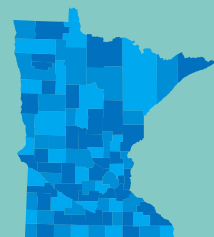


March 2026

Minnesota residential wood combustion survey results



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Minnesota Department of Natural Resources – Division of Forestry

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Summary

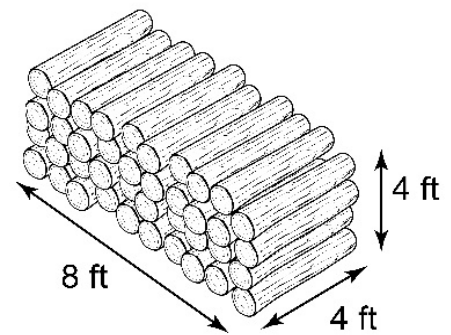
In 2024 the Minnesota Pollution Control Agency (MPCA) conducted a statewide survey to find out how much wood is harvested and burned annually for heat or pleasure in Minnesota. This survey has been conducted in varying forms every few years since 1960, with the previous survey having been conducted in 2021. The most recent study described in this report was for the 2023-2024 heating season, May 2023-April 2024.

The MPCA conducts this survey to gather information about residential wood combustion practices. Due to the levels of fine particles (PM_{2.5}) in ambient air, it is important to have accurate information about the sources of this pollutant. Residential wood combustion is an important source of fine particle emissions and accounted for 55% of Minnesota's direct fine particle emissions¹ in 2020². This survey provides an improved understanding of residential wood burning in Minnesota by type of equipment, purpose for burning, source of wood fuel, and region of the state. These data have been used by state and federal agencies, as well as trade organizations, to manage forests, inform policymakers and scientists, and assist the hearth and fireplace industry by examining trends in wood burning.

In May 2024, the Department of Natural Resources (DNR) sent out 7,000 invitations to complete the survey to randomly selected households throughout the state. For purposes of data collection and analysis, the state was divided into five regions. These regions are characterized by their main forest type and the expectation that their populations will have similar wood burning practices. These regions (Northern Pine, Aspen-Birch, Prairie, Metro, and Central Hardwoods; see [Figure 2](#)) have been used in past surveys.

This year's survey showed Minnesota households burned an estimated 1.024 million cords of wood over the course of a year. If all that wood were stacked on a single football field, the pile would rise to about half a mile in height.

Figure 1. One cord of wood.



¹ Direct fine particle emissions are released from pollution sources. Fine particles in the air are a mixture of the directly released fine particles and those that are created in the air by chemical reactions between other pollutants such as the gases released from coal plants and vehicles.

² Minnesota Pollution Control Agency's 2020 Statewide air emissions data

Key findings

- Since 2003, residential wood burning has had a nonlinear but overall increasing trend. The estimated total volume of wood burned in 2024 totaled 1,024,000 cords, a 33% decrease since the 2021 survey and the lowest reported volume since the 2008 survey.
- For the first time, the survey examined the relationship between monthly average temperature and wood consumption, finding evidence that higher temperatures corresponded with fewer cords burned in 2024.
- Roughly, 1,125,000 households, about 50% of all Minnesota households, burned some wood between May 2023 and April 2024.
- Statewide, the greatest volume of wood burned was for primary heat, but burning for pleasure was the most common reason a household burned wood.
- When analyzed by equipment type, outdoor recreational equipment (fire pits, fire rings, chimineas, etc.) accounted for the largest proportion of total wood burned, as first observed in the 2021 survey.
- About half of wood stoves and one third of fireplace inserts used were manufactured prior to 1989; these older models pollute significantly more than newer models.
- Consistent with past surveys, wood boilers and wood furnaces burned the most wood per unit of equipment.
- The 2024 survey marks the first time in recent years that the Metro Region has reported the total highest volume of wood burned. However, the Metro region had both the lowest per-household wood consumption and the lowest household burning rate at 38%, reflecting the influence of its large population.
- Most wood burned (59% completely or mostly covered) was stored protected from elements, which is expected to burn more cleanly and efficiently.

Survey use

This survey provides data to support the MPCA's air emission inventories for criteria pollutants, criteria pollutant precursors, and hazardous air pollutants. These inventories are released every three years for all air emission sources to support effective air quality tracking for pollution reduction programs and health risk assessments. This survey will inform a more complete picture of the overall impact of wood burning on air quality across the state.

This survey, along with other data on wood burning collected by the MPCA and other agencies, is an important tool to help Minnesota policy planners make informed policy decisions regarding overall forestry management and environmental strategies, especially relating to air emissions in the state. For example, the data collected in this survey helps inform the need for appliance change-out incentive programs.

The data collected is also used to estimate the amount of residential fuel wood burned as reported in the annual Minnesota Department of Natural Resources' Forest Resource Report. This report describes Minnesota's forest resources, such as current conditions and trends in forest resources and industrial use.

Introduction

Project purpose

Between April and August 2024, the Minnesota Pollution Control Agency (MPCA), assisted by Wilder Research (Wilder), and the Minnesota Department of Natural Resources (DNR) randomly selected households across Minnesota to estimate the volume of residential wood burned between May 1, 2023 and April 30, 2024. The State of Minnesota has been surveying wood use since 1960 and now conducts this survey every three years³. These surveys are part of a long-term effort to monitor trends in the use and harvesting of Minnesota's wood supply by Minnesota households.

For more information on wood smoke and wood burning in Minnesota, visit <https://www.pca.state.mn.us/air/wood-smoke>

These surveys provide data for Minnesota's air pollutant emission inventories, which are assessed every three years by the MPCA. The MPCA estimates statewide emissions of various air pollutants, such as fine particles (PM_{2.5}), volatile organic compounds (VOCs), and other pollutants released from factories, vehicles, residential wood combustion, and other activities. The emission inventories offer valuable information about the activities that contribute to ambient air concentrations of fine particles and other air pollutants. Minnesota's emission inventory has indicated that residential wood combustion is a primary source of directly emitted fine particles from combustion processes.

The collected data are used to estimate residential wood fuel burned for DNR's annual Forest Resource Report. The Forest Resource Report describes Minnesota's current forest conditions and trends in forest resource use.

Results of the survey are described in graphic form in the results section of this report. Reference to data tables is provided for some of the figures. These data tables are provided in Appendix A:

Survey objectives

Similar to previous recent surveys, the objectives for this survey were to:

1. Estimate the total volume and type of residential wood burned from May 1, 2023, through April 30, 2024, by category of equipment used and geographic location.
2. Estimate the amount of wood burned for various purposes, including heat (primary or secondary), pleasure, disposal of wood from residential properties, or more than one of these reasons.
3. Compare with results of previous surveys to identify wood burning trends.
4. Estimate the temporal distribution of wood burning throughout the year.
5. Inform air pollution reduction strategies by understanding the amount and location of wood burned, equipment used to burn wood, and reasons for burning.

³ Similar surveys were conducted for the years of 1960, 1969-1970, 1979-1980, 1984-1985, 1988-1989, 1995-1996, 2002-2003, 2007-2008, 2011-2012, 2014-2015, 2017-2018, and 2020-2021.

6. Estimate the volume and type of fuel wood harvested or obtained, including the amounts harvested from living or dead trees and from land owned by different entities (state, federal, county, forest industry, and private lands).

Results

For purposes of data collection and analysis, the state was divided into five regions: Northern Pine, Aspen-Birch, Prairie, Metro, and Central Hardwoods ([Figure 2](#)). These regions have been used in analyzing several previous surveys as well. They are characterized mainly by forest type but also serve to stratify the statewide household population into subgroups that are expected to have similar wood burning practices.

Data was collected via 7,000 residential self-reported surveys with an overall response rate of 20%. More information about data collection can be found in the Methods section.

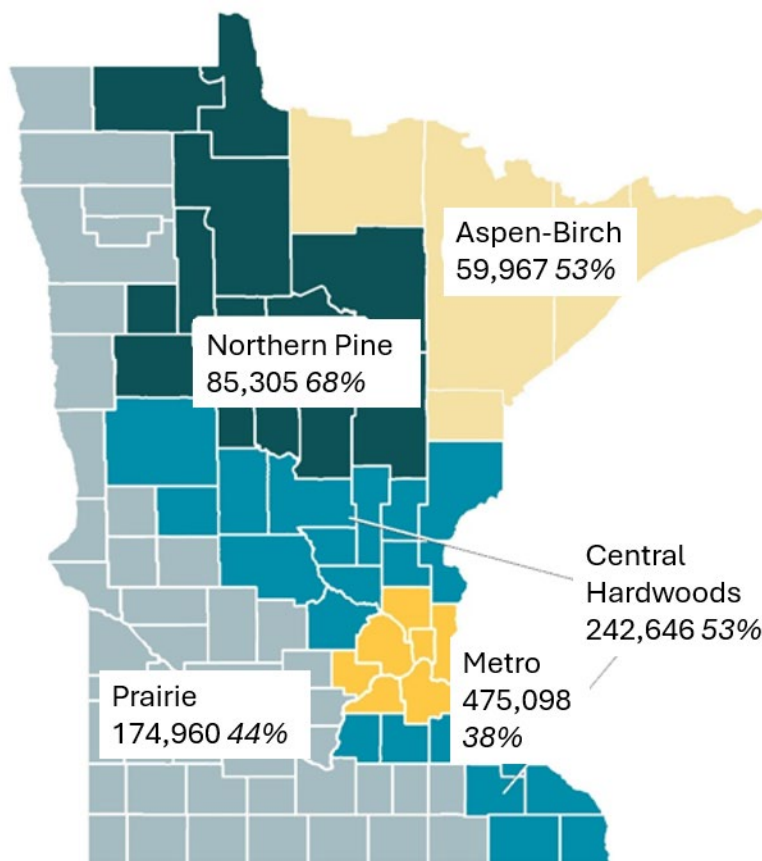
Household burning practices

Between May 1, 2023, and April 30, 2024, an estimated 1,125,000 Minnesota households burned some wood, about 50% of occupied households in the state.

Burning rates (the percentage of all occupied households in a region that burned wood at any location) varied by region. The highest burning rate was in the Northern Pine region, where 68% of households whose primary residence was in the region reported burning wood. The burning rate was lowest in the Metro region (38%), but because it is more densely populated, it has the greatest number of households estimated to have burned wood (475,000).

The percentages in [Figure 2](#) are based on the location of the primary residences of the households that reported burning wood in any amount anywhere in the state. Since some households also burned wood in regions outside their region of primary residence (such as at a secondary residence or a campsite), these results do not necessarily reflect the amounts of wood burned in each region.

Figure 2. Estimated number and percent of household population that burned wood by region.



Volume of wood fuel burned

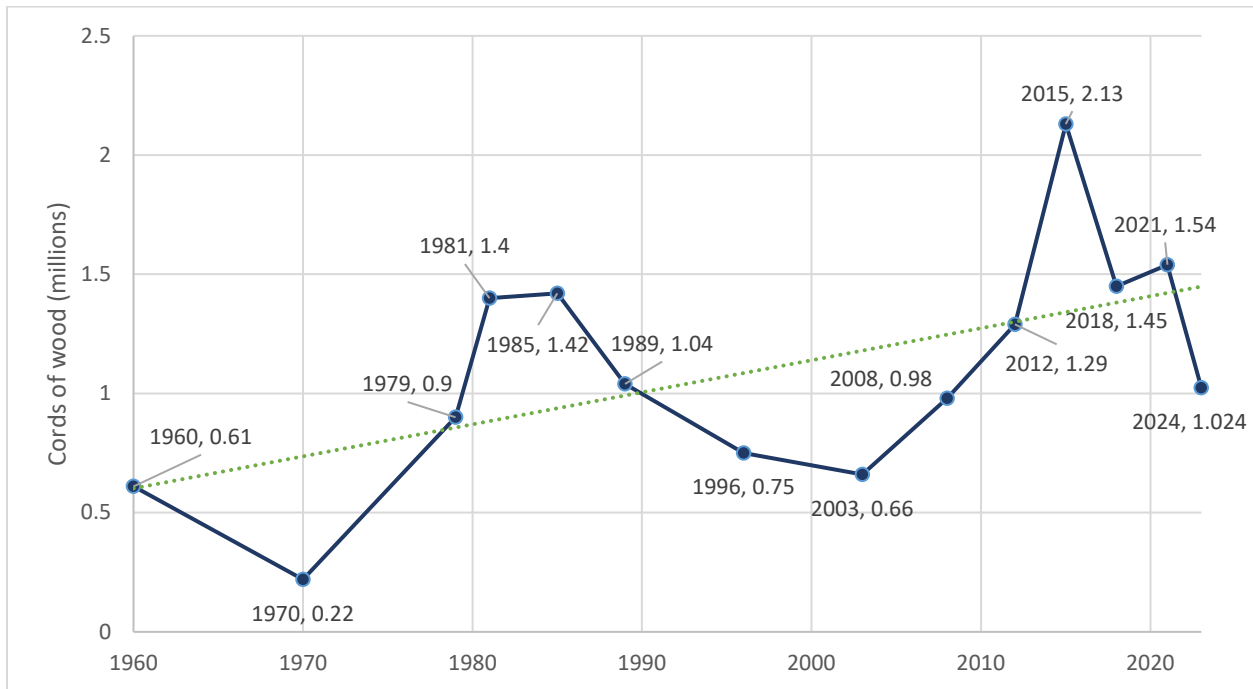
Total volume burned over time

Between May 1, 2023, and April 30, 2024, Minnesota households burned an estimated 1.024 million cords of wood⁴. This is a 33% decrease from 2021 (Figure 3), and the lowest reported volume of wood burned since the 2008 survey. However, due to changes to improve the survey design and methodology, past surveys are not directly comparable, and trends should be interpreted carefully.

Despite the decrease in wood burning in 2024, wood burning in general appears to be increasing over time. The estimated amount of wood burned over all survey years has increased by an average of about 13,500 cords per year. Since 2003, the estimated amount of wood burned has increased by about 31,800 cords per year.

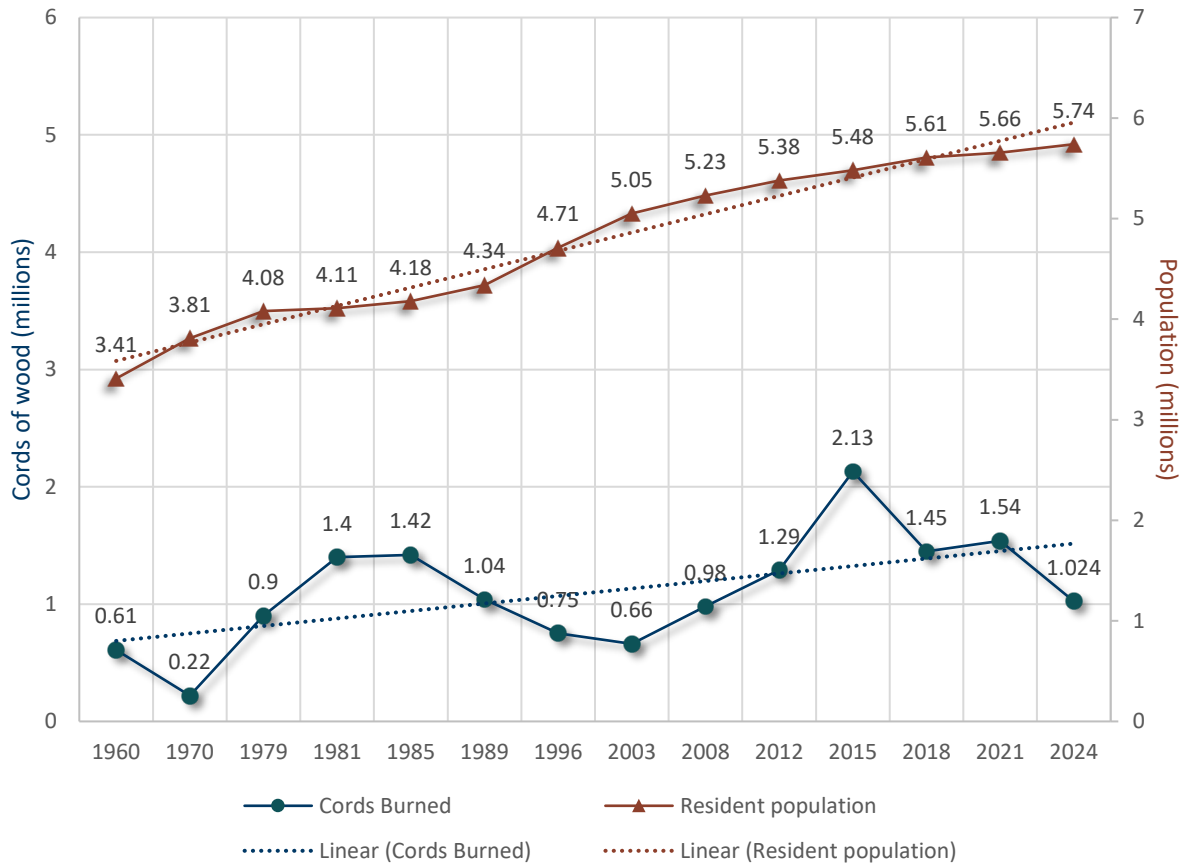
⁴ One cord of wood measures 8 x 4 x 4 feet (Figure 1). Unless otherwise noted, “wood” may include wax logs, wood reported in cords, face cords or bundles, wood pellets, pallets, slabs, and tree branches and woody brush. Table 1 describes the breakdown.

Figure 3. Estimated volume of wood burned over all survey years.



Concurrent to the general increase in the amount of wood burned over all survey years, Minnesota’s resident population has been increasing at a rate of approximately 37,000 people per year (Figure 4), corresponding to a 0.86% average annual growth rate. The average annual growth rate of wood burned over the same time period is 0.83%, down from recent years and now trending lower than population growth. However, when looking at recent data, since 2003, the volume of wood burned has been increasing by an average rate of 2.2% annually, while population has only increased by 0.7% per year. These estimates give a general idea of how increases in wood burning have compared to population growth, rather than a precise estimate.

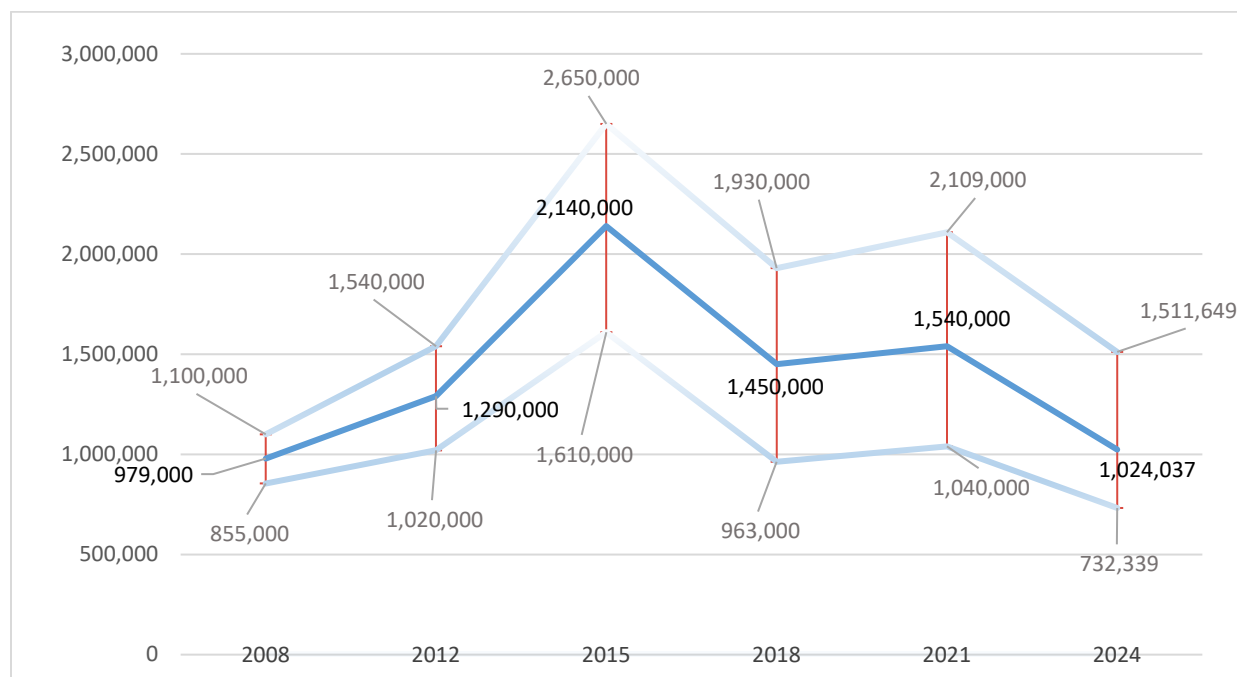
Figure 4. Estimated volume of wood burned and resident population over all survey years⁵.



⁵ US Census Data collated <https://www.statista.com/statistics/206236/resident-population-in-minnesota/>

When applying a 95% confidence interval around the estimation of total wood burned in the 2024 survey, the results range from 0.73 to 1.51 million cords (Figure 5). In the 2021 report, the 95% confidence interval yielded a range between 1.04 to 2.11 million cords. The overlap between these two intervals suggests that there was not a statistically significant decrease in wood burning between the two surveys.

Figure 5. Estimated volume of wood burned by survey year with 95% confidence interval.



Minimal changes in survey design between 2021 and 2024 surveys and similar response rates are important, but comparisons across surveys should be considered carefully. Observed trends over multiple survey years may also be affected by changes in survey design, which have not been tested for statistical significance.

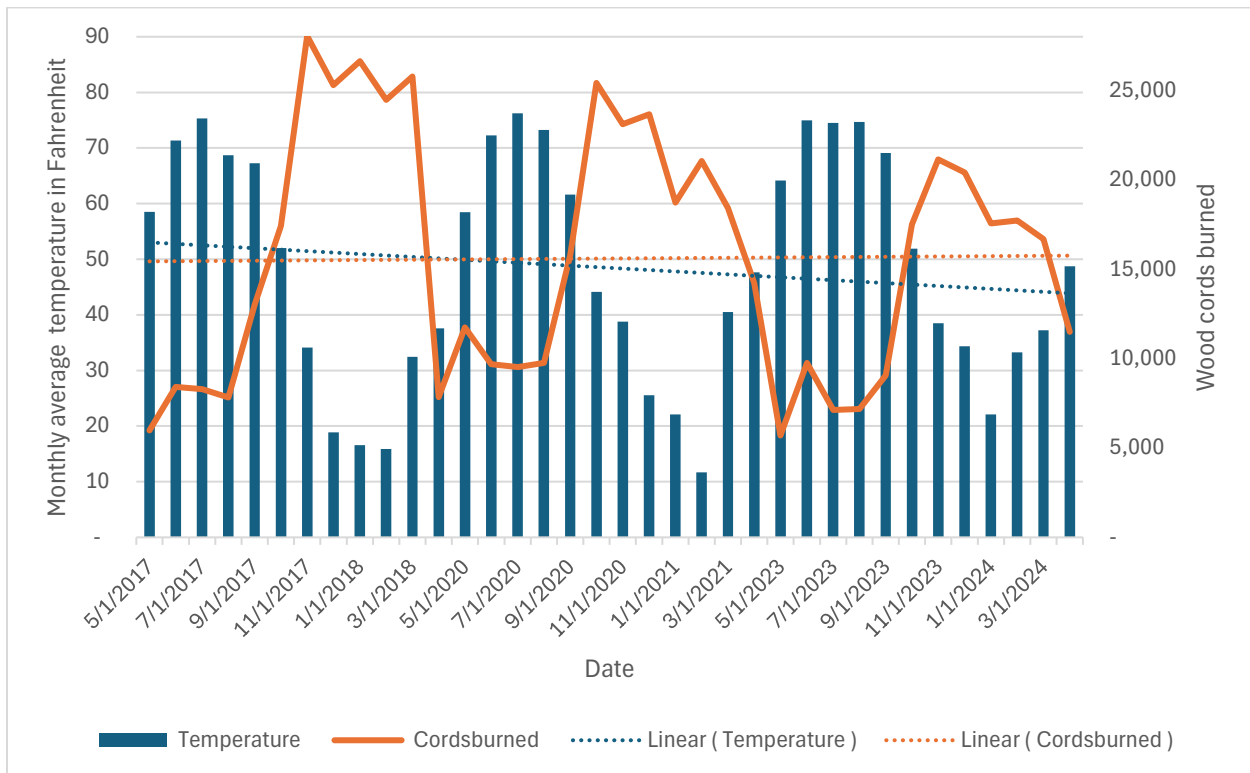
Several potential factors might contribute to variation between years. It was hypothesized in 2021 the increase in wood burning was influenced by the COVID-19 executive stay-at-home order. The decrease in wood burning in 2024 supports that hypothesis. In this report, we also examined how temperature may have impacted wood burning.

6 shows there is some correlation between increasing monthly average temperatures, especially over winter months, and decreasing residential wood burning activity in the Metro area in Minnesota. The 2023 winter survey season was on average warmer than the 2021 and 2018 surveys. As overall temperatures are increasing, households generally require less supplemental heating, reducing the need for wood burning stoves and fireplaces. As Figure 6 shows, there is a correlation in the warmer 2023 winter months and fewer cords of wood burned compared to past surveys.

Another potential influence on residence’s wood burning behavior could be unpleasant air quality. According to data from MPCA meteorologists, Minnesota saw an increase in air quality alerts (*a public notification by MPCA to warn residents that pollution levels – such as ozone or fine particulate matter– have risen or are expected to rise to unhealthy levels*) from 2020 to 2024⁶. In 2023 there were a record 52 air quality alert days, 16 of which were due to wildfire smoke⁷. Once an air quality alert is issued, residents are encouraged to stay indoors and reduce wood burning to limit additional particulate pollution. In addition, unpleasant wildfire smoke could drive more people indoors or discourage them to burn wood. This may have also contributed to lower outdoor recreational wood burning activities in Minnesota in the summer.

Additional factors such as fuel price and social behaviors are not considered in this report but could also contribute to the variability between years. It is also reasonable that it is not just one of these factors that drive the variability between survey years, but rather multiple with varying degrees of influence from year to year.

Figure 6. Monthly average temperature compared with cords of wood burned each month over the past three survey years in the Metro region.



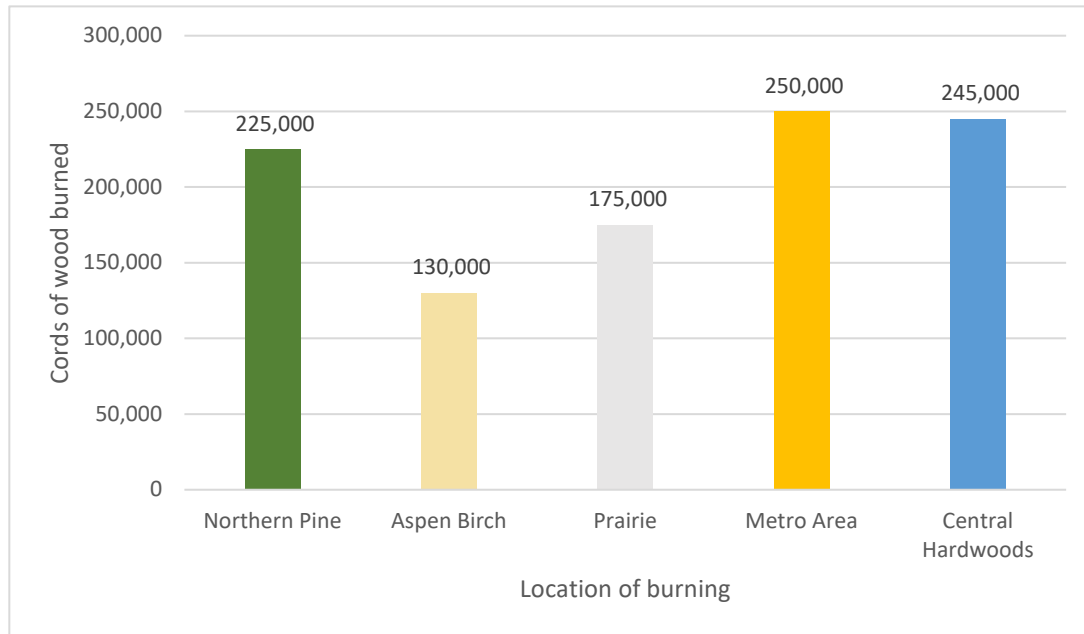
⁶ MPCA Statewide AQI report

⁷ MPCA News Release [“MPCA Meteorologists forecast another summer of increased air quality alerts for MN”](#)

Amount of wood burned by region

The greatest amount of wood burned in any of the five regions was in the Metro region. Of the estimated 1.024 million cords burned statewide, an estimated 24%, or about 250,000 cords, was burned in the Metro region (Figure 7). The Central Hardwoods had a similar rate with 245,000 cords burned. The fewest estimated number of cords burned was in the Aspen-Birch region, with 13% of all wood burned. These totals include all wood burned in each region at primary residences, secondary residences, or campsites.

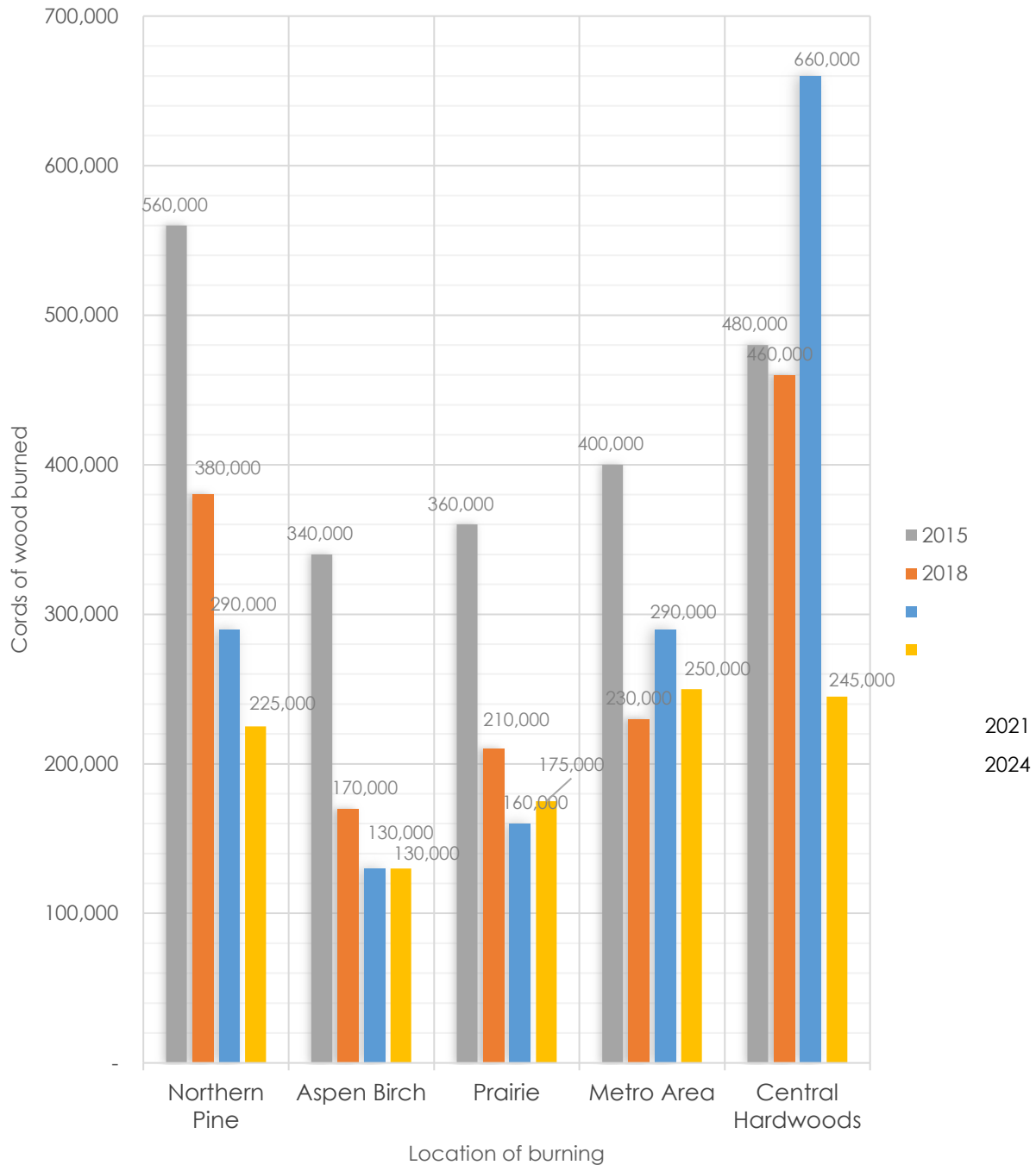
Figure 7. Estimated volume of wood burned in each region.



The 2024 survey marks the first time in recent years that the Metro region has led the state in total volume of wood burned (Figure 8). In the 2018 and 2021 surveys, the Central Hardwoods region reported the highest volume of wood burned, but there was a 63% decrease in the most recent survey. The Metro region also experienced a decline, though more modest, at approximately 14%. The sharp decrease in the Central Hardwoods region may be attributed to a few reasons, including it reporting a 35% decrease in the use of wood boilers, an equipment type that burns large amounts of wood. There were also a few survey responses from this region that were discarded because they were improbable, and a few outliers discarded and not scaled down. The methods section further details how outliers and non-sensical data were addressed.

The Metro and Central Hardwoods regions have the largest populations in the state, which likely contributes to their higher wood-burning totals. Because of their greater population density, reductions in wood burning within these regions could decrease potential exposure to wood smoke and associated health impacts.

Figure 8. Estimated volume of wood burned in each region, by survey year from 2015 to 2024.



Statewide, households that burned wood burned an estimated average of 0.9 cords of wood per household, regardless of property type (primary or secondary residences or campsites). However, the average varies considerably among regions. Households in the Northern Pine region on average burned the most amount of wood per household, 2.6 cords (Figure 9). Households in the Aspen Birch region burned the next highest estimated amount of wood, at 2.1 cords per household. Metro households burned the least at 0.5 cords per household.

Figure 9. Estimated cords of wood burned per household by region.

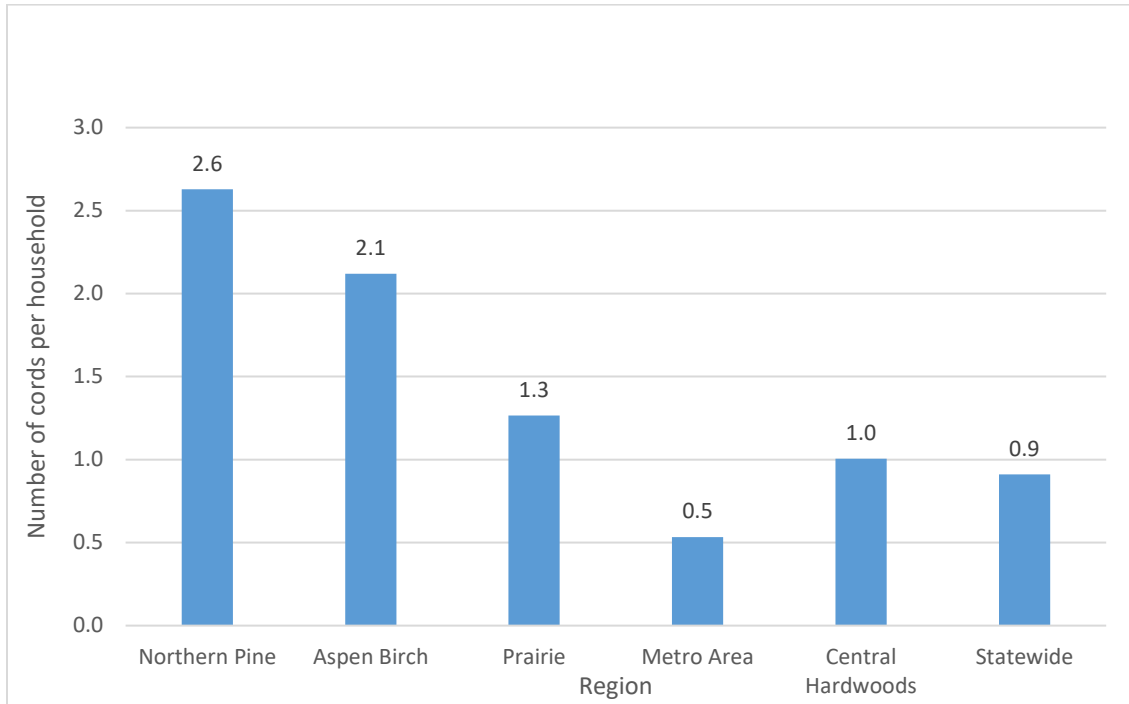
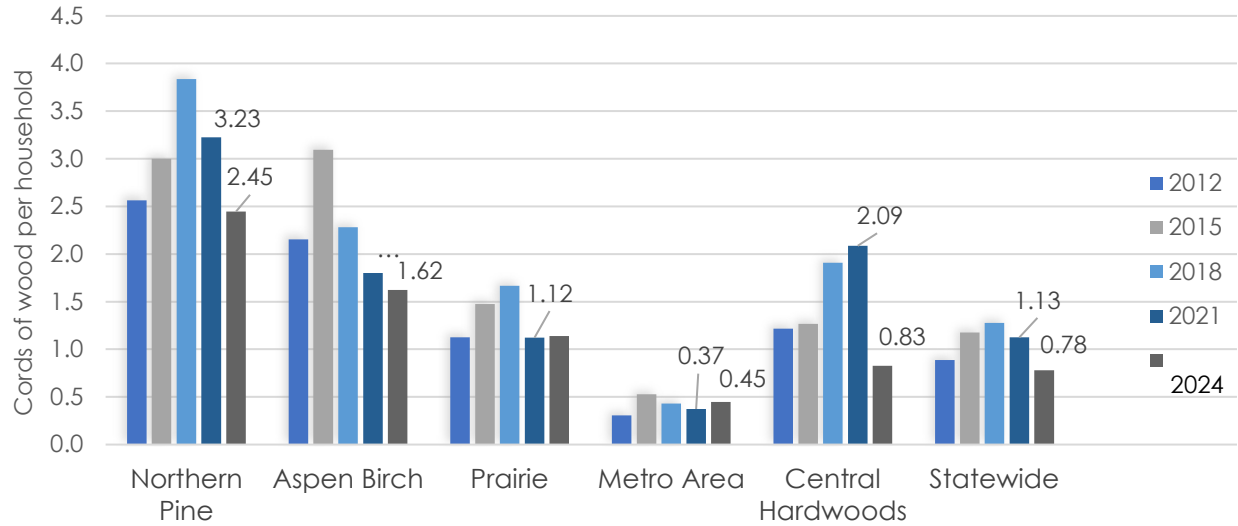


Figure 10 shows the average wood burned per household at their primary residence by region over the past four surveys. Statewide, the overall amount of wood burned per household has stayed relatively flat with a slight decrease across the previous two surveys. The Central Hardwoods region experienced the greatest decrease, with over a cord less burned per household. Meanwhile, regions such as the Northern Pine and Metro reported increases in the number of cords burned per household. The amount of wood burned per household has a direct impact on the total volume of wood burned in the state, in addition to population changes and the proportion of residents burning wood. These results indicate cords burned per household has decreased statewide, contributing to the decreased total volume of wood burned.

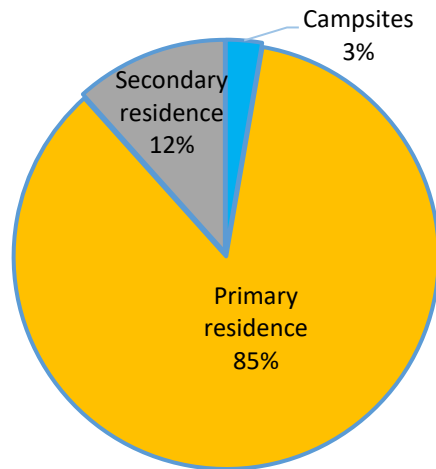
Figure 10. Estimated cords burned per household by region and year.



Location of wood burning by region

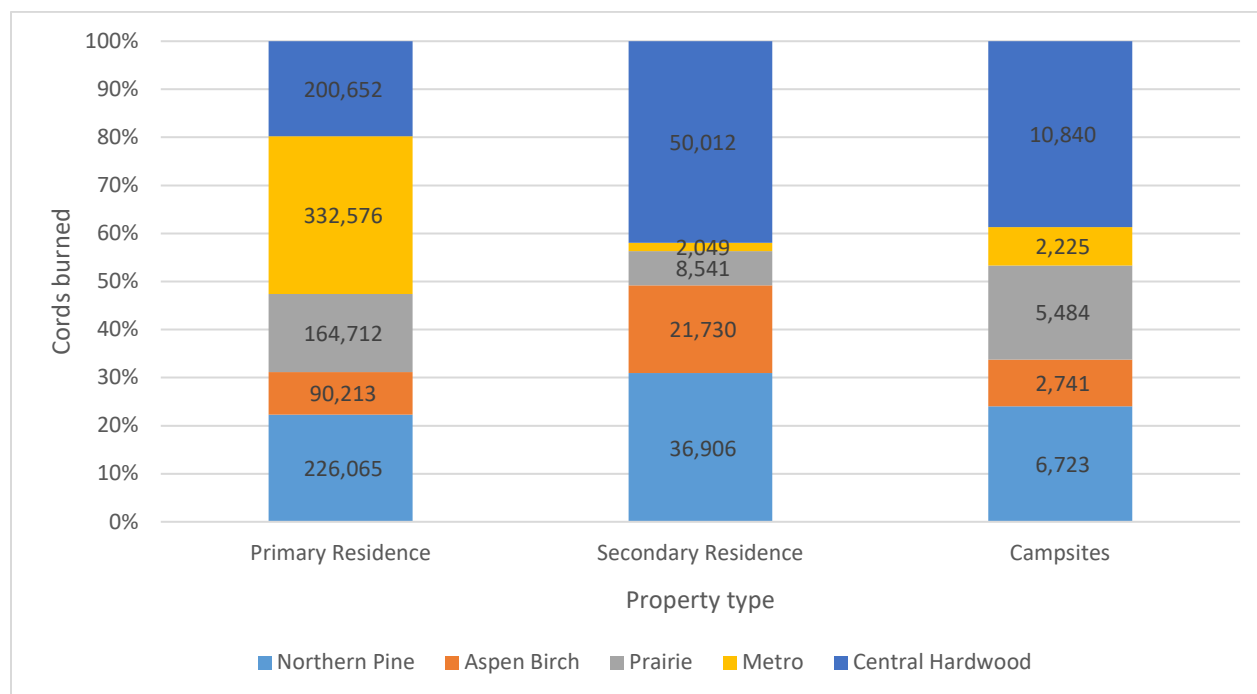
Most of the estimated wood burned statewide was at primary residences (877,000 cords, 85%), followed by secondary residences (119,000 cords, 12%), and campsites (28,000 cords, 3%; Figure 11).

Figure 11. Estimated wood burned by property type.



The greatest total estimated volume of wood burned at primary residences was in the Metro region with 332,600 cords, or 33% of all wood burned at primary residences (Figure 12). The Central Hardwoods accounted for the greatest proportion of wood burned at secondary residences and campsites, with 42% (50,000 cords) and 39% (10,800 cords) respectively.

Figure 12. Estimated volume of wood burned by property type and region.



Equipment used for wood burning

Number of equipment pieces used

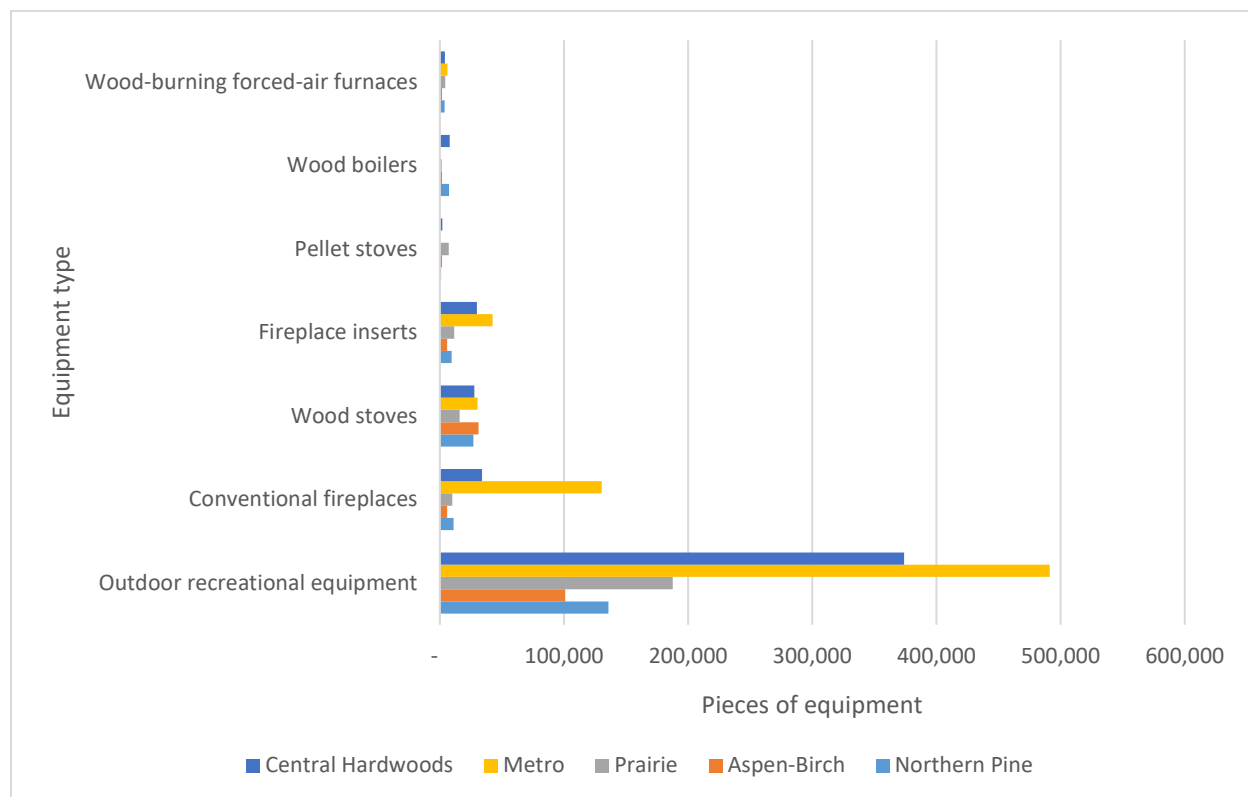
Between May 1, 2023, and April 30, 2024, Minnesota households used an estimated 1.76 million pieces of wood-burning equipment. The most common type of equipment owned at primary and secondary residences statewide was outdoor recreational equipment (fire pits, fire rings, chimineas, etc.), making up over 73% of all equipment used (not including equipment at campsites). This represents an increase from the previous survey, where outdoor recreational equipment made up 40% of all equipment used. An increase in the number of outdoor recreational equipment was observed across all regions. Tracking this category in future surveys will help determine whether this increase represents a trend, or if it reflects a variation in this survey or underlying factors. The next most common pieces of equipment used were conventional fireplaces (11%), wood stoves (7.5%), and fireplace inserts (5.6%). Less frequently reported equipment included wood boilers (1%), wood furnaces (1.1%), and pellet stoves (0.7%).

Recognizing the increasing popularity of low-smoke outdoor wood equipment, the 2024 survey asked about its use for the first time. Low-smoke fire pits are typically engineered to have a secondary burn resulting in fewer emissions. A study by USDA Forest Service, Rocky Mountain Research Station in consultation with MPCA found that PM_{2.5} emission factors are more than five times lower from low

smoke firepits compared to emissions from outdoor wood burning devices⁸. Low-smoke fire pits represented 10% of all outdoor wood equipment reported.

Figure 13 shows the estimated amount of equipment used in each region by equipment type. Forty percent of all equipment used was in the Metro region, in part due to the region’s large population. The Metro had the most outdoor recreation equipment (490,000), conventional fireplaces (130,000), fireplace inserts (42,000), and wood burning furnaces (6,000). Wood stoves were most commonly used in the Aspen-Birch region (31,000), with Metro (30,000), Central Hardwoods (28,000) and Northern Pine (27,000) falling closely behind. Wood boilers were most common in the Central Hardwoods (8,000) and Northern Pine region (7,400). The Prairie region accounted for the most pellet stoves (7,000), which were overall the least popular type of equipment.

Figure 13. Estimated number of pieces of wood burning equipment used by region⁹.



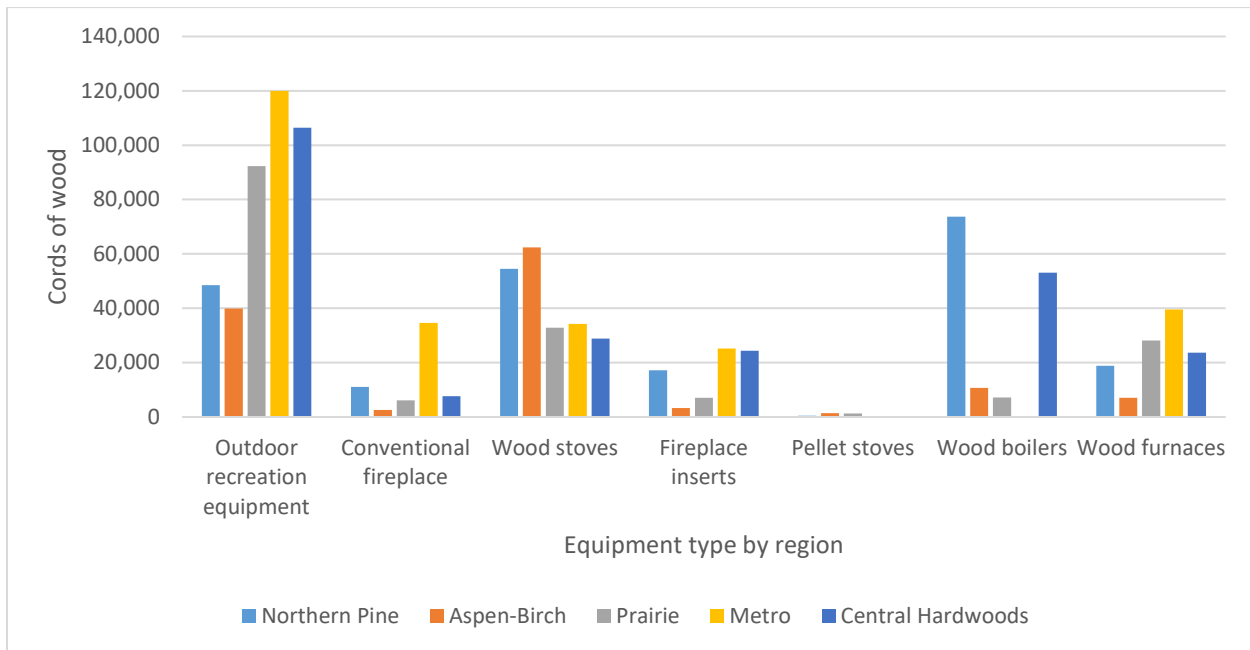
⁸ Recreation Fire Pit Emissions Testing, published in: [Minnesota residential wood combustion survey results](#)

⁹ Does not include outdoor recreation equipment at campsites, since they are not owned by Minnesota households.

Volume of wood burned by equipment and region

The greatest volume of wood burned occurred in the Metro and Central Hardwoods regions. As shown in Figure 14, most of this wood was consumed using outdoor recreational equipment, with approximately 120,000 cords in the Metro region and 106,000 cords in the Central Hardwoods region. Outdoor equipment also accounted for the highest volume of wood burned in the Prairie region (92,000 cords). In the Aspen-Birch region, wood stoves accounted for the largest share of wood burned within the region (62,000 cords) and represented the highest woodstove use among all regions. By equipment type, wood boilers consumed the most wood in the Northern Pine (74,000 cords) and Central Hardwoods (53,000 cords) regions. Pellet stoves consistently represented the lowest wood consumption across all regions.

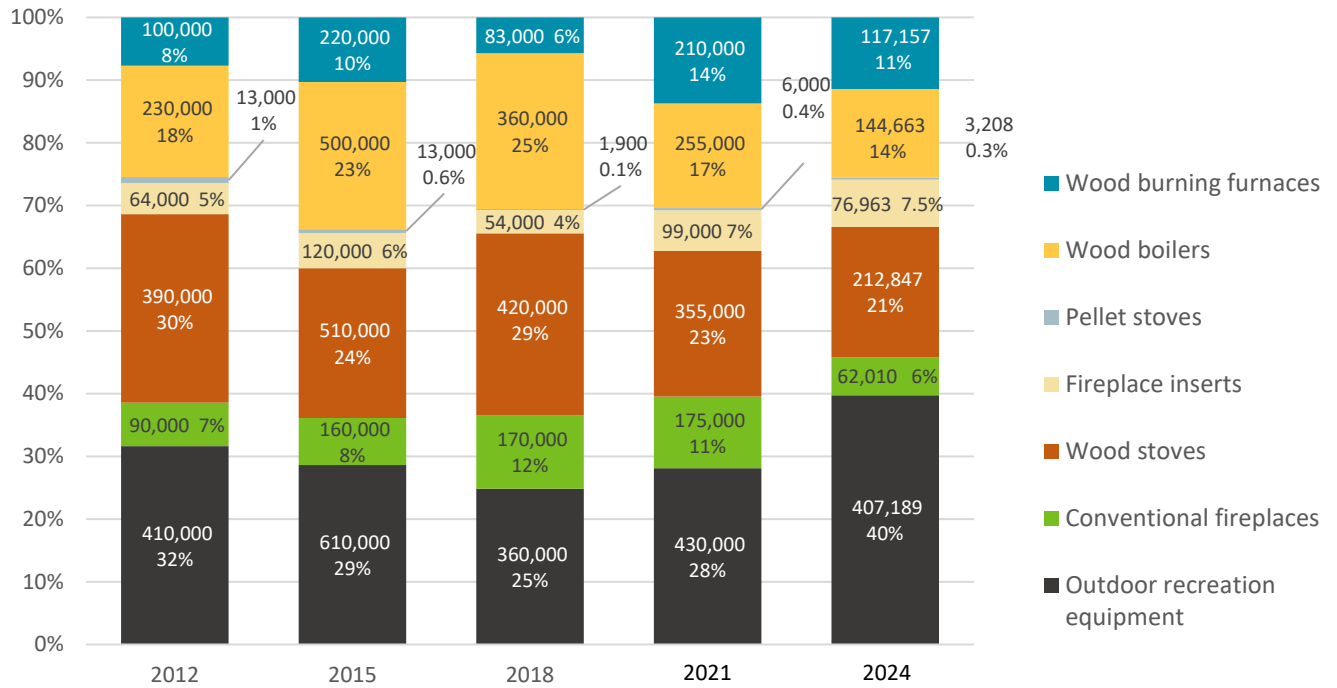
Figure 14. Estimated volume of wood burned by equipment type and region.



Wood burning by equipment over time

The estimated proportion of all wood burned in each type of equipment has varied slightly between 2012 and 2024 (Figure 15). Wood burned in outdoor recreational equipment decreased from 2012 to 2018, but since has increased to its highest proportion yet at 40% total wood burned. Meanwhile, the proportion of all other equipment types has decreased slightly or remained relatively the same. The total volume of wood burned has decreased in all equipment types, with the largest being an approximate 65% decrease in conventional fireplaces. Pellet stoves, furnaces, boilers, and wood stoves all had between a 40% and 45% decrease. Comparatively, outdoor recreation equipment decreased only by 5% contributing to its higher overall proportion in the 2024 survey.

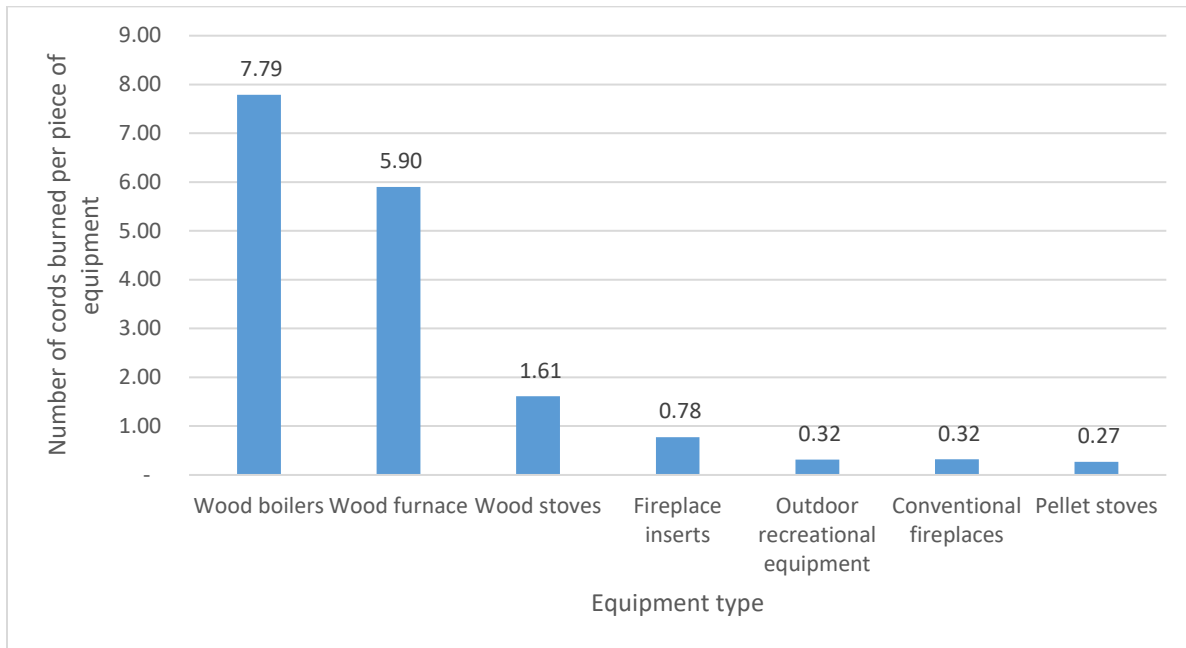
Figure 15. Estimated percent of total wood cords burned by equipment type and survey year.



Wood burning rate by equipment type

On average, individual wood boilers and wood furnaces burned much higher quantities of wood than other types. Figure 16 shows the estimated average number of cords burned per unit. Wood boilers have consistently used the most wood across recent survey years, with an average of 7.8 cords per unit in the most recent survey. Wood furnaces had the second-highest consumption, averaging 5.9 cords per unit. Pellet stoves burned the least wood (0.27 cords), which is expected given their higher heating efficiency (see conversion factor in [Appendix A](#)). Outdoor recreational equipment also burned small amounts of wood (0.32 cords) since this type of equipment is generally used for pleasure and disposal of woody yard waste.

Figure 16. Average estimated volume of wood burned annually by equipment type.¹⁰



Age of wood stoves and fireplace inserts

Federal standards to limit the amount of air pollution from wood stoves and fireplace inserts were initially adopted in 1989. In 2015, the U.S. Environmental Protection Agency (EPA) updated the standards to reduce air emissions, reflecting emissions and efficiency technology advances in the wood stove industry. The EPA further updated standards in 2020. Survey respondents were asked to report the age of their wood stoves and whether or not the stoves had catalyst technology.

There were an estimated 66,000 wood stoves and 32,000 fireplace inserts used in Minnesota that were manufactured before 1989, compared with 23,000 wood stoves and 19,000 fireplace inserts manufactured since 2015 (Figure 17 and Figure 18). This is up from the 2021 survey where 54,429 wood stoves and 10,430 fireplace inserts used were manufactured before 1989. These estimates inform an understanding of the potential quality of air emissions and the potential emission reductions that could be achieved from stove replacement programs. We know these are estimates because fireplace inserts and wood stoves may have worn or hidden tags where it is not accessible to view the manufacture date. Similarly, unexplained differences in percentages across survey years highlight sampling variability.

¹⁰ Does not include wood burned in outdoor recreation equipment at campsites.

Figure 17. Manufacture date of wood stove equipment.

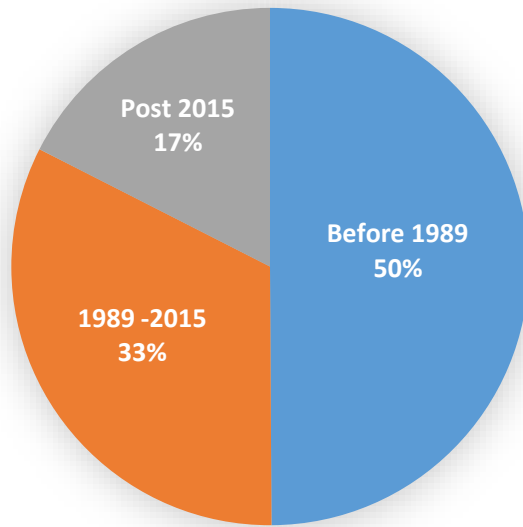
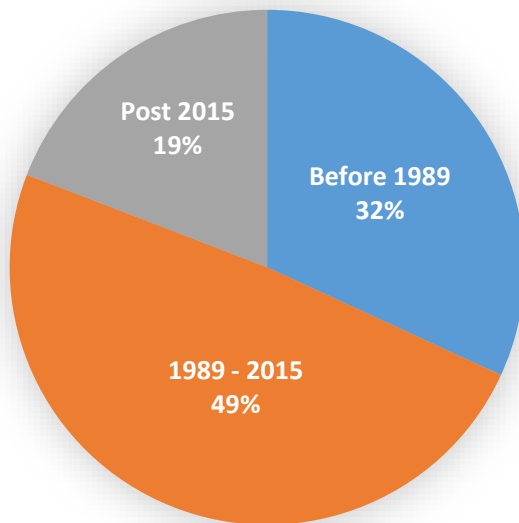


Figure 18. Manufacture date of fireplace inserts.



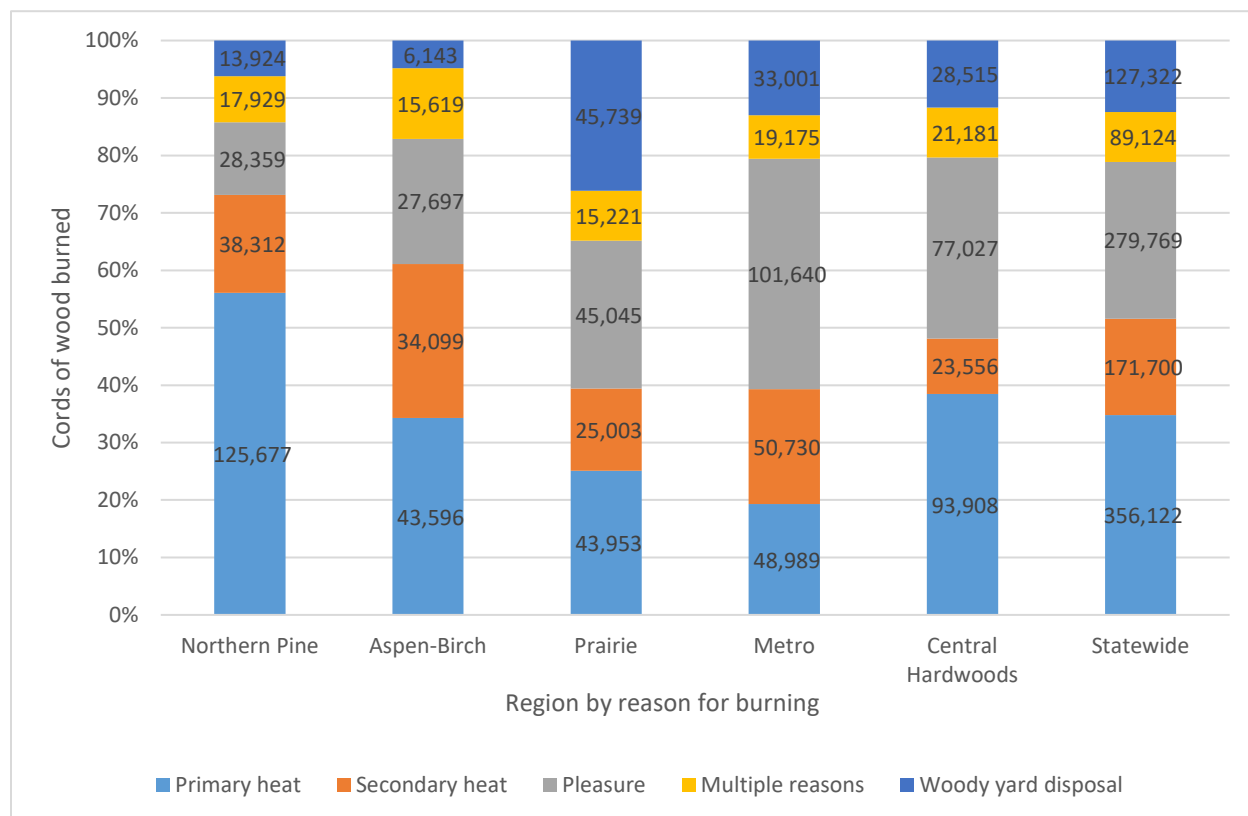
Characteristics of wood fuel users

Reasons for wood burning

Survey respondents were asked to report their reason(s) for burning wood in each type of equipment they used. For each type, respondents could select from the following five options: pleasure, primary heat source, secondary heat source, multiple reasons, or disposal of woody yard materials. Statewide, an estimated 35% of the total wood volume was burned for primary heating, followed by 27% for pleasure and 17% for secondary heating. Burning for disposal of woody yard materials accounted for 12%, while multiple reasons represented approximately 9% of the total volume burned.

Figure 19 shows how the estimated distribution and purpose for wood burning varied between regions. Across all regions and reasons, the highest volume of wood was burned in the Northern Pine region for primary heat (126,000 cords). For primary heat, the Central Hardwoods region followed with the second highest volume of wood burned with 94,000 cords. Burning for pleasure was most common in the Metro region, where 101,640 cords were consumed, considerably higher than in other regions. The Prairie region uniquely had a large portion of wood (45,700) burned for the disposal of woody yard materials. This may reflect debris generated by storms or pest management activities, along with limited access to alternative disposal options in rural areas. Secondary heating was most prevalent in the Metro region (50,700), followed by the Northern Pine region (38,300).

Figure 19. Estimated cords of wood burned as a percent of total wood burned by reason and region.



The distribution of reasons for burning wood from the last nine surveys conducted is shown in Figure 20. Note that “woody yard disposal” and “multiple reasons” were first added to the survey in 2015. The estimated proportion of wood burned for primary heating has slightly decreased over the last two surveys, now accounting for 34.7% of the total volume of wood burned. Beginning after 2003, the proportion and total amount of wood burned for pleasure began to increase rapidly over the following decade, accounting for 12% of wood burned in the 2003 survey and peaking at 41% in 2012. In 2021, wood burned for pleasure rose again to 38%, the highest recorded volume for that category, hypothesized to be due to the COVID-19 pandemic stay-at-home orders. In 2024, the amount burned for pleasure dropped to 27%, providing evidence for the 2021 hypothesis. This volume of wood burned for pleasure is higher than levels reported before the 2000s but falls within the range that has been observed since the 2003 survey. Wood burned for woody yard disposal reached its highest proportion yet at 12.4%, representing the second-largest volume of wood burned for this purpose on record.

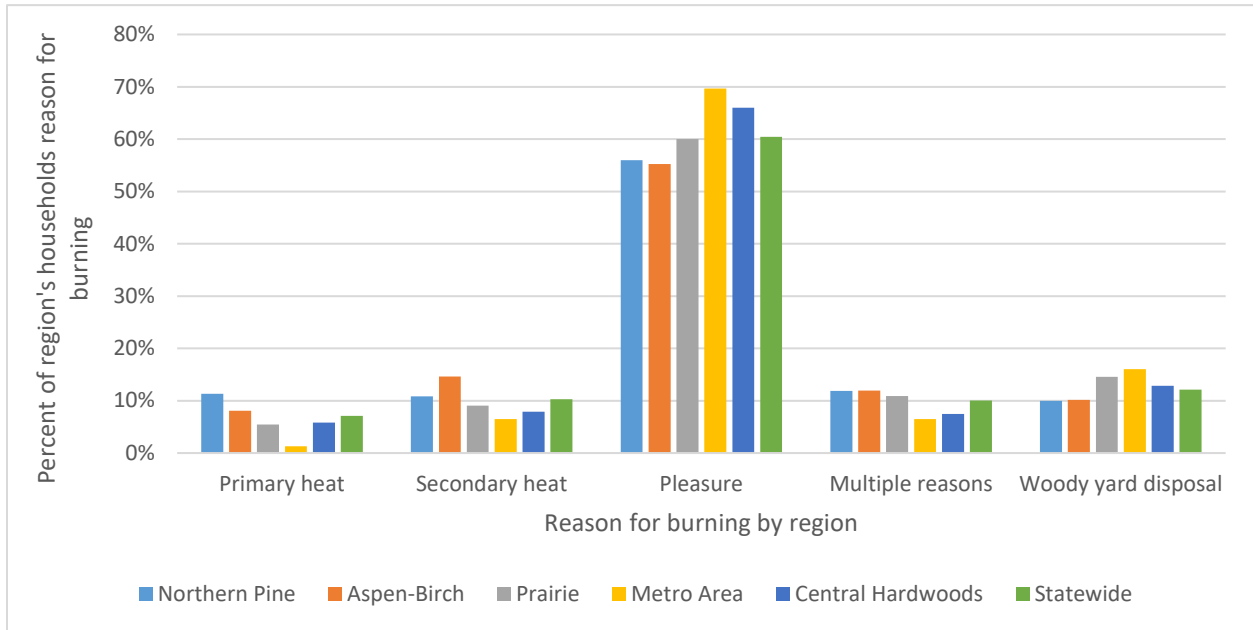
Figure 20. Estimated cords of wood burned by reason for burning, as percent of total wood burned by survey year.



*Note that “woody yard disposal” and “multiple reasons” were first added to the survey in 2015.

Figure 21 shows the proportion of the total household population in each region according to their reasons for burning wood. Statewide, 60.5% of households that burned wood did so for pleasure, and this held true across all regions. Comparatively, only 7% of households statewide burned for primary heat. The estimated percentage of households that burned for primary heat across regions ranged from 1% in the Metro to 11% in the Northern Pine region.

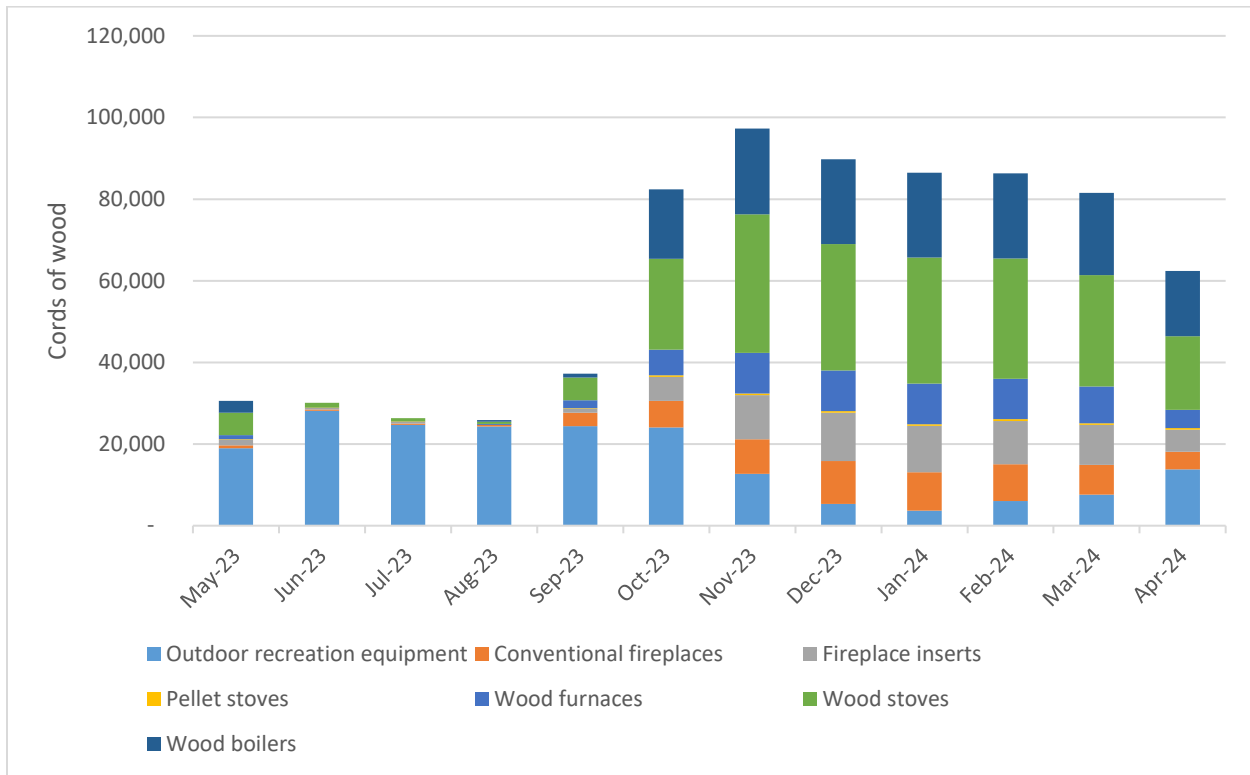
Figure 21. Percent of total household population in each region by reason for burning.



Time of year

Survey respondents were asked to report the months of the year in which they burned wood. Most was burned from October to April, reflecting the use of wood for heating purposes (Figure 22). Outdoor recreational burning took place year-round but was most common in the spring, summer, and fall. Wood stoves, conventional fireplaces, and fireplace inserts saw continued but limited use during the summer months.

Figure 22. Estimated volume of wood burned each month by equipment type.¹¹



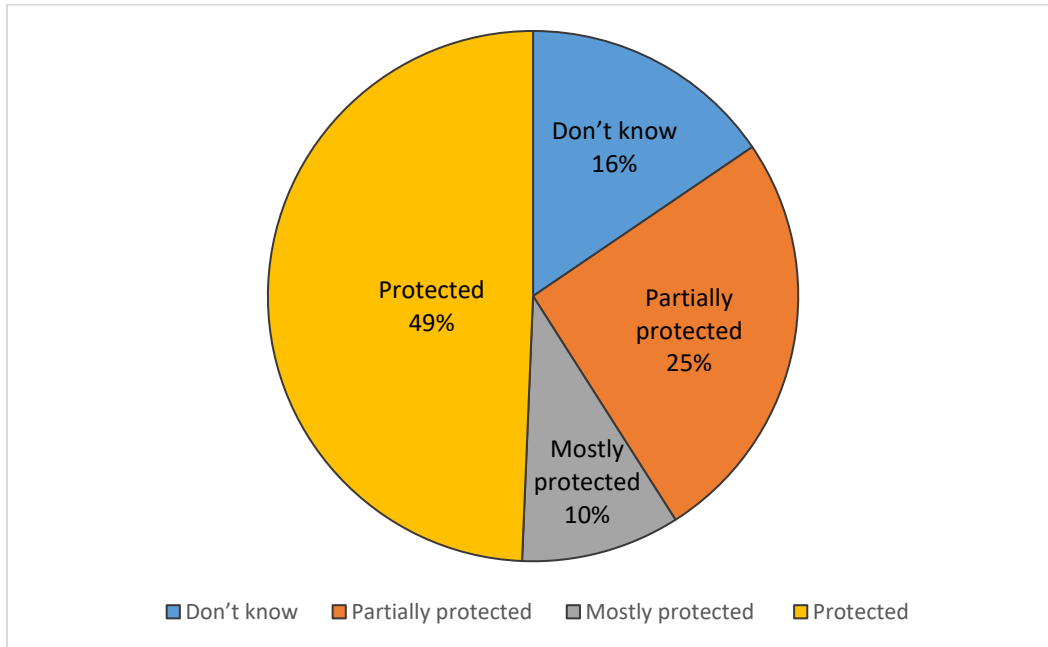
Wood storage practices

Survey respondents were asked to report whether their wood was stored protected from the elements, such as rain, at primary and secondary residences. Protected is defined as wood stored over 75% of the time, mostly protected as 36-75%, and partially protected as 0-35% of the time. Wood storage is important in addressing air quality since burning dry wood emits fewer air pollutants than burning wet wood.

Almost half of the wood burned (49%) in the 2024 season was stored protected from the elements (Figure 23). This represents an increase from the previous survey in 2021, when 36% of burned wood was reported as protected. A considerable proportion of respondents (16%) did not know the storage condition of their wood.

¹¹ Does not include wood burned at campsites. Some respondents did not indicate in which months they used their equipment.

Figure 23. Wood storage conditions.¹²



Types and sources of wood burned

Survey respondents reported the volume of wood they burned in units of cords, face cords, bundles, and bags of branches. Depending on the equipment type, they could also report the volume of wood in the form of pallets, slabs, wood pellets, and wax logs. These volumes were converted to full cords for analysis. Most of the wood burned in the state consisted of wood logs and split wood (95%). Pallets accounted for a small share (3.17%), while wood pellets and wax logs both contributed less than 1% of the total volume burned (Table 1).

Table 1. Estimated volume of wood burned by fuel type.

| Fuel type | Cords | Percent of total |
|-----------------------------------|-----------|------------------|
| Wood (cords, face cords, bundles) | 978,258 | 95.53% |
| Pallets | 32,450 | 3.17% |
| Wood pellets | 6,158 | 0.60% |
| Wax logs | 7,171 | 0.70% |
| Total | 1,024,037 | |

Types of wood burned

The distribution of types of wood burned in 2024 was similar to that observed in previous surveys. The greatest estimated known percentage of wood burned was oak (30%) followed by ash (13%). Maple

¹² Only includes wood burned at primary and secondary residences, not campsites.

(8%), Pine (7%), Birch (7%) and Aspen (7%) made up a smaller, similar proportion of wood burned. A considerable amount of wood burned was from unknown species (23%) (Table 2). Long-term trends are difficult to determine because of the addition and removal of species categories over time, as well as changes to survey design and methodology.

Table 2. Estimated percent of wood burned by species type.

| Type | Percent of statewide total | | | | | | | | |
|------------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
| | 1988-89 | 1995-96 | 2002-03 | 2007-08 | 2011-12 | 2014-15 | 2017-18 | 2020-21 | 2023-24 |
| Oak | 32% | 27% | 38% | 29% | 29% | 27% | 22% | 37% | 30% |
| Pine | N/A | N/A | N/A | N/A | 6% | 7% | 11% | 8% | 7% |
| Birch | 13% | 14% | 13% | 9% | 11% | 11% | 10% | 7% | 7% |
| Ash | 8% | 4% | 10% | 17% | 11% | 11% | 9% | 12% | 13% |
| Maple | 8% | 4% | 8% | 10% | 9% | 6% | 9% | 9% | 8% |
| Other hardwoods | N/A | N/A | N/A | N/A | N/A | 5% | 6% | N/A | N/A |
| Aspen | 7% | 10% | 8% | 12% | 7% | 9% | 5% | 5% | 7% |
| Elm | 14% | 3% | 5% | 9% | 6% | 5% | 5% | 4% | 3% |
| Other softwoods | N/A | N/A | N/A | N/A | N/A | 3% | 4% | N/A | N/A |
| Basswood | N/A | N/A | N/A | N/A | 1% | 2% | 3% | 4% | 1% |
| Unknown species | N/A | N/A | N/A | N/A | N/A | 14% | 17% | 14% | 23% |
| Cedar | N/A | N/A | N/A | N/A | <1% | N/A | N/A | N/A | |
| Mixed species | N/A | N/A | N/A | N/A | 16% | N/A | N/A | N/A | N/A |
| Other species | 3% | 6% | 9% | 10% | 4% | N/A | N/A | N/A | N/A |
| Slabs and scrap lumber | 15% | 32% | 8% | 4% | N/A | N/A | N/A | N/A | N/A |

Note: Changes over time should be interpreted carefully due to changes in the survey design, methodology, response rate, and conversion rates for different types of wood.

N/A: Minimal or not asked on the survey

Procurement of wood for burning

The survey asked respondents to report how and where they procured the wood they burned. About 50% of the wood Minnesota residents burned was self-harvested by the household or an immediate family member, while just 1% was purchased or received for free (Table 3). A significant portion (47%) is listed as unknown, because respondents that reported harvesting wood but then did not report the procurement method were placed in the unknown category. The total cords of wood harvested does not include wood gathered during yard cleanup or maintenance.

Table 3. Estimated amount and percent of wood burned by procurement method.

| Procurement method | Percent of state total | Cords |
|--------------------------------|------------------------|---------|
| Harvested | 50.35% | 515,634 |
| Purchased or received for free | 0.53% | 5,397 |
| Sawmills | 0.42% | 4,323 |
| Dealer or logger | 1.32% | 13,527 |
| Camping | 0.28% | 2,854 |
| Unknown or unreported | 47.10% | 482,301 |

Wood harvesting

The survey asked respondents how much firewood they harvested for the purpose of burning over the course of the year, not including wood gathered during yard cleanup or maintenance.

Results of the survey indicated an estimated 927,005 cords of wood were harvested by Minnesotans between May 2023 and April 2024.

Types of wood harvested

Similar to the distribution of wood burned, the greatest percent of wood harvested was oak (30%), followed by pine (16%), ash (12%) and birch (10%). (Table 4).

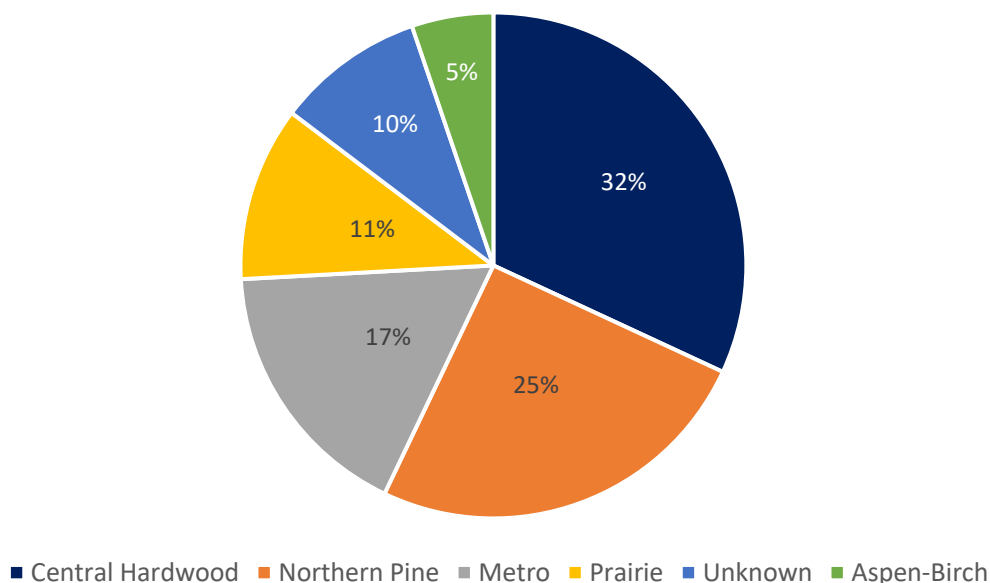
Table 4. Estimated percent of wood harvested by species.

| Type | Percent of total |
|----------|------------------|
| Oak | 30% |
| Pine | 16% |
| Ash | 12% |
| Birch | 10% |
| Maple | 9% |
| Unknown | 9% |
| Aspen | 8% |
| Elm | 4% |
| Basswood | 2% |

Location of wood harvesting

The Central Hardwoods region had the greatest reported amount of wood harvested from the region with 32% of the total (Figure 24), followed by Northern Pine at 25%. This question was redesigned from the 2018 survey which listed “Unknown” as the first option. Over half of the respondents chose that answer in the 2018 survey. Moving the “unknown” response as the last option may have resulted in more accurate answers for subsequent surveys.

Figure 24. Estimated percent of wood harvested by region.



The majority of harvested wood was from private land (85%). Small proportions were harvested from county land (7%), and state land (5%) (Table 5). A small proportion came from unknown location (2%), municipal land (1%), and national forestland (<1%).

Table 5. Estimated amount and percent of wood harvested by property type.

| Harvest location | Cords | Percent of total |
|---------------------|---------|------------------|
| Private land | 786,003 | 85% |
| County land | 63,674 | 7% |
| State land | 50,445 | 5% |
| Unknown | 14,047 | 2% |
| Municipal land | 9,062 | 1% |
| National forestland | 3,777 | <1% |
| Total | 927,006 | |

An estimated 31% of the wood harvested came from dead trees from forestland (Table 6). Wood harvested from live or dead trees from yards inside city limits, or other non-forest land (26%) was the

second-greatest source of harvested wood. A much larger proportion of firewood in this survey came from live trees on forest land at 23%, compared with less than 1% in the 2021 survey. There was also an increase in wood sourced from live or dead trees on pasture and cropland, which now accounts for 15%.

Table 6. Estimated amount and percent of wood harvested by type of harvest source.

| Harvest source | Cords | Percent of total |
|--|----------------|-------------------------|
| Live or dead trees from yards, inside city limits, or other non-forestland | 237,732 | 26% |
| Dead trees from forestland | 285,364 | 31% |
| Live or dead trees from pasture land and cropland | 134,764 | 15% |
| Live trees from forestland | 215,354 | 23% |
| Cut trees or tops and branches after a timber harvest | 26,424 | 3% |
| Unknown | 27,368 | 3% |
| Total | 927,006 | |

Conclusions

Key findings

Since 2003, residential wood burning appears to be increasing non-linearly over time. However, despite the increasing trend, this survey saw a noticeable decrease. An estimated 1.024 million cords were burned between May 1, 2023 and April 30, 2024. This is the lowest reported volume of wood burned since the 2008 survey, and a 33% decrease from the 2021 survey.

Roughly 1,125,000 households, about 50% of all Minnesota households, burned some wood between May 2023 and April 2024. This proportion varies between the five survey regions. The Northern Pine region had the highest estimated proportion of households that burned wood, at 63% of the region's total households, while the Metro region had the lowest, at 38%.

Statewide, the greatest volume of wood burned was for primary heat, but burning for pleasure was the most common reason a household burned wood. Statewide, an estimated 34.7% of all wood burned was burned for primary heat. However, only 7% of households statewide burned for primary heat, while 60% of households burned for pleasure. These findings suggest that statewide wood-burning totals are driven both by a small number of households consuming large quantities for heating and by a large number of households each burning small amounts for pleasure.

Across regions, the Metro had the highest proportion of total volume of wood burned, making up 24% of the statewide total. Within the Metro, the largest share (40%) of the total wood burned was for pleasure, and similarly, 70% of Metro households' motivation for burning was for pleasure. On the other hand, this region had the lowest average wood consumption per household, at 0.5 cords. The Metro region contains the largest population in the state, influencing its high wood-burning total. These findings further illustrate that a substantial portion of wood burned statewide comes from many households burning relatively small amounts of wood primarily for pleasure.

In past surveys, data has shown a large proportion of wood burned in wood boilers and wood stoves. For the first time in the 2024 survey, outdoor recreational equipment burned more wood than boilers and stoves combined, accounting for 40% of all wood burned.

Per piece of equipment wood boilers (7.79 cords) and wood furnaces (5.90 cords) burn the most wood. However, these types of equipment are less common statewide compared to wood stoves (less than 20,000 of both statewide compared to 113,000 of wood stoves). Despite their lower numbers, combined, boilers and furnaces account for 25% of the total volume of wood burned in the state.

Most wood burned was stored completely or partially protected from the elements. Unprotected, wet wood burns less efficiently than dry wood and releases more smoke.

Implications

Opportunities still exist for wood-burning equipment change-out programs. In this most recent survey, there was a higher proportion of woodstoves and fireplace inserts (50% and 32% respectively) manufactured before 1989 compared to other recent surveys, illustrating there are still substantial improvements to be made. Information about the number, location, and types of old, inefficient wood

burning equipment still being used will be useful for efforts such as Environmental Initiative's Project Stove Swap¹³ in designing those incentive programs.

The Metro region covers a much smaller geographic area than any other region, but its households burned the largest proportion of wood volume. **On average, the Metro region burns more cords of wood per acre than any other region.** Due to the region's higher population density, reducing wood burning or improving wood burning practices could meaningfully decrease exposure to wood smoke and associated health impacts.

The amount of air pollution released from the different types of wood-burning equipment varies depending on the air pollution controls. Outdoor recreational residential fires, which have no controls, account for 47% of the wood burned in the Metro region and 40% of the wood burned statewide. Action could be taken to reduce emissions from outdoor recreational fires, such as information campaigns about how to build clean-burning backyard fires or increasing the use of low-smoke firepits, providing benefits throughout Minnesota, especially in more densely populated neighborhoods. These data will inform the MPCA's partners in Clean Air Minnesota¹⁴, who are working on voluntary measures to reduce air pollution from sources such as residential wood burning.

Wood boilers and furnaces present an opportunity to decrease wood burning and associated emissions as these equipment types burn the most wood per unit and therefore produce higher emissions.

Estimates from this study indicate residents use their backyard recreational equipment to dispose of woody materials from their yards. If other methods for disposing of branches and brush from residential properties were convenient and widely available, this air pollution source could be reduced.

Additional analysis and possible future research

In February 2015 and again in 2020, the EPA revised the standard for new wood stoves and fireplace inserts as well as boilers (hydronic heaters) and forced-air furnaces. As the survey data show, we are already seeing households using these cleaner-burning units. However, people are keeping old devices in use, or could find loopholes to install uncertified devices. The MPCA will be evaluating how to incorporate the increasing use of these newer devices into its emissions inventory estimates, and how to encourage replacement of uncertified units.

Other factors have been speculated as affecting wood use trends and need further evaluation. Further studies could examine non-wood energy prices' influence on wood use and quantities. Air Quality Index (AQI) alerts, signaling bad air quality days, were not statistically evaluated in this report but they could impact individuals' decisions to burn wood. This future evaluation is encouraged especially if Minnesota continues to see more AQI alerts due to wildfires or air pollution. For the first time, this report evaluated the impact of outdoor temperature on wood burning. As climate change creates more unpredictable weather patterns, continuing or expanding research on weather's impact to wood burning will be needed.

Similarly, wood use, particularly as a heating fuel, will have a role in addressing and adapting to climate change. Survey results will need to be evaluated through this lens.

¹³ Environmental Initiative <https://environmental-initiative.org/work/project-stove-swap/>

¹⁴ Clean Air Minnesota <https://environmental-initiative.org/work/clean-air-minnesota/>

Survey methods

As in prior surveys, Minnesota households were independently sampled from five geographic regions. Surveys stratify the population into subgroups expected to have similar behaviors as a way to cost-effectively improve the precision of the estimates. These five survey regions, depicted in Figure 25, are based on four U.S. Forest Service survey units for Minnesota forests. The Aspen-Birch and Northern Pine survey regions contain most of the state's boreal forest. The Aspen-Birch region has Minnesota's largest area of reserved forest land, including the Boundary Waters Canoe Area Wilderness and Voyageurs National Park. The Central Hardwoods survey region is dominated by hardwoods. The more densely populated seven-county Twin Cities Metro region was sampled separately from the less densely populated portion of the Central Hardwoods region. The Prairie survey region is dominated by croplands.

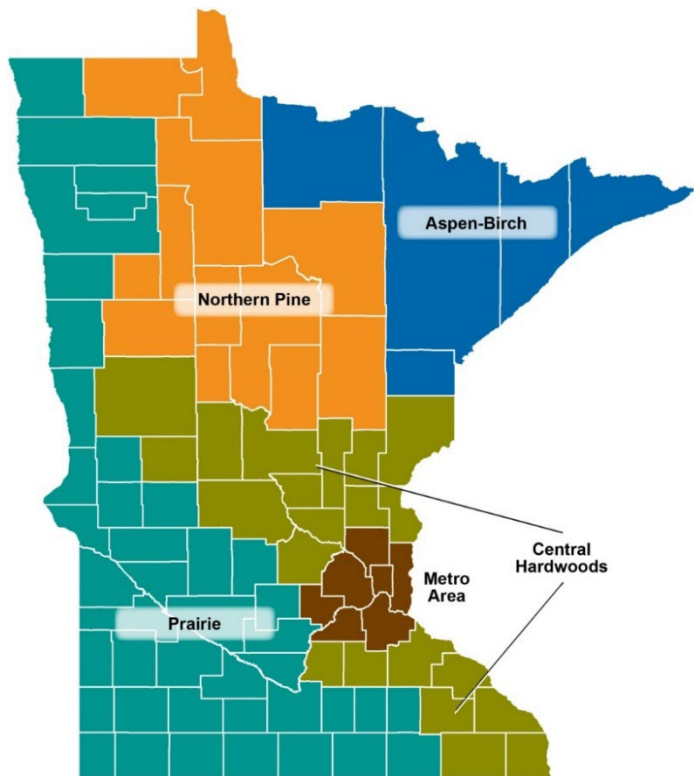
Based on recent census data, the Metro region is geographically the smallest region but contains just over half of Minnesota's occupied households (55.1%). The Aspen-Birch (5.0%) and Northern Pine (5.5%) regions are the least densely populated. The Prairie (14.0%) and Central Hardwoods (20.4%) regions are also much less densely populated than the Metro region. See Table 7 for the number of households in each region.

Sample selection

A sample of 7,000 addresses selected at random from valid Minnesota residential addresses, based on a U.S. postal service list of residential addresses, was purchased from Marketing Systems Group (MSG), a company specializing in sampling services. Vacant, seasonal, P.O. Boxes, and drop points (single addresses that are for multiple residences) were excluded from the sample.

These Minnesota households were included in the sampling frame using a disproportionate stratified sampling design. Households in the Northern Pine and Aspen-Birch regions had a five times greater chance of being invited to take the survey than did those living in the Metro region. Chances for households in the Prairie and Central Hardwoods regions to be surveyed were respectively 2.0 and 1.3 times higher than for the Metro region. Based on the number of households in each region, this resulted in the Metro region being sent about twice as many surveys as each of the other regions. This is consistent with the sampling method used in the 2012, 2015, 2018, and 2021 survey designs. Table 7 shows the number of occupied households in and sampled from each survey region. The pre-2012 surveys invited similar numbers of households to take the survey from each region. Beginning with the 2012 survey, the Metro area was sent twice as many surveys as each of the other regions for several reasons: because more than half of the households in Minnesota are in the Metro area, residential wood smoke from the relatively dense population in the Metro area has been estimated to result in a larger localized air quality impact due to a denser population than the rest of the state, and the Metro region has previously experienced slightly lower response rates.

Figure 25. Survey regions for stratified sample.



Survey administration

On April 26, 2024, all addresses in the sample were mailed an invitation letter with a paper survey packet and an addressed, postage-paid envelope. Two weeks later, on May 10, 2024, a reminder postcard was sent to the full sample. Addresses for materials returned completed or as undeliverable were then removed from the sample, and the remaining addresses were sent a final, full survey on May 24, 2024.

There were no within-household respondent selection quotas, so any resident of the household could complete the survey. Presumably, the household member who was willing or who knew the most about the household's wood burning practices completed the survey.

Each survey had a unique number printed in the lower left-hand corner that corresponded to an address in the sample. As surveys were completed, the unique survey numbers were checked off a master list. In the end, 1,350 surveys were returned.

Table 7. Population and survey responses by region.

| Survey mailings and response rates | Northern Pine | Aspen-Birch | Prairie | Metro Area | Central Hardwoods | Statewide |
|---|----------------------|--------------------|----------------|-------------------|--------------------------|------------------|
| Number of occupied housing units | 124,597 | 112,932 | 315,884 | 1,243,276 | 459,437 | 2,256,126 |
| Number of addresses in sample | 1,195 | 1,168 | 1,195 | 2,300 | 1,142 | 7,000 |
| Number returned as undeliverable | 64 | 43 | 39 | 61 | 25 | 232 |
| Number of refusals | 2 | 1 | 4 | 2 | 1 | 10 |
| Total completed | 241 | 258 | 217 | 403 | 231 | 1,350 |
| Response rate | 21% | 23% | 19% | 18% | 21% | 20% |

Paper survey results were entered into an electronic database so all the data could be compared easily using Excel software. Once all responses were entered and checked for quality, the unique numbers were disassociated from the addresses to maintain privacy of the respondents and prevent associating responses with specific mailing addresses. The data could still be tracked by city, county, ZIP code, and survey region.

Data analysis methods

Prepare data for analysis

The first step in preparing data for analysis was to import the paper survey responses into the statistical software package (SPSS), review responses for quality, and recode responses into formats appropriate for analysis. To ensure data quality, manually entered data from the paper surveys were rechecked to make any necessary corrections. An additional review of the data set was done to ensure data validity and to discard any unusable surveys. (Discarded surveys included those with duplicate entries and those returned blank). Once the data were checked and quality ensured, the resulting total survey sample was 1,350 responses.

Correct missing, invalid, or contradictory responses

Dealing with missing, invalid, and contradictory responses was a lengthy process that involved a combination of inference, imputation, and common sense. Many of the key assumptions that were made are documented below. Throughout this process, any questionable responses were checked with the actual paper surveys to ensure that data were captured correctly. If a questionable response was verified, it was reclassified as invalid, and a replacement value for the response was imputed based on the assumptions and methods listed below.

Missing location information

A first step in the data analysis was to determine the location, by survey region, of every reported wood burning activity. Wood burning could occur at three location types: primary residence, secondary residence, or campsite. For respondents who filled out the survey completely and accurately, geographic locations for all these activities were provided. However, in some instances this information was missing or incomplete. In all cases in which respondents did not provide the location of their primary residence, it was assumed that the primary residence was the address to which the survey was mailed. A total of 30 respondents mailed only in the first page of the survey (all of which indicated that they did not burn wood). The region of their primary residence was imputed using a hot-deck procedure (described below). In most cases where respondents *did* provide the location of their primary residence, it matched our information on where the survey was mailed. In the few cases where there was not a match, the location in the survey response overrode the survey region where the survey was mailed.

When respondents indicated wood burning at a secondary residence but did not provide location information for a secondary residence, its location was inferred based on probabilities for all respondents who did provide secondary residence information (This is known as a random hot deck method). For example, for all Northern Pine residents who provided secondary residence information, data showed the following probabilities for the location of its secondary residence (hypothetical example with made-up numbers):

Primary residence: Northern Pine

Secondary residence: Northern Pine: 70%

Aspen-Birch: 10%

Prairie: 5%

Metro Area: 0%

Central Hardwoods: 15%

Then, for all households with a primary residence in the Northern Pine region that did not provide the location of their secondary residence, their secondary residence location was randomly chosen according to the indicated probabilities.

The final location type for wood burning was campsites. Survey respondents were instructed to select the regions in Minnesota in which they burned wood at campsites. Respondents could select more than one of the five regions. When respondents indicated more than one camping location, the total wood burned while camping was allocated equally to all regions listed. In cases where respondents did not provide campsite locations, the location was inferred based on the modal response of all other responses from households with primary residences in the same region. For example, if among all households with a primary residence in the Metro region, the most common camping location was in the Central Hardwoods region, then all respondents from the Metro region that did not provide campsite locations were assumed to have camped in the Central Hardwoods region.

Missing or invalid wood burning quantities

There were many instances when respondents indicated owning particular wood burning equipment, but they did not enter the quantity of wood burned. Quantities were inferred or imputed in the following ways. In the majority of cases, a missing quantity was inferred to indicate that the respondent did not use the particular wood burning equipment. Only in cases where other responses made it clear that the household did indeed burn wood were missing quantities inferred or imputed. Such responses

included indicating the months of the year in which the particular equipment was used. In these cases, simple regression models were used to impute missing quantities based on all those that did provide quantities for that particular equipment. For all households that did provide burning quantities for use of equipment, their reported number of pieces of equipment type and the number of months in which they used equipment were used to estimate the following regression equation:

$$\text{Quantity Burned} = \alpha + \beta_1 \text{ Number of Equipment} + \beta_2 \text{ Number of Months Equipment Used}$$

Thus, using the responses of all other households that did provide burning quantities, the coefficients in the above equation (α , β_1 , β_2) were estimated and used to impute the amount of wood burned by any household that did not provide quantities based on the number of pieces of equipment the household reported to have¹⁵ and the number of months¹⁶ for which burning activity was reported. Note that a separate version of the equation above was estimated and applied for each different type of equipment, and separate equations were estimated for primary and secondary residences.

1 Throughout the survey, if a respondent indicated having a particular type of wood burning equipment, but did not indicate how many pieces of the equipment they had, it was assumed they had one piece, which was the modal response for all equipment types for all households who did indicate the number of equipment pieces.

2 Missing numbers of months were replaced with the median response.

In the case of campfires, when respondents reported having campfires, but did not provide the quantity of wood burned, the median campfire burning amount for all respondents was assumed.

Other missing information

In several cases, respondents indicated having and using wood burning equipment, but did not give complete information. When respondents failed to indicate how many pieces of a particular type of equipment they had, it was assumed they had only one piece of equipment (which was the modal response for all the equipment types for the households that did provide this information). When respondents did not provide their main purpose for using a piece of equipment, we followed the guidelines from the 2012, 2015, 2018 and 2021 studies by replacing missing data with the most typical burning purpose of a particular equipment type: "pleasure" for fireplaces and outdoor wood burning equipment; "secondary heat source" for wood stoves, fireplace inserts, and pellet stoves; and "primary heat source" for wood burning boiler or furnace. For all but wood burning boilers or furnaces, the purpose question was changed into a multiple response question. In order to impute the purpose in the analysis, people who gave more than one response were placed in a "multiple answers" category. For all four of the "purpose" questions, respondents who said "none" were left as "none".

For each type of equipment, we determined whether the respondent had the equipment and, if so, whether that equipment was used. Having the equipment was determined from all the questions in the equipment section of the survey. If the respondent said they had the equipment (for instance, a fire pit), or if any of the follow-up items indicated the equipment existed (for instance, they reported using it for pleasure), then we said that the respondent had that type of equipment. Using the equipment was

¹⁵ *Throughout the survey, if a respondent indicated having a particular type of wood burning equipment, but did not indicate how many pieces of the equipment they had, it was assumed they had one piece, which was the modal response for all equipment types for all households who did indicate the number of equipment pieces.*

¹⁶ *Missing numbers of months were replaced with the median response.*

defined as having the equipment and reporting any one of the following: a purpose for burning, months during which there was burning, or the amount of wood burned.

Other responses revealed clear contradictions that suggested that respondents either did not thoroughly understand the survey or did not know the specific type of equipment that they had. For example, in the section on wood burning furnaces and boilers, some respondents crossed out question 24 indicating they did not have a wood boiler or wood furnace but answered questions 29 and 30. In cases of obvious contradictions such as this, corrections were made to most accurately reflect the true behaviors of responding households. In the example above, we corrected the survey to indicate the respondent did not have a wood boiler or furnace.

We expected the type of wood burned and the type of wood harvested responses to add up to 100%. In some cases, that was not true. On those three questions, if the sum was greater than 100%, the forms were reviewed for coding and/or keying errors and updated. This review resulted in no cases summing to more than 100% on any of those three questions. If one of the three questions' percentages summed to less than 100%, the residual was placed in an "unknown" category. Similarly, respondents who harvested wood were asked to list the counties (up to four) from which the wood came and the percentage of wood that came from each county. Again, forms were reviewed for coding and/or keying errors. After the review, there were no cases where the county percentages needed to be adjusted.

There were 44 instances of respondents indicating that they used wood stoves, fireplace inserts or pellet stoves but did not know (or did not provide a response) when their equipment was made. These missing values were calculated using known probabilities from non-missing responses for each type of equipment. It was assumed that if a respondent skips or doesn't know when the equipment was manufactured, they do not have a unit that was made after 2015.

Concurrent to the completion of analysis for this report, the quality-assured data with all the inferences and calculations described above is being transferred into a relational database. It will be publicly available when the transfer is completed.

Aggregate survey responses

Based on locations of primary and secondary residences and provided (or inferred) locations for campsite burning, every burning activity reported in the survey was assigned to one of the five regions. All wood burning quantities were converted into common units of cords. Some survey units (full cords, face cords, and bundles) were converted based on standard conversion factors.¹⁷ Other wood burning units (wax logs, pallets, pounds of pellets) were converted into cord equivalents using the conversion factors listed in Appendix A:

Applying the survey findings to the entire population

Estimates of the total wood burned, as well as subtotals by equipment type and burning purpose, were extrapolated to determine approximate wood burning amounts for the entire population for each region. This extrapolation was based on the number of occupied households in each survey region, according to the 2018-2022 five-year U.S. Census American Community Survey, table DP04. For example, there were 410¹⁸ survey responses from the Metro region, and there are 1,243,276 households in the region. Thus, Metro region totals for the survey sample were scaled up by a factor of

¹⁷ Three face cords or 170 bundles equal one full cord.

¹⁸ There were 410 surveys that identified a primary residence in the Metro region, compared to 403 respondents whose survey was mailed to a Metro region address.

$1,243,276/410 = 3,032^{19}$ to estimate total burning activities for the region. Scaling survey region-wide estimates in this manner corrects for the unequal probability of selection caused by *disproportionate stratified sampling* (i.e., the fact that the proportion of completed surveys from any individual survey region was unequal to that region's proportion of the total state household population).

Additional technical details

- If secondary residence was not in Minnesota or open-end response indicated that the residence was not actually a residence (e.g., a campground), all responses for secondary residence burning were dropped.
- If information written on a form indicated that wood burning reported for secondary residence was actually for the primary residence (e.g., Q42 to Q45), the responses were moved to primary (Q38 to Q41).
- If respondent failed to answer campfire burning activity or said "no" (Q5) but provided answer for amount of wood burned (Q6) or region(s) in which burning took place (Q7), then the response to Q5 was assumed to be "yes".
- Missing burning amounts for wood stoves were calculated collectively, without regard to the specific equipment sub-type (convention, non-catalytic, catalytic). This was also done for fireplace inserts.
- If the only burning reported in a survey was of yard waste, all items in the harvesting section (Q52 through Q56) were recoded to not applicable (NA)
- Respondents that responded that they did not do any burning were not asked their county location. Instead, the county came from the sample list.
- We assume that respondents with no evidence of a secondary residence who did not check the check box "I do not have a secondary residence" do not have one.
- If there was evidence of wood burning in a boiler or furnace, and Q24 or Q31 is blank, then we coded Q24 or Q31 = 4 "Yes, unknown device"
- Respondents describe burning throughout the survey. It is necessary to review the entire form to determine where the burning occurred, and the volume. We found that some respondents put identical information in multiple sections (for instance, in fireplaces and fireplace inserts). When that happened, we deleted the duplicate.
- If the respondent said they harvested wood (Yes to Q51) but then put 0 cords in Q52, all the following harvesting questions were deleted.
- The percentages for Q50, sources of harvested wood, should add to 100%. Forms were reviewed for coding and/or keying errors. After the review, when the questions summed to less than 100%, the residual was put into an unknown variable.
- The percentages for Q53, the locations of harvested wood, should add to 100%. Forms were reviewed for coding and/or keying errors. After the review, all did, so no adjustments were needed.
- The percentages for Q54, harvesting sources, should add to 100%. Forms were reviewed for coding and/or keying errors. After the review, when the questions summed to less than 100%, the residual was put into an unknown variable.

¹⁹ This is equivalent to saying that each household responding to the survey from the Metro region represents 3,032 households in the population as a whole.

Appendix A: Sources of secondary calculations of wood fuel volumes

1. Wood slabs. A conversion factor of 1.0368 tons per cord was used for sawmill slabs and edgings, based on: Bell, G. E., & Brooks, E. (1955). *Cord-cubic volume of relationship of slab wood and edgings* [Release No. 232]. American Pulpwood Association. New York, NY.

2. Wood pellets. A conversion factor of 2.752 tons per cord was used for wood pellets, based on information from Jason Berthiaume, Pellet Fuels Institute (PFI). Current standards require a minimum density for PFI-graded pellets of 40lbs/cu ft. Under standards, implemented in 2009, density for super-premium and premium pellets are 40-46lbs/cu ft, with standard and utility grades at 38-46lbs/cu ft. As super-premium and premium make up the vast majority of residential heating pellets, it makes sense to use the 40-46 range. Mid-range of 43 X 128 cubic feet per cord = 2.752 tons per cord.

3. Wax logs. A conversion factor of 1.0989 tons per cord was used for wax/manufactured fireplace logs, based on: Houck, J. E. (July 2002). OMNI Consulting Services, Inc. Beaverton, Oregon. He determined 444 typical logs make up a cord. The weighted average mass of wax/sawdust fireplace logs is 4.95 lbs. (2.5 lbs., 3.2 lbs., 5 lbs., and 6 lbs. logs are sold). The average mass of densified logs sold is 5 lbs.

4. Wood pallets. A conversion factor of 0.5184 tons per cord was used for wood pallets and crates, based on: WikiAnswers: “How much does a pallet weigh?” and “What is the standard size of a wooden pallet?” It was assumed the Grocery Manufacturers' Association pallet was 48 inches by 40 inches, and each weighed 45 pounds.

5. 30-gallon bag of branches. A conversion factor of 63 “30-gallon bags of tree branches and wood brush collected from your yard” per cord of wood was used. This is based on a commonly used estimate of 300 pounds per cubic yard of loose yard waste branches from the National Recycling Measurement Standards and Reporting Guidelines, based on information from John Springman, Ramsey County Minnesota Yard Waste Program (2016). This estimate falls within the 250 to 350 pound per cubic yard of loose brush range referenced in Resource Recycling, November 1991.

Calculation of regional and statewide total amounts

Survey results were tallied using the populated relational database and reported as state totals and for the five regions based on the region in which the burning took place. The wood burning equipment and burning activities were grouped into seven categories — outdoor recreational equipment, conventional fireplaces, wood stoves, fireplace inserts, wood pellet stoves, wood boilers (hydronic heaters), and forced-air furnaces. Wood burned in each equipment category was grouped according to the main purpose for which the household reported burning the wood.

Calculation of average annual growth rate

Average annual growth rates in volume of wood burned and population over time were calculated by solving for the compound annual growth rate.

Calculation of the confidence interval for the total wood burned statewide

We calculated a confidence interval for the estimate of the total cords of wood burned statewide. This indicates the range where the true statewide amount burned was expected to be, with a 95% level of confidence. This reflects the inherent variability in how much wood a household burns and the fact that all population-level estimates derived from survey responses have an inherent degree of uncertainty. This uncertainty arises from many causes, including the survey sampling method and size.

Confidence intervals for statewide wood-burning totals were calculated in the following manner. First, we calculated a regionally adjusted non-scaling weight. Out of 1,350 total completed surveys, 403 were from respondents with primary residences in the Metro region. Thus, the percentage of surveys in the total survey sample from the Metro region was $\frac{403}{1,350} = 29.85\%$. The overall number of households in the Metro region is 1,243,276, while there are 2,256,126 households in the state. Thus, the percentage of the state's households in the Metro region is $\frac{1,243,276}{2,256,126} = 55\%$. Therefore, Metro region households make up 55% of the state population but only 29.85% of the survey sample population, so the Metro region was under-represented in the survey sample. Similarly, other regions were either under- or over-represented in the survey sample. As was appropriate for the calculations of the regionally adjusted scaling weights above, because wood-burning behaviors may vary across regions of primary residence, giving equal weight to all surveys regardless of residence location could introduce bias in the total estimates for statewide burning. Weights for surveys from over-represented survey regions were given regionally adjusted non-scaling weights less than one (i.e., the contribution of their wood burning activities to state totals was adjusted down), while under-represented regions were given regionally adjusted non-scaling weights greater than one (their contribution to total estimates was adjusted up). Continuing the Metro region example, responses from this region were given weights of $\frac{55\% \text{ of population}}{29.85\% \text{ of survey sample}} =$ a weight of 1.84. Weights across the five regions ranged from 0.26 in the most over-represented regions (Aspen-Birch) to 1.84 in the most under-represented region (Metro). Specifically, the regionally adjusted non-scaling weights for the Northern Pine, Aspen-Birch, Prairie, Metro, and Central Hardwoods regions were 0.31, 0.26, 0.87, 1.84 and 1.19, respectively, for respondents living in those regions.

These weights are generally termed “post-stratification weights,” and their use is fairly common in survey analysis where response rates are not equivalent across different subgroups within the survey sample or when some subsets of the population are sampled more than others.

A regionally adjusted non-scaling weight was assigned to each of the 1,350 responding households. Next, the mean and standard deviation of the individually reported unweighted total wood burned by the households was calculated for each region. For each household respondent, this calculation used the total number of cords of wood (and wax logs) they burned in all types of equipment anywhere in the state, including zeros for the households that did not report burning any wood or wax logs. The standard deviation of the amounts of wood burned for each region was divided by the square root of the number of surveys in the sample to estimate the standard error (SE) of the sample for each region. (See Table 7 for the sample sizes of each region based on location of primary residences.) For 95% confidence intervals, a critical value (t^*) was obtained from tables of the t distribution with a significance level (α) of

one minus the 95% confidence level, or 0.05. The SE of the sample was multiplied by t^* to obtain a margin of error around each region's sample mean. Finally, to correct for the design effect, which entails greater variance in the data and thus greater uncertainty in population-wide wood burning estimates due to the weighting described above, the following correction was made to each region's margin of error. The design effect was calculated as

$$1 + \left(\frac{\sigma}{\mu}\right)^2$$

where σ is the standard deviation of the regionally adjusted non-scaling weight parameters and μ is the mean of the regionally adjusted non-scaling weight parameters across all 1,350 households in the survey sample. Each region's confidence interval was scaled up by the square root of the design effect, which served to widen the confidence intervals by roughly 17%. Each confidence interval was then multiplied by the total number of households in the respective region to scale the interval to the region. The confidence intervals from all five regions were summed together to apply a confidence interval around the statewide estimate of total cords of wood burned, to obtain overall estimates of a 95% confidence interval for statewide wood burning quantities.

Limitations

There are some important limitations to this study that should be considered when interpreting the results. First, of the 6,768 households invited to participate in the survey, 1,350 completed the survey for a response rate of 20%. The response rate by region varied from 18% to 23%, with the Metro region having the lowest response rate (see Table 7). Estimated results from this year's survey should still be interpreted with caution, since there are margins of error surrounding the extrapolation of survey results to whole populations.

The survey also relied on retrospective self-reporting of burning and wood harvesting behaviors. These retrospective reports are likely to be strong approximations of actual behaviors, but they should be treated as estimates, as opposed to precise measurements.

It is difficult to confidently compare survey years and examine trends. Each survey administration has involved changes to the survey instrument and collection methods, which may change the results. For example, one change to the 2021 year's survey was asking, "In the last year, have you burned any wood?" on the front cover of the survey packet. Respondents could either check a box labeled "Yes" or "No" and were encouraged to return the survey whether they burned wood or not. This change was made in response to a concern that the design of the 2015 survey may have made it more likely for people who did not burn wood to disregard the survey, which may have led to a higher estimated rate of burning in each survey region and amount of wood burned than had actually occurred. Despite survey design changes, some comparisons and trends across survey years were examined in this report, but it should be recalled that all results are estimations, as opposed to precise measurements.

Similarly, starting with the 2018 survey, respondents who indicated they burned no wood immediately ended the survey. Therefore, any wood-burning equipment they may have owned (but did not use) was not accounted for, since they did not continue the survey to indicate what equipment they may or may not have owned. In cases where a respondent reported owning more than one piece of wood-burning equipment but did not use all of them during the survey period, only the used pieces of equipment were coded into the relational database used to analyze results. This report, therefore, only captures the number of pieces of wood-burning equipment *in use* in the state, as opposed to the number of pieces of equipment owned.

Estimated rates of equipment ownership of wood stoves and outdoor recreational equipment, which are common in all regions, are likely more reliable than estimates for less frequently reported equipment.

The survey did not ask respondents if their conventional fireplaces were wood or gas fueled. It is likely that respondents may have reported a gas-burning conventional fireplace as what would have then been interpreted as a wood-burning fireplace during data analysis. Likewise, the survey did not ask respondents about burning done in any undesignated, impermanent locations, outside of any formal pieces of equipment (say, in an unofficial “spot” in a yard).

Additional weighting by household type, which has been explored in past surveys, was not possible because households that reported no burning activity immediately ended the survey prior to the household type question.

This survey report is limited to residential wood burning. It does not include or discuss commercial or industrial wood burning in Minnesota to any degree.

Despite these limitations, the survey results contain an abundance of information that can be used by a variety of interested parties.

Appendix B

Glossary and definitions for this report

Bundle: A unit measure for wood volume that measures about 16 inches by 9 inches by 9 inches (0.75 cubic feet). One hundred and seventy-one bundles is equivalent to one cord. Note that in prior surveys a bundle was defined as 2 cubic feet or 64 bundles per cord.

Catalyst technology: In a wood stove with catalyst technology, the stove contains a specially formed ceramic, metal coated catalyst. The catalyst makes wood burn more efficiently by creating a chemical reaction with wood smoke that produces a secondary burn, causing a more complete combustion to reduce smoke and emissions.

Chimenea: An outdoor fireplace, typically made of clay or metal, that vents smoke through a chimney.

Combustion: The process of burning where fuel reacts with oxygen to produce heat and gases.

Confidence interval: A range of values centered on the sample estimate that is known to contain the true value with a given degree of confidence (usually 95%).

Conventional fireplace: Conventional fireplaces are generally used for aesthetic purposes rather than for heat. They are often open but may have non-sealed glass doors. The survey did not distinguish whether the fireplaces were located inside or outside the residence.

Cord: A unit of measure for a volume of wood. It measures four feet high by four feet wide by eight feet long and has a volume of 128 cubic feet ([Figure 1](#)). Cords do not describe how much the wood weighs, so a cord of one species of wood may weigh more than a cord of a less dense wood.

Criteria pollutant: An air pollutant regulated by the Clean Air Act and that the U.S. Environmental Protection Agency (EPA) has established standards to protect public health and the environment.

Design effect: An adjustment used in some statistical studies, which inflates the variance of parameter estimates, to allow for the design structure. In this case, it is an adjustment for the population weighting that was done to address the disproportionate stratified sampling and response rates. The weighting of the data increases its variance, and the design effect is used to adjust confidence interval estimates to account for the increased variance.

Differential response rates: These refer to the situation where the response rate was (substantially) different in different subgroups of the population (e.g., in households from different survey regions or from different demographic groups).

Disproportionate stratified sampling: Conducting a survey where the sizes of different groups (in this case, number of surveys sent to each survey region) vary and do not represent the percentage of any particular group within the larger population.

Estimate: The value obtained from a sample, which is used with a known margin of error, as an approximation for a population characteristic.

Face cord: A unit of volume that is four feet high by eight feet long by 16 inches wide, equal to one-third of a cord.

Fireplace insert: An enclosed space-heating device, similar in function to a wood stove that is designed to fit into the opening of an existing fireplace. These are designed to be more energy efficient than most conventional fireplaces.

Household: The person or people occupying a housing unit.

Margin of error: The statistic that describes the amount of random sampling error in a survey's results. When the margin of error is great, there is less confidence that the results of the survey correctly represent what would have been found by surveying the entire population.

Methodology: A description of the way in which data are collected and analyzed in a research project.

Outdoor recreational burning: In this study, outdoor recreational burning includes burning in outdoor fire pits, chimineas, or fire rings. They may be used for recreational backyard burning or at campgrounds.

Outlier: An extremely small or extremely large value in a set, compared with the mean, or average, of all values in the set.

PM_{2.5}: Fine particulate matter with a diameter of 2.5 micrometers or smaller, allowing it to penetrate deep into the lungs and cause negative health impacts.

Primary residence: The dwelling where a person or people usually live, typically a house or an apartment. The survey questionnaire defined the primary residence as "your main home."

Response bias: Inaccuracy of data collected caused by participant error. This could be caused by misunderstanding or misinterpreting survey questions or in some cases could be deliberate misrepresentation of one's actions.

Response rate: The number of completed surveys divided by the number of eligible units (i.e., households) in a sample. In other words, this is the number of completed surveys returned divided by the number of surveys sent that successfully reached the households. The surveys sent out that were returned by the post office are not included.

Sample: A subset of the population from which data are collected to be used in estimating actions or behaviors of the total population. In this case, the "survey sample" is all the households who completed and submitted a survey.

Secondary residence: This includes all dwellings that are not the primary place where a person or people live. In this study, it includes second homes, cabins, trailers, or other vacation properties. Camping locations were not included.

Selection bias: A type of non-sampling error that occurs when participants who chose to participate in some research (i.e., who choose to fill out and submit a survey) are systematically different than the intended sample. This type of bias is caused by certain types of participants replying to a survey invitation more than others or when participants put themselves into groups to which they aspire but do not currently belong. For this study, a potential source of selection bias could be that households who burn wood are more likely to answer a survey about residential wood burning than households who do not burn wood. As a result, the survey analysis could overestimate wood burning activity in the overall population. Similar to "non-response error," which is error caused by some sub-groups of the sample responding less often than the rest of the sample.

Slab: Rounded edges of wood typically sawn from a log face when squaring a log.

Statistical significance: Refers to whether some research results genuinely reflect a population of interest in some way or whether the results could occur by chance. Statistical significance is determined by comparing the research results with the values defined by the confidence interval.

Survey regions: The key geographic unit for this analysis. The five survey sampling regions have been used in past Minnesota residential wood fuel use surveys. Minnesota is comprised of five regions that roughly correspond to the state's ecoregions. An ecoregion is an area of land with similar ecological characteristics. The five survey regions of Minnesota — Northern Pine, Aspen-Birch, Prairie, Metro Area, and Central Hardwoods — were delineated based on forest cover and predominant tree types.

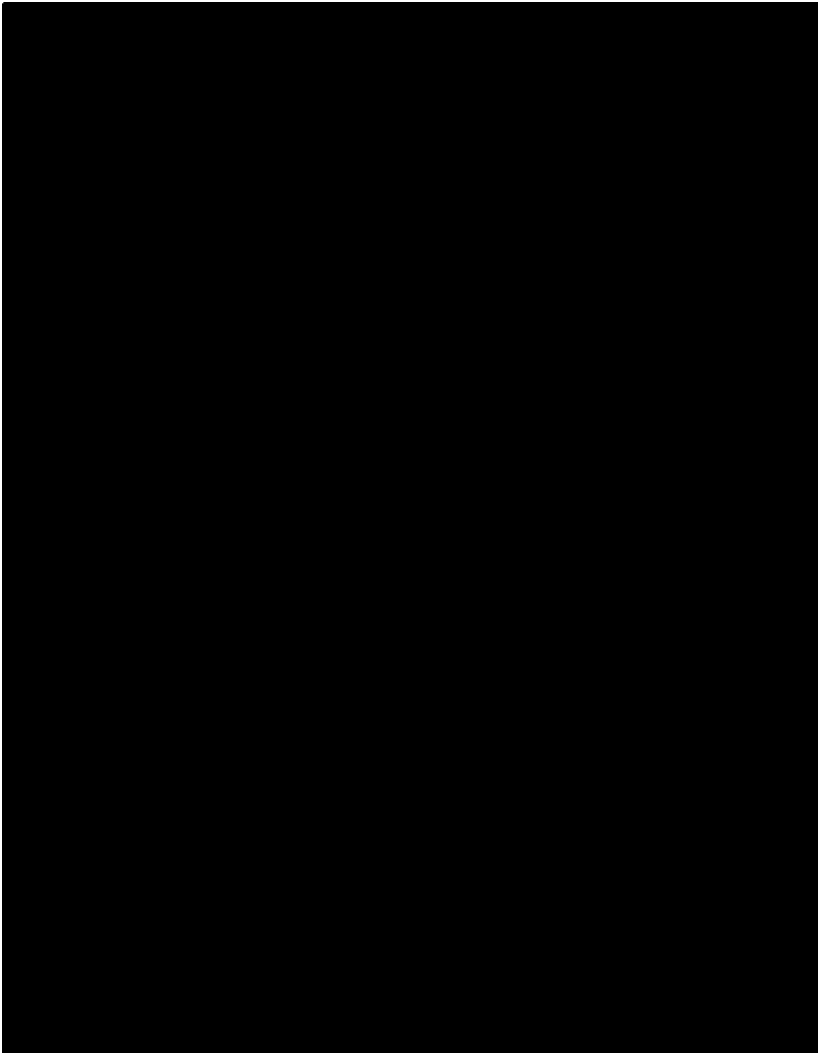
Wood boiler: A wood burning central heating device that heats a liquid (generally water or glycol) as the medium to transfer the heat to where it is needed. Hydronic heater is the more technical term for this equipment as they do not actually boil the water. Wood boilers are generally, though not exclusively, located outside the main building. The heated liquid may provide space heat through radiators, in-floor heating, or to the air using a heat exchanger. In residential settings, they may also be used to heat multiple buildings, the domestic water supply swimming pools, etc. Because some wood “boilers” (hydronic heaters) are called “outdoor wood furnaces,” this survey distinguished the boilers from the forced-air furnaces using descriptive characteristics, including brand or model information and whether it used water to transfer the heat.

Wood furnace: A wood burning central heating device in which the heat in the combustion chamber directly heats air that is transferred through ducts to provide space heat to the home or building. In this survey, the term “furnace” was specifically used for the forced-air furnaces that heat air, not those that use water as the heat transfer medium.

Wood pellet stove: A room heating device similar to a wood stove, designed to burn wood pellets.

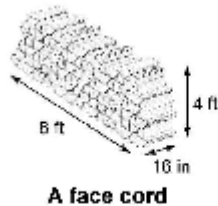
Wood stove: An enclosed, free-standing heating appliance capable of burning wood fuel generally connected by ventilating stove pipes to a suitable chimney or flue. A wood stove can generally be used to burn wood, or wood-derived biomass fuel, such as wood pellets. It is generally designed to heat the air in a few rooms or a smaller home.

Appendix C

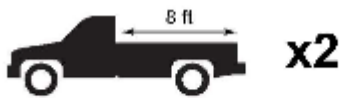


Section A: Key

A **full cord of wood** measures 4 feet high by 4 feet wide by 8 feet long (4' x 4' x 8') and has a volume of 128 cubic feet.



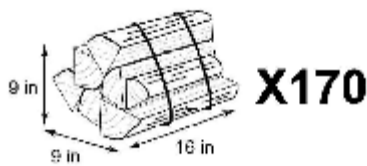
A **face cord of wood** is 4 feet high by 8 feet long and is as wide as the individual firewood pieces but averages 16 inches wide. A 16-inch wide face cord (sometimes called a **fireplace cord**) is equal to one-third of a full cord.



Two full-size pick-up truck loads (8 foot box) equals **one full cord**, whether the wood is stacked carefully so it is about level with the truck box sides, or is thrown into the truck box with the top of the pile about as high as the cab.



Four compact pick-up truckloads (6 foot box) equals **one full cord**, whether the wood is stacked carefully so it is about level with the truck box sides, or is thrown into the truck box with the top of the pile about as high as the cab.



Bundles of wood sold at gas stations, hardware stores and state parks are often 0.75 cubic feet. They often measure about 16 inches x 9 inches x 9 inches. 170 bundles equals **one full cord**.

Section B: Residence

The survey asks about the **wood-burning equipment** you use. **Wood-burning equipment** includes wood-burning fireplaces, fireplace inserts, wood stoves, wood furnaces, wood boilers, outdoor fire pits, chimeneas, etc.

The survey also asks about how much you burn at your primary and secondary residence **in Minnesota**. We are using the following definitions for these residences:

- **Primary residence** includes your main home, including garages and outbuildings.
- **Secondary residence** includes your or your family's second home, cabin, trailer, rented cabin, or other residential property. If you have more than one secondary residence, please consider only the most frequently used secondary residence.

1. Where **in Minnesota** is your **primary** residence located? (Your main home, including garages and other outbuildings.)

Primary residence location:

County: _____

City/Township: _____

Zip Code: _____

2. Which of the following best describes your **primary** residence?

- ¹ Single-family house (detached)
² Townhouse or twinhome (attached)
³ Multi family building (such as condominiums, apartments, or cooperatives)
⁴ Mobile home or trailer

I do not have a secondary residence in Minnesota.

If you do not have a secondary residence in Minnesota skip all questions about secondary residence.

3. If you have a **secondary residence in Minnesota**, where is it located? (A second home, cabin, trailer, rented cabin, or other residential property that is located in Minnesota. If your **secondary residence** is not in Minnesota do not include it.)

Secondary residence location:

County: _____

City/Township: _____

Z.P.: _____

4. Which of the following best describes your **secondary** residence, cabin, trailer, rented cabin, or vacation property?

- ¹ Single-family house (detached)
² Townhouse or twinhome (attached)
³ Multi family building (such as condominiums, apartments, or cooperatives)
⁴ Mobile home or trailer
⁵ Cabin

Section C: Campsites and campgrounds

5. Did you burn firewood at a campsite or campground in **Minnesota** between May 2023 and April 2024?

¹ No. **Skip to Q8.**

² Yes. Please continue.

6. If you burned firewood at a campsite in **Minnesota** between May 2023 and April 2024, please estimate the total amount of wood burned

_____ Estimated total amount (in bundles) of wood burned at all campsites

7. Please check all of the regions in which you burned wood at a campsite between May 2023 and April 2024, based on the following map.

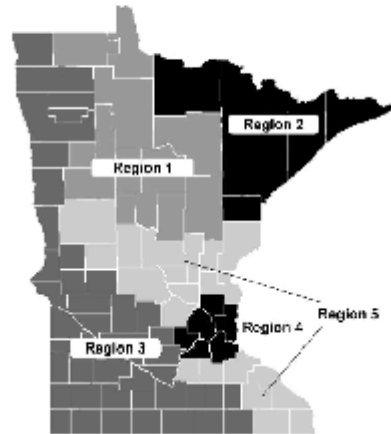
¹ Region 1

² Region 2

³ Region 3

⁴ Region 4

⁵ Region 5



Section D: Outdoor wood burning fire pits, chimeneas or fire rings

Chimenea



Fire pit



Chimeneas, fire pits, fire rings, etc.

- Can be above the ground or dug into the ground
- Are located outside the house
- May be a designated "spot" used to burn wood on the property
- **Please answer only for those that burn wood rather than propane**

If you do not have a secondary residence in Minnesota skip all questions about secondary residence.

PRIMARY RESIDENCE

8. Do you have a fire ring, fire pit, chimenea or similar type of equipment/area at your **PRIMARY RESIDENCE**?

- ¹ No. **Go to Q12.**
² Yes, traditional equipment, like chimenea or fire pit.
³ Yes, smokeless/low smoke fire pit, like a Solo stove

9. In the past 12 months, did you use this equipment **mainly** for:

- ¹ Pleasure
² Disposal by burning of woody yard materials (e.g. fallen branches, trees and twigs, brush/trees collected from property)
³ None. Please check if you did not burn wood in this equipment during the last year and **Go to Q12.**

10. Please check which months you used this wood-burning equipment at your home over the last year.

| 2023 | | | | | | | 2024 | | | | |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|--|--|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR |
| <input type="checkbox"/> ¹ | <input type="checkbox"/> ² | <input type="checkbox"/> ³ | <input type="checkbox"/> ⁴ | <input type="checkbox"/> ⁵ | <input type="checkbox"/> ⁶ | <input type="checkbox"/> ⁷ | <input type="checkbox"/> ⁸ | <input type="checkbox"/> ⁹ | <input type="checkbox"/> ¹⁰ | <input type="checkbox"/> ¹¹ | <input type="checkbox"/> ¹² |

11. Please indicate how much wood or wax logs you burned in the past 12 months in your fire ring, fire pit, chimenea or any similar type of equipment. (Respond to as many as you need to collectively best describe how much wood was burned.)

- ¹ _____ Bundles of wood (0.75 cubic foot each)
² _____ Bags of tree branches and woody brush collected from your yard (Estimate how many 30 gallon bags – typical size of yard waste bags sold)
³ _____ Full cords of firewood (answer to the nearest tenth of a cord)
⁴ _____ Face cords of firewood (answer to the nearest tenth of a face cord)
⁵ _____ Number of wax logs (such as Duraflame, Emuiro Log, Pine Mountain, etc.)
⁶ _____ Number of wood pallets

Residential Wood Fuel Survey

SECONDARY RESIDENCE

12. Do you have a fire ring, fire pit, chimenea or similar type of equipment/area at your **SECONDARY RESIDENCE**?

- ¹ No. **Go to Q16.**
² Yes, traditional equipment, like chimenea or fire pit.
³ Yes, smokeless/low smoke fire pit, like a Solo stove

13. In the past 12 months, did you use this equipment **mainly** for:

- ¹ Pleasure
² Disposal by burning of woody yard materials (e.g. fallen branches, trees and twigs, brush/trees collected from property)
³ None. Please check if you did not burn wood in this equipment during the last year and **Go to Q16.**

14. Please check which months you used this wood-burning equipment at your home over the last year.

| 2023 | | | | | | | 2024 | | | | |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|--|--|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR |
| <input type="checkbox"/> ¹ | <input type="checkbox"/> ² | <input type="checkbox"/> ³ | <input type="checkbox"/> ⁴ | <input type="checkbox"/> ⁵ | <input type="checkbox"/> ⁶ | <input type="checkbox"/> ⁷ | <input type="checkbox"/> ⁸ | <input type="checkbox"/> ⁹ | <input type="checkbox"/> ¹⁰ | <input type="checkbox"/> ¹¹ | <input type="checkbox"/> ¹² |

15. Please indicate how much wood or wax logs you burned in the past 12 months in your fire ring, fire pit, chimenea or any similar type of equipment. (Respond to as many as you need to collectively best describe how much wood was burned.)

- ¹ _____ Bundles of wood (0.75 cubic foot each)
² _____ Bags of tree branches and woody brush collected from your yard (Estimate how many 30 gallon bags – typical size of yard waste bags sold)
³ _____ Full cords of firewood (answer to the nearest tenth of a cord)
⁴ _____ Face cords of firewood (answer to the nearest tenth of a face cord)
⁵ _____ Number of wax logs (such as Duraflame, Emuiro Log, Pine Mountain, etc.)
⁶ _____ Number of wood pallets

Wilder Research, April 2024

Section II: Wood/pellet/barrel stoves and wood burning fireplace inserts for heat

Wood stoves



Wood stoves are freestanding space heaters often used to heat a small house or zone of the house.

Wood burning fireplace inserts



Wood burning fireplace inserts are space heaters designed to fit into an existing fireplace opening.

Wood pellet stoves



Wood pellet stoves burn small compressed wood pellets. A pellet-burning appliance has a hopper to hold the fuel.

Barrel stoves



Barrel stove is a wood burning device used in an indoor area made from one or more steel barrels with a door that allows wood to be loaded into it and a chimney or flue that conveys the exhaust outside.

PRIMARY RESIDENCE

16. Do you have this equipment (wood stove, wood pellet stove, barrel stove, or fireplace insert) in your **PRIMARY RESIDENCE** (including outbuildings such as pole barns or garages)?

- ¹ No. **Go to Q20**
 ² Yes. → If yes, how many pieces of equipment do you use? _____

17. In the past 12 months, did you use this equipment *mainly* for:

- ¹ Pleasure ³ Supplemental heating for my residence
 ² Primary heat source for my residence ⁴ None. Please check if you did not burn wood in your wood stove, fireplace insert, or wood/pellet/ barrel stove, and **Go to Q20**.

18. Check the months in which you used this wood-burning equipment in your home over the last year.

| 2023 | | | | | | | | 2024 | | | |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|--|--|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR |
| <input type="checkbox"/> ¹ | <input type="checkbox"/> ² | <input type="checkbox"/> ³ | <input type="checkbox"/> ⁴ | <input type="checkbox"/> ⁵ | <input type="checkbox"/> ⁶ | <input type="checkbox"/> ⁷ | <input type="checkbox"/> ⁸ | <input type="checkbox"/> ⁹ | <input type="checkbox"/> ¹⁰ | <input type="checkbox"/> ¹¹ | <input type="checkbox"/> ¹² |

Beginning in 1989, wood stoves and fireplace inserts sold were required to have EPA-certified pollution control technology. Some EPA-certified woodstoves and fireplace inserts have a ceramic or metal honeycomb catalyst as one such control device.

19. Fill in the grid below for each piece of equipment you have at your **PRIMARY RESIDENCE**.

| Equipment number | EQUIPMENT | | | TOTAL AMOUNT OF WOOD BURNED IN UNIT between May 2023 and April 2024 | | | | |
|------------------|--|---|--|---|--------------|----------------|------------|------------------------|
| | Type | When was it made? | Does it have a catalyst? | # Full cords | # Face cords | # Wood bundles | # Wax logs | Pounds of wood pellets |
| 1 | <input type="checkbox"/> ¹ Wood stove | <input type="checkbox"/> ¹ Before 1989 | <input type="checkbox"/> ¹ Yes | — | — | — | — | — |
| | <input type="checkbox"/> ² Wood-burning fireplace | <input type="checkbox"/> ² 1989 - 2015 | <input type="checkbox"/> ² No | | | | | |
| | <input type="checkbox"/> ³ Pellet stove | <input type="checkbox"/> ³ After 2015 | <input type="checkbox"/> ³ Don't know | | | | | |
| | <input type="checkbox"/> ⁴ Barrel stove | <input type="checkbox"/> ⁴ Don't know | | | | | | |
| 2 | <input type="checkbox"/> ¹ Wood stove | <input type="checkbox"/> ¹ Before 1989 | <input type="checkbox"/> ¹ Yes | — | — | — | — | — |
| | <input type="checkbox"/> ² Wood-burning fireplace | <input type="checkbox"/> ² 1989 - 2015 | <input type="checkbox"/> ² No | | | | | |
| | <input type="checkbox"/> ³ Pellet stove | <input type="checkbox"/> ³ After 2015 | <input type="checkbox"/> ³ Don't know | | | | | |
| | <input type="checkbox"/> ⁴ Barrel stove | <input type="checkbox"/> ⁴ Don't know | | | | | | |
| 3 | <input type="checkbox"/> ¹ Wood stove | <input type="checkbox"/> ¹ Before 1989 | <input type="checkbox"/> ¹ Yes | — | — | — | — | — |
| | <input type="checkbox"/> ² Wood-burning fireplace | <input type="checkbox"/> ² 1989 - 2015 | <input type="checkbox"/> ² No | | | | | |
| | <input type="checkbox"/> ³ Pellet stove | <input type="checkbox"/> ³ After 2015 | <input type="checkbox"/> ³ Don't know | | | | | |
| | <input type="checkbox"/> ⁴ Barrel stove | <input type="checkbox"/> ⁴ Don't know | | | | | | |

Section E: Wood/pellet/barrel stoves and wood burning fireplace inserts for heat

If you do not have a secondary residence in Minnesota skip all questions about secondary residence.

SECONDARY RESIDENCE

20. Do you have this equipment (wood stove, wood pellet stove, barrel stove, or fireplace insert) in your **SECONDARY RESIDENCE** (including outbuildings such as pole barns or garages)?

- ¹ No. **Go to Q24**
² Yes. → If yes, how many pieces of equipment do you use? _____

21. In the past 12 months, did you use this equipment **mainly** for:

- ¹ Pleasure ³ Supplemental heating for my residence
² Primary heat source for my residence ⁴ None. Please check if you did not burn wood in your wood stove, fireplace insert, or wood/pellet/ barrel stove, and **Go to Q24**.

22. Check the months in which you used this wood-burning equipment in your home over the last year.

| 2023 | | | | | | | | 2024 | | | |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|--|--|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR |
| <input type="checkbox"/> ¹ | <input type="checkbox"/> ² | <input type="checkbox"/> ³ | <input type="checkbox"/> ⁴ | <input type="checkbox"/> ⁵ | <input type="checkbox"/> ⁶ | <input type="checkbox"/> ⁷ | <input type="checkbox"/> ⁸ | <input type="checkbox"/> ⁹ | <input type="checkbox"/> ¹⁰ | <input type="checkbox"/> ¹¹ | <input type="checkbox"/> ¹² |

Beginning in 1989, wood stoves and fireplace inserts sold were required to have EPA-certified pollution control technology. Some EPA-certified woodstoves and fireplace inserts have a ceramic or metal honeycomb catalyst as one such control device.

23. Fill in the grid below for each piece of equipment you have at your **SECONDARY RESIDENCE**.

| Equipment number | EQUIPMENT | | | TOTAL AMOUNT OF WOOD BURNED IN UNIT between May 2023 and April 2024 | | | | |
|------------------|--|---|--|---|--------------|----------------|------------|------------------------|
| | Type | When was it made? | Does it have a catalyst? | # Full cords | # Face cords | # Wood bundles | # Wax logs | Pounds of wood pellets |
| 1 | <input type="checkbox"/> ¹ Wood stove | <input type="checkbox"/> ¹ Before 1989 | <input type="checkbox"/> ¹ Yes | — | — | — | — | — |
| | <input type="checkbox"/> ² Wood-burning fireplace | <input type="checkbox"/> ² 1989 - 2015 | <input type="checkbox"/> ² No | | | | | |
| | <input type="checkbox"/> ³ Pellet stove | <input type="checkbox"/> ³ After 2015 | <input type="checkbox"/> ³ Don't know | | | | | |
| | <input type="checkbox"/> ⁴ Barrel stove | <input type="checkbox"/> ⁴ Don't know | | | | | | |
| 2 | <input type="checkbox"/> ¹ Wood stove | <input type="checkbox"/> ¹ Before 1989 | <input type="checkbox"/> ¹ Yes | — | — | — | — | — |
| | <input type="checkbox"/> ² Wood-burning fireplace | <input type="checkbox"/> ² 1989 - 2015 | <input type="checkbox"/> ² No | | | | | |
| | <input type="checkbox"/> ³ Pellet stove | <input type="checkbox"/> ³ After 2015 | <input type="checkbox"/> ³ Don't know | | | | | |
| | <input type="checkbox"/> ⁴ Barrel stove | <input type="checkbox"/> ⁴ Don't know | | | | | | |
| 3 | <input type="checkbox"/> ¹ Wood stove | <input type="checkbox"/> ¹ Before 1989 | <input type="checkbox"/> ¹ Yes | — | — | — | — | — |
| | <input type="checkbox"/> ² Wood-burning fireplace | <input type="checkbox"/> ² 1989 - 2015 | <input type="checkbox"/> ² No | | | | | |
| | <input type="checkbox"/> ³ Pellet stove | <input type="checkbox"/> ³ After 2015 | <input type="checkbox"/> ³ Don't know | | | | | |
| | <input type="checkbox"/> ⁴ Barrel stove | <input type="checkbox"/> ⁴ Don't know | | | | | | |

Section F: Wood burning boiler or furnace

DEFINITION: WOOD BURNING BOILER OR FURNACE

Outdoor wood boiler



Wood boilers

- Wood boilers are usually installed outside and may look like a small shed
- Wood boilers heat water that moves in pipes to where the heat is used

Indoor wood furnace



Wood furnaces

- Wood furnaces are usually installed in basement or utility rooms
- Wood furnaces heat air directly and are connected to ducts that move the hot air around the building

PRIMARY RESIDENCE

24. Do you use any of this equipment to heat your **PRIMARY RESIDENCE**?

- ¹ No. **Go to Q31.**
- ² Yes a forced air furnace
- ³ Yes a wood boiler

25. Brand and model (if known)

26. Is the equipment inside or outside the house?

- ¹ Inside
- ² Outside

27. When was the wood burning boiler or furnace made?

- ¹ 2014 or before
- ² 2015 to 2019
- ³ 2020 or after
- ⁴ Don't know

28. In the past 12 months did you use this equipment *mainly* for:

- ¹ Primary heat source at my residence
- ² Supplemental heating at my residence
- ³ None. Please check if you did not burn any wood in your heater or boiler, then **Go to Q31.**

29. Please check which months you used your wood burning boiler or furnace in your home.

| 2023 | | | | | | | | 2024 | | | |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|--|--|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR |
| <input type="checkbox"/> ¹ | <input type="checkbox"/> ² | <input type="checkbox"/> ³ | <input type="checkbox"/> ⁴ | <input type="checkbox"/> ⁵ | <input type="checkbox"/> ⁶ | <input type="checkbox"/> ⁷ | <input type="checkbox"/> ⁸ | <input type="checkbox"/> ⁹ | <input type="checkbox"/> ¹⁰ | <input type="checkbox"/> ¹¹ | <input type="checkbox"/> ¹² |

30. If you used your boiler or furnace, please indicate how much wood you burned in your furnace or boiler in the past 12 months (If necessary, you can answer in fractions of full cords, such as 1/2, 1.5).

- ¹ _____ Full cords of wood
- ² _____ Full cords of slabs (the round parts of a log cut off to make milled wood)
- ³ _____ Face cords of wood
- ⁴ _____ Number of wooden pallets

Section F: Wood burning boiler or furnace

If you do not have a secondary residence in Minnesota skip all questions about secondary residence.

SECONDARY RESIDENCE

31. Do you use any of this equipment to heat your **SECONDARY RESIDENCE**?

- ¹ No. Go to Q38.
- ² Yes a forced air furnace
- ³ Yes a wood boiler

32. Brand and model (if known)

33. Is the equipment inside or outside the house?

- ¹ Inside
- ² Outside

34. When was the wood burning boiler or furnace made?

- ¹ 2014 or before
- ² 2015 to 2019
- ³ 2020 or after
- ⁴ Don't know

35. In the past 12 months did you use this equipment *mainly* for:

- ¹ Primary heat source at my residence
- ² Supplemental heating at my residence
- ³ None. Please check if you did not burn any wood in your heater or boiler, then Go to Q38.

36. Please check which months you used your wood burning boiler or furnace in your home.

| 2023 | | | | | | | | 2024 | | | |
|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--|--|--|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR |
| <input type="checkbox"/> ¹ | <input type="checkbox"/> ² | <input type="checkbox"/> ³ | <input type="checkbox"/> ⁴ | <input type="checkbox"/> ⁵ | <input type="checkbox"/> ⁶ | <input type="checkbox"/> ⁷ | <input type="checkbox"/> ⁸ | <input type="checkbox"/> ⁹ | <input type="checkbox"/> ¹⁰ | <input type="checkbox"/> ¹¹ | <input type="checkbox"/> ¹² |

37. If you used your boiler or furnace, please indicate how much wood you burned in your furnace or boiler in the past 12 months (If necessary, you can answer in fractions of full cords, such as 1/2, 1.5).

- ¹ _____ Full cords of wood
- ² _____ Full cords of slabs (the round parts of a log cut off to make milled wood)
- ³ _____ Face cords of wood
- ⁴ _____ Number of wooden pellets

Section G: Conventional wood burning fireplaces



DEFINITION: A CONVENTIONAL FIREPLACE

- Often for aesthetic use rather than primarily for heating
- May have hot air grilles
- May either have no doors or glass doors without gaskets (not airtight)
- Doors can be double or bi-fold doors
- Includes fireplaces known as "heatlators" and fireplaces with tubular grates or other devices intended to increase heat flow
- Includes freestanding fireplaces
- Does not have an insert (If your fireplace has an insert go to Section E, page 5)
- Please answer only for those that burn wood rather than propane or natural gas

PRIMARY RESIDENCE

38. Do you have a conventional wood burning fireplace at your **PRIMARY RESIDENCE** (including outbuildings such as pole barns or garages)?

- ¹ No. Go to Q42.
² Yes → How many? _____

39. During the past 12 months, did you use this equipment **mainly** for:

- ¹ Pleasure
² Primary heat source for my residence
³ Supplemental heating for my residence
⁴ None. Please check if you did not burn wood in your fireplace and Go to Q42.

40. Please check which months you used this wood-burning equipment in your home.

| 2023 | | | | | | | | | | | | 2024 | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | | | | |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

41. If you used your fireplace please indicate how much wood or wax logs you burned in your fireplace(s) in the past 12 months.

- ¹ _____ Full cords of wood (if necessary, you can answer in fractions of full cords, such as 1/2, 1.5)
² _____ Face cords of wood
³ _____ Bundles of wood (0.75 cubic feet each)
⁴ _____ Number of wax logs (such as Duraflame, Emulro Log, Pine Mountain, etc.)

If you do not have a secondary residence in Minnesota skip all questions about secondary residence.

SECONDARY RESIDENCE

42. Do you have a conventional wood burning fireplace at your **SECONDARY RESIDENCE** (including outbuildings such as pole barns or garages)?

- ¹ No. Go to Q46.
² Yes → How many? _____

43. During the past 12 months, did you use this equipment **mainly** for:

- ¹ Pleasure
² Primary heat source for my residence
³ Supplemental heating for my residence
⁴ None. Please check if you did not burn wood in your fireplace and Go to Q46.

44. Please check which months you used this wood-burning equipment in your home.

| 2023 | | | | | | | | | | | | 2024 | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | | | | |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

45. If you used your fireplace please indicate how much wood or wax logs you burned in your fireplace(s) in the past 12 months.

- ¹ _____ Full cords of wood (if necessary, you can answer in fractions of full cords, such as 1/2, 1.5)
² _____ Face cords of wood
³ _____ Bundles of wood (0.75 cubic feet each)
⁴ _____ Number of wax logs (such as Duraflame, Emulro Log, Pine Mountain, etc.)

Section H: Types of wood, storage and how obtained (burned in the past 12 months)

PRIMARY RESIDENCE

46. At your **PRIMARY RESIDENCE**, what percentage of your wood is stored in a way that is protected from the elements, such as rain?

- ¹ 76% to 100%
² 36% to 75%
³ 0% to 35%
⁴ I did not store wood at my primary residence

47. Of all the firewood you **burned** at your **PRIMARY RESIDENCE** this past 12 months, what percent was burned of each type (if known)? (Percentages should add up to 100%.)

| | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|----------|---------|---------------------|--------|
| Oak | Birch | Ash | Elm | Maple | Aspen | Basswood | Pine | Unknown or other | = 100% |
| _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | |

If you do not have a **SECONDARY RESIDENCE** in Minnesota skip Q48 and Q49 about secondary residences.

SECONDARY RESIDENCE

48. At your **SECONDARY RESIDENCE**, what percentage of your wood is stored in a way that is protected from the elements, such as rain?

- ¹ 76% to 100%
² 36% to 75%
³ 0% to 35%
⁴ I did not store wood at my primary residence

49. Of all the firewood you **burned** at your **SECONDARY RESIDENCE** this past 12 months, what percent was burned of each type (if known)? (Percentages should add up to 100%.)

| | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|----------|---------|---------------------|--------|
| Oak | Birch | Ash | Elm | Maple | Aspen | Basswood | Pine | Unknown or other | = 100% |
| _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | |

50. Of all the wood your household burned **in Minnesota** (including at your primary/secondary residence and/or while camping) between May 2023 and April 2024, indicate the percent(s) you harvested or obtained from the following sources (Percentages should add up to 100%):

- ¹ _____ % Purchased or free slabs from sawmills
² _____ % Purchased from a firewood dealer or logger
³ _____ % Purchased from a store or campground
⁴ _____ % Free or purchased from other sources
⁵ _____ % Harvested by someone in your household (**Harvested** includes all live or dead whole trees harvested primarily for the purpose of firewood anywhere in Minnesota, excluding yard waste.)

Section I: Complete this section if someone in your household harvested wood in Minnesota in the past 12 months

For the following questions, please use the following definitions:

- **Harvested** includes all live or dead whole trees harvested primarily for the purpose of firewood anywhere in Minnesota.
- Harvested wood excludes **yard waste**, which is wood produced from the care and maintenance of landscaped areas, gardens, and lawns. Yard waste includes material such as: pruned branches and stems, brush, Christmas trees, mulch, stumps and roots. Wood yard waste also includes the removal of unwanted live trees and dead or diseased trees or any wood cleared for construction in a maintained area.

51. Did you or someone in your household **harvest wood in Minnesota** between May 2023 and April 2024 (this includes all live or dead whole trees harvested primarily for the purpose of firewood anywhere in Minnesota, but does not include yard waste)?

- ¹ No, my household did not harvest wood ➔ **IF NO, PLEASE SKIP ALL REMAINING QUESTIONS AND RETURN THE SURVEY.**
- ² Yes, my household harvested wood ➔ Please complete the remaining questions on this page.

52. Indicate the total amount of firewood that was **harvested in Minnesota** by someone in your household between May 2023 and April 2024: (If necessary, you can answer in fractions of full cords, such as 1/2, 1.5. If none enter "0")

_____ Full cords

53. What percent of that **harvested wood** came from the following locations: (Percentages should add up to 100%)

- | | |
|------------------------|-------------------------------|
| 1 _____ % Private land | 4 _____ % Municipal land |
| 2 _____ % State land | 5 _____ % National forestland |
| 3 _____ % County land | |

54. What percent of that **harvested wood** came from the following sources? (Percentages should add up to 100%)

- | | |
|---------------------------------------|---|
| 1 _____ % Live trees from forest land | 3 _____ % Cut trees and/or tops and branches after a timber harvest |
| 2 _____ % Dead trees from forest land | 4 _____ % Live or dead trees from pasture land and/or cropland |
| | 5 _____ % Live or dead trees from yards, inside city limits, or other non-forest land |

55. What percent of that **harvested wood** were of the following species: (Percentages should add up to 100%)

| | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|----------|---------|--------------------------|--------|
| Oak | Birch | Ash | Elm | Maple | Aspen | Basewood | Pine | Unknown or other species | |
| _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | _____ % | = 100% |

56. Please identify what counties in **Minnesota** did that **harvested wood** come from and the percent from each county (Percentages should add up to 100%.):

| | |
|-----------------------|------------------|
| County name: 1. _____ | Percent: _____ % |
| 2. _____ | _____ % |
| 3. _____ | _____ % |
| 4. _____ | _____ % |

¹ I do not know

Thank you for completing this survey. Please place the survey in the postage paid envelope provided and mail it promptly.

Survey sponsored by: Minnesota Department of Natural Resources
Minnesota Pollution Control Agency
U.S. Forest Service

Thanks to John Gulland of Gulland and Associates, Killaloe, CA, for allowing the use of parts of his survey.