125.4 million board feet of timber under contract but uncut in 2013. The 2013 harvested volume is half of the early 1990's harvest volumes, but represents an increase from the Recession induced lows experienced in the mid-2000's (Figure 4.12). During the Recession and continuing through the recovery period there remains a large amount of Chippewa National Forest that is under a timber sale contract but remains uncut (Figure 4.13).

Figure 4.5. Statewide trends in timber harvesting by ownership class, 2000-2010 and 2011-2012 estimates.



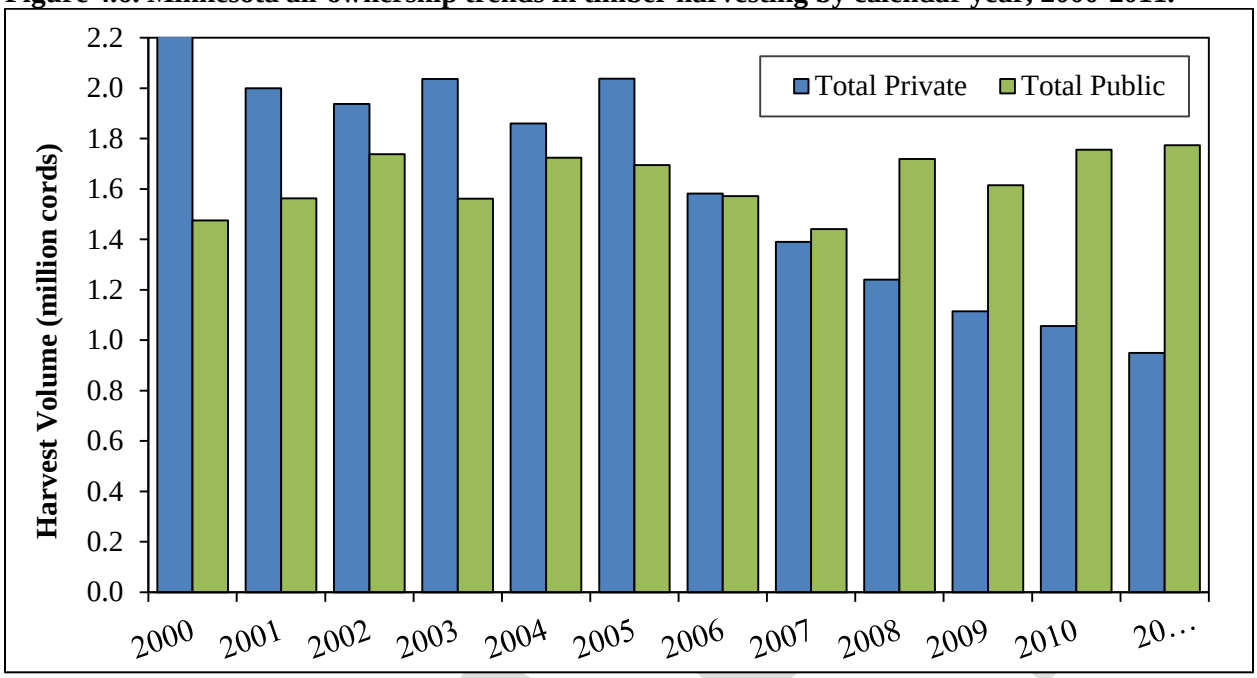
Source: Don Deckard, Minnesota DNR, Division of Forestry.

Table 4.6. Minnesota timber harvest estimate, 2012.

Timber Harvest 2011 (est.)	Million cords[1]	% of total cords
Pulpwood	1.8	69%
Sawlogs & Specialty Products	0.5	19%
Fuel wood	0.3	12%
Total	**2.6**	**100%**

Source: Don Deckard, Minnesota DNR, Division of Forestry.
[1]Cord = 80 cubic feet of solid wood.

Figure 4.6. Minnesota all-ownership trends in timber harvesting by calendar year, 2000-2011.



Source: Don Deckard, Minnesota DNR, Division of Forestry.

Table 4.7. Minnesota annual industrial timber harvest volume and stumpage value by ownership, 2008.

Ownership	Harvest (Cords)	Market Share (% Cords)
Family and Tribal	1,000,000	33%
State DNR	775,000	26%
County and Local Govt.	720,000	24%
Industrial / Corporate	350,000	12%
Federal	160,000	5%
Total	**3,005,000**	**100%**

Source: Deckard and Skurla 2011.
Note: Three-year average harvest volumes do not include residential fuelwood at 200,000 cords per year. Stumpage values from Minnesota DNR, Public Stumpage Price Review.

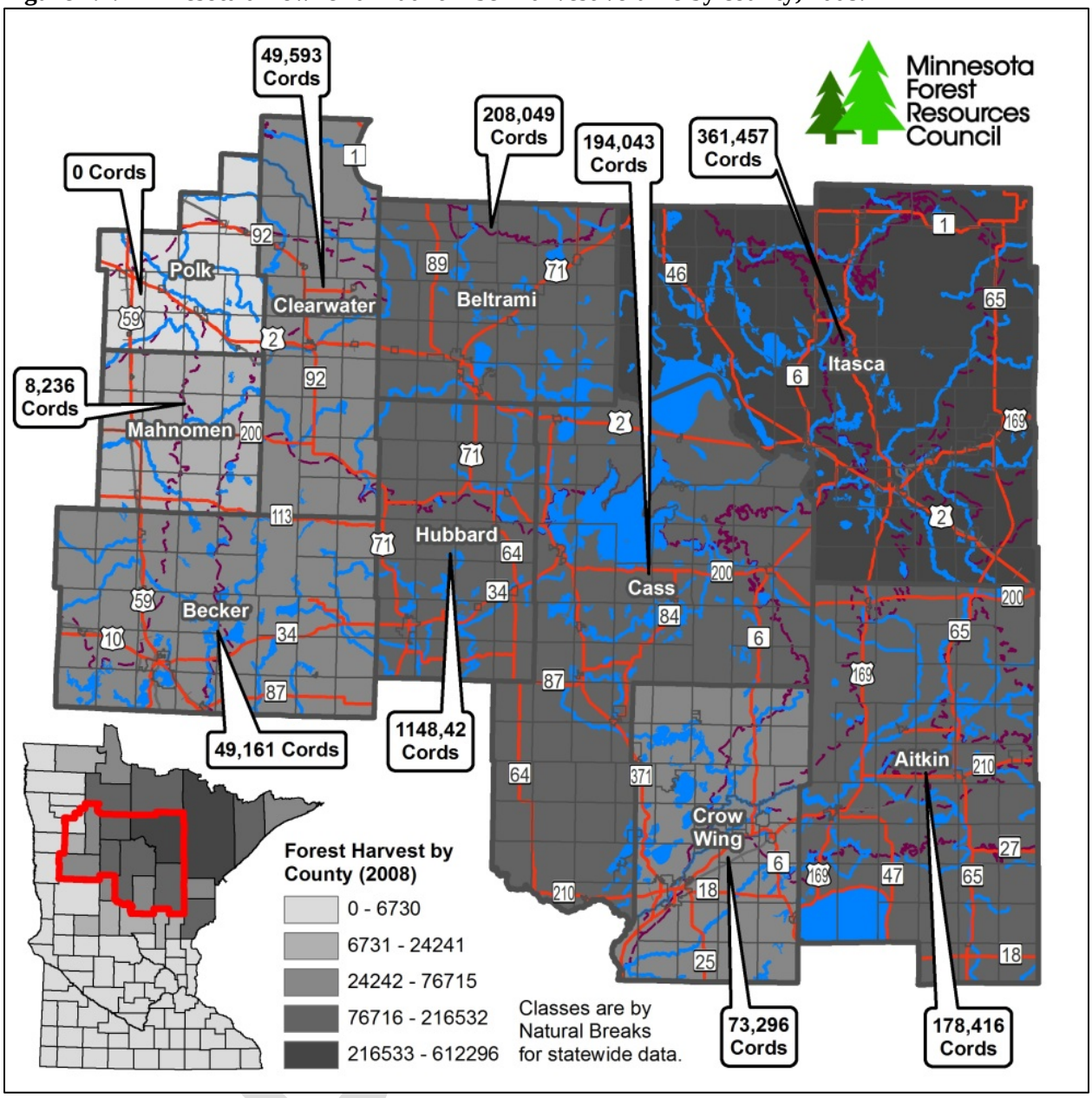
Table 4.8. Timber harvest by County in the North Central Landscape, 2008.

State Rank	County	Cords
2	Itasca	361,457
4	Beltrami	208,049
5	Cass	194,043
6	Aitkin	178,416
8	Hubbard	114,842
11	Crow Wing	73,296
13	Clearwater	49,593
14	Becker	49,161
23	Mahnomen	8,236
50*	Polk	0
Total		**1,237,093**

Source: Deckard and Skurla 2011.

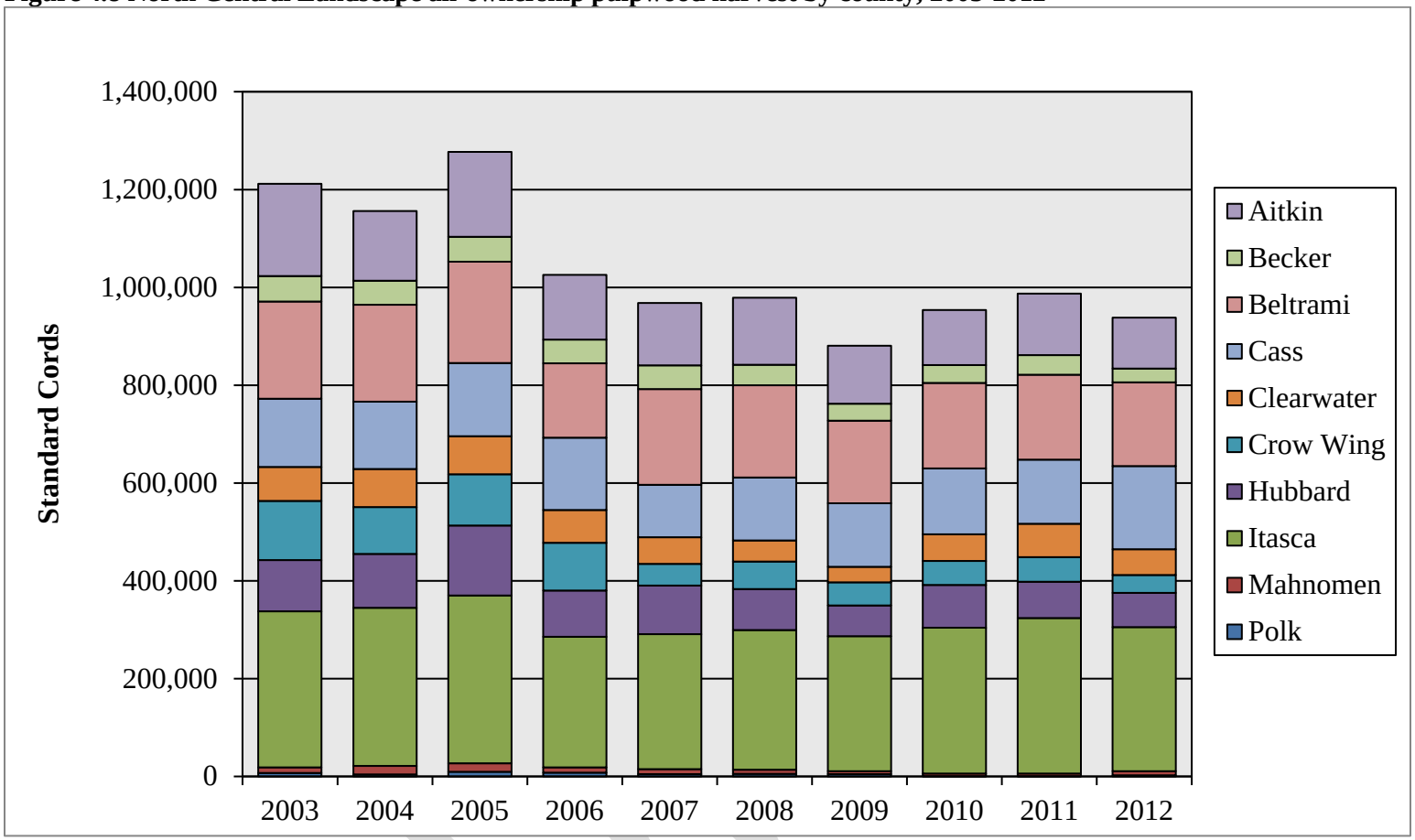
* There were 38 counties that were tied for 50th with zero cords harvested.

Figure 4.7. Minnesota all-owner annual timber harvest volume by county, 2008.



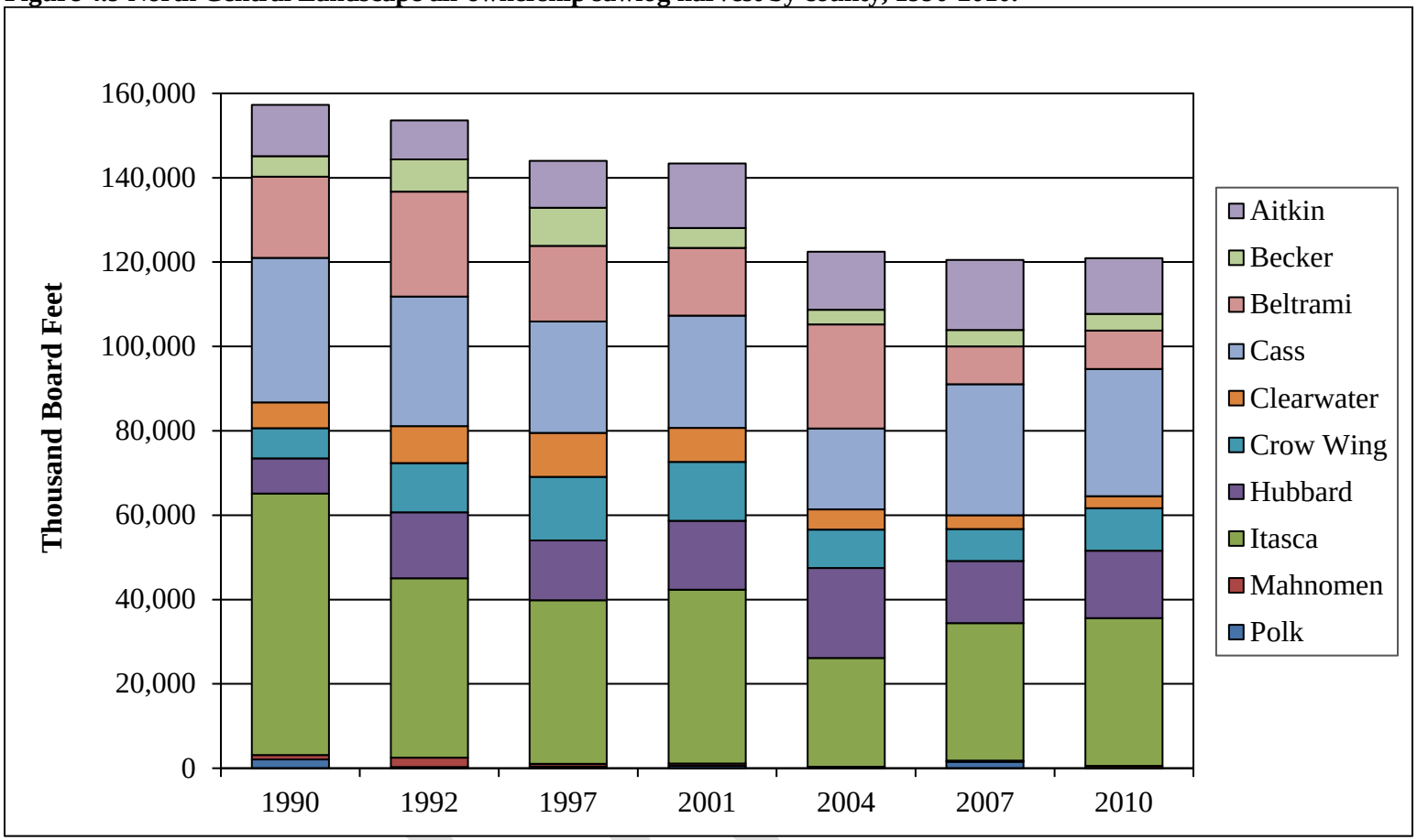
Source: Compiled by Deckard and Skurla 2011 from the combined annual harvest volumes as reported from annual USFS pulpwood surveys and periodic Minnesota DNR sawmill, fuelwood, and biomass surveys.

Figure 4.8 North Central Landscape all-ownership pulpwood harvest by county, 2003-2012



Source: US Forest Service Annual Pulp Mill Surveys; compiled by Don Deckard, Minnesota DNR, Division of Forestry.
Note: The MFRC North Central Landscape splits Beltrami and Polk Counties. These counties could not be split for these harvest estimates and therefore the total harvest does not represent the true harvest of the region.

Figure 4.9 North Central Landscape all-ownership sawlog harvest by county, 1990-2010.



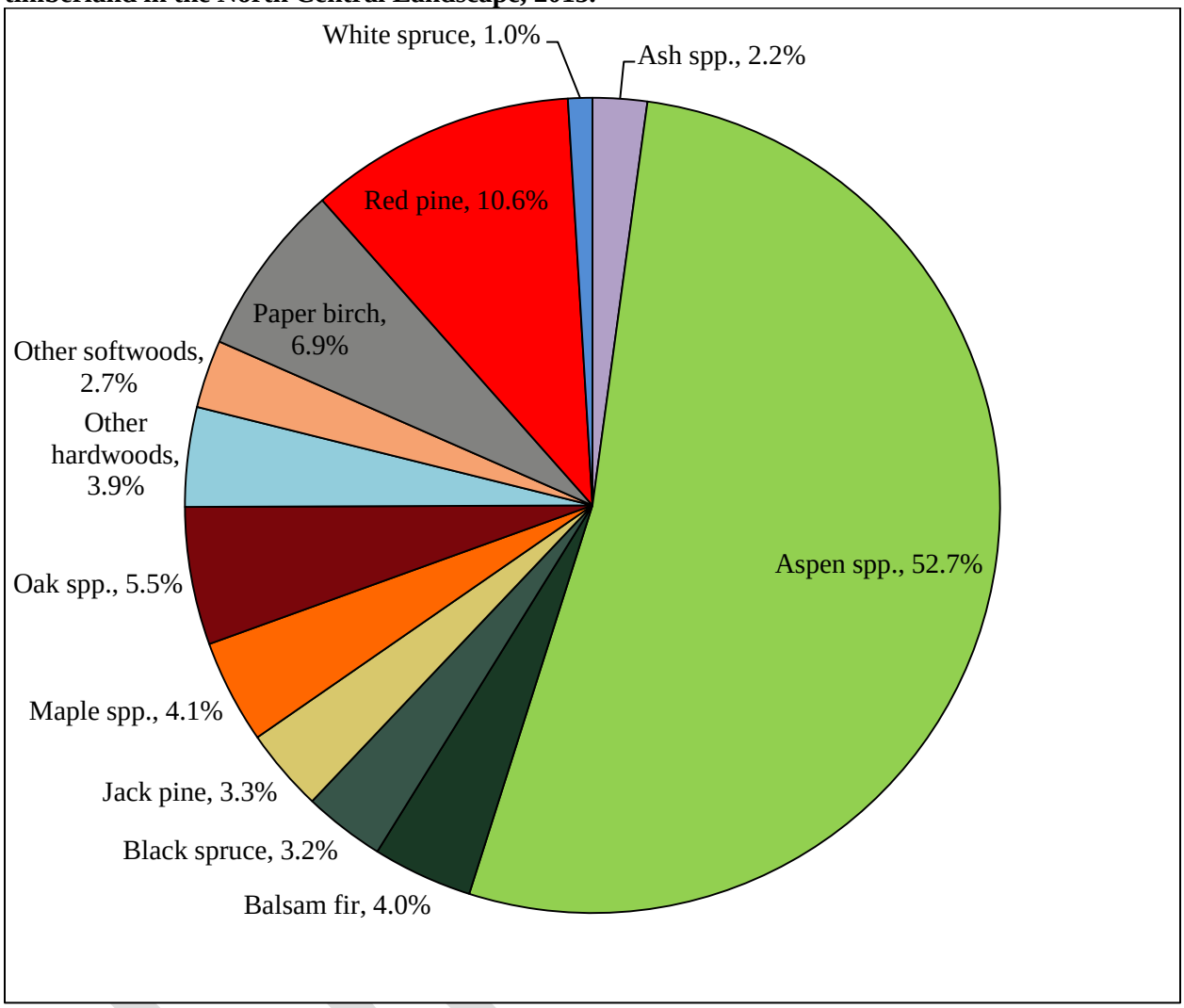
Source: Minnesota DNR periodic sawmill & specialty surveys, International 1/4-inch rule; compiled by Don Deckard, Minnesota DNR, Division of Forestry.
Note: The MFRC North Central Landscape splits Beltrami and Polk Counties. These counties could not be split for these harvest estimates and therefore the total harvest does not represent the true harvest of the region.

Table 4.9. Annual growing stock harvest removal estimate (ft^3) as a percent of timberland volume in the North Central Landscape, 2015.

Species	Volume (ft^3)	Harvest Removal (ft^3)	% of Volume	% of Harvest
Quaking aspen	1,137,102,423	37,119,585	3.3%	47.4%
Red pine	575,205,571	8,273,547	1.4%	10.6%
American basswood	406,946,812	2,882,972	0.7%	3.7%
Black ash	371,788,425	1,477,983	0.4%	1.9%
Paper birch	314,380,117	5,384,171	1.7%	6.9%
Bur oak	304,085,217	973,624	0.3%	1.2%
Northern red oak	247,639,648	2,928,369	1.2%	3.7%
Northern white-cedar	219,243,299	95,930	0.0%	0.1%
Sugar maple	214,246,876	1,166,769	0.5%	1.5%
Tamarack (native)	205,480,198	1,933,156	0.9%	2.5%
Balsam fir	178,506,529	3,099,198	1.7%	4.0%
Eastern white pine	157,947,568	83,936	0.1%	0.1%
Bigtooth aspen	157,912,830	2,675,124	1.7%	3.4%
Red maple	152,846,487	2,049,834	1.3%	2.6%
Green ash	104,878,297	210,498	0.2%	0.3%
Balsam poplar	94,903,402	1,471,823	1.6%	1.9%
Black spruce	93,245,557	2,522,016	2.7%	3.2%
Jack pine	92,280,443	2,575,141	2.8%	3.3%
White spruce	80,641,654	754,197	0.9%	1.0%
Northern pin oak	42,629,931	374,598	0.9%	0.5%
American elm	38,320,523	202,758	0.5%	0.3%
Other hardwoods	42,863,079	--	--	--
Total Current	**5,233,094,886**	**78,255,227**	**1.5%**	**100.0%**

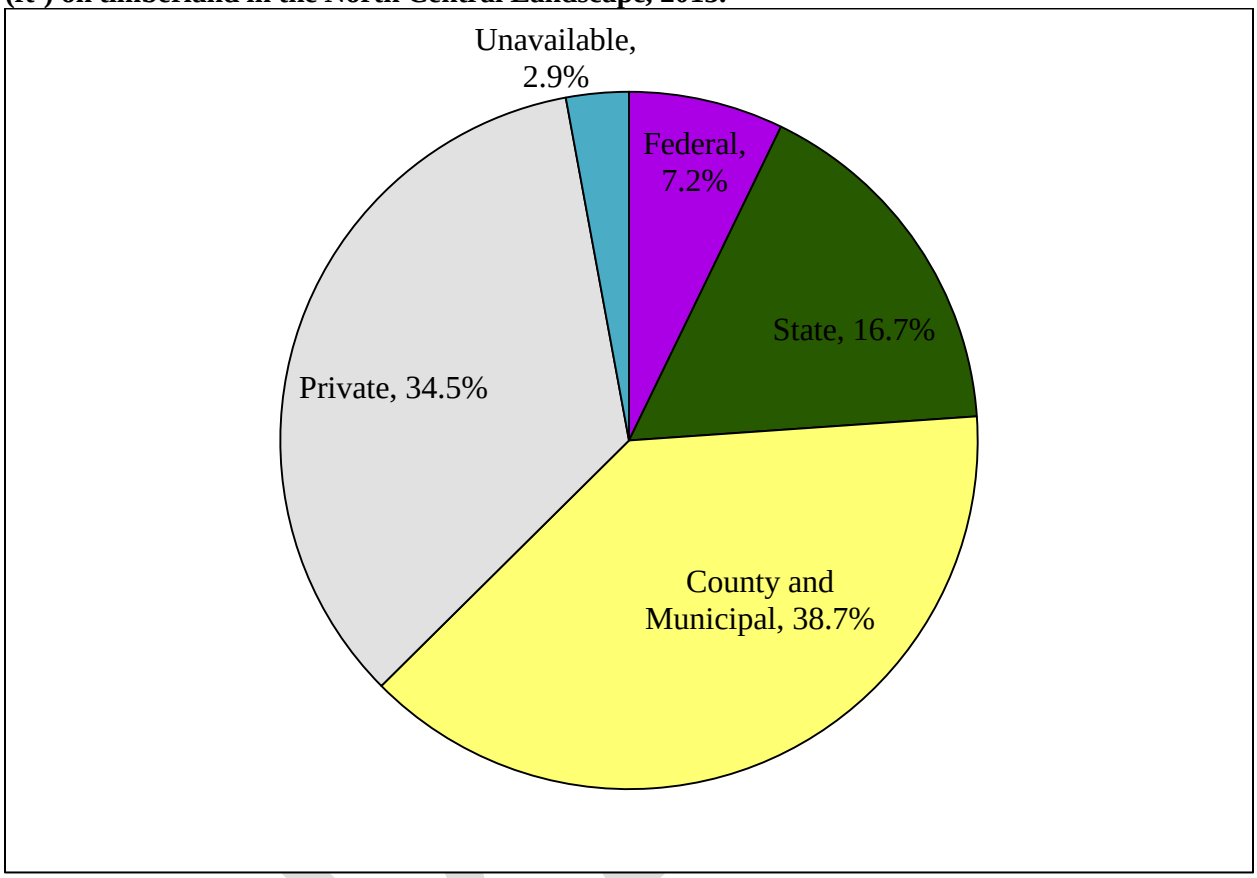
Source: Forest Inventory Analysis estimate.

Figure 4.10. Species breakdown of estimated annual growing stock harvest volume (ft^3) on timberland in the North Central Landscape, 2015.



Source: Forest Inventory Analysis estimate.

Figure 4.11. Ownership category breakdown of estimated annual growing stock harvest volume (ft^3) on timberland in the North Central Landscape, 2015.



Source: Forest Inventory Analysis estimate.
* The FIA database combines Tribal, Forest Industry, and Non-industrial Private as 'Private'. For some analysis these categories cannot be separated due to disclosure laws.

Table 4.10. Annual growing stock harvest removal estimate (ft^3) as a percent of timberland volume by ownership category in the North Central Landscape, 2015.

Species	National Forest				State			
	Volume (ft^3)	Harvest Removal (ft^3)	% of Volume	% of Harvest	Volume (ft^3)	Harvest Removal (ft^3)	% of Volume	% of Harvest
Quaking aspen	211,432,823	2,604,771	1.2%	46.4%	150,649,685	3,978,818	2.6%	30.4%
Red pine	204,445,233	2,651,196	1.3%	47.2%	56,675,612	1,480,319	2.6%	11.3%
American basswood	70,023,900	120,872	0.2%	2.2%	41,311,936	809,784	2.0%	6.2%
Black ash	45,389,410	--	--	--	67,163,174	155,187	0.2%	1.2%
Paper birch	61,169,773	70,534	0.1%	1.3%	30,674,640	1,035,405	3.4%	7.9%
Bur oak	20,685,076	--	--	--	32,019,099	7,232	0.0%	0.1%
Northern red oak	12,890,270	7,086	0.1%	0.1%	35,598,831	618,817	1.7%	4.7%
Northern white-cedar	59,516,815	--	--	--	46,373,862	--	--	--
Sugar maple	26,736,517	--	--	--	24,515,225	430,570	1.8%	3.3%
Tamarack (native)	30,563,434	--	--	--	80,599,297	833,287	1.0%	6.4%
Balsam fir	27,085,829	96,463	0.4%	1.7%	21,785,629	232,305	1.1%	1.8%
Eastern white pine	43,204,929	--	--	--	11,201,799	--	--	--
Bigtooth aspen	23,867,936	54,271	0.2%	1.0%	21,138,740	318,040	1.5%	2.4%
Red maple	15,088,674	--	--	--	23,987,665	673,049	2.8%	5.1%
Green ash	4,653,771	--	--	--	9,290,114	19,447	0.2%	0.1%
Balsam poplar	13,076,603	--	--	--	20,672,073	7,426	0.0%	0.1%
Black spruce	15,698,883	--	--	--	32,018,685	1,774,174	5.5%	13.6%
Jack pine	9,573,871	--	--	--	7,676,243	488,738	6.4%	3.7%
White spruce	9,578,633	13,918	0.1%	0.2%	10,843,165	181,337	1.7%	1.4%
Northern pin oak	2,195,835	--	--	--	1,104,714	--	--	--
American elm	2,924,104	--	--	--	4,347,257	38,174	0.9%	0.3%
Other hardwoods	1,534,565	--	--	--	2,450,038	--	--	--
Total Current	**911,336,883**	**5,619,111**	**0.6%**	**100.0%**	**732,097,482**	**13,082,110**	**1.8%**	**100.0%**

Table 4.10. Continued.

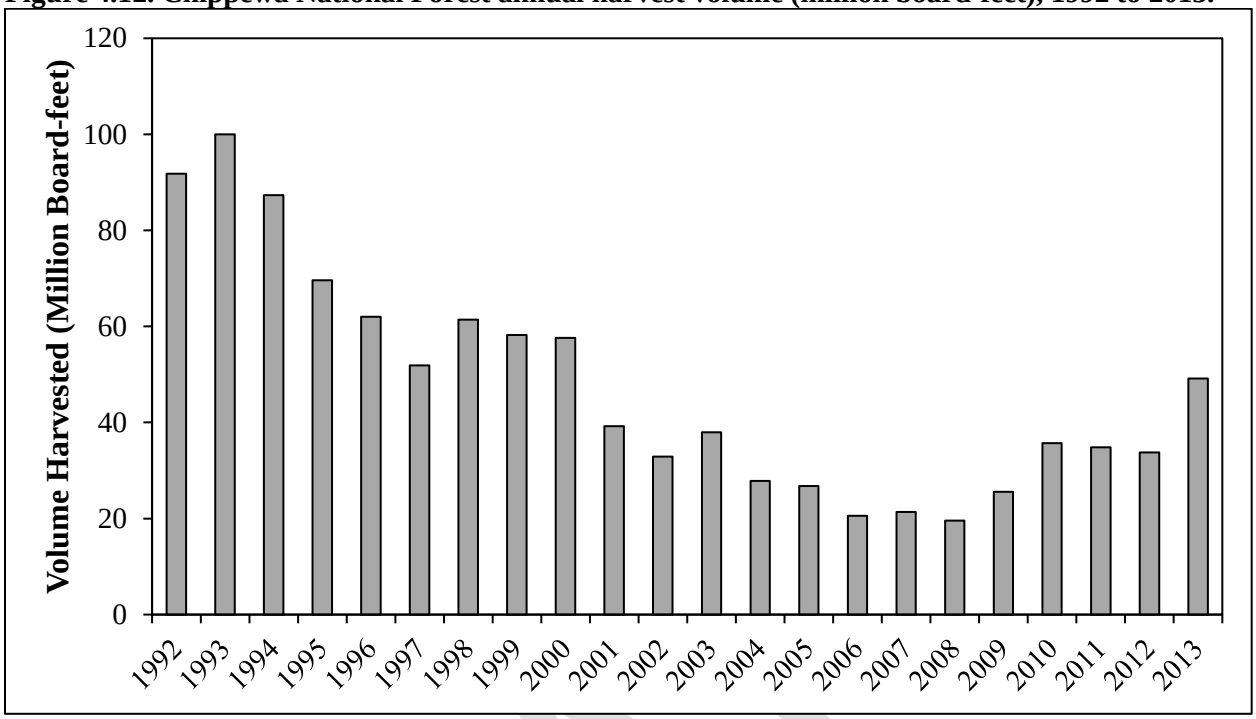
Species	County and Municipal				Private			
	Volume (ft^3)	Harvest Removal (ft^3)	% of Volume	% of Harvest	Volume (ft^3)	Harvest Removal (ft^3)	% of Volume	% of Harvest
Quaking aspen	252,983,458	15,897,787	6.3%	52.5%	522,036,457	14,144,133	2.7%	52.4%
Red pine	94,376,061	778,274	0.8%	2.6%	219,708,665	3,233,492	1.5%	12.0%
American basswood	69,807,053	707,048	1.0%	2.3%	225,803,923	1,197,192	0.5%	4.4%
Black ash	76,672,450	604,488	0.8%	2.0%	182,563,390	681,418	0.4%	2.5%
Paper birch	70,719,691	2,883,554	4.1%	9.5%	151,816,013	1,184,459	0.8%	4.4%
Bur oak	44,086,598	410,656	0.9%	1.4%	207,294,443	389,800	0.2%	1.4%
Northern red oak	60,530,462	1,466,339	2.4%	4.8%	138,620,085	381,076	0.3%	1.4%
Northern white-cedar	52,341,110	--	--	--	61,011,512	95,930	0.2%	0.4%
Sugar maple	41,700,587	444,608	1.1%	1.5%	121,294,547	291,592	0.2%	1.1%
Tamarack (native)	40,649,771	1,099,869	2.7%	3.6%	53,667,697	--	--	--
Balsam fir	44,827,353	1,538,283	3.4%	5.1%	84,807,718	825,371	1.0%	3.1%
Eastern white pine	37,437,825	15,312	0.0%	0.1%	66,103,015	68,623	0.1%	0.3%
Bigtooth aspen	27,209,765	1,811,596	6.7%	6.0%	85,696,388	491,217	0.6%	1.8%
Red maple	38,911,500	1,085,226	2.8%	3.6%	74,858,648	291,559	0.4%	1.1%
Green ash	18,856,812	71,935	0.4%	0.2%	72,077,600	81,397	0.1%	0.3%
Balsam poplar	20,105,818	123,236	0.6%	0.4%	41,048,909	1,130,843	2.8%	4.2%
Black spruce	20,965,969	747,842	3.6%	2.5%	24,562,021	--	--	--
Jack pine	20,451,699	102,885	0.5%	0.3%	54,578,630	1,976,648	3.6%	7.3%
White spruce	15,869,321	112,895	0.7%	0.4%	44,350,535	446,047	1.0%	1.7%
Northern pin oak	10,503,929	354,575	3.4%	1.2%	28,825,453	20,023	0.1%	0.1%
American elm	9,211,051	7,057	0.1%	0.0%	21,838,111	87,245	0.4%	0.3%
Other hardwoods	6,396,471	--	--	--	32,482,004	--	--	--
Total Current	**1,074,614,755**	**30,263,463**	**2.8%**	**100.0%**	**2,515,045,766**	**27,018,066**	**1.1%**	**100.0%**

Source: Forest Inventory Analysis estimate.

* The FIA database combines Tribal, Forest Industry, and Non-industrial Private as 'Private'. For some analysis these categories cannot be separated due to disclosure laws.

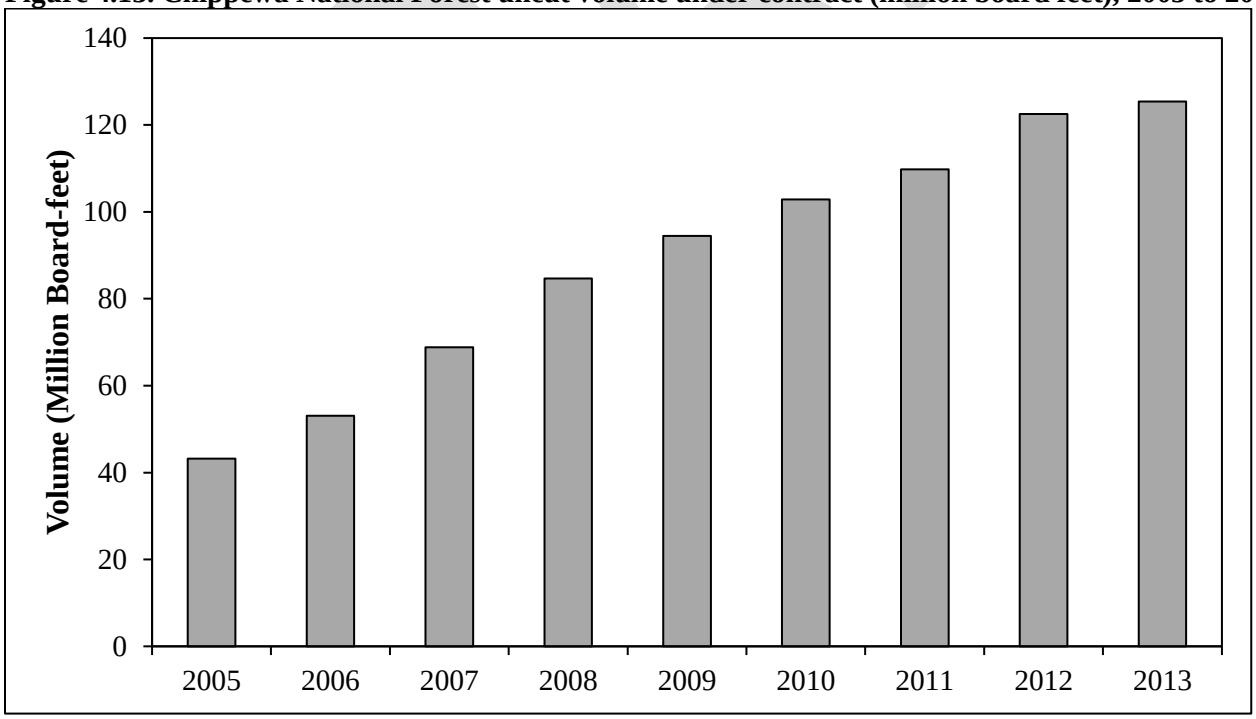
Note: There was an additional 2.3 million cubic feet (2.9% of total) of harvested volume for which the ownership information was not available

Figure 4.12. Chippewa National Forest annual harvest volume (million board-feet), 1992 to 2013.



Source: Compiled from USDA Forest Service, Chippewa National Forest Annual Monitoring and Evaluation Reports. Reports available at: www.fs.usda.gov/detail/chippewa/maps-pubs/?cid=fsm9_016537

Figure 4.13. Chippewa National Forest uncut volume under contract (million board feet), 2005 to 2013.



Source: Compiled from USDA Forest Service, Chippewa National Forest Annual Monitoring and Evaluation Reports. Reports available at: www.fs.usda.gov/detail/chippewa/maps-pubs/?cid=fsm9_016537

4.2.2. Woody biomass and non-timber forest products

The use of woody biomass as a feedstock for bioenergy has emerged as a prominent issue in the Lake States. In the D'Amato et al., 2009 study a total of 7,642 acres were reportedly sold specifically as biofuels harvests in 2008, with the majority of that acreage on state and county lands and to a lesser extent on industry and Native American ownerships (Table 4.11). This acreage is likely an underestimate of the total amount of sales involving biofuels, as this information is not recorded separately on timber sale documents for all agencies. Biofuels harvests focused primarily on logging residues, although roundwood, sub-merchantable trees, and hard snags were harvested for biofuels on 20, 72, and 17% of biofuel sales, respectively (Table 4.11). Although logging residues were largely collected from piles at landings, 21% of biofuels harvests involved a second entry into the stand to collect harvest residues.

A number of cottage industries are supported in rural communities throughout Minnesota on non-timber forest products (NTFP). The economic impact of this NTFP' can be substantial. For example, the Minnesota fir bough and wreath business exceeded $23 million in 2007 (Deckard and Skurla 2011). NTFPs include: decorative products such as fir boughs, decorative spruce tops, cones, birch bark, and vines; specialty wood products, e.g., woven baskets and burls; edible products such as maple syrup, nuts, and mushrooms; and medicinal and herbal products such as ginseng. Harvest numbers are difficult to estimate for many of these industries.

Table 4.11. Summary of biofuels harvests reported within Minnesota in 2008. Percentages represent proportion of harvests.

Survey Variable	State	County	Federal	Forest Industry	Native American	Total
Number of respondents	1	7	2	1	4	15
Total acres of biofuel harvests	5,467	1,675	0	300	200	7,642
Percent of biofuels removed on second entry	25%	58%	--	0%	0%	21%
Percent of biofuel harvests where roundwood was sold as biofuel	25%	36%	--	10%	10%	20%
Percent of biofuel harvests for which:						
Sub-merchantable materials were harvested	75%	65%	--	75%	--	72%
Hard snags were harvested	15%	2%	--	50%	0%	17%

Source: D'Amato et al., 2009.
Note: Harvest levels are likely an underestimate, as not all agencies recorded biofuels harvests separately from roundwood harvests.

4.2.2. Forest product exports and imports

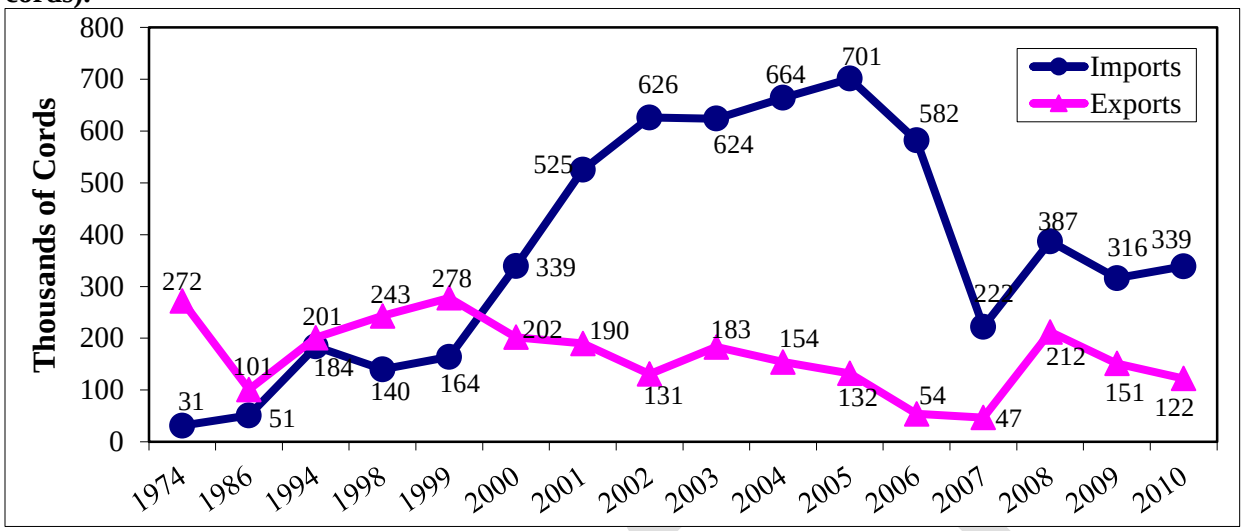
No good information is available on imports and exports on the county level for North Central Minnesota so the following section provides forest product import-export data on the state level.
Minnesota has been a net importer of pulpwood since 2000; peaking at 701,000 cords in 2005. (Figure 4.14). As mill demand and stumpage prices increased in the mid-2000's, mills increasingly looked outside of Minnesota's borders in order to meet their raw material needs, especially for aspen and maple. Imports in 2008 were largely from Wisconsin (303,600 cords), with fair amounts from Canada and Michigan. Minnesota pulpwood exports are mainly to Canadian and Wisconsin mills and ranged from 278,000 to 47,000 cords between 1974 and 2010. While Minnesota remains a net importer of timber, imports remain substantially less than 2005 levels. The change has been due to several factors, most notably reduced demand due to mill closures and slowdowns.

Sixty-two percent of the $47 million dollars of 'logs and other wood in the rough' transported in Minnesota has a final destination out of the state; most of this is sent to Wisconsin. Minnesota exports $15.3 million in raw forestry products to other countries. China is the state's number one trade partner, importing $5.1 million or 33% of all Minnesota raw forestry product exports to other countries (Figure 4.15).

Forty three percent ($2.8 billion) of the $6.6 billion of manufactured wood products shipments originating in Minnesota is utilized in-state and 57% ($3.8 billion) is shipped to other states. Primary U.S. markets for Minnesota manufactured wood products include: Wisconsin, Illinois, Michigan, Iowa, and North Dakota (Figure 4.16). Minnesota also exports $87.7 million worth of manufactured wood products to other countries. Canada is the state's number one trade partner in wood products, importing $57 million or 65% of all Minnesota wood products exports to other countries (Figure 4.17).

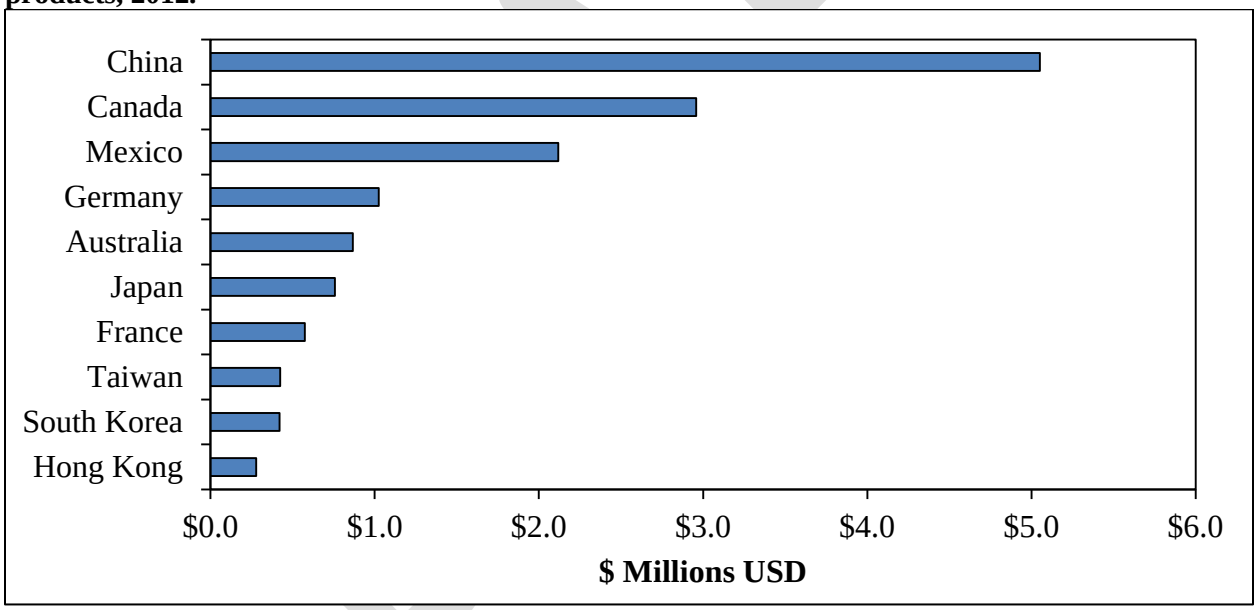
Approximately forty one percent of the $4.9 billion in pulp, paper, and paperboard shipments originating in Minnesota is utilized in-state and 59% is shipped to other states including Wisconsin, Illinois, Iowa, Indiana, and California (Figure 4.18). Minnesota exports $706 million in pulp, paper, and paperboard products to other countries. China and Canada are the state's top two trade partners in pulp, paper, and paperboard, importing about 22% and 18% respectively (Figure 4.19).

Figure 4.14. Minnesota imports and exports of roundwood pulpwood, 1974-2010 (Values thousands of cords).



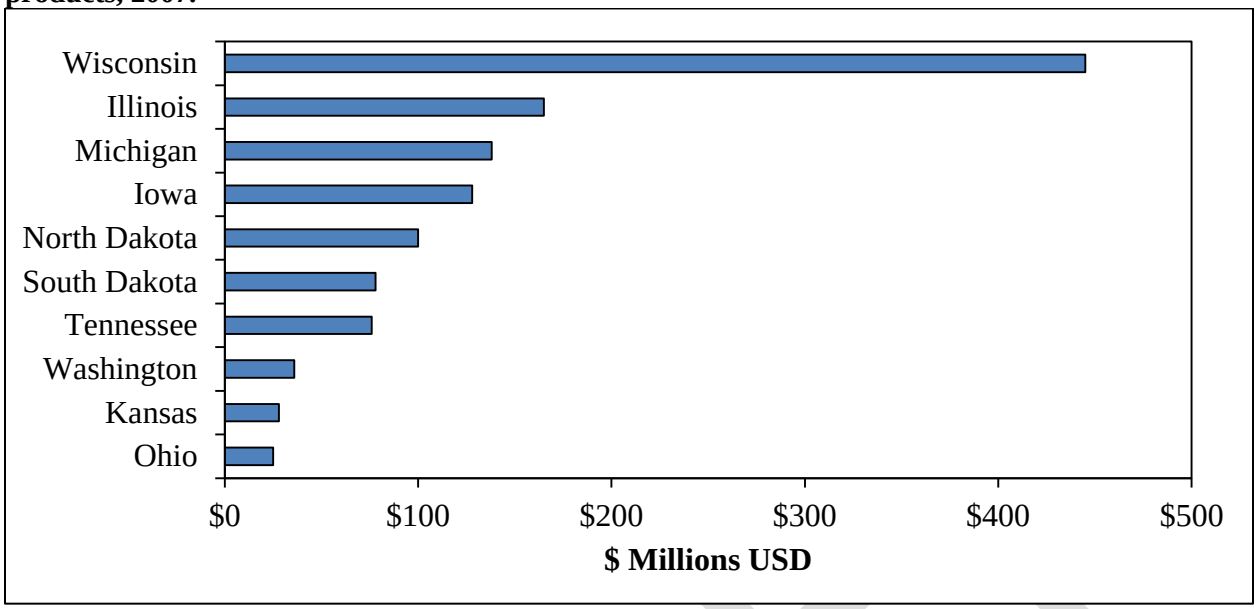
Source: US Forest Service Mill Surveys.

Figure 4.15. Minnesota forestry product exports (NAICS 113), top ten countries importing Minnesota products, 2012.



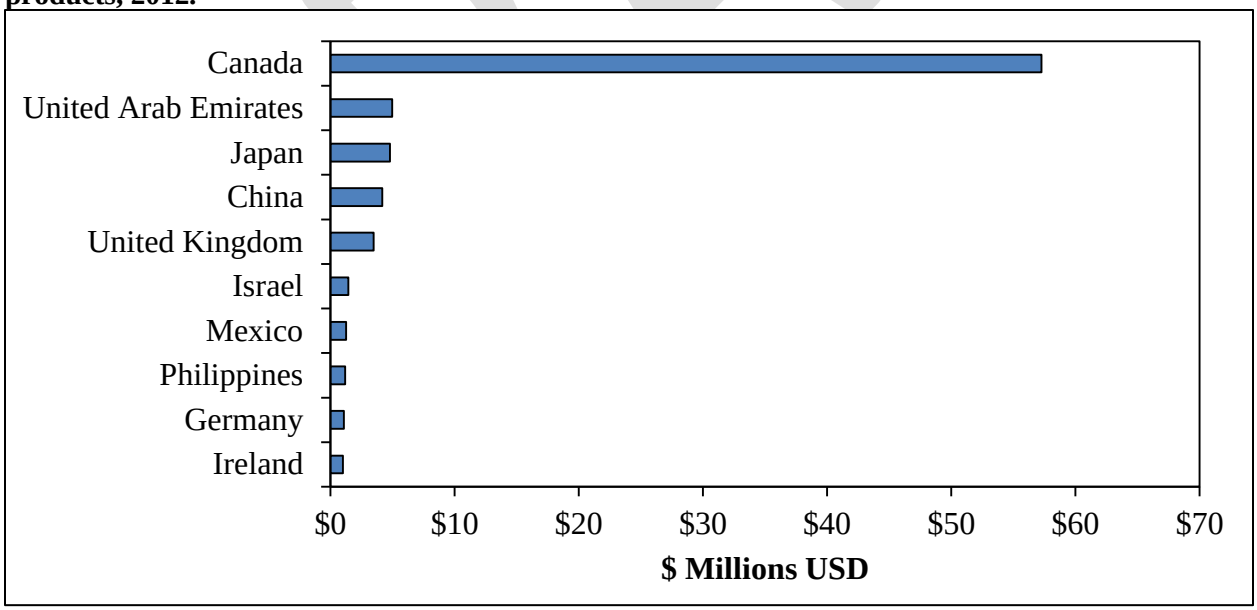
Source: Office of Trade and Industry Information, Manufacturing and Services, International Trade Administration, U.S. Department of Commerce. Trade Statistics Express Database.
Note: NAICS 113 "Forestry and Logging" is a non-manufactured goods sector which includes industries that grow and harvest timber on a long production cycle greater than 10 years and establishments gathering forest products, such as gums, barks, balsam needles, rhizomes, fibers Spanish moss, ginseng and truffles.

Figure 4.16. Minnesota 'Wood Products - SCTG Code # 26' exports, top ten states importing Minnesota products, 2007.



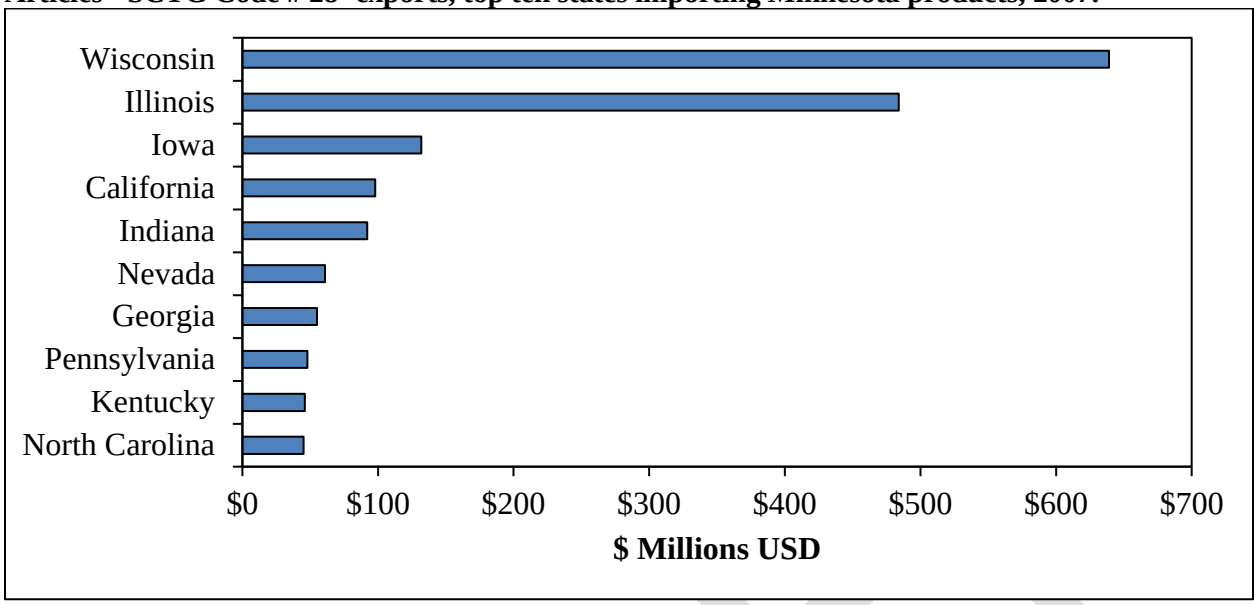
Source: U.S. Census Bureau, 2007 Commodity Flow Survey.
Note: Standard Classification of Transported Goods (SCTG) Code # 26 "Wood Products" includes: Wood chips or particles, lumber, plywood, veneer, laminated wood, shingles and shakes, particle board, fiberboard, windows, doors, frames and thresholds, wood packing containers, cable drums, pallets, skids, and cask and barrels, and other wood products, not elsewhere classified.

Figure 4.17. Minnesota wood product exports (NAICS 321), top ten countries importing Minnesota products, 2012.



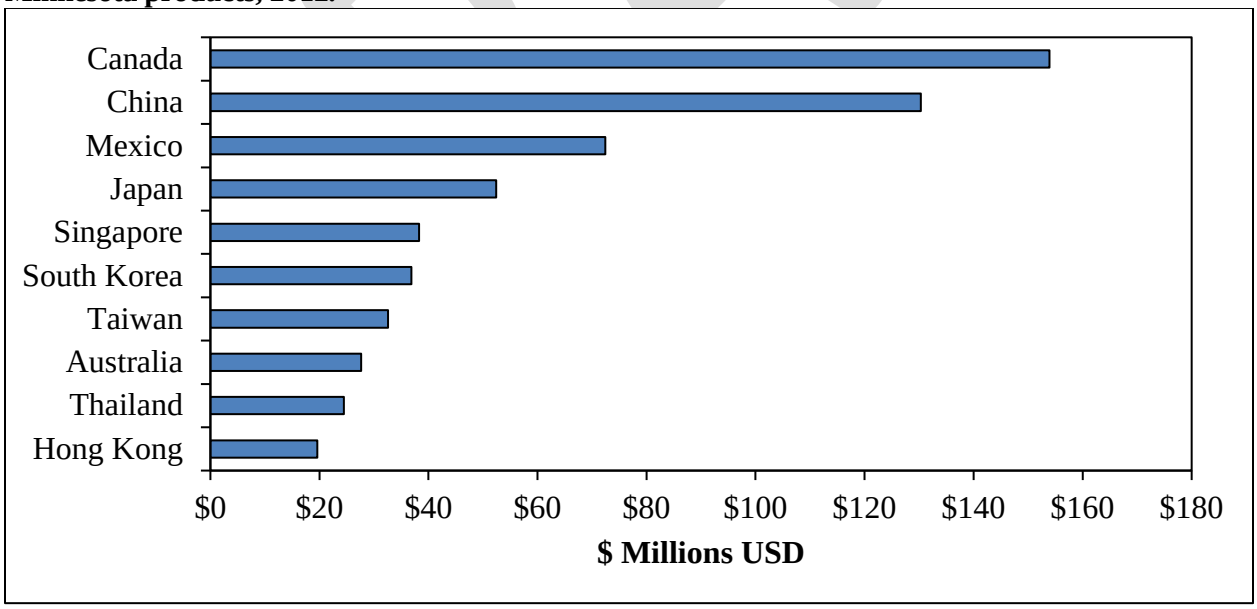
Source: Office of Trade and Industry Information, Manufacturing and Services, International Trade Administration, U.S. Department of Commerce. Trade Statistics Express Database.
Note: NAICS 321 "Wood Products" is a manufactured goods sector which includes industries that manufacture wood products, such as lumber, plywood, veneers, wood containers, wood flooring, wood trusses, manufactured homes (i.e., mobile homes), and prefabricated wood buildings.

Figure 4.18. Minnesota 'Pulp, Paper, and Paperboard - SCTG Code # 27' and 'Paper and Paperboard Articles - SCTG Code # 28' exports, top ten states importing Minnesota products, 2007.



Source: U.S. Census Bureau, 2007 Commodity Flow Survey.
Note: Standard Classification of Transported Goods (SCTG) Code # 27 "Pulp, Paper, and Paperboard" includes: Pulp of fibrous cellulosic materials and paper and paperboard in largerolls or sheets. SCTG Code # 28 "Paper and Paperboard Articles" includes other paper and paperboard articles. See the following website for a full definition: http://bhs.econ.census.gov/bhs/cfs/Commodity%20Code%20Manual%20(CFS-1200).pdf

Figure 4.19. Minnesota pulp, paper, and paperboard exports (NAICS 322), top ten countries importing Minnesota products, 2012.



Source: Office of Trade and Industry Information, Manufacturing and Services, International Trade Administration, U.S. Department of Commerce. Trade Statistics Express Database.
Note: NAICS 322 "Paper manufacturing" is a manufactured goods sector which make pulp, paper, or converted paper products.

4.2.4. Regional mills and consumption capacities

The larger forest product mills in the North Central Landscape, and those with procurement areas within the ten county area, reported consumption of over 2.5 million cords in 2015 (Table 4.12). Approximately 13% of this consumption came from nine large sawmills with annual production exceeding 3 million board feet. The sawmill sector is very important to forestry because it creates market diversity. The approximately 494,900 cords used annually statewide which is about 16% of the statewide timber harvest and provides value-added markets for various species, sizes, and qualities of timber; in addition to providing significant employment and economic benefits for many rural communities.

In 2013, there were 86 sawmills in the North Central Landscape (Table 4.13 and Figure 4.20). In Minnesota there are over 500 sawmills, but most are small, portable bandsaw mills that account for a tiny fraction of wood use. In contrast, the ten largest sawmills in Minnesota (by production volume) account for over 70 percent of the total, with one large softwood mill (Potlatch Corp.) accounting for about 40 percent of the total volume utilized by all sawmills. Eight of these ten sawmills with annual production exceeding 3 million board feet annually are located in Northern Minnesota and five are in the North Central Landscape

Table 4.12. Roundwood consumption capacities of mills in the North Central Landscape and those with procurement areas within the ten county area (Values are cords).

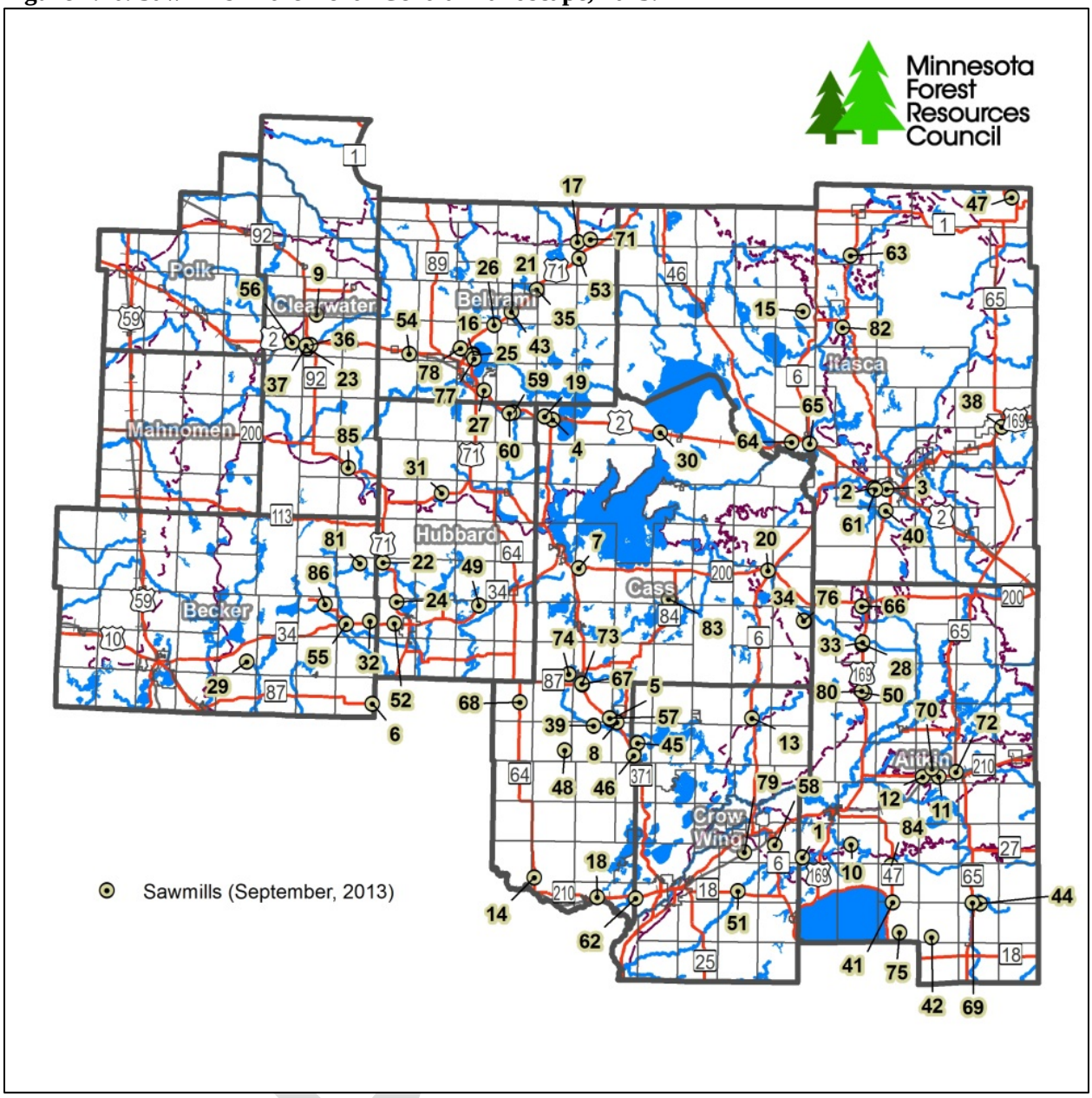
Pulp and Paper			
Firm	**Wood Used**	**Product**	**2015 Reported Consumption[1] (Cords)**
UPM - Blandin Paper Mill Grand Rapids	Aspen, Balsam Fir, Basswood, Spruce	Lightweight coated publication papers	196,505
Boise White Paper, LLC* International Falls	Aspen, Balm, Pine, Spruce, Balsam Fir, Birch, Tamarack, Maple	Office papers, label and release papers, base sheets, business and specialty printing grades	573,350
NewPage* Duluth	Balsam Fir, Spruce, small amount of Pine	Uncoated, lightweight supercalendered magazine and publication papers	137,162
SAPPI North America* Cloquet	Aspen, Maple, and minor amounts of birch and ash	Coated freesheet fine printing and publication paper, market pulp, specialized cellulose	848,174
Pulp and Paper – Recycling Mills			
Firm	**Wood Used**	**Product**	**2015 Reported Consumption[1] (Cords)**
Rock-Tenn Company* St. Paul	Recycled paper and corrugated	Cardboard and corrugated boxes	N/A
NewPage* Recycled Fiber Mill Duluth	Recycled High grade office paper and computer paper	Market pulp	N/A
Liberty Paper Company* Becker	Recycled paper and corrugated	Cardboard and corrugated boxes	N/A

Table 4.12. Continued.

Oriented Strand Board and Engineered Wood Products			
Firm	**Wood Used**	**Product**	**2015 Reported Consumption[1] (Cords)**
Louisiana-Pacific* Two Harbors	Aspen, Balm, Birch	OSB – engineered siding panel	113,683
Norbord Bemidji	Aspen, Balm, Birch, Maple	OSB	301,743
Hardboard and Specialty			
Firm	**Wood Used**	**Product**	**2015 Reported Consumption[1] (Cords)**
International Bildrite* International Falls	Aspen, Balm and recycled paper	Sheathing	12,289
Jarden Home Brands*	Aspen, Birch	Specialty wood products for food industry, matches, other	4,521
Sawmills (>3,00,000 board feet annual production)			
Firm	**Wood Used**	**Product**	**2015 Reported Consumption[1] (Cords)**
Cass Forest Products Cass Lake	Aspen, Jack Pine, Red Pine, White Pine	Cants, lumber	18,927
Hawkins Sawmill* Isle	Mixed Hardwoods	Cants, lumber	10,950
Hedstrom Lumber Co* Grand Marais	Aspen, Jack Pine, Red Pine, White Pine, White Spruce	Lumber	27,450

Source: Minnesota DNR Division of Forestry. 2015. "Minnesota's Forest Resources 2014".
Available: www.dnr.state.mn.us/forestry/um/index.html
[1]Minnesota Department of Labor and Industry; Reporting required under Minn. Stat. § 176.130, Targeted Industry Fund - Loggers.
Note: Data represents roundwood consumption only and does not include residual chips purchased from sawmills.
* Mill procurement area includes the ten North Central Landscape counties.

Figure 4.20. Sawmills in the North Central Landscape, 2013.



Source: Minnesota Department of Agriculture.

Table 4.13. Sawmills in the North Central Landscape, 2013.

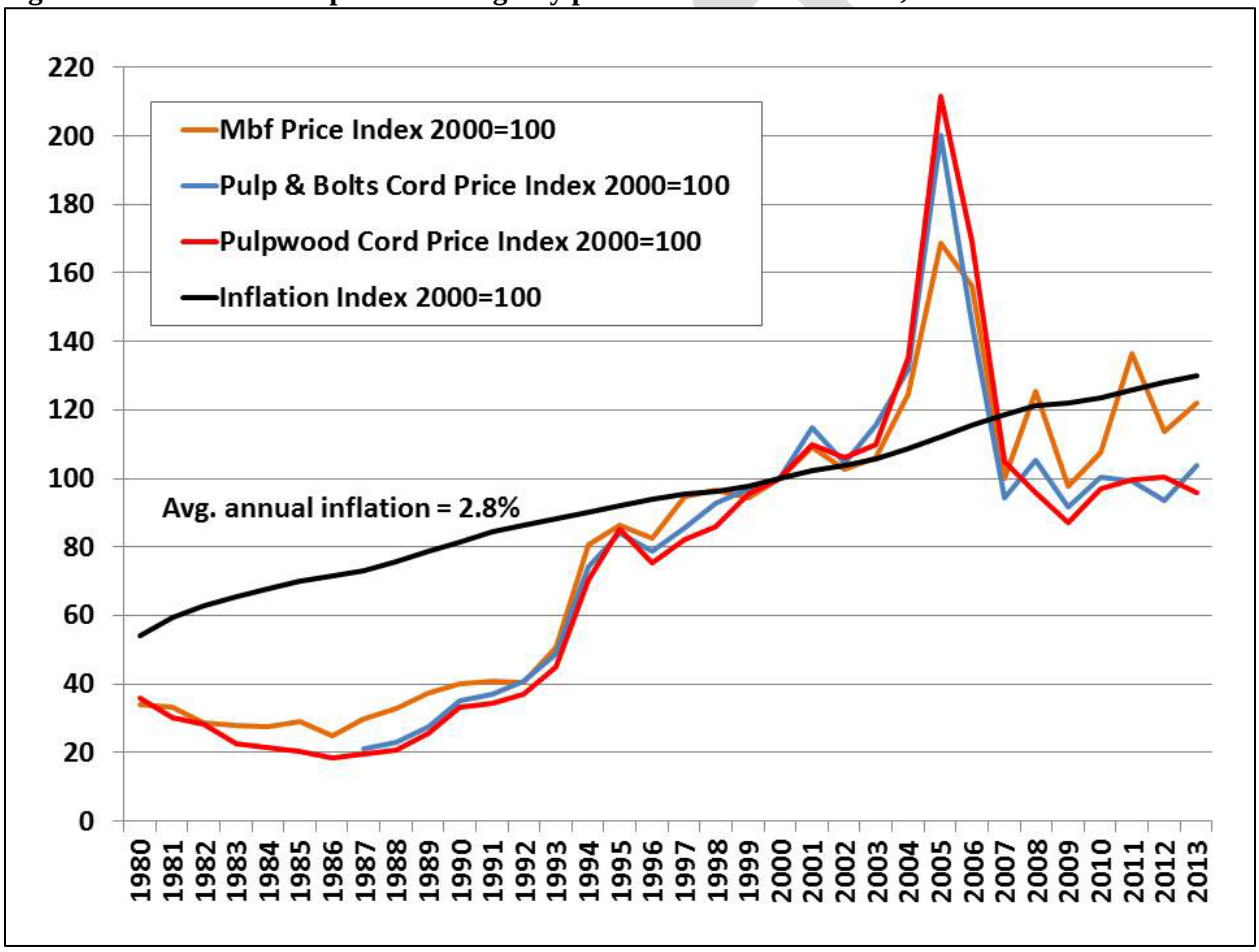
Map #	Name	City	Map #	Name	City
1	Bartel Logging And Lumber	Aitkin	44	Meb Custom Sawing	Mcgrath
2	Blandin Paper - Blandin West	Grand Rapids	45	Nagel Sawmill	Jenkins
3	Blandin Paper Co. - Pulp Logs	Grand Rapids	46	Nagel Sawmill & Logging	Pine River
4	Cass Forest Products	Cass Lake	47	Nelson Wood Products	Togo
5	Christensen Forest Prod Inc.	Pine River	48	Neumann - Lynn	Pine River
6	Clyde Schwartz Logging	Menagha	49	Nevis Lumber	Nevis
7	Country Sawmill	Walker	50	Nistler - Leroy	Waukenabo Area
8	Dabil Mill	Pine River	51	Nokasippi Logging & Lumber	Brainerd
9	Dahlke Sawmill	Clearbrook	52	North Star Lumber Inc.	Menahga
10	Dba Lumber	Aitkin	53	Northern Hardwood	Blackduck
11	Demenge Sawmill	Mcgregor	54	Northwood Panelboard Co.	Solway
12	Demenge Sawmill - Woodyard	Mcgregor	55	Osage Lumber & Milling	Osage
13	Emily Forest Products	Emily	56	Pallet Minnesota Inc.	Bagley
14	Enberg Logging	May Twp #	57	Pine River Lumber Co.	Pine River
15	Etter Lumber & Timber	Talmoon	58	Portage Lake Wood Processing	Deerwood
16	Fox Lake Log Creations	Bemidji	59	Potlatch - Osb Bemidji	Bemidji
17	Frenzel Mill	Blackduck	60	Potlatch - Wood Products	Bemidji
18	Frisbee (Frank) Mill	Pillager	61	Potlatch Corp. - Grand Rapids	Grand Rapids
19	Gehrke Mill	Cass Lake	62	Potlatch Wood Concentration Yard	Baxter
20	Hi Tech Milling Inc.	Remer	63	Rajala Mill Co. - Bigfork	Bigfork
21	Highland Timber	Bemidji	64	Rajala Timber Co. - Deer River	Deer River
22	Highway 71 Sawmill Co.	Park Rapids	65	Rajala Veneer Co.	Deer River
23	Hillside Lumber Inc.	Bagley	66	Rassier Lumber	Hill City
24	Hooker (Melvin) ┬Álog & Lumber	Park Rapids	67	Red Pine Log Homes Inc.	Backus
25	Hurd Sawmill	Bemidji	68	Richards Brothers Inc.	Backus
26	Hwy 71 Woodyard	Pending	69	Robinson Lumber & Treating	Mcgrath
27	International Paper Woodyard	Bemidji	70	Rock Lake Mill	Mcgregor
28	Jewett Woodyard	Haypoint Area	71	Rockensock Lumber	Blackduck
29	John's Mill	Frazee	72	Savanna Pallets	Mcgregor
30	Johnson Lumber Co.	Bena	73	Sawyer Timber Company	Backus
31	Kahlstorf Lumber Co. Inc.	Lake George	74	Schmidtke - Mark	Backus
32	Kimball's Sawmill & Logging	Park Rapids	75	Simonson David	Isle
33	Kromy Ted - Woodyard	Grand Rapids	76	Smokey Hollow Enterprises	Swatara
34	Lakeside Sawmill	Swatara	77	Steamboat Sawmill	Bemidji
35	Land O' Lakes Wood Presv Co.	Tenstrike	78	Summit Sawmill	Bemidji
36	Larson Lumber	Bagley	79	Trus Joist Macmillan	Deerwood
37	Larson Lumber	Littlefork	80	Tviet Logging And Lumber	Palisade
38	Latvala Sawmill	Nashwauk	81	Two Inlets Mill	Park Rapids
39	Liane (Paul) Mill	Pine River	82	Valley Forest Resources	Marcell
40	Liila Forest Products	Grand Rapids	83	Weaver Lumber Co.	Longville
41	Malmo Logging & Lumber Co.	Isle	84	Westerlunds Sawmill	Aitkin
42	Maple Wood Resources	Mcgrath	85	Wildwood Lumber	Shevlin
43	Mason Bros. Sawmill	Bemidji	86	Wilson Wood Products	Ponsford

4.2.5. Stumpage prices

Across the state there was a general rise in stumpage prices received by public agencies peaking in 2005 and then a decline following mill closures and the economic downturn (Figure 4.21). Using the Implicit Price Deflator for Gross Domestic Product (GDP) as baseline inflation (base year 2000 = 100), the all-agencies all-species pulpwood composite price index decreased by 4.4% while the pulp and bolts and MBF composite price indices increased by 11.1% and 7.2% respectively from 2012 to 2013.

Prices received by public agencies in the North Central Landscape tend to be similar or slightly below the statewide average (Table 4.14). Prices among agencies varied widely, with orders of magnitude of difference between price highs and lows for a given product. County Land Departments generally received a higher price than the Chippewa National Forest for pulps & bolts and pulpwood, but lower for sawlogs.

Figure 4.21. Inflation and public land agency price indices in Minnesota, 1980-2013.



Source: 2013 Public Stumpage Price Review and Price Indices, MN DNR Division of Forestry. www.dnr.state.mn.us/forestry/timbersales/stumpage.html
Note: Implicit Price Deflator for Gross Domestic Product (GDP) was used as the baseline for inflation (base year 2000 = 100)

Table 4.14. Stumpage prices received by County Land Departments and the Chippewa National Forest in the North Central Landscape, 2013.

	Sawlogs			Pulp & Bolts (Mixed Products)[1]			Pulpwood			Biomass[2]		Fuelwood[3]	
	Total MBF	Total Value ($)	Avg $ / MBF	Total Cords	Total Value ($)	$/Cd	Total Cords	Total Value ($)	Avg $ / Cd	Total Tons	Total Value ($)	Total Cords	Total Value ($)
County Land Departments													
Aitkin	2,043	106,710	52.23	9,021	149,202	16.54	32,592	669,492	20.54	--	--	1,003	6,753
Becker	--	--	--	2,993	56,727	18.95	10,419	289,747	27.81	12	120	--	--
Beltrami	211	40,622	192.52	14,354	559,514	38.98	22,256	542,968	24.4	440	880	--	--
Cass*	305	34,060	111.64	31,065	594,723	19.14	47,930	814,870	17.00	490	1,225	--	--
Clearwater	137	14,801	107.72	1,814	37,380	20.61	19,132	369,640	19.32	180	540	--	--
Crow Wing	180	17,718	98.22	1,290	39,131	30.33	27,287	463,795	17.00	3	30	2,926	2,926
Hubbard	1,216	139,530	114.75	17,460	543,867	31.15	57,351	1,369,309	23.88	1,840	9,840	1,110	1,110
Itasca	5,698	560,776	98.42	22,442	504,582	22.48	70,816	1,545,864	21.83	8	64	6,107	6,107
National Forest													
Chippewa	6,490	951,655	146.63	2,543	35,772	14.07	83,098	1,388,999	16.72	1,109	4,485	4,014	1,337
County and NF Total	**16,281**	**1,865,872**	**114.61**	**102,982**	**2,520,898**	**24.48**	**370,880**	**7,454,684**	**20.10**	**4,082**	**17,184**	**15,160**	**18,233**
Reporting Public Agencies Statewide	**23,029**		**$130.39**	**272,503**		**$26.82**	**1,363,001**		**$20.12**	**17,116**	**$2.40**	**92,366**	**$1.03**

Source: 2013 Public Stumpage Price Review and Price Indices, MN DNR Division of Forestry. www.dnr.state.mn.us/forestry/timbersales/stumpage.html

[1] Include volume and value of miscellaneous products such as poles and piling not included elsewhere.

[2] Include logging residues, bark, cull, and other biomass wood sold by species under a commercial contract or permit (report in green tons).

[3] Include wood sold by species as fuelwood (firewood) under commercial and noncommercial contract or permit.

4.2.6. Logging operators

Logging businesses are a crucial component in the wood supply chain. Although no regional data is available on the status of these businesses in the North Central Landscape; Minnesota Forest Industries, Minnesota Logger Education Program, University of Minnesota Department of Forest Resources, University of Minnesota Extension, and the Minnesota Agricultural Experiment Station conducted a study regarding 2011 logging operations across the state (C. Blinn, T. O'Hara, D. Chura, and M. Russell – Status of the Minnesota Logging Sector in 2011 – in development). The objectives of this study were to (1) to update the understanding of Minnesota's logging sector as of 2011, (2) to compare those results to previous surveys where appropriate in Minnesota, Wisconsin, and Michigan, and (3) gain insight into what the current status of the logging industry and markets in Minnesota may mean for the future.

This data is based on surveys sent to 427 individuals who were listed in the Minnesota Logger Education Program (MLEP) database. Of the original 427 surveys, 226 (51%) were completed by firms producing 100 cords or more in 2011 and were used in data analysis. Approximately 26% of the respondents' logging businesses were located (although not necessarily where the timber was harvested) within the North Central Landscape (58% were located in the DNR's NE Region). Statewide, respondents reported a total of 1,605.5 full- or part-time employees and subcontractors of which 57.1% are full-time employees, 22.0% are part-time employees and 20.9% are subcontractors (Table 4.15). The total combined number of employees and subcontractors for the 216 responding firms ranged from 1 to 62 with a median of 5 and an average of 7.43 (Figure 4.22). The average logging business had been in operation for 28.1 years (median 29) in 2011 and approximately 70% of the responding businesses had been in operation for more than 20 years (Figure 4.23). Eighty two percent of the 2011 volume was harvested using conventional equipment, 16% by cut-to-length and 2% by chainsaw.

Survey respondents produced approximately 69-77% of the estimated 2011 statewide harvest and showed considerable range in production from 100 to 138,393 cords (mean 9,518; median 4,000) in 2011 (Table 4.16). Only 26% of the respondents produced 10,000 cords or more but they were responsible for 75.6% of the total volume harvested (Table 4.16). Similar to the agriculture industry, the percentage of larger business has increased over time. On average, 4.64 gallons of fuel were required to harvest and deliver each cord of wood produced.

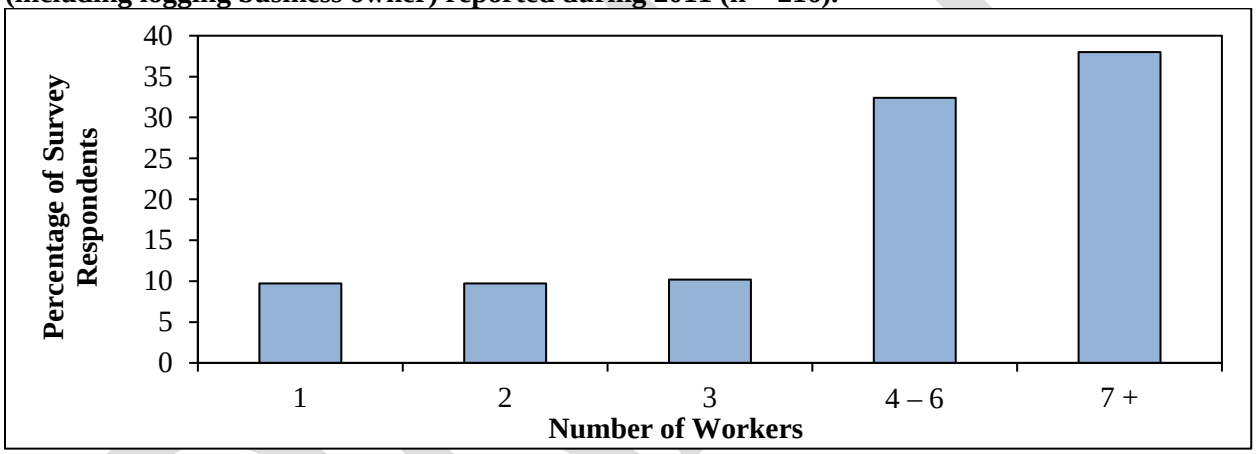
Additional information on types of harvesting, season of harvest, harvesting equipment, and stumpage source can be found in *"Status of the Minnesota Logging Sector in 2011"*; 2014; C. Blinn, T. O'Hara, D. Chura, and M. Russell - University of Minnesota, Department of Forest Resources.

Table 4.15. Summary of number of full- and part-time workers and subcontractors employed by responding logging business owners during 2011 (n=216). The number of respondents for each type of worker is noted in parentheses.

Type of worker	Employees Full-Time	Employees Part-time	Subcontractor	Total number of workers
Woods worker	484 (161)	155 (80)	63.5 (36)	702.5
Truck driver	250.5 (99)	98.5 (50)	236.5 (94)	585.5
Procurement/Forester/Landowner Assistance	25 (22)	9 (9)	9 (9)	43
Mechanic	47.5 (32)	39 (29)	21 (14)	107.5
Office/clerical	56.5 (44)	37 (35)	6 (6)	99.5
Supervisor/manager	53.5(48)	14 (13)	0 (0)	67.5
Total	**917**	**352.5**	**336**	**1605.5**

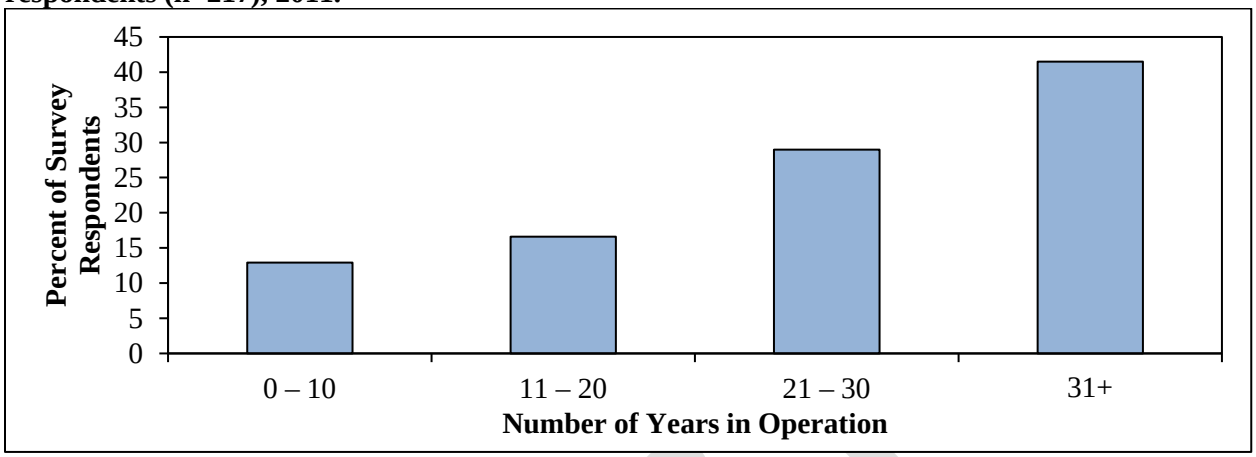
Source: C. Blinn, T. O'Hara, D. Chura, and M. Russell – Status of the Minnesota Logging Sector in 2011.

Figure 4.22. Summary of total number of workers from the statewide survey of logger operators (including logging business owner) reported during 2011 (n = 216).



Source: C. Blinn, T. O'Hara, D. Chura, and M. Russell – Status of the Minnesota Logging Sector in 2011.

Figure 4.23. Statewide summary of years in operation by the percent of logging business respondents (n=217), 2011.



Source: C. Blinn, T. O'Hara, D. Chura, and M. Russell – Status of the Minnesota Logging Sector in 2011.

Table 4.16. Statewide cords harvested by survey respondents (n = 209), 2011.

Volume harvested (cords)	Number of respondents	% of respondents	% of total volume
< 1,000	55	26.3	1.5
1,001 – 2,500	27	12.9	2.6
2,501 – 5,000	40	19.1	7.6
5,001 – 10,000	32	15.3	12.6
10, 001 – 15,000	17	8.1	11.1
15,001 – 20,000	8	3.8	7.6
20,001 – 30,000	20	9.6	24.3
30,001 – 40,000	4	1.9	6.7
40,001 – 50,000	1	0.5	2.3
> 50,000	5	2.4	23.6

Source: C. Blinn, T. O'Hara, D. Chura, and M. Russell – Status of the Minnesota Logging Sector in 2011.
Note: Percentages may not total 100 due to rounding error.

4.3. Recreation and tourism

Outdoor recreation and tourism is a significant portion of the North Central Landscape's economic base. Travelers come to experience the woods and waters of North Central Minnesota which provide multi-season opportunities for a variety of outdoor activities amid beautiful scenery. Tourism is a substantial and growing component of the regional economy with $640 million in gross sales and providing jobs for over 13,000 people.

The following section outlines the regional recreation and tourism resources and their economic impact.

4.3.1. Regional Attractions

According to Explore Minnesota, Itasca State Park was the most popular tourism attraction in the North Central Landscape and the 15th ranked attraction in the state (of attractions that monitored and reported attendance to Explore Minnesota in 2010), with 550,599 visitors. Other popular attractions included Lake Bemidji State Park (151,678), Brainerd International Raceway (144,957), and Cayuna County State Recreation Area (118,484). These rankings include both local visitors and tourists and can be found under "Top Minnesota Attractions by Region, 2010." at www.exploreminnesota.com

4.3.2. Resident Recreational Preferences

Data on recreation activity preferences of North Central Landscape residents is not specifically available for the 10-county region however the University of Minnesota Center for Changing Landscapes has developed reports for the broader 9-county DNR Northeast Region (contains: Aitkin, Crow Wing, and Itasca) and the 24-county DNR Northwest Region (contains: Becker, Beltrami, Cass, Clearwater, Hubbard, Mahnomen, and Polk) as defined in the 2004 Outdoor Recreation Participation Survey of Minnesotans. According to this 2004 study, the recreation activities Northeast and Northwest Region residents most frequently participate in are walking or hiking, boating, swimming and driving for pleasure, which parallel state-wide participation figures (Table 4.17). Northeast Region residents participate in gathering mushrooms, berries or other wild foods, ATV driving, and snowmobiling to a greater extent than state residents overall and are less likely to participate in biking, golfing, walking/hiking, or running and jogging. Northwest Region residents participate in hunting, ATV driving, and snowmobiling to a greater extent than state residents overall and are less likely to participate in biking, running or jogging, or ice skating/hockey outdoors.

A study specific to Itasca County residents found residents there most frequently participated in fishing, hunting and camping (Itasca County 2002, Table 4.18).

Table 4.17. Recreation Activity Participation in the Northeast and Northwest DNR Regions (Including but not limited to Counties in the North Central Landscape)

Activity	Participation (%)		
	Northeast	Northwest	Statewide
Walking/hiking	49	48	54
Boating of all types, including fishing from a boat	42	43	43
Swimming or wading (all places)	38	37	41
Driving for pleasure on scenic roads or in a park	37	40	37
Picnicking	36	34	36
Fishing of all types	34	35	30
Biking (bicycling of all types, including mountain biking)	20	19	29
Camping of all types	32	30	26
Visiting nature centers	21	19	25
Nature observation of all types (e.g., viewing, identifying)	24	20	24
Golfing	17	19	24
Outdoor field sports (e.g., soccer, softball/baseball, football)	20	21	21
Visiting historic or archaeological sites	19	17	21
Sledding and snow tubing	16	15	18
Outdoor court sports (e.g., volleyball, basketball, tennis)	13	15	18
Hunting of all types	23	23	16
Running or jogging	9	6	14
Ice skating/hockey outdoors	8	5	12
Inline skating, rollerblading, roller skating, roller skiing	5	6	11
Off-road ATV driving	19	17	10
Snowmobiling	18	16	10
Downhill skiing/snowboarding	5	3	9
Gather mushrooms, berries, or other wild foods	19	11	9
Cross country skiing	6	4	7
Horseback riding	4	3	5
Snowshoeing	8	2	4

Notes: Data based on population 20 years of age and older. The Northeast and Northwest Regions follow the Minnesota DNR regional boundaries and split through the MFRC North Central Landscape. The North Central Landscape counties in each DNR Region are identified in the text above. It should be noted that Minnesota citizens in the North Central Landscape may value different recreation activities than those in the larger regions.
Source: Kelly, T. (2005). 2004 Outdoor Recreation Participation Survey of Minnesotans: Report on Findings. Saint Paul, MN: Minnesota Department of Natural Resources, Office of Management and Budget Services. In Davenport, M, I. Schneider, A. Date, and L. Filter. 2010. Minnesota's Network of Parks and Trails, An Inventory of Recreation Experience Opportunities in Minnesota: Northeast and Northwest Region Profiles. University of Minnesota, College of Design. Available online at: http://ccl.design.umn.edu/mnpat.html

Table 4.18. Outdoor Activity Participation of Itasca County Residents, 2002.

Activity	% of Respondents	Frequency (n=195)
Fishing	17.9	35
Hunting	9.2	18
Camping	8.7	17
Bicycle riding	8.2	16
ATV riding	7.7	15
Snowmobile riding	6.2	12
Motor-boating	6.2	12
Walking	5.1	10
Cross country skiing	5.1	10
Hiking	5.1	10
Outdoor athletics/sports	5.1	10
Golfing	3.6	7
Parks/playgrounds	3.6	7
Picnicking	2.1	4
Canoeing	1.5	3
Horseback riding	1	2
Auto touring	1	2
Swimming	1	2
Kayaking	0.5	1
Jet-skiing	0.5	1
Wildlife viewing	0.5	1

Source: Itasca County recreation resources plan: 2002-2012 Update (2002). In Davenport, M, I. Schneider, A. Date, and L. Filter. 2010. Minnesota's Network of Parks and Trails, An Inventory of Recreation Experience Opportunities in Minnesota: Northeast and Northwest Region Profiles. University of Minnesota, College of Design. Available online at: http://ccl.design.umn.edu/mnpat.html

4.3.3. Trails

North Central Minnesota has an extensive and diverse trail network that create a major tourism draw to the region during all seasons. There are numerous trails managed by other organizations throughout the North Central Landscape, but the two main trail management agencies in the region are the US Forest Service and the Minnesota DNR.

The US Forest service maintains trails within the Chippewa National Forest for a wide range of uses, the most common being hiking (Table 4.19). Conversely, snowmobile trails are the most common type of MN DNR recreational trail in both Minnesota and the North Central Landscape (Table 4.20). All-terrain vehicle trails and off-highway motorcycle trails are also common MN DNR trail types, comprising over 41% of statewide ATV trails and 38% of the statewide off-highway motorcycle trail miles.

Table 4.19. Length of US Forest Service recreational trails in the Chippewa National Forest.

Trail Type	Miles
Snowmobile	285.0
Bicycle (includes mountain bike)	44.4
Hiking	331.0
Portage	3.3
Cross-country ski	61.6
All-Terrain Vehicle (ATV) trails (category includes both Class 1 and Class 2 ATVs	70.5
Horse Trails	29.4
Total	**825.2**

Source: US Forest Service, Chippewa National Forest.
Note: Miles are by opportunity; therefore, some trails are open for more than one type of use. For instance, some hiking trails are also cross country ski trails.

Table 4.20. Length of MN DNR recreational trails in Minnesota and North Central Landscape.

Trail Type	Minnesota (miles)	North Central (miles)	% of State miles
Snowmobile[1]	22,387	4,351	19.4%
Bicycle[2]	730	208	28.5%
Mountain Bike[2]	1,146	297	25.9%
Hiking[2]	2,455	463	18.9%
Winter Hiking[2]	142	0	0.0%
Horse[2]	1,059	95	9.0%
Cross-country ski[2]	992	111	11.2%
All-Terrain Vehicle (ATV) trails (category includes both Class 1 and Class 2 ATVs[2]	1,972	819	41.5%
Off-Highway Motorcycle (OHM) trails[2]	1,351	513	38.0%
Off-Road Vehicle (ORV) trails[2]	463	50	10.8%
Total	**32,697**	**6,907**	**21.1%**

Source: MN DNR Division of Parks and Trails (queried on 7/29/2014 by Sonia Dickerson, MNIT). Represents trails that DNR PAT oversees as reported by the authoritative Divisional GIS data sources ([1]Snowmobile GDRS layer and [2]WHEELS Trail Use layer).
Note: The mileage value for each trail use was calculated from the subset of trail features that met the conditions of the associated query; therefore each use category is NOT mutually exclusive, since many trails permit more than one use. Therefore, some dual use trail miles may be counted twice. Motorized Off-Highway Vehicle categories included here correspond to those defined in the DNR Off-Highway Vehicle Regulations 2012-2013 (http://files.dnr.state.mn.us/rlp/regulations/ohv/ohv_regs.pdf).

4.3.4. Public parks, campgrounds, and recreation areas

The North Central Landscape is a very popular destination for camping and sightseeing. This region contains eight Minnesota State Parks and two State Recreation Areas. These include: McCarthy Beach, Scenic, Crow Wing, Schoolcraft, Savanna Portage, Itasca, Hill-Annex Mine, and Lake Bemidji State Parks and the Cuyuna Country and La Salle Lake State Recreation Areas.

These parks contain 759 campsites and see and annual visitation in excess of 1.1 million (Table 4.21). State park campsites are open all year; however, full services are generally only provided mid-May through mid-October and use of campsites is highest during this full-service season. These eight State Parks and two State Recreation Areas brought in over $2.57 million in total sales including over $1.92 million through camping fees and and lodging in 2013 (Table 4.22). These figures only count the State Park Stickers sold at the park itself. Many of the State Park Stickers used to enter these parks were likely purchased elsewhere, therefore the actual use of these parks is likely much greater than represented in permit sales.

The North Central Landscape also contains all of the Chippewa National Forest. This national forest estimated roughly 768,000 site visits in 2011 which was down from the estimated 1,281,000 million visits in 2006 (Table 4.23). This decrease in visitation may have resulted from the recent economic downturn, yet the percent of travelers coming from greater than 100 miles increased from 37.4% to 45.3% between 2006 and 2011 (Table 4.24).

The Chippewa National Forest has 21 developed campgrounds with 659 sites. Maximum occupancy of individual sites is 8 but average use is 4.5 people. The campground season is typically runs from mid-May to mid-September and the average monthly occupancy is 24%. These campgrounds generated $385,398.77 in the 2015 fiscal year (Christine Brown – Chippewa National Forest Lands & Recreation Program Manager, personal communication, January 26, 2016).

In addition to the camping areas listed here there are a number of private campgrounds and campsites managed by other organizations. One of these is the famed North Country Trail which passes through the North Central Landscape and provides backcountry campsites with no fees, reservations, or permits required.

Table 4.21. State park capacity, use, and receipts in the North Central Landscape, 2013.

Camping capacity	
Drive-in sites [1]	712
Other sites [1]	47
Cabins (number – capacity) [1]	54 total (13: 4-person, 2: 6-person, 7: 8-person, 6: camper cabins, 2: guest houses, 1: club house, 8: rooms, 15: suites)
Use of parks	
A. Total visitors (No data for La Salle Lake*) [2]	1,100,228
B. Overnight visitors (Includes La Salle Lake*) [2]	186,629
C. Campsites occupied [1]	43,430
D. Lodge units (includes camper cabins) occupied [1]	6,871
State park receipts	
Daily vehicle permits [3]	$239,919.00
Annual vehicle permits [3]	$404,420.00
Camping permits [4]	$1,050,020.00
Lodging/cabins [4]	$ 878,871.78
Total	**$2,573,230.78**

[1] Source: Compiled from the Business Intelligence Reporting Service by Megan Klotz, MN DNR. Business Intelligence Report provided count of occupied nights at the selected parks for the 2013 camping season.
[2] Source: Compiled from PAT Attendance Database by Dave Lonetti, PAT IS Team.
[3] Source: Permit data was compiled using Recreation Dynamics Headquarters Manager Permit Pacing Report by Megan Klotz, MN DNR.
[4] Source: Camping permit/fee data compiled using an export of all reservations from the PAT Database which included fees paid per reservation (not including reservation or lodging fees) by Megan Klotz, MN DNR.
* Only overnight, and not total, visitation was collected for La Salle SRA in 2013; therefore, due to absence of total visitation data for La Salle Lake, A does not include any visitor data from La Salle Lake, even the overnight visitors that we know were there, while B above does include La Salle Lake overnight visitor data.

Table 4.22. State park camping receipts in the North Central Landscape, 2013.

Park Name	Total Visitors	Overnight Visitors	% of Visitors Staying Overnight	Total Camping / Lodging Revenue	% of Regional Camping / Lodging Revenue
Cuyuna Country State Recreation Area	179,829	4,874	2.7%	$ 2,600.00	0.1%
La Salle Lake State Recreation Area	N/A	3,422	--	$ 54,144.35	2.8%
McCarthy Beach State Park	104,687	17,030	16.3%	$ 103,213.00	5.4%
Scenic State Park	59,305	15,112	25.5%	$ 109,539.29	5.7%
Crow Wing State Park	49,088	9,207	18.8%	$ 62,406.00	3.2%
Schoolcraft State Park	3,711	330	8.9%	$ 2,744.00	0.1%
Savanna Portage State Park	46,676	11,579	24.8%	$ 99,851.88	5.2%
Itasca State Park	506,262	103,520	20.4%	$ 1,306,089.26	67.7%
Hill-Annex Mine State Park	3,507	0	N/A	$ 0.00	0.0%
Lake Bemidji State Park	147,163	21,555	14.6%	$ 188,304.00	9.8%
Total	**1,100,228**	**186,629**	**17.0%**	**$1,928,891.78**	**100%**

Source: Minnesota DNR Division of Parks and Trails, Recreation Dynamics Headquarters Manager (Collected by Dave Lonetti and Megan Klotz, PAT IS Team on 7/29/14).
* Total visitors were not collected at La Salle Lake State Recreation Area (and therefore this cell contains no data), but total visitors for La Salle would presumably be higher than 3,422 (overnight visitors).
Note: No camping facilities exist at Hill-Annex Mine SPK.

Table 4.23. Annual visitation estimate for the Chippewa National Forest, 2006 and 2011.

Visit Type	2006 Visits	2011 Visits
Day use developed site visits	71,000	104,000
Overnight use developed site visits	47,000	41,000
General forest area visits	1,163,000	623,000
Total estimated site visits	**1,281,000**	**768,000**

Source: Chippewa National Forest, 2006 and 2011 Visitor Use Reports.
Note: A 'Site Visit' is the entry of one person onto a National Forest site or area to participate in recreation activities for an unspecified period of time.

Table 4.24. Percent of Chippewa National Forest visits by distance traveled, 2006 and 2011.

Miles from survey respondent's home to interview location	2006	2011
0 - 25	36.6	33.4
26 - 50	15.4	15.5
51 - 75	4.9	3.0
76 - 100	5.7	2.8
101 - 200	17.1	21.5
201 - 500	18.2	19.6
Over 500	2.1	4.2

Source: Chippewa National Forest, 2006 and 2011 Visitor Use Reports.
Note: National Forest visits are defined as the entry of one person upon a national forest to participate in recreation activities for an unspecified period of time. Travel distances were self-reported.

4.3.5. Hunting, fishing, and harvesting

Hunting, fishing, and harvesting are important social and economic components for residents and visitors of the North Central Landscape. The economic impact of the activities is difficult to track but license sales can give a general picture of use in the region. Caution should be taken when interpreting these data because it is recorded based on location of purchase and not location of use but16.6% of the total statewide hunting, fishing, and harvesting license sale transactions occurred in the North Central Landscape worth a total of $10.8 million (Table 4.25).

Table 4.25. State hunting, fishing, and harvesting licenses, 2013.

County	Residency	Total # of Transactions	Agent Fee ($)	State Fee ($)	Total Fee ($)
Aitkin	Non Resident	3,221	3,046	122,881	125,927
	Resident	26,865	21,601	574,400	596,001
	Combined	30,086	24,647	697,281	721,928
Becker	Non Resident	7,688	7,313	313,786	321,099
	Resident	30,955	23,172	608,631	631,803
	Combined	38,643	30,485	922,416	952,901
Beltrami	Non Resident	8,014	7,513	319,754	327,267
	Resident	45,795	32,320	883,841	916,161
	Combined	53,809	39,833	1,203,594	1,243,427
Cass	Non Resident	19,197	18,433	738,353	756,786
	Resident	40,308	31,367	844,589	875,956
	Combined	59,505	49,800	1,582,941	1,632,741
Clearwater	Non Resident	721	659	29,916	30,575
	Resident	6,018	4,788	119,828	124,616
	Combined	6,739	5,447	149,745	155,192
Crow Wing	Non Resident	15,289	14,711	539,308	554,019
	Resident	93,078	73,532	1,959,004	2,032,536
	Combined	108,367	88,243	2,498,312	2,586,555
Hubbard	Non Resident	7,664	7,433	318,203	325,636
	Resident	25,712	20,346	544,790	565,136
	Combined	33,376	27,779	862,993	890,772
Itasca	Non Resident	16,065	15,160	634,283	649,443
	Resident	58,884	43,593	1,172,451	1,216,044
	Combined	74,949	58,753	1,806,734	1,865,487
Mahnomen	Non Resident	579	549	25,378	25,927
	Resident	3,656	2,829	73,147	75,976
	Combined	4,235	3,378	98,525	101,903
Polk	Non Resident	5,417	4,658	275,190	279,848
	Resident	19,279	15,298	397,868	413,166
	Combined	24,696	19,956	673,057	693,013
North Central Landscape		**542,772**	**$348,321**	**$10,495,597**	**$10,843,918**
Minnesota		2,828,898	$2,101,409	$63,052,763	$65,154,172

Source: Minnesota DNR License Bureau.
Note: This data represents where the licenses are sold not where the hunting, fishing, and harvesting licenses are used. Many licenses used in the North Central Landscape are not purchased there. In addition, nearly 5% of all transactions statewide (138,989 of 2,828,898) are now sold on-line or over the phone.

4.3.6. Economic impact of tourism industry

Tourism and travel expenditures fall across many industries, but account for only a portion of sales in each of these industries making accurate estimates of the total economic impact of tourism on a region difficult to measure directly. Travel and tourism also create "indirect" and "induced" economic impacts beyond direct expenditures. Because of these complexities, the impact of travel and tourism must be estimated rather than measured directly. In 2012, Explore Minnesota Tourism estimated the economic impact of travel/tourism in the North Central Landscape to be nearly $640 million in gross sales and account for over 13,000 full- and part-time private sector jobs (Table 4.26). These numbers encompass accommodations, food and drink places, and arts, entertainment, and recreation. Crow Wing County makes up nearly 1/3 of this industry in the region with over $200 million in gross sales in 2012 and nearly 3,900 jobs. The next four top grossing counties in the region are Cass, Beltrami, Itasca, and Becker. Clearwater County was the lowest in the region with just over $4.5 million in total sales.

'Food Services and Drinking Places' account for a significant amount of the regional tourism economy with output and value added over double the next closest sector and over four times the number of private sector full- and part-time employees (Table 4.27, Figure 4.24).

Location quotients indicate the degree of concentration for an identified industry. A location quotient over one identifies that industry as being over-represented in the region and classifies that industry as being a part of the region's economic base or a driver of the regional economy.
Table 4.28 shows the North Central location quotients in the hospitality sectors. Accommodation sectors have the top two location quotients in the region and play a significant role in the regions exporting sector. Only Fitness and recreational sports centers, Performing arts companies, and Spectator sports companies are part of the importing economy with a location quotient less than one.

Explore Minnesota Tourism estimated the total economic impact of expenditures by travelers in the North Central Landscape in 2007-2008 to support nearly 30,000 full-time equivalent jobs (Table 4.29). This estimate includes the direct impacts in addition to the estimated indirect impacts. Indirect impacts are the additional jobs and wages supported during additional rounds of spending. As part of the 2007-2008 report Explore Minnesota Tourism also estimated traveler expenditures by season (Table 4.30). In the North Central Landscape 50% of the total traveler expenditures are between June and August.

Table 4.26. Leisure and hospitality industry in the North Central Landscape, 2012.

County	Gross Sales	Sales Tax	Private Sector Employment*
Aitkin	$20,692,436	$1,425,354	497
Becker	$68,776,424	$4,399,765	1,459
Beltrami	$82,096,909	$5,249,317	1,872
Cass	$102,411,781	$6,196,420	1,736
Clearwater	$4,562,173	$328,117	138
Crow Wing	$201,073,526	$12,686,611	3,892
Hubbard	$29,955,194	$2,018,357	741
Itasca	$69,252,200	$4,458,591	1,501
Mahnomen	$16,465,104	$970,379	122
Polk	$43,504,674	$2,711,711	1,099
Total	**$638,790,421**	**$40,444,622**	**13,057**

*****Includes both full- and part-time jobs.
Note: The Leisure and Hospitality industry consists of Accommodations; Food Services and Drinking Places; and Arts, Entertainment and Recreation.
Sources: Minnesota Department of Revenue; Minnesota Department of Employment and Economic Development. In Explore Minnesota Tourism. 2014. Tourism and Minnesota's Economy factsheet.
Accessed at: www.exploreminnesota.com/industry-minnesota/research-reports/researchdetails/?nid=135

Table 4.27. Top ten hospitality sectors in the North Central Landscape based on value added, output, and employment according to IMPLAN modeling, 2009.

Sector	Value Added	Output	Employment*
Food services and drinking places	$184,478,864	$412,618,016	8,940
Hotels and motels, including casino hotels	$84,875,760	$174,415,840	2,226
Amusement parks, arcades, and gambling industries	$22,472,408	$39,032,496	809
Other accommodations	$15,954,291	$39,872,392	630
Automotive equipment rental and leasing	$14,272,209	$23,855,084	69
Other amusement and recreation industries	$13,985,476	$24,647,464	698
Fitness and recreational sports centers	$2,920,843	$5,972,045	215
Performing arts companies	$2,314,136	$4,567,495	190
Spectator sports companies	$2,043,210	$3,245,229	104
Bowling centers	$1,978,913	$3,023,810	95

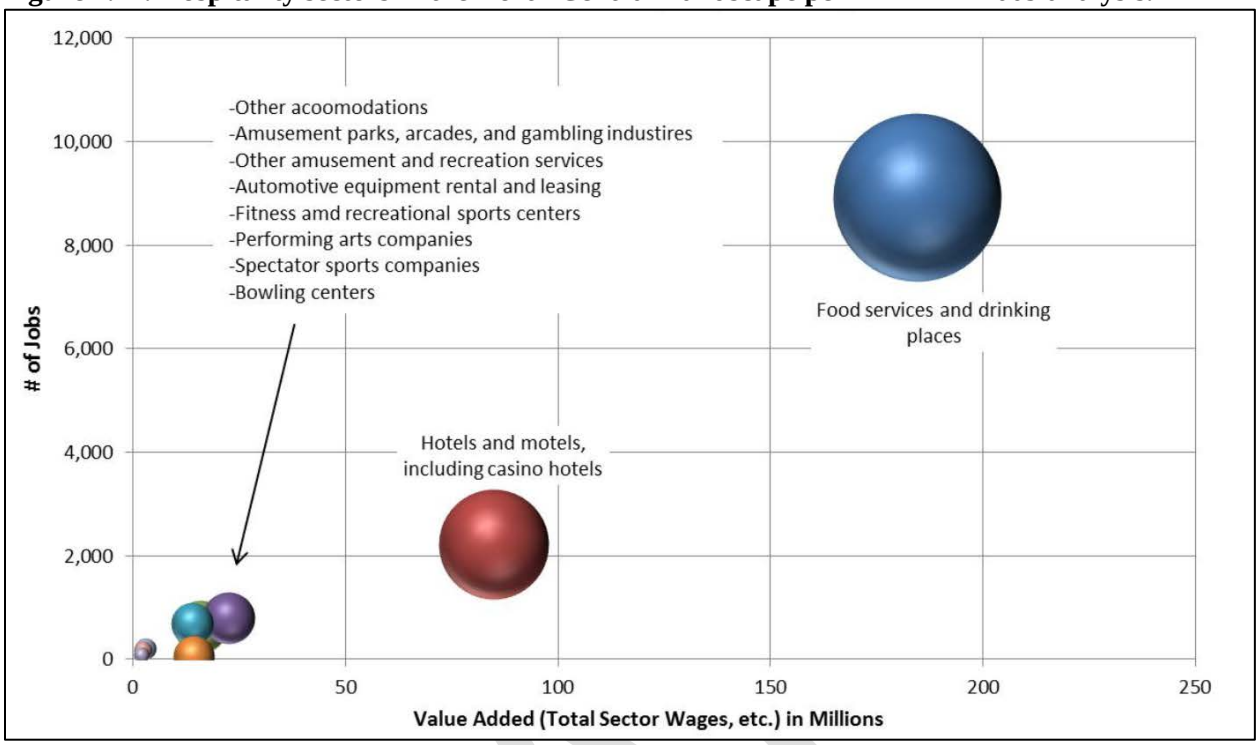
*****Includes both full- and part-time jobs.
Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

Table 4.28. Location quotients for hospitality sectors in the North Central Landscape vs. the United States.

	Value Added	Output	Employment
Exporting Industries in Economic Base:			
Other accommodations	3.5	4.61	10.47
Hotels and motels, including casino hotels	2.16	2.5	6.02
Bowling centers	2.06	2.1	5.01
Other amusement and recreation industries	1.46	1.67	4.55
Food services and drinking places	1.1	1.29	2.68
Amusement parks and recreation services	0.92	1.02	3.02
Automotive equipment rental and leasing	1	1	1
Importing Industries to the Economic Base:			
Fitness and recreational sports centers	0.52	0.61	1.23
Performing arts companies	0.53	0.55	0.47
Spectator sports companies	0.18	0.18	0.25

Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

Figure 4.24. Hospitality sectors in the North Central Landscape per IMPLAN 2009 analysis.



Note: Size of bubble = Industry output in 2009 dollars.
Source: 'Northern Minnesota Forestry Analysis', (2011) prepared by the Bureau of Business and Economic Research at the Labovitz School of Business and Economics – University of Minnesota Duluth. Available at: http://mn.gov/frc/initiatives_llm_committees_North Central.html

Table 4.29. Total economic impact of expenditures by travelers in the North Central Landscape from June 2007 - May 2008.

	Total Traveler Expenditures			Total Economic Impact of Traveler Expenditures*	
County	**$**	**County Rank**	**% of State**	**Full-time Job Equivalents**	**% of State**
Aitkin	74,257,356	32	0.6	1,556	0.6
Becker	109,496,540	23	0.9	2,687	1.0
Beltrami	128,505,015	21	1.1	3,152	1.2
Cass	245,867,979	10	2.0	6,033	2.3
Clearwater	26,643,919	61	0.2	653	0.2
Crow Wing	294,295,204	8	2.4	7,218	2.7
Hubbard	99,248,707	24	0.8	2,431	0.9
Itasca	179,317,876	14	1.5	3,755	1.4
Mahnomen	42,484,736	52	0.4	1,043	0.4
Polk	51,337,075	43	0.4	1,259	0.5
North Central Landscape	**1,251,454,407**	**--**	**10.3**	**29,787**	**11.2**
Minnesota	12,120,810,401	--	100	265,611	100.0

* The Total Economic Impacts of Expenditures by Travelers include all of the direct impacts but also include the estimated indirect impacts. Indirect impacts are the additional jobs and wages supported during additional rounds of spending. Those dollars create the indirect impact of the initial traveler expenditures through many additional rounds of spending in the economy.

Source: 'The Economic Impact of Expenditures By Travelers On Minnesota - County Report'. June 2007 – May 2008. Explore Minnesota Tourism, an office of the State of Minnesota. Accessed at: www.exploreminnesota.com/industry-minnesota/research-reports/researchdetails/?nid=138

Table 4.30. Traveler expenditures (millions of dollars) by season in the North Central Landscape June 2007 - May 2008.

	June - Aug.		Sept. - Nov.		Dec. - Mar.		Apr. - May		Total Expenditures
County	**Million $**	**% of Total**	**Million $**	**% of Total**	**Million $**	**% of Total**	**Million $**	**% of Total**	
Aitkin	35.0	47%	18.1	24%	9.1	12%	12.0	16%	74.3
Becker	53.3	49%	23.6	22%	18.3	17%	14.3	13%	109.5
Beltrami	62.3	48%	28.3	22%	23.2	18%	14.8	12%	128.5
Cass	136.8	56%	45.9	19%	35.1	14%	28.1	11%	245.9
Clearwater	14.2	53%	5.3	20%	4.3	16%	2.8	11%	26.6
Crow Wing	143.9	49%	60.9	21%	51.1	17%	38.4	13%	294.3
Hubbard	59.5	60%	18.3	18%	10.5	11%	10.9	11%	99.2
Itasca	87.2	49%	40.2	22%	29.3	16%	22.6	13%	179.3
Mahnomen	17.6	42%	9.4	22%	9.6	23%	5.8	14%	42.5
Polk	20.3	40%	12.7	25%	11.1	22%	7.2	14%	51.3
North Central Landscape	**630.2**	**50%**	**262.7**	**21%**	**201.6**	**16%**	**157.0**	**13%**	**1,251.5**
Minnesota	4,512.1	37%	3,043.6	25%	2,832.5	23%	1,732.5	14%	12,120.8

Source: 'The Economic Impact of Expenditures By Travelers On Minnesota - County Report'. June 2007 – May 2008. Explore Minnesota Tourism, an office of the State of Minnesota. Accessed at: www.exploreminnesota.com/industry-minnesota/research-reports/researchdetails/?nid=138

4.4. Roads

This section provides information on the length, distribution, and usage of roads in the North Central Landscape. The North Central Landscape roadway network includes US Highways 2, 71, and 169 in addition to state and county highways systems. This region also features numerous scenic byways such as the End of the Wilderness, Avenue of Pines, Ladyslipper, Lake Country, and Paul Bunyan Scenic Byways.

There are over 19,000 miles of roads in the North Central Landscape and approximately 91 percent of them are designated collector or local roadways (Table 4.31). This network of roadways is important for accessing the region's timber resources but many of these lower level roadways are subject to spring weight restrictions which limit access to logs in these regions (Figure 4.25). With increasingly early springs, transportation logistics required to insure logs harvested in the winter are able to be transported to the mills will become increasingly challenging.

Approximately 94.5% of the traffic volume in the North Central Landscape – quantified as Annual Average Daily Vehicle Miles Traveled (AAD VMT) – occurs on US, Minnesota, and County State Aid highways (Table 4.32). As would be expected, the heaviest AAD VMT clusters around and between major city centers (Figure 4.26). Approximately 4.7% of the AAD VMT can be attributed towards heavy commercial vehicles (Table 4.33). Measurements of Heavy Commercial Annual Average Daily Vehicle Miles Traveled are restricted to US and Minnesota highways, and show a less concentrated distribution around city centers and instead flow through them via the major highways (Figure 4.27).

Table 4.31. Roadway functional classes in the North Central Landscape.

Road Functional Class	Miles
Principal Arterial – Interstate	0
Principal Arterial - Other Freeways & Expressways	3
Principal Arterial – Other	885
Minor Arterial	797
Total Arterial	**1,686**
Major Collector	2,520
Minor Collector	1,667
Total Collector	**4,186**
Local	13,371
Total Local	**13,371**
Total North Central Region	**19,243**

Source: Minnesota Department of Transportation.
www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/

Table 4.32. Average annual vehicle use of roadways in the North Central Landscape.

Route Type	Length (miles)	Annual Average Daily Vehicle Miles Traveled	Annual Average Daily Traffic
US Highway	581.5	3,208,983	960,350
MN Highway	1240.4	3,642,242	1,547,345
County State Aid Highway	3837.4	2,364,223	1,298,350
Municipal State Aid Street	93.6	249,304	830,385
County Road	1910.1	274,155	150,755
Township Road	16.2	3,554	1,685
Municipal Street	3.1	10,817	22,930
Indian Service Road	3.0	2,649	870
Total North Central Region	**7685.4**	**9,755,927**	**4,812,670**

Source: Minnesota Department of Transportation www.dot.state.mn.us/tda/index.html
Note: Annual Average Daily Vehicle Miles Traveled (AAD VMT) is the number of vehicles that travel a section of road per day (averaged for 365 days in one year) multiplied by the length of the section of road. If 2 vehicles traveled a 2 mile section of road every day over the course of one year, the AAD VMT for that section of road would be 4. The AAD VMT should be used when comparing routes for traffic volume given that it provides a normalized comparison for traffic measurements (the Annual Average Daily Traffic count can be skewed by the presence of multiple sections of a Route Type).
Note: Annual Average Daily Traffic (AADT) is the number of vehicles that travel a section of road per day (averaged for 365 days in one year). MNDOT measures traffic for road sections every 2-4 years. Note that AADT is per section of road. If more sections of road exist for a Route Type, more AADT will be reported for that Route Type in the table above. For a normalized comparison of the amount of traffic on each route type, refer to the Annual Average Daily Vehicle Miles Traveled.

Table 4.33. Average annual heavy commercial vehicle use of roadways in the North Central Landscape.

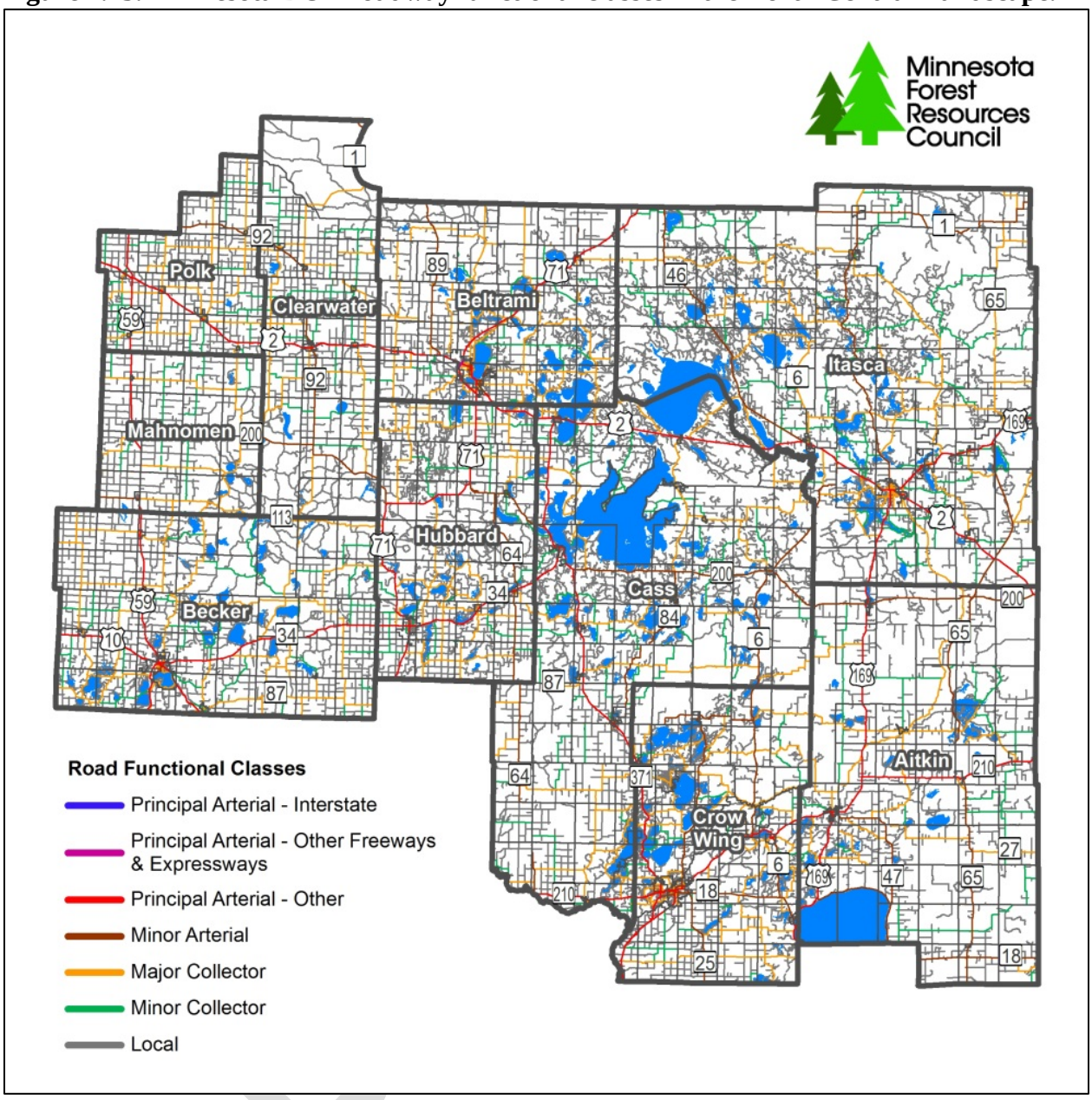
Route Type	Length (miles)	Heavy Commercial Annual Average Daily Vehicle Miles Traveled	Heavy Commercial Annual Average Daily Traffic
US Highway	581.3	241,973	72,305
MN Highway	1230.4	220,944	78,885
Total North Central Region	**1811.7**	**462,918**	**151,190**

Source: Minnesota Department of Transportation www.dot.state.mn.us/tda/index.html

Note: Heavy Commercial Annual Average Daily Vehicle Miles Traveled (HCAAD VMT) is the number of trucks with at least 2 axles and 6 tires that travel a section of road per day (averaged for 365 days in one year) multiplied by the length of the section of road. If 2 trucks traveled a 2 mile section of road every day over the course of one year, the HCAAD VMT for that section of road would be 4. The HCAAD VMT should be used when comparing routes for traffic volume given that it provides a normalized comparison for traffic measurements (the Heavy Commercial Annual Average Daily Traffic count can be skewed by the presence of multiple sections of a Route Type).

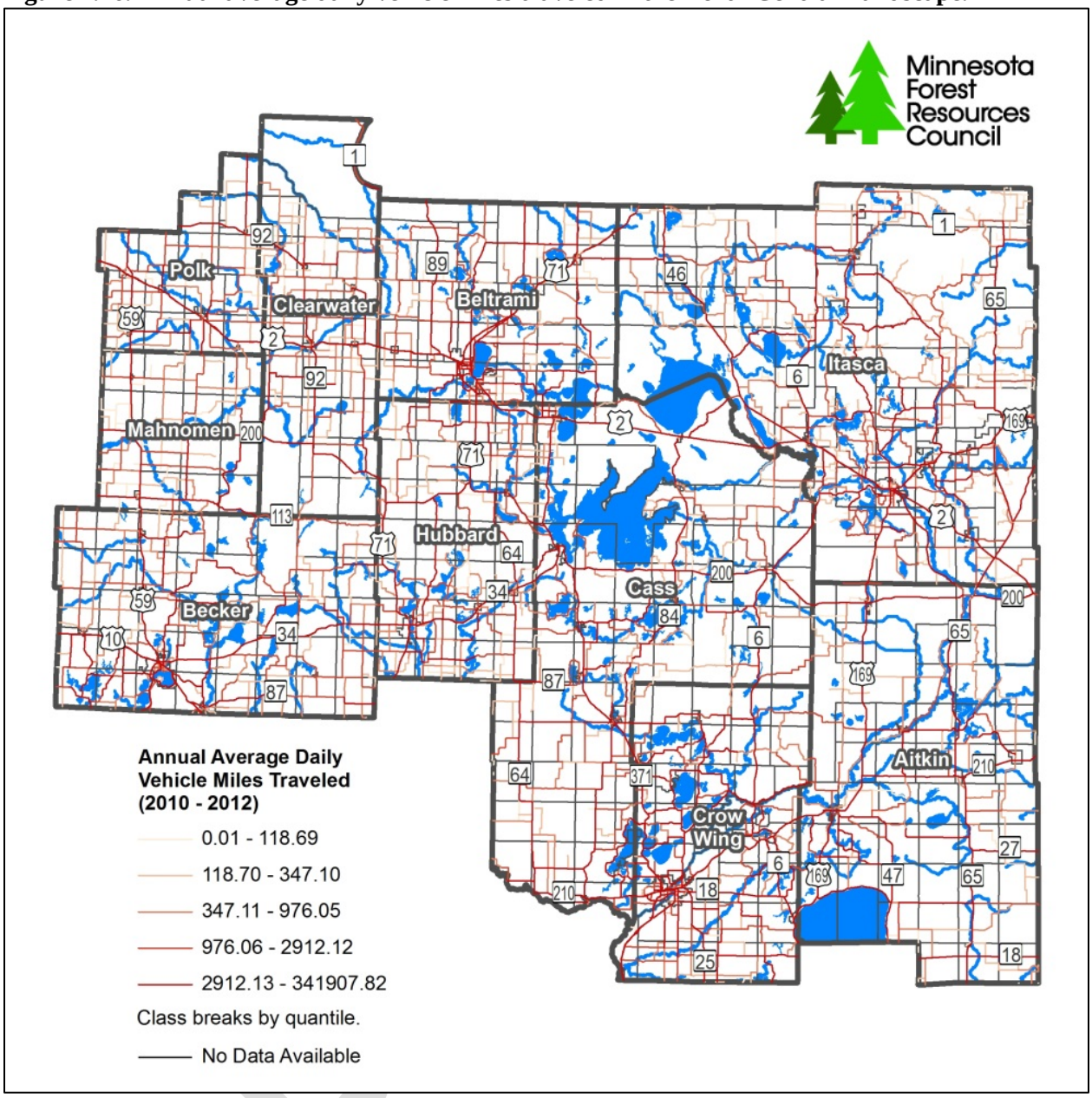
Note: Heavy Commercial Annual Average Daily Traffic (HCAADT) is the number of trucks with at least 2 axles and 6 tires that travel a section of road per day (averaged for 365 days in one year). MNDOT measures traffic for road sections every 2-4 years. Note that HCAADT is per section of road. If more sections of road exist for a Route Type, more HCAADT will be reported for that Route Type in the table above. For a normalized comparison of the amount of traffic on each route type, refer to the Heavy Commercial Annual Average Daily Vehicle Miles Traveled map.

Figure 4.25. Minnesota DOT roadway functional classes in the North Central Landscape.



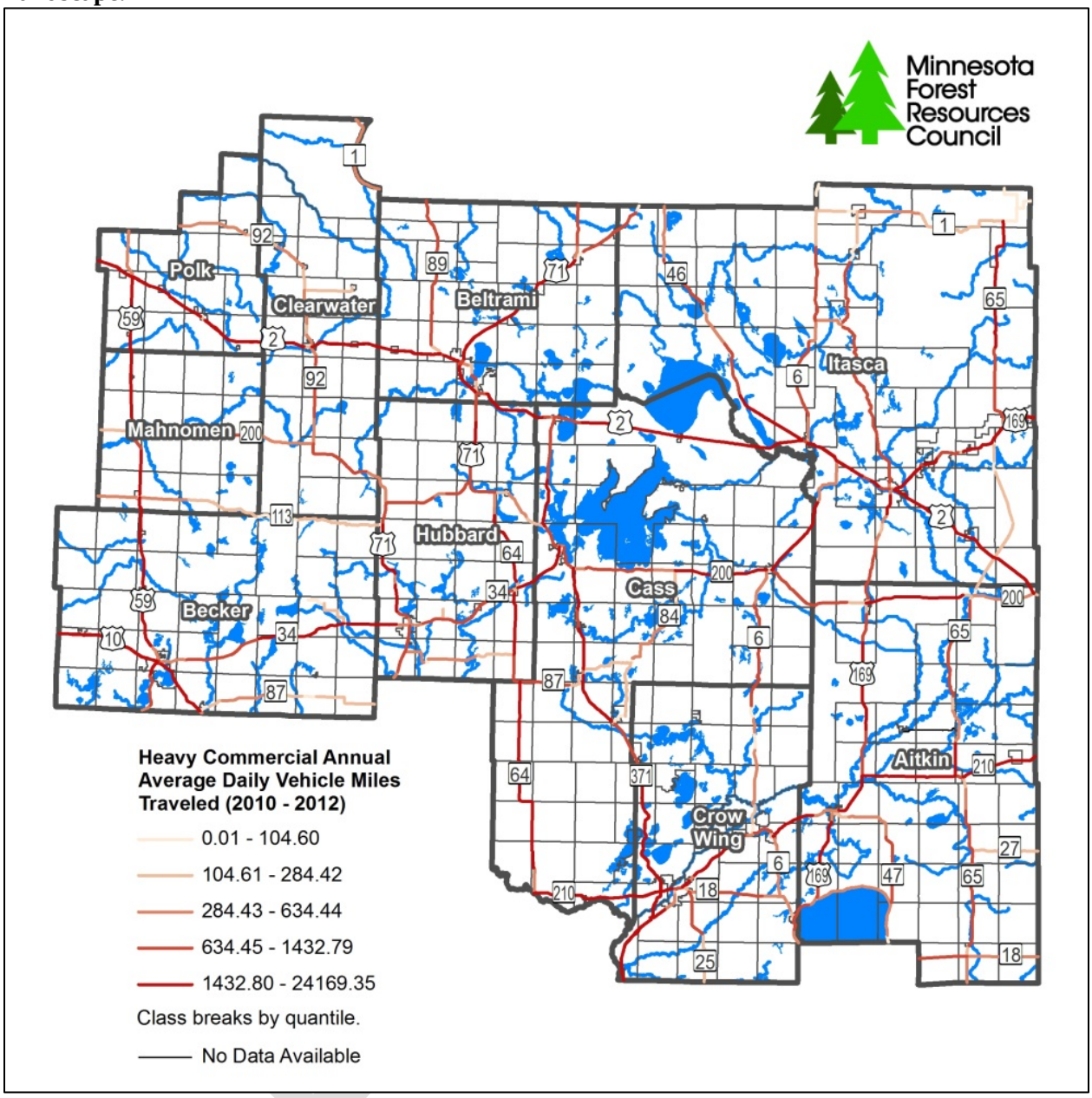
Source: Minnesota Department of Transportation
www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/

Figure 4.26. Annual average daily vehicle miles traveled in the North Central Landscape.



Source: Minnesota Department of Transportation www.dot.state.mn.us/tda/index.html

Figure 4.27. Heavy commercial annual average daily vehicle miles traveled in the North Central Landscape.



Source: Minnesota Department of Transportation www.dot.state.mn.us/tda/index.html