
Midpoint Assessment of Forest Management Strategic Direction:

Sustainable Timber Harvest Implementation –
Fiscal Years 2019-2022



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Contents

Contents	3
Preface.....	5
Executive Summary	6
Results summary	7
Improvement Opportunities	9
Conclusions.....	10
Introduction.....	11
Strategic direction summary	14
Purpose and scope	15
Forest Resource Management Planning System implementation	16
Case Studies.....	17
Assessment results	19
Strategic direction implementation	19
Annual volume offered.....	19
Case Studies: Wildlife Habitat in Wildlife Management Areas (WMAs)	22
Ash and Tamarack Pilot	29
Case Study: Forest Health.....	30
Stand Exam Accomplishments	31
Annual Plan Additions	33
Acres Summary.....	34
Prescriptions.....	34
Current conditions context.....	36
Age Class Distributions	36
Case Study: Forest Productivity, Wildlife Habitat, and Biodiversity.....	42
Older aspen	43

Forest patch size and age distributions	44
Watersheds.....	45
Incorporating multiple values in management	46
Rare species.....	46
Case Studies: Endangered, Threatened, and Special Concern Species	47
Age of stands at planned examination	48
Management Objectives	49
Planning Progress	51
Forest Certification	52
Conclusions.....	53
Results summary	53
Overall assessment results	53
Ash and Tamarack pilot results	55
Benefits to the State of Minnesota of implementing the statewide sustainable forest management strategic direction	55
Going Forward	56
Appendix A. Age Class Distributions.....	58
Even-aged-managed cover types	58
Uneven-aged-managed cover types.....	61
Appendix B. Patch size age and size class distributions by ecological section	62

Preface

When the Minnesota Department of Natural Resources (DNR) completed its sustainable timber harvest analysis (STHA) in 2018, the effort was prompted by then-Governor Dayton’s request that the DNR analyze the sustainability of harvesting one million cords of timber per year from DNR-administered forest lands (excluding lands within State Parks and Scientific and Natural Areas). If the analysis determined that an annual harvest of one million cords was not sustainable, the governor asked the DNR to determine what level of harvest was sustainable on these lands. The results of that analysis informed the DNR’s strategic direction in managing forest lands at a statewide and landscape level for fiscal years 2019-2028.

The volume-focused question that prompted the analysis framed how we talked about the analysis and subsequent decisions about the forest management strategic direction. However, producing a specific timber harvest volume was never the goal of the strategic direction. Rather, managing forests sustainably to support multiple forest values was the goal. Timber harvest is a key tool by which we achieve that sustainable forest management goal.

Over the past four years of implementing the forest management strategic direction, which was informed by the STHA and other data sources, we have learned that the way we have been talking about implementation – focusing on a key management tool (timber harvest) rather than the goal (managing forests to sustain multiple forest benefits now and into the future, with the balance of benefits varying across different administrative land status types) – has led to misperceptions regarding the DNR’s intent in managing forests. Through this report and future communications, we will ensure that we articulate our strategic approach to sustainable forest management more clearly and comprehensively. This shift is intentional and reflects our efforts to listen to and learn from others and improve our descriptions of this effort to better communicate the DNR’s commitment to sustainably managing the state’s forest resources to achieve multiple important benefits, including wildlife habitat, biodiversity, carbon storage, forest health, recreation, and water quality and quantity, in addition to wood supply and healthy natural resource economies. We will also clearly identify where the mix and balance of those objectives varies across the different forest lands we manage.

Executive Summary

The Minnesota Department of Natural Resources (DNR) is responsible for sustainably managing the state's forest resources to achieve economic, environmental, and social goals (M.S. 89A) in alignment with other applicable laws concerning various resources and land statuses. To do this, in 2018, the DNR established strategic direction for forest resource management on DNR-administered lands for fiscal years (FY) 2019-2028.

The strategic direction is an amalgamation of DNR decisions designed to move forest conditions on DNR-administered lands toward long-term desired conditions that sustainably provide a range of forest benefits over time. These benefits include wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity. The strategic direction was informed by multiple data sources, including the Sustainable Timber Harvest Analysis (STHA); partner, stakeholder and public input; forest health information; and state and federal statutes, rules, and policies.

The DNR has long aimed to maintain a mix of young, intermediate, and older forest conditions on state-managed lands to ensure that multiple forest values are available to Minnesotans now and into the future. A hallmark of this landscape planning approach includes planning the forest disturbances necessary to develop a mix of forest ages and tree species that optimizes the balance of these values, recognizing that the "optimal balance" varies depending on the land status. Forests are not static. As forests grow and age, natural and human-caused disturbances create age classes across the landscape that provide benefits continuously over time. At the landscape scale, the DNR uses timber harvest and reforestation as an efficient, cost-effective tool to regenerate forests and manage the mix of age classes and cover types, standing in for some of the disturbance mechanisms that are less tolerated today (e.g., wildfire). A balance of young, intermediate, and older forest across diverse forest cover types at any given time ensures the many forest values that Minnesotans expect are available now and into the future.

By state statute, Division of Forestry-administered lands are managed for multiple uses. By state statute and federal statute for Land Utilization Project lands and lands managed or acquired with Pittman-Robertson and Dingell-Johnson funds, Division of Fish and Wildlife-administered lands are managed for fish and wildlife first, with other compatible uses as appropriate.¹ Developing a mix of young, intermediate, and older forests and tree species is critical on both Forestry and Fish and Wildlife administered lands. On Division of Forestry administered lands, balanced age class distributions and a diverse species mix sustainably provide multiple forest benefits, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity. On Division of Fish and Wildlife administered lands, a diverse mix of forest ages and species ensures the continued presence of varied forest habitats – and wildlife species dependent on those habitats – over time.

¹ School trust lands occur on Division of Forestry and Division of Fish and Wildlife-administered lands. As directed by state statute, school trust lands are managed to ensure maximum long-term economic return, consistent with sound natural resource conservation and management principles.

The DNR uses timber volume as a metric when planning and implementing forest and habitat management to advance landscape-scale goals for forest age structure and species mix. As described above, timber harvest is an important tool for initiating the disturbance needed to meet landscape-scale forest condition goals and ultimately provide broad environmental, social, and economic benefits in perpetuity. Volume of timber offered is the most efficient and effective metric available to help ensure our management actions are aligned with objectives and to evaluate progress in working toward those objectives. The DNR's determination of how much timber volume to offer to achieve the disturbance needed to sustain a balance of multiple values and forest benefits over time and to meet the objectives for different forest lands administered by the DNR is a core component of the strategic direction of the DNR's Forest Resource Management Planning System (referred to as the "planning system" throughout this document). The timber volume determination was informed by the 2018 [Sustainable Timber Harvest Analysis](#), along with the input of a diverse stakeholder group and individual public comments. The determination was communicated in the [Sustainable Timber Harvest \(STH\) Determination Report](#).

In the STH Determination Report, the DNR committed to assessing implementation progress at the midpoint of the planning period. This report contains the results of that midpoint assessment based on the progress demonstrated for FY 2019-2022. Because the assessment covers the first four years of the planning period, it focuses heavily on metrics related to the timber volume determination, as these are the measures for which we have sufficient data to evaluate (such as timber volume planned, offered, and sold). The assessment focuses less on strategic direction outcomes for which we do not have sufficient data to measure at this point. For example, we assessed whether we are offering the amount of volume planned but not outcomes on forest age class distributions (although forest age class distributions are presented for context on current conditions). Outcomes will be analyzed in future assessments of the strategic direction when the necessary data are available. This report also includes context about how the DNR incorporates multiple values into management as we implement the strategic direction, including our strong commitment to managing for wildlife values on Fish and Wildlife-administered lands. Overall, this assessment helped the DNR to identify opportunities for implementation improvements over the remainder of this planning period and in preparing for the next planning period.

Results summary

The DNR's current sustainable forest management strategic direction was designed to achieve the disturbance necessary to develop healthy, diverse forests and sustain them over time. Because timber harvest is a key tool for initiating the disturbance necessary to create and maintain diverse forests, a key component the strategic direction is the volume of timber offered for harvest. Volume of timber offered is an efficient and effective metric available to help the DNR evaluate if its forest management actions align with its objectives to promote wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity on state-administered forest lands. The following bullets summarize the results of the assessment of the DNR's forest management implementation progress during FY 2019-2022.

- On average, the DNR is advancing the overall sustainable forest management strategic direction across all tree species groups, offering within 1% of the total planned annual timber volume during FY 2019-2022.

- The strategic direction established in 2018 included a range of annual planned volume offered by tree species groups. Volume offered for most tree species groups was within or slightly above the planned range in most years.
 - The DNR offered slightly more than the planned aspen range on average (+3%). Aspen is a component of nearly all other forest cover types, making it more difficult to control the precise volume offered for this species.
 - Mixed hardwood and pine volume offered were 24% and 6% below the respective volume ranges for those species groups. The actual volume available has differed from what was estimated by the model during stand exam list development due to differences between conditions on the ground and modeling assumptions and challenges in modeling the appropriate timing for intermediate treatments, such as thinning.
- On average, over 99% of the volume expected from Division of Forestry-administered lands and 93% of the volume expected from Division of Fish and Wildlife-administered lands was offered during FY 2019-2022. Of the total expected volume, 88% was anticipated to come from Division of Forestry-administered lands, and 12% was anticipated to come from Division of Fish and Wildlife-administered lands.
- Timber volume offered was generally steady within ecological sections and species for FY 2019-2022.
- Seventy-two percent of the volume offered was sold, and 28% was unsold.
 - Aspen and pine had the highest sell rates (90+%)
 - Tamarack, spruce, and ash had the lowest sell rates (50-62%)
- Timber volume harvested in FY 2019-2022 was slightly lower on average compared to the average volume harvested from FY 2013-2018 on both Division of Forestry- and Division of Fish and Wildlife-administered lands. Timber harvested in FY 2019-2022 was a mix of timber offered for sale during this planning period and the previous planning period.
- Increased offerings from ash and tamarack forests to address forest health threats did not increase the volume sold or harvested beyond what could be achieved by offering volume within the standard volume-offered ranges for those species.
- The acres on the 10-year stand exam list were generally sufficient to meet the DNR's planned annual volume offered amount (except for mixed hardwoods and pine) while addressing various site conditions and objectives.
 - 51% of the acres examined ultimately were offered for harvest to meet forest management objectives
 - 49% of examined acres were not included on an offered timber sale permit because they were not appropriate to harvest due to current site conditions (e.g., the inventory did not match conditions on the ground or an endangered species was present) or site objectives (e.g., it would be more silviculturally appropriate to harvest in the next planning period or harvest would not advance wildlife habitat objectives within a Wildlife Management Area)
- Current cover type age class distributions are the result of multiple factors, including past planning, management, natural disturbances, and markets. Age class distributions on DNR-administered lands under the forest resource management planning system currently conform to desired distributions to varying degrees. The aspen cover type, in particular, is currently well-balanced, the result of decades of work toward that goal.
- The DNR continues to retain older aspen in state-managed forests. Statewide, 5.5% of the aspen cover type is at least 60 years old on DNR lands where planned timber harvest may be employed for forest management. This is more than double the minimum amount of older aspen the DNR determined must

remain on DNR lands available for planned timber harvest to provide habitat for species that rely on older aspen, including woodpeckers, ducks, owls, songbirds, fisher, marten, and bats.

- The DNR is managing for multiple forest values while implementing the sustainable forest management strategic direction, which includes a strong commitment to managing for wildlife values on Fish and Wildlife-administered lands.
 - DNR-administered lands have a diversity of forest patch sizes and ages that provide for a range of species' habitat needs.
 - On average, DNR staff examine forest stands for potential harvest when they are significantly older than their planned rotation age (the age at which forest stands of a cover type are typically planned for management). The DNR is examining the oldest stands and working toward long-standing forest age class distribution goals, including goals for older age class distributions on Fish and Wildlife-administered lands and in other areas with goals for mature forests (e.g., old forest management complexes around old growth forests).
- DNR-administered lands within priority watersheds have retained forest cover above the threshold at which potential negative water quality impacts may be observed.
- Site-level prescriptions were designed to protect cultural resources, increase compositional and structural diversity, conserve biodiversity, protect rare species and native plant communities, maintain or develop wildlife habitat, and protect riparian areas on thousands of acres examined in FY 2019-2022. Most of these actions also aligned with climate adaptation strategies described by the Northern Institute of Applied Climate Science (NIACS), such as maintaining and increasing species projected to be capable of withstanding climate change and protecting rare native plant communities and species.
- The DNR continued to maintain forest certification through third-party certification organizations during FY 2019-2022, demonstrating the DNR's commitment to sustainable forest management.

Improvement Opportunities

This report outlines improvements for the second half of this planning period, including:

- completing updates to and re-emphasizing Section Forest Resource Management Plan (SFRMP) goals and strategies, which provide guidance to staff on incorporating multiple forest values in management decisions
- completing plans for major Wildlife Management Area (WMA) units and the system of smaller WMAs to articulate wildlife habitat objectives for Fish and Wildlife-administered lands and identify how timber harvest and other tools will be used to achieve these objectives
- re-emphasizing staff familiarity with the DNR's forest management policy system, which includes direction on how to balance among multiple forest values, with that balance varying across different administrative land status types
- using management objective codes to document the goals of specific forest management forest activities more comprehensively
- discontinuing the pilot to offer additional ash and tamarack volume due to low sell and harvest rates for those species
- applying lessons learned to date during this planning period as the DNR prepares to assess the strategic direction for the next planning period

As the DNR finalized the midpoint assessment report, it also became apparent that there is a significant difference between the DNR's intent for forest management coordination, which is reflected in written implementation procedures, and what DNR staff are experiencing. The DNR is committed to addressing these implementation issues in a timely manner. To do so, the directors and management teams of the DNR divisions involved in forest management coordination are working together to develop and implement a continuous improvement plan that has specific, actionable, and timely steps.

Conclusions

Overall, based on the available data, the DNR is successfully advancing the 10-year strategic direction for forest resource management to ensure that DNR-administered lands sustainably provide forest benefits over time, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity. The DNR is committed to continuously improving the implementation of the strategic direction and has begun to act on the opportunities for improvement identified in this report.

Introduction

The Minnesota Department of Natural Resources (DNR) is responsible for sustainably managing the state's forest resources to achieve economic, environmental, and social goals (M.S. 89A) in alignment with other applicable laws concerning various resources and land statuses. The DNR's mission – to work with Minnesotans to conserve and manage the state's natural resources, to provide outdoor recreation opportunities, and to provide for commercial uses of natural resources in a way that creates a sustainable quality of life – reflects this responsibility.

In 2018, the DNR established the strategic direction for forest resource management on DNR-administered lands for FY 2019-2028, which is a key element of the statewide Forest Resources Management Planning System (hereafter, "planning system") (Figure 1). The strategic direction applies to DNR-administered forest lands, excluding lands within State Parks and Scientific and Natural Areas (SNAs).

The strategic direction decisions were informed by the Sustainable Timber Harvest Analysis (STHA) project, which evaluated the level of forest disturbance via timber harvest that would sustainably provide multiple forest benefits over time, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity (see the [Sustainable Timber Harvest Determination Report](#)). The STHA project included a robust, thorough, third-party analysis conducted by Mason, Bruce & Girard, an established professional natural resources consulting firm based in Portland, Oregon. The analysis modeled a range of scenarios to demonstrate the tradeoffs between important forest resource values, which were identified by a diverse Stakeholder Advisory Group, at various levels of timber harvest. The strategic context provided by the analysis was important as the DNR determined its forest management strategic direction. DNR leadership determined the strategic direction after considering many factors, including the analysis results, stakeholder responses, public comments, discussions with the Office of School Trust Lands, and statutory requirements for managing different DNR land statuses. The DNR committed to assessing implementation at the midpoint of the planning period to review progress made and identify whether improvements to performance are needed.

The DNR's forest management strategic direction is designed to optimize the balance of multiple forest values and their corresponding benefits over time, recognizing that the "optimal balance" of forest benefits varies across the different lands managed by the DNR. Young, intermediate, and mature forests each provide different forest benefits, so it is important to have a mix of forest age classes across the landscape at all times. Different tree species and forest cover types also provide different benefits, so species diversity is also important. Therefore, balancing forest age classes and maintaining or enhancing diversity is foundational to the DNR's landscape planning approach² because it ensures a consistent, sustainable flow of forest benefits now and into the future. Forest age classes and species mix are balanced through disturbance.

² The DNR's landscape planning approach develops direction to move DNR-managed forest resources toward desired future forest conditions within forested ecological sections.

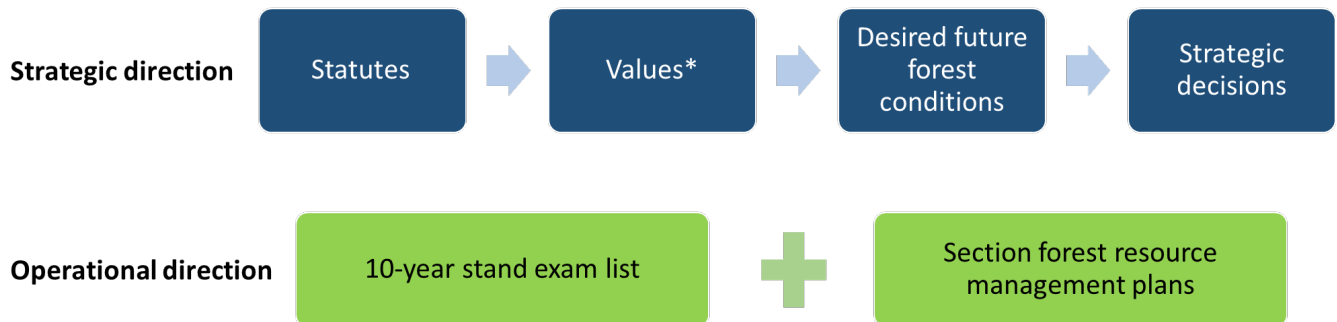
While the DNR uses a variety of disturbances such as timber harvest, prescribed fire, and brushing to advance site-level goals for habitat, stand improvement, or native plant community composition, forest regeneration through planned timber harvest is the most effective and efficient tool to advance landscape-scale goals for forest age classes and species mix. As the forest ages, these planned treatments transition some mature forests to young forests; they also create an opportunity to diversify the forest or shift the cover type. A balance of young, intermediate, and older forests ensures that the benefits associated with each forest age class are available to Minnesotans over time.

The DNR uses timber sale permits as a key tool to initiate and manage the disturbance necessary to create age class distributions and species mixes that provide forest benefits over time. The extent of disturbance achieved is a function of the volume of timber offered for sale that is ultimately sold and harvested. Therefore, the determination for how much volume of timber to offer for sale annually is an important component of the DNR's forest management strategic direction.

Volume offered is an efficient and effective metric to evaluate if our harvest-dependent management actions are aligned with our objectives and to track our progress in real-time. In the 1980s, when Minnesota lacked an aspen market to sufficiently balance the aspen age class distribution, the DNR paid contractors to use equipment to create younger forest habitat for early successional species such as grouse. Today, the DNR lacks the resources needed to achieve desired age class distributions and species mix by paying for disturbance. Additionally, timber harvest provides societal and economic benefits while meeting forest management objectives. For this planning period, the DNR determined the amount of volume to offer on timber sale permits annually to optimize the sustainability of the values listed above based on the STHA results, stakeholder input, and interdisciplinary assessments by staff in the DNR divisions of Forestry, Fish and Wildlife, and Ecological and Water Resources.

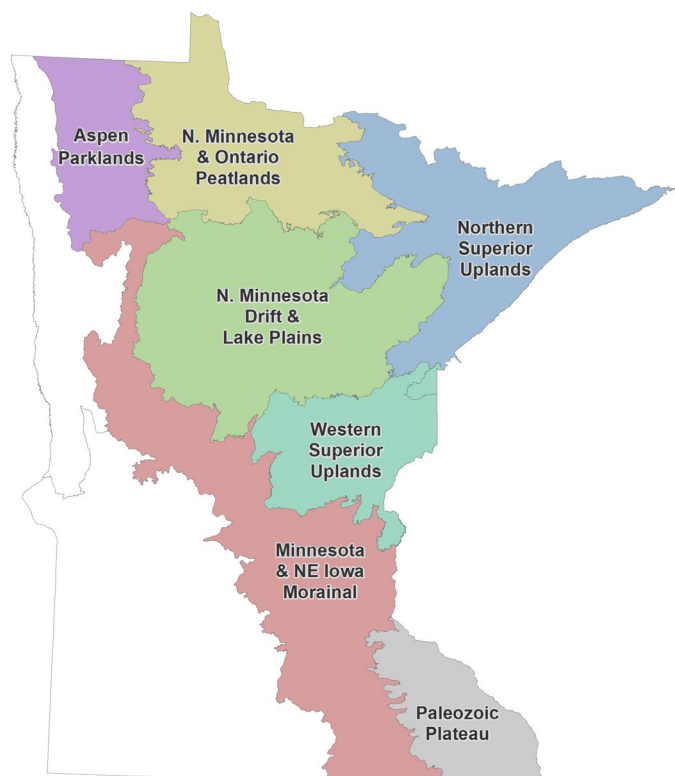
Figure 1. Components of the DNR’s Forest Resource Management Planning System.

- Strategic direction – decisions for how to fulfill statutory requirements and balance multiple values sustainably through forest resource management
- Operational direction
 - [10-year stand exam list](#) – a list of forest stands to examine for potential management to meet the strategic direction
 - [Section Forest Resource Management Plans \(SFRMPs\)](#) – narrative plans for what to consider when making management decisions regarding stands on the 10-year stand exam list to advance landscape-scale goals within ecological sections (**Figure 2**)



*wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity

Figure 2. Ecological sections with Section Forest Resource Management Plans.



Strategic direction summary

The strategic direction for FY 2019-2028 includes the following elements:

- continue to develop the desired forest age class distributions and species mixes over time, consistent with the specific management objectives of different forest lands administered by the DNR, by offering an average of 870,000 cords per year for sale on timber harvest permits
- test whether we can stimulate markets and increase management of forests threatened by emerald ash borer and Eastern larch beetle by offering an additional 30,000 cords of ash and tamarack annually as a pilot during the first five years of the planning period
- employ timber harvest to move Division of Forestry-administered lands toward a balanced age class distribution and species mix that provides multiple benefits, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity; this was projected to amount to 88% of the total timber volume offered each year and therefore, the DNR uses offering an average of approximately 792,000 cords per year from Division of Forestry-administered lands as the metric to assess whether we are initiating the disturbance necessary to provide multiple benefits
- through timber harvest, implement the forest disturbance needed to maintain a balanced age and species structure that supports diverse wildlife habitat values on Fish and Wildlife-administered lands; this was projected to amount to 12% of the total timber volume offered each year (on average across the planning period) and consequently, the DNR uses offering an average of approximately 108,000 cords per year from Fish and Wildlife-administered lands as the metric to assess whether we are initiating the disturbance necessary to meet habitat goals
- provide older aspen habitat and meet forest certification requirements to achieve a diversity of growth stages on DNR-administered lands by ensuring that at least 2.5% of the aspen cover type is at least 60 years old on DNR-managed forest lands statewide (aspen is the only species group that the planning model results projected would not retain sufficient older habitat without this decision)
- ensure a sustainable balance of forest values overall by offering a relatively stable amount of volume by species and ecological sections over time
- meet the statutory requirements associated with various plant and animal species, DNR land administrations, and land statuses (e.g., school trust lands, wildlife management areas, etc.) and take advantage of opportunities for addressing wildlife and ecological values by applying different approaches to estimating volume yield and management parameters based on cover type, ecological section, DNR land administrator, school trust land status, presence of endangered and threatened species, and other special considerations in particular areas, such as management opportunity areas

The DNR used the parameters listed above to identify forest stands to examine for potential treatment to implement the strategic direction (see the [Development of the DNR 10-year Stand Exam List](#) report for more information). These parameters shaped the development of a model to identify candidate stands for examination based on rotation ages that varied by factors including cover type, ecological section, DNR land

administrator, and various sites (e.g., management opportunity areas) with management that differs, on average, from standard management. DNR staff reviewed the lists of candidate stands and adjusted them manually to develop the 10-year stand exam list. The 10-year stand exam list identifies specific stands for DNR staff to evaluate in the next 10 years for potential treatment. In general, more acres were included on the 10-year stand exam list than estimated to be necessary to ensure that the DNR could meet the strategic direction while accounting for examined stands that don't end up being appraised for one reason or another (see the Stand Exam Accomplishments section for more information).

Purpose and scope

This report communicates the assessment of the DNR's progress in implementing the forest management strategic direction during FY 2019-2022 and identifies mid-point opportunities for improvement. It assesses the degree to which DNR forest management actions matched what we planned to achieve in our mandate to sustainably manage the state's forest resources for multiple benefits (e.g., whether we are offering the aspen volume and retaining the amount of older aspen we said we would). This report also identifies improvements for the remaining years in this planning period based on lessons learned and provides context concerning how the DNR incorporates multiple values into forest management.

This assessment covers the first four years of the planning period; it focuses heavily on implementation progress metrics that we have sufficient data to evaluate (such as timber volume planned, offered, and sold). This assessment does not examine the effectiveness of the planning system's strategic direction from an outcomes perspective. For example, it does not analyze the effect of timber volume offered and subsequent harvest on the cover type age class distributions on DNR-administered forest lands. It can take years after a stand examination for harvest to occur and for the forest to reflect the resulting change. This means that we will only begin to see changes to resource conditions, such as cover type age class distributions, during future forest resource monitoring and assessment work ahead of the next planning period. Nevertheless, this report includes a snapshot of some resource conditions as context, including age class distributions, to show current conditions that resulted primarily from past plans and decisions as context.

This assessment of progress is also not a re-evaluation of the strategic direction itself. Evaluating the strategic direction requires updated data and a complete modeling effort to account for multiple factors. The DNR intends to reassess the forest management strategic direction on a 10-year cycle. Before the end of this planning period, the DNR will evaluate available data and new analyses and consider stakeholder and partner perspectives to determine whether and how to update the strategic direction for the next ten years.

Other monitoring efforts assess different aspects of the DNR’s sustainable forest management, including:

- [Minnesota Forest Resources Council Voluntary Site-level Guidelines Implementation Monitoring](#)
- [Sustainable Forestry Initiative and Forest Stewardship Council certification audit reports](#)
- [Forest health reports](#)
- SFRMP monitoring
- Internal program reviews
- Timber sale inspections
- Timber sale and harvest reporting
- Regeneration monitoring
- Forest inventory

Forest Resource Management Planning System implementation

The DNR implements the forest management strategic direction within a framework designed to ensure that we manage forests sustainably for multiple values, adhere to our mission, and meet our statutory, forest certification, and fiduciary obligations. For example, state statutes require the DNR to manage wildlife management areas “for the production of wildlife, for public hunting, fishing, and trapping, and for other compatible outdoor recreational uses” (M.S. 86A.05 Subd. 8) and school trust lands “to secure the maximum long-term economic return from the school trust lands consistent...with sound natural resource conservation and management principles...” (M.S. 127A.31). To operationalize the strategic direction, the DNR developed 10-year stand exam lists for each forested ecological section of the state, which identified specific stands for DNR staff to evaluate in the next 10 years for potential treatment.

Forest Resource Management Planning System implementation includes the following steps each year:

1. An annual stand exam list, which lists the specific forest stands identified for review (i.e., examination), is derived from the 10-year stand exam list. DNR staff (foresters, wildlife biologists, ecologists, archaeologist) review the annual list, and tribes and the public are invited to comment on it (see the DNR’s [Annual Stand Exam List webpage](#)).
2. After receiving comments from internal staff, tribes, and the public, DNR staff visit the sites on the annual stand exam list to evaluate them for potential management. These stand examinations can have several different outcomes. Some stand exams result in postponing management to another planning period for biodiversity, habitat, or silvicultural reasons (e.g., the stand is not ready to harvest). Sometimes, the forest inventory requires correction, and the site is not ready to harvest. In some cases, timber harvest is appropriate. Timber harvest can take many forms, including regenerating an entire site, applying an intermediate treatment such as thinning to improve tree growth, selectively cutting trees to adjust forest composition and structure, or addressing a forest health issue. DNR forest managers incorporate many sources of information and direction into these management decisions, including:
 - Current site conditions
 - Comments from DNR foresters, wildlife biologists, ecologists, and archaeologists; tribal natural resources staff; and the public
 - Specific considerations regarding:
 - DNR land administrator (which may affect the desired balance of forest values at the site)

- land status (e.g., [school trust, acquired, consolidated conservation](#))
 - resources on the site (e.g., rare native plant communities, federal or state endangered or threatened species, High Conservation Value Forest, water features, wildlife habitat components, legacy trees, bald eagle nests, recreational trails, roads, etc.)
 - Best practices outlined in Minnesota Forest Resource Council Voluntary Site-Level Guidelines (DNR policy requires staff to apply the Guidelines)
 - Section Forest Resource Management Plans, including management opportunity area goals and strategies
 - Wildlife Management Area unit plans
3. DNR foresters appraise timber from sites for which timber harvest is determined to be appropriate and offer timber permits for sale at public auctions. The DNR Division of Forestry Timber Program tracks the timber volume offered annually to ensure that we do not systematically over- or under-offer timber for sale and thereby impact our ability to achieve the sustainable forest management strategic direction. If planned stands are not offered on a timber sale, they become available for examination and appraisal during a future year.
 4. When a business or individual purchases a timber permit, they typically have three years to harvest the stand in accordance with the specifications provided in the appraisal and terms and conditions of the permit. The purchaser notifies the DNR of their intent to harvest during the applicable season of operation, and DNR Forestry staff supervise the permit's execution to ensure that harvest activities follow the management design and all applicable policies designed to protect the site, water quality, protected plants and animals, and other resources.

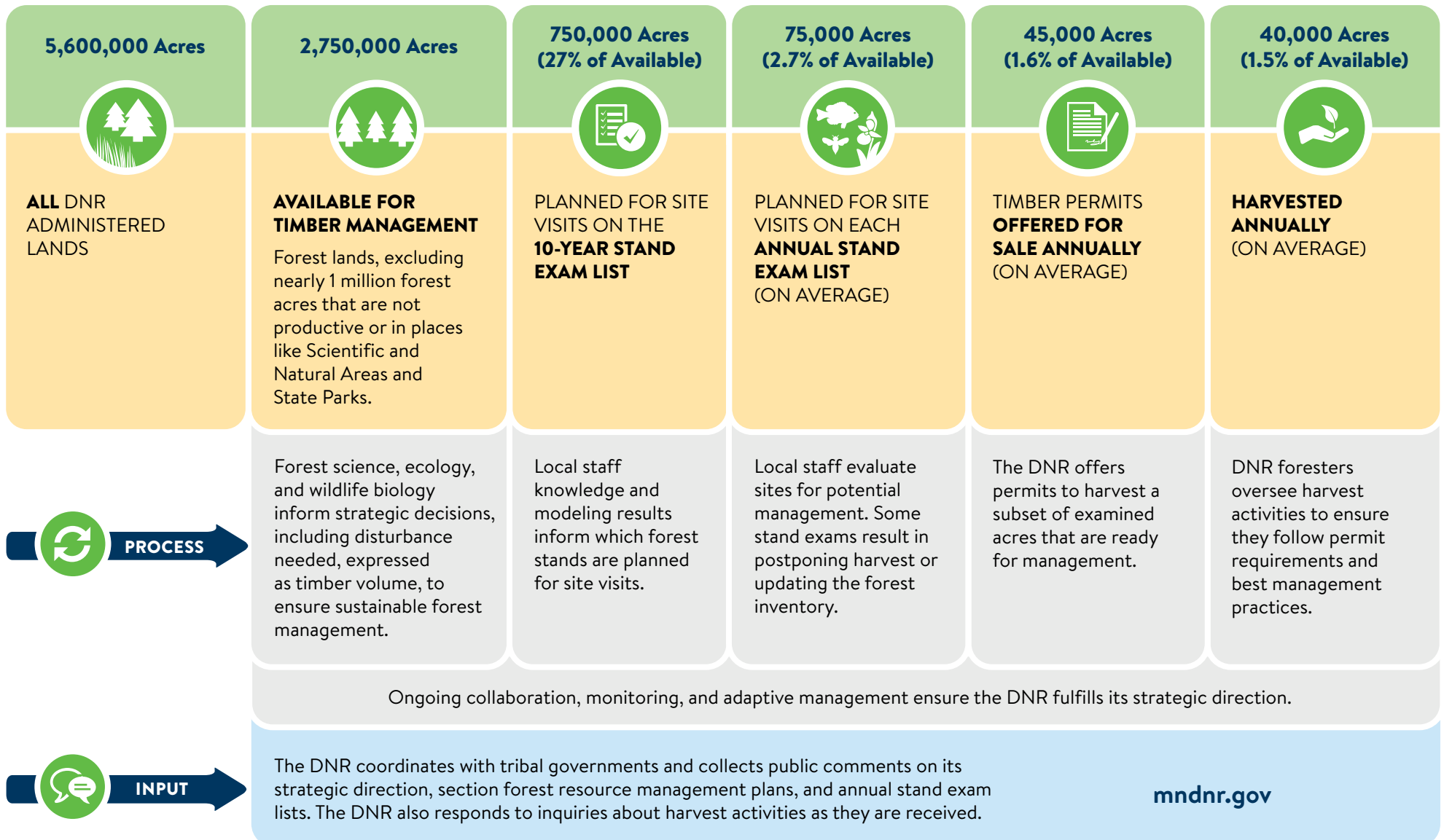
The Forest Planning & Management Process graphic below illustrates the forest resource management planning process through the implementation steps outlined above and provides additional information about acres of land available for timber management that are harvested each year.

Case Studies

This report includes case studies as examples of how the sustainable forest management strategic direction is implemented to illustrate how different forest values and policies are incorporated into management at the site level.

FOREST PLANNING & MANAGEMENT PROCESS

1.5% of lands available for timber management are harvested annually to ensure healthy, diverse forests that provide multiple benefits, including timber supply for Minnesota's forest products economy.



Assessment results

Strategic direction implementation

The DNR's sustainable forest management strategic direction is designed to create a balance of young, intermediate, and older forest and a mix of tree species. As the forest ages, the DNR commonly uses timber harvest to disturb forests to sustainably provide diverse forest benefits over time. Timber harvest is accomplished through offering volume for sale on timber harvest permits. Thus, timber volume offered is a key metric in assessing the DNR's progress toward creating and maintaining our desired landscape-scale forest age class and diversity objectives, which are the foundation for providing the range of benefits for which the DNR manages forests, including wildlife habitat, biodiversity, timber productivity, forest health, wood supply and healthy natural resource economies, recreation, carbon sequestration and storage, and water quality and quantity.

This section presents information on the annual timber volume offered compared to what was planned overall and by DNR land administrator (Division of Forestry and Division of Fish and Wildlife), ecological section, and tree species group. It also includes information about the acres examined for potential harvest and the outcomes of those examinations, the volume sold and harvested, and patterns of management prescriptions by forest cover type. Together, these results show that the DNR has been working toward the strategic direction as planned.

Annual volume offered

In working toward developing and maintaining balanced forest age class distributions and diverse species mixes, the DNR offered 99% of the planned statewide timber volume annually, on average, during FY 2019-2022 and offered within the planned range of volume by species group in most years (**Table 1**).

- On average, aspen and birch volume offered was 3% (12,322 cords) and 36% (10,745 cords) above the high end of their planned ranges, respectively. Key drivers of this result include:
 - Precise volume-offered accomplishments for these species can be difficult to control because they are components of nearly all other forest cover types. Aspen and birch volume contributions from other forest cover types are challenging to estimate due to natural variations among stands.
 - In some fiscal years, a proportion of the aspen volume was offered from the Aspen Parklands ecological section to advance wildlife habitat management objectives, exceeding the planned volume in that ecological section for those years.
- On average, mixed hardwood and pine volume offered was 24% (25,908 cords) and 6% (6,900 cords) below the low end of their planned volume-offered ranges, respectively.
 - Volume-offered ranges were based on model-estimated volume yields, with simplified assumptions about management. In FY 2019-2022, the actual yields differed from what was expected for hardwoods and pine for several reasons, including:
 - differences in conditions on the ground compared to the forest inventory and simplified assumptions about stand composition on which planning was based

- difficulty in modeling the appropriate timing for intermediate treatments for these cover types and how much timber volume those treatments would yield

Table 1. Annual volume offered by species during FY 2019-2022 compared to the planned range.

Species	FY19-28 planned range	FY2019	FY2020	FY2021	FY2022	Average
Ash	25,000-40,000*	46,402	60,982	43,867	34,363	46,404
Aspen and Balm of Gilead	360,000-400,000**	423,582	390,034	429,221	405,487	412,081
Balsam Fir	30,000-40,000	39,993	42,449	37,955	33,391	38,447
Birch	30,000	44,926	41,905	39,804	35,913	40,637
Spruce	105,000-115,000	113,326	109,142	92,973	118,734	108,544
Mixed Hardwoods	110,000-120,000	79,394	101,546	75,722	78,148	83,703
Pine	110,000-120,000	95,672	95,814	107,214	113,682	103,096
Tamarack	30,000-40,000*	59,296	52,726	65,456	51,225	57,176
White Cedar and Other	2,000	2,572	1,177	1,912	2,055	1,929
Total	870,000 (+30,000 cords ash and tamarack)	905,162	895,775	894,124	872,998	892,015

*During this planning period's first five years, the DNR aimed to offer 30,000 cords of ash and tamarack combined in addition to the planned ranges listed in the table for those species.

**The strategic direction for this planning period includes gradually reducing the annual aspen volume offered from 400,000 cords to 360,000 cords by the end of the 10-year planning period.

Volume offered by DNR land administrator

Using information generated during the STHA project, the DNR determined the amount of timber volume that should be offered from lands administered by the divisions of Forestry and Fish and Wildlife to achieve the forest management objectives specific to each DNR land administrator. The DNR determined that approximately 792,000 cords per year, 88% of the total planned timber volume, should be offered from Division of Forestry-administered lands to achieve a balanced age class distribution that provides multiple forest benefits, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity. The DNR determined that achieving a balanced age and species structure that supports diverse wildlife habitat values on Division of Fish and Wildlife-administered lands would result in offering approximately 108,000 cords per year, or 12% of the total planned timber volume offered. Consequently, the DNR uses offering an average of approximately 108,000 cords per year from Fish and Wildlife-administered lands as the metric to assess whether we are initiating the disturbance necessary to meet habitat goals. Offering this amount of volume per year from Division of Fish and Wildlife-administered lands represents a decrease in volume offered from Fish and Wildlife-administered lands compared to the years before this planning period (e.g., on average, 130,000 cords, or about 14% of the total volume offered, was offered annually from Division of Fish and Wildlife-administered lands during fiscal years 2011-2017).

On average, over 99% of the volume expected from Division of Forestry-administered lands and 93% of the volume expected from Division of Fish and Wildlife-administered lands was offered during FY 2019-2022 (**Table 2**).

Table 2. Annual volume offered compared to volume planned by DNR land administrator for FY 2019-2022 with the percent of the total planned volume for each land administrator in each fiscal year in parentheses.³

Admin	Planned Volume	FY2019	FY2020	FY2021	FY2022	Average FY2019-2022
FOR	792,000	789,968 (87.8%)	778,510 (86.5%)	794,545 (88.3%)	802,350 (89.2%)	791,343 (87.9%)
FAW	108,000	115,194 (12.8%)	117,263 (13.0%)	99,570 (11.0%)	70,642 (7.8%)	100,667 (11.2%)
Total	900,000	905,162 (100.6%)	895,773 (99.5%)	894,115 (99.3%)	872,992 (97.0%)	892,015 (99.1%)

³ Percentages do not add up to 100% because the annual volume offered varied slightly from the total planned volume each year, as does the contribution of volume from each land administrator.

Case Studies: Wildlife Habitat in Wildlife Management Areas (WMAs)

The DNR manages forests on WMAs differently than forests on other lands. Wildlife habitat is the primary value for which the DNR manages WMAs. Timber harvest, accomplished through selling timber harvest permits, is often the most effective way to achieve important habitat objectives such as altering the composition or age of forest habitat.

Example 1: Dorr WMA forest habitat improvement

Management objectives:

- Remove non-native Scotch pine and Norway spruce trees
- Reestablish native hardwoods
- Enhance wildlife habitat adjacent to old growth forest

Staff coordinated to design, plan, offer, and administer a timber sale to remove nonnative tree species and enhance wildlife habitat. Removal of the non-native trees also promoted the development of older forest habitats representative of the native plant community adjacent to old growth forest.

Dorr WMA following removal of non-native trees with healthy native forest in the background (top photo). Dorr WMA native hardwood regeneration (bottom).



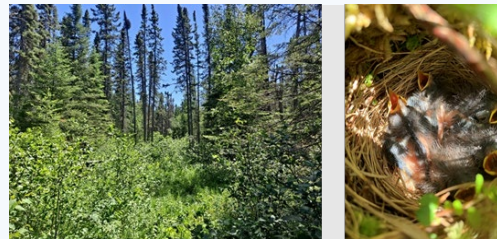
Example 2: Red Lake lowland conifer research

Management objectives:

- Test harvest methods to provide habitat for the uncommon songbirds Boreal Chickadee and Connecticut Warbler
- Evaluate the operational and economic feasibility of harvest methods

DNR wildlife managers and foresters are collaborating with researchers at the Natural Resources Research Institute (NRRI) to test the effects of different black spruce and tamarack harvest methods on Boreal Chickadee and Connecticut Warbler habitats. The study includes traditional strip cuts and alternative gap selection cutting. The permits for this harvest were sold in 2022. The researchers are also evaluating the effects of alternative management prescriptions on operational costs.

DNR staff and NRRI researchers lay out experimental harvest blocks for the Connecticut Warbler project (top). Lowland conifer forest and Connecticut Warbler nest (bottom).



Example 3: Ruffed Grouse Management Areas

Management objectives:

- Enhance habitat for early successional - dependent species, such as Ruffed Grouse.
- Increase recreational opportunities for hunters, birders, and outdoor enthusiasts.

The DNR manages Ruffed Grouse Management Areas (RGMAs) to provide easy habitat access for hunters. These areas often contain walking trails, making them especially popular with new hunters. Within RGMAs, DNR staff coordinate to maintain blocks of trees of different ages, from young to mature, that provide habitat for grouse at all life stages and other species with similar requirements. Management for these habitat characteristics requires regular, planned timber harvest to provide the younger forest on which grouse depend.

Hunter walking trail in a ruffed grouse management area (top) and hunter with grouse (bottom).



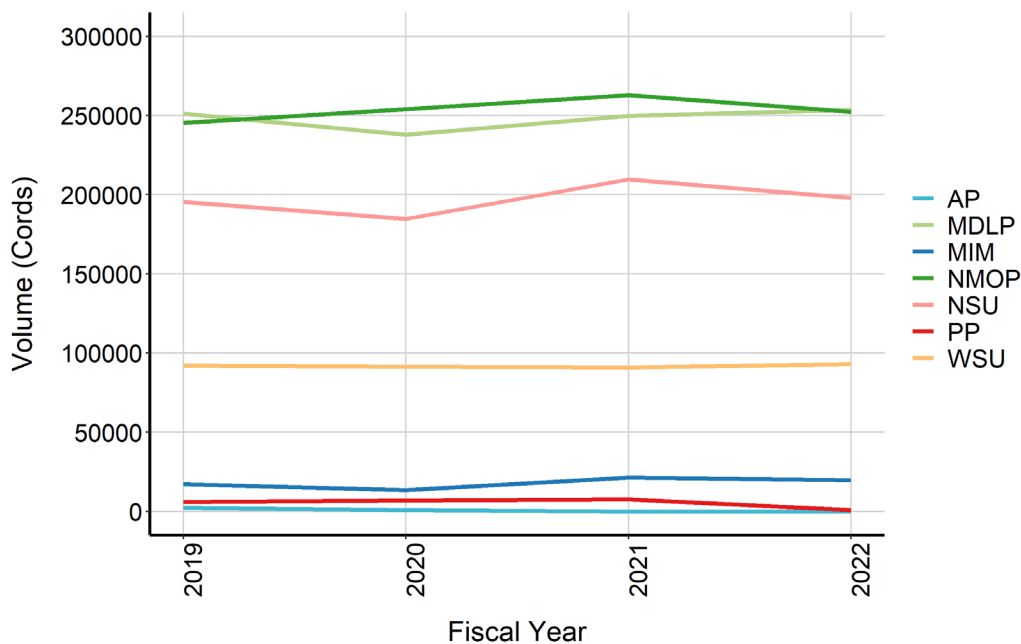
Stability of volume offered over time within ecological sections

During the development of the 10-year stand exam list, the model was programmed so that the potential volume available to be offered from the candidate stand exam list would vary up to 10% within each ecological section and up to 15% for each species over time. These ranges of variability were set to ensure a steady, predictable supply of forest products and the right mix of young and older forest habitats on DNR-administered lands into the future.

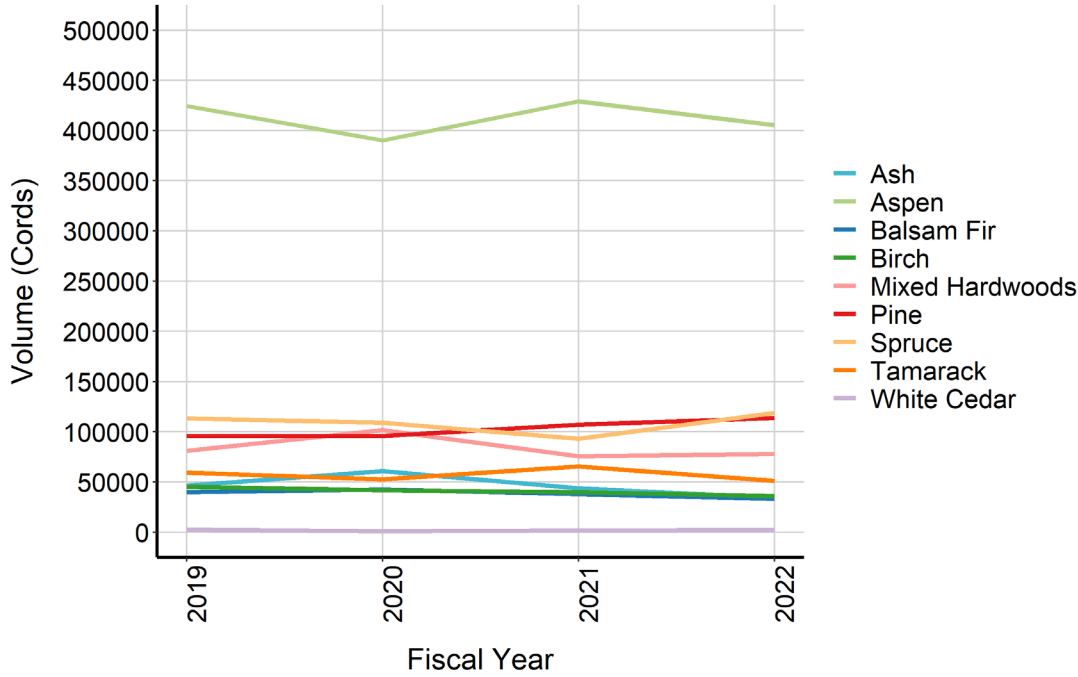
In FY 2019-2022, the annual variation in volume offered was well within the acceptable range for the ecological sections from which most volume is offered (**Figure 3A**). The Northern Minnesota and Ontario Peatlands (NMOP), Minnesota Drift and Lake Plains (MDLP), and Northern Superior Uplands (NSU) Sections together produce over 85% of the annual volume offered from DNR-administered lands, on average. In these top three volume-producing sections, the annual volume offered varied from 0.3% to 6.2% from the average. Similarly, the annual variation in volume offered for species groups that produce most of the volume offered (aspen, spruce, pine) was within the acceptable range (0.6-14% from average; **Figure 3B**). Annual variation exceeded the acceptable ranges in a few ecological sections (Paleozoic Plateau and Aspen Parklands) and species (cedar, ash, and hardwoods in FY 2020). In these cases, small absolute differences from the average resulted in relatively large percentage differences because fewer total cords were offered from these sections and species overall.

Figure 3. Annual volume offered by ecological section (A) and species (B) from FY 2019-2022. AP=Aspen Parklands, MDLP=Minnesota Drift and Lake Plains, MIM=Minnesota and Northeast Iowa Morainal, NMOP=Northern Minnesota and Ontario Peatlands, NSU=Northern Superior Uplands, PP=Paleozoic Plateau, WSU=Western Superior Uplands.

A.

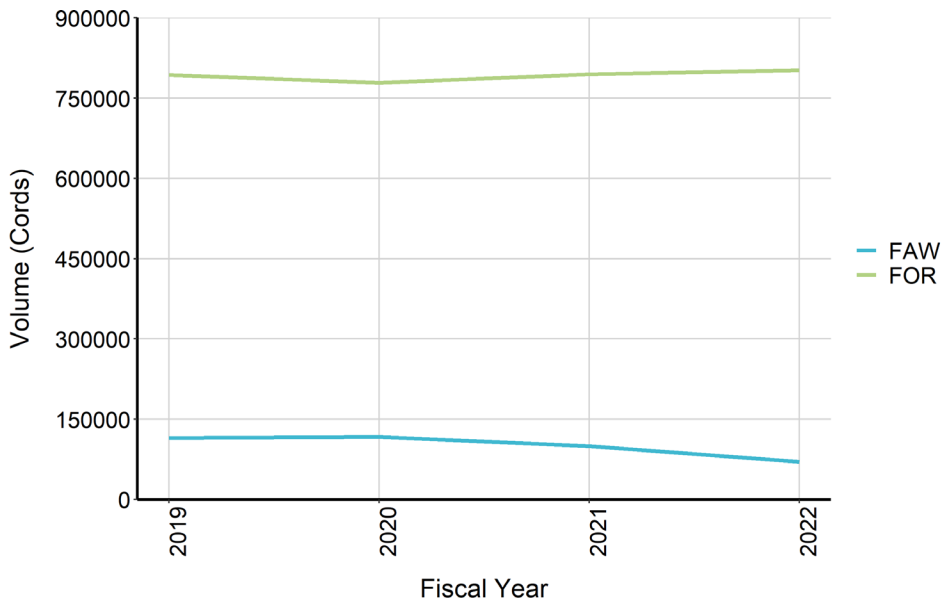


B.



Over time, the volume offered from Division of Forestry-administered (FOR) lands was steady, varying 0.1 to 1.7% from the average (Figure 4). Percent variation in annual volume offered was greater on Division of Fish and Wildlife-administered lands (FAW), with total volume offered generally decreasing over FY 2019-2022.

Figure 4. Annual volume offered by DNR land administrator from FY 2019-2022.



Volume sold

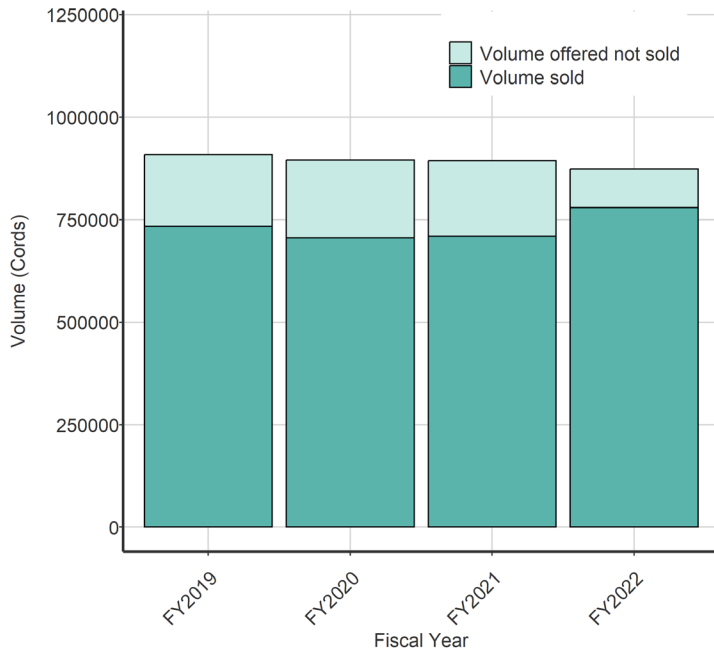
On average, 72% of the timber volume offered from FY 2019-2022 was sold on a timber permit (**Figure 5A**). However, the percent volume sold (sell rate) varied by species and ecological section (**Figure 5B-C**):

- Spruce and tamarack had the lowest sell rates (50%), followed by ash (64%).
- Aspen and pine had the highest sell rates (90 and 92%, respectively).
- Balsam fir, birch, hardwoods, cedar, and other miscellaneous species had intermediate sell rates ranging from 73-75%.
- The NMOP and MDLP ecological sections had the highest sell rates (95% and 99%, respectively); AP, NSU, and WSU had moderate sell rates (60-73%); and MIM and PP had the lowest sell rates (47% and 14% respectively).

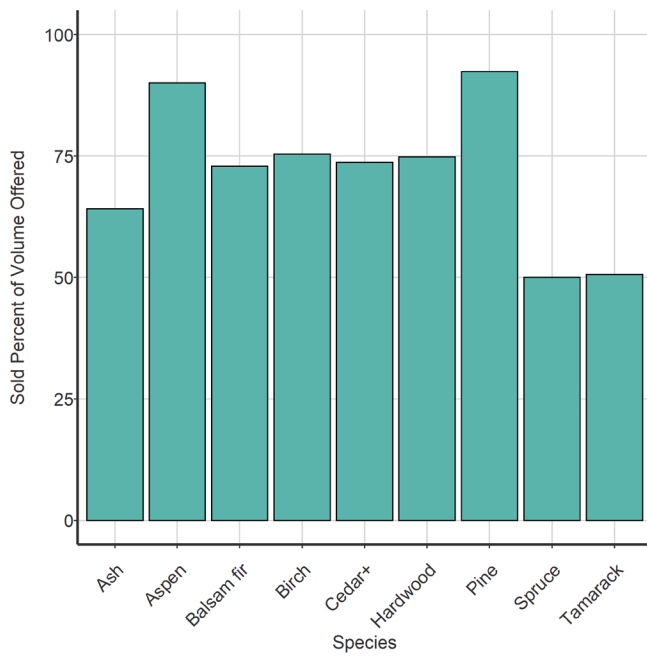
Wood markets vary across the state, and logging operation costs, including trucking, limit the ability to accomplish harvest-related forest management actions everywhere. For example, in southeast Minnesota, there are local markets for walnut sawlogs and pine poles but fewer opportunities to use other species and products. Low sell rates in the MIM and PP ecological sections underscore the challenge of achieving forest management objectives without a robust market for harvesting timber, given the importance of timber harvest as a tool for forest management. Despite low sell rates, the DNR offers timber volume in these areas to try to initiate sound forest management by providing information to prospective markets about available timber.

Figure 5. Total new timber volume (cords, excluding reoffered volume) sold compared to offered across all species for FY 2019-2022 (A) and average percent volume sold over this period by species group (B) and ecological section (C).

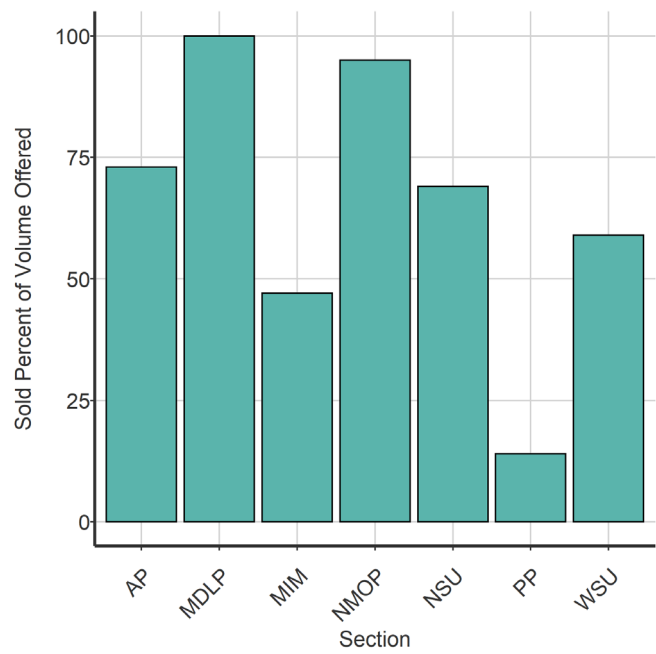
A.



B.



C.



Volume scaled

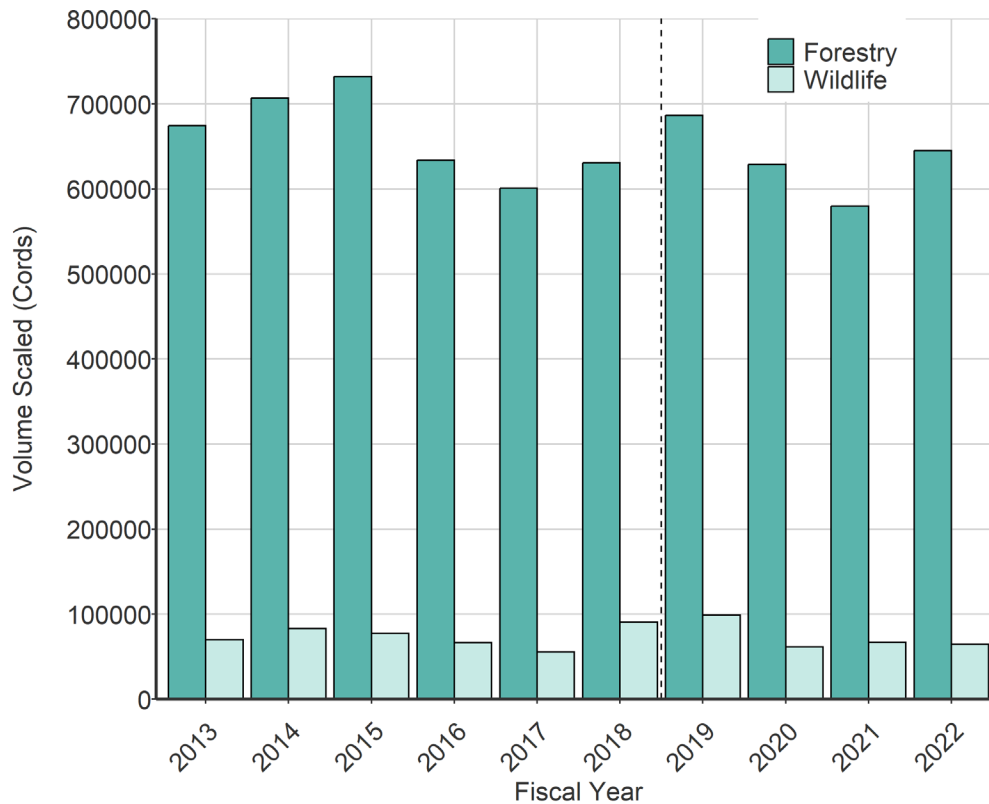
Scaled volume (the measured volume of harvested logs) measures timber harvest disturbance on DNR-administered lands in a given year. It results from the volume offered and sold in previous years. When and whether sold timber volume is harvested depends on several factors. DNR field staff prescribe the permit period and the preferred or required season to harvest, but harvest timing depends on the permit holder, market demand, and weather, among many other factors.

The average fiscal year volume harvested during FY 2019-2022 (725,567 cords, ranging from 646,072 to 785,104) was slightly lower than the average from FY 2013-2018 (736,745 cords, ranging from 656,175 to 822,903). This holds for both Division of Forestry and Division of Fish and Wildlife-administered lands (**Table 3, Figure 6**).

Table 3. Average fiscal year volume harvested (in cords, with the range in parentheses) before the current planning period (FY 2013-2018) and from FY 2019-2022 by the DNR land administrator.

DNR Land Administrator	FY 2013-2018	FY 2019-2022
Fish and Wildlife	73,736 (55,580 to 90,860)	72,866 (61,484 to 98,743)
Forestry	663,009 (600,595 to 732,043)	634,856 (579,485 to 686,360)

Figure 6. Volume (cords) harvested (scaled) per fiscal year by DNR land administrator from FY 2013-2022. The dashed vertical line shows the beginning of the current planning period in FY 2019.



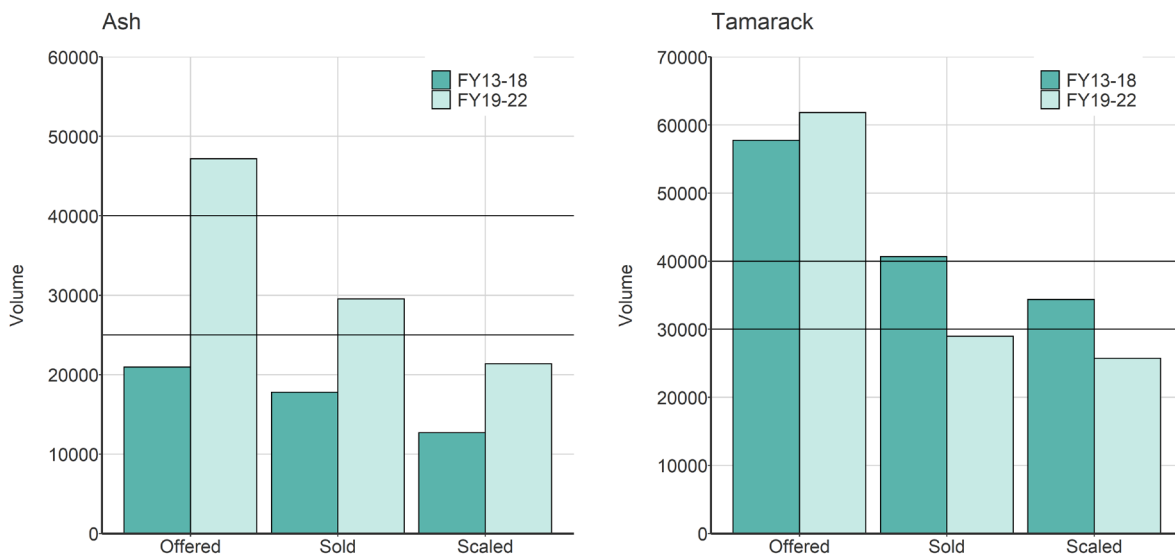
Ash and Tamarack Pilot

The DNR increased the volume offered for ash and tamarack as part of a pilot to learn whether doing so would lead to increased timber sales and harvest to help address forest health issues for these species.

- Emerald ash borer (EAB) and Eastern larch beetle (ELB) continue to spread and damage ash and tamarack trees, respectively (see the [DNR's annual forest health report](#) for more information).
- Over the last four years, the volume of ash offered increased significantly, and the volume of tamarack offered increased slightly compared to the six years before this planning period (**Figure 7**).
- The ash volume sold and scaled increased during FY 2019-2022 compared to the prior six years (FY 2013-2018); however, the proportion of offered volume that was sold and scaled decreased significantly compared to the six years before this planning period.
- For tamarack, volume sold and scaled decreased significantly compared to the six years before this planning period, as both a percentage of offered volume and in absolute volume sold and scaled.

Increased offerings from ash and tamarack forests to address forest health threats did not increase the volume sold or harvested beyond what could be achieved by offering volume within the standard volume-offered ranges for those species.

Figure 7. Average ash and tamarack volume (cords) offered, sold, and scaled before (FY 2013-2018) and during (FY 2019-2022) this planning period. Black lines show the current planned volume-offered ranges, not including the additional 30,000 cords of ash and tamarack combined for the pilot.



While managing tamarack ahead of ELB mortality is preferable, tamarack stands affected by ELB are regenerating even if they are not managed. When salvage does occur, the DNR follows best management practices and retains live seed trees where present. Following Minnesota Forest Resource Council Voluntary Site-Level Guidelines and leaving seed trees in these cases is an important regeneration strategy.

Minnesota ash forests are increasingly affected by EAB, yet it is spreading more slowly than in other affected states. Management continues to focus on keeping these sites forested to maintain hydrology by retaining an appropriate density of ash trees and increasing the abundance of other tree species within ash stands.

Management is not considered a tool for slowing EAB spread in the state. Where opportunities exist, managing ash stands ahead of decline due to EAB remains a priority to keep stands forested. Ash remains marketable for years after infestation, and timber volume from stands can be offered and harvested several years after infestation.

Case Study: Forest Health

Diversity Planting in Ash Stands in the Deer River Forestry Area

Management objective: diversify ash stands to increase resilience to emerald ash borer and climate change

In 2019, the Leech Lake Band of Ojibwe Division of Resource Management approached the DNR about joining a collaborative project to diversify ash stands on multiple ownerships within the Leech Lake Reservation, including lands owned or administered by the DNR, Leech Lake Band of Ojibwe, US Forest Service (USFS), and counties. The project was subsequently funded by a Conservation Partners Legacy grant.

On DNR-administered lands, candidate sites were selected in very wet ash swamps that are currently dominated almost exclusively by ash trees, with preference given to sites adjacent to ash stands under other ownerships. DNR foresters and project partners consulted multiple sources of information, including research by the USFS Northern Research Station, DNR Ash Management Guidelines, DNR tree suitability tables, and the USFS Tree Atlas to select species to plant in place of ash that are appropriate to the native plant community and projected to be adaptive to climate change. These alternative species include swamp white oak, hackberry, and silver maple.

Increasing diversity on these sites will be a multi-year process involving preparing the sites for planting, planting a diversity of tree seedlings, release treatments to decrease competition between tree seedlings and other vegetation, and monitoring tree seedling survival.

Very wet black ash swamp native plant community comprised almost exclusively of black ash.



Stand Exam Accomplishments

In FY 2019-2022, the DNR planned sufficient stand exam acres to meet the timber volume offered component of the strategic direction while also meeting other policies, ecological and habitat needs reflected in the strategic direction, and accounting for forest inventory data corrections.

92% of the acres⁴ on the FY 2019-2022 annual stand exam lists were examined and either appraised for timber harvest, altered, or deferred (**Table 4**; see Box 1 for definitions of stand accomplishment categories).

- The DNR did not examine 8% of the stand exam list acres for several reasons, including having already met strategic goals without examining the additional acres, a pause in examining stands on Land Utilization Project (LUP) lands leased from the US Fish and Wildlife Service, and known mortality in tamarack stands.
- Approximately half of the stand exam list acres resulted in appraisals (51% of total planned exams, 56% of examined acres).
 - Appraisal rates differed slightly by the land administrator and trust status (+2% on school trust vs. non-school trust lands; -6% on Division of Fish and Wildlife-administered lands vs. Division of Forestry-administered lands).
 - Appraisal rates differed more significantly between cover types (**Figure 8**). Cover types managed more frequently (e.g., aspen and red pine) had higher appraisal rates. They also had lower alteration rates, reflecting greater inventory accuracy.

Box 1. Stand Exam Dispositions Defined

<i>Appraised</i>	Acres that lie within a timber sale boundary, including small patches of leave trees.
<i>Altered</i>	Acres visited, where on-the-ground observations identified that the site will not be ready for timber harvest in the near-term. Examples include the stand having a significantly different cover type or age class from the inventory; an endangered or threatened species present that cannot tolerate disturbance; or the stand being inoperable, too small or isolated, not marketable, or inaccessible. Altered acres are not replaced on the annual stand exam list. These acres are available for examination and may be added to a stand exam list in the next planning period.
<i>Deferred</i>	Acres visited but not appraised for a timber sale with treatment deferred until the next planning period. Deferral reasons include the stand not being ready for harvest or delaying treatment for habitat or ecological reasons. These acres are replaced on the annual stand exam list if needed to offer the planned amount of volume. These acres are available for examination and may be added to a stand exam list in the next planning period.

⁴ Acres on stand exam lists do not include annual plan additions (see Annual Plan Additions below).

Table 4. Disposition of acres on the FY 2019-2022 stand exam lists.

Planned acres	Examined acres (%)	Appraised acres (%)	Altered acres (%)	Deferred acres (%)
296,762	273,486 (92%)	152,803 (51%)	66,402 (22%)	54,281 (18%)

- 22% of examined acres resulted in alterations that made the stand unavailable to harvest until at least after the next planning cycle.
 - Tamarack has the highest alteration rate (**Figure 8**), reflecting forgone harvest to allow low-density stands to regenerate after heavy ELB mortality through retaining live seed trees or promoting advanced regeneration.
- 18% of examined acres had treatment deferred (postponed) beyond the planning period. 76% were deferred for silvicultural reasons, and 24% (4.7% of examined acres) for ecological and habitat reasons.
 - Deferrals for ecological and habitat reasons occurred more often, on average, than in the five years before this planning period (+5%), while silviculture-related deferrals occurred less often (-4%).
 - Aspen, Norway pine, ash, northern hardwoods, and oak had the most deferred acres (5,000+ per year on average). Of these, northern hardwoods and oak had the highest deferral rates, corresponding to the challenge the DNR has experienced in offering the planned volume for some species associated with those cover types (**Figure 8**). Relatively large numbers of deferred acres in the hardwoods and Norway pine cover types also reflect the difficulty of determining the best year for stand exams for these cover types. White pine had the highest deferral rate (48%), primarily for silvicultural reasons such as allowing stands to continue to mature or develop advanced regeneration before harvesting.
 - About 10% of deferred acres were part of stands that included appraised or altered acres (i.e., only a portion of the planned stand was deferred).

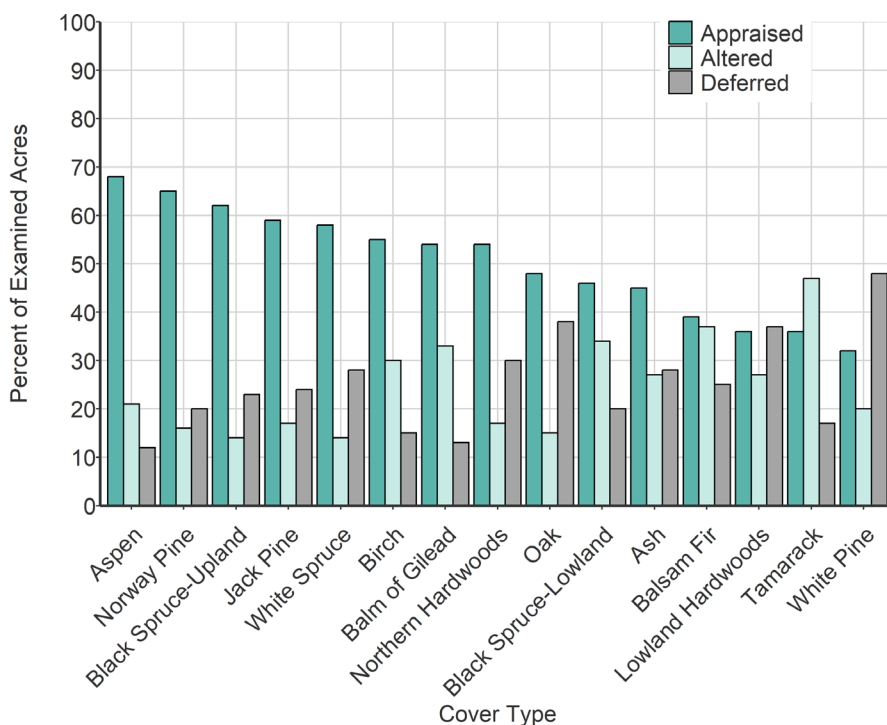


Figure 8. Appraisal, alteration, and deferral rates for examined acres by cover type.

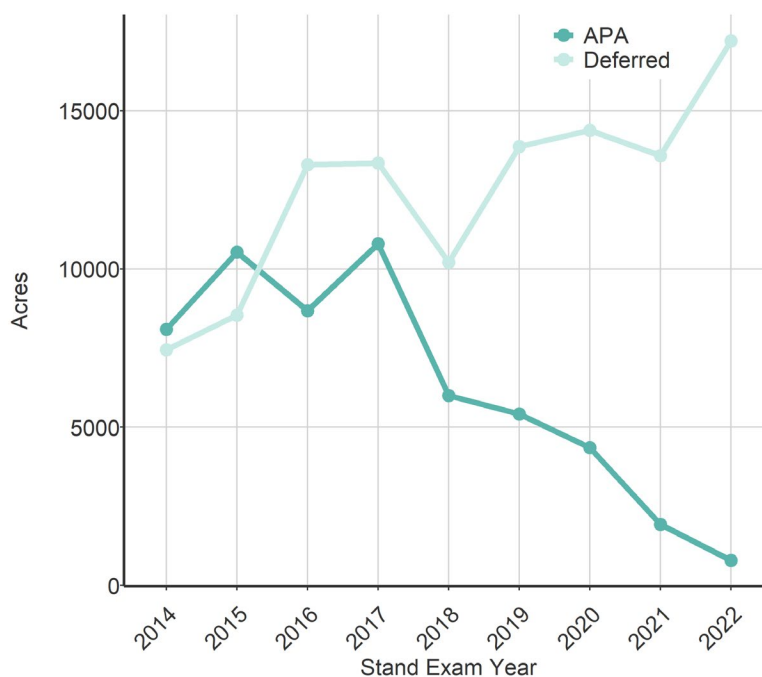
Annual Plan Additions

Annual plan additions (APAs) are stands or portions of stands added to the DNR’s annual stand exam list that were not previously planned for examination. Stands are added to the annual stand exam list to receive near-term treatment in various circumstances, including when deteriorating stand conditions, inaccurate inventory information, or forest health issues are discovered, and in response to natural disturbances.

- Annual plan additions (APAs) decreased from an average of 8,800 acres per year in the five years before this planning period to 3,900 acres per year in FY 2019-2022 (**Figure 9**).
- Over the last nine years, deferred acres have increased, while APA acres have significantly decreased, especially in this planning period compared to the years before. For past SFRMPs, the DNR monitored the balance of deferred and APA acres to ensure that the planned amount of disturbance was initiated. So far in this planning period, the acres on the 10-year stand exam list afforded the DNR the flexibility to defer acres for various reasons while offering the planned amount of volume without needing to add as many stands to the stand exam list.
- The decrease in APAs during FY 2019-2022 was partially due to fewer natural disturbances requiring APAs compared to prior years.

For FY 2019-2022, APAs were most frequently used to address forest health, inventory, and location (e.g., stand adjacent to a planned stand in an area that is difficult to access) issues or to substitute a stand in greater need of harvest for one on the current annual stand exam list. Other reasons less frequently cited included addressing environmental damage from wind or fire, increasing the productivity of forest stands in decline, cooperating with other landowners, and examining stands from an earlier stand exam list that were not previously examined. Although FY 2019-2022 had fewer APAs than in the recent past, APAs are still critical for addressing the above circumstances and may increase in future years if needed.

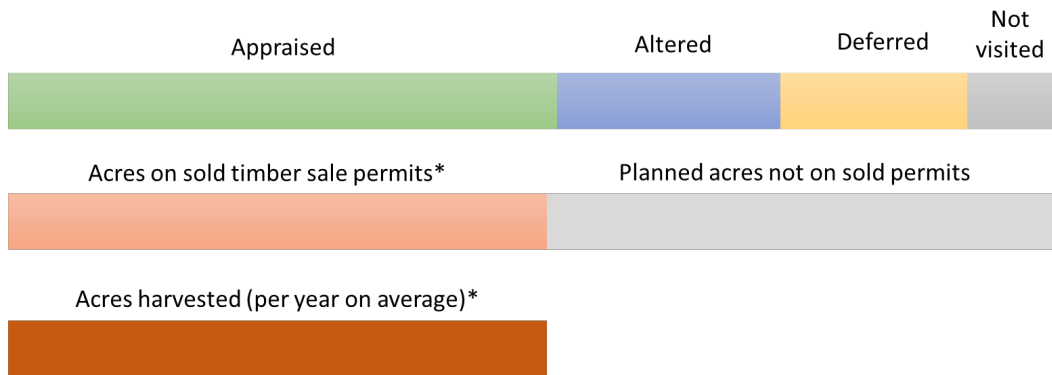
Figure 9. Annual plan additions decreased while deferred acres increased in FY 2019-2022.



Acres Summary

On average, 92% of annual stand exam list acres were visited and examined in the field. Fifty-one percent of examined acres were appraised, with the remaining 49% altered or deferred. During FY 2019-2022, timber was offered from 1.18% of the total DNR lands where planned timber harvest may be employed for forest management. This included 1.25% of Forestry-administered acres per year on average and 0.80% of Fish and Wildlife-administered acres. Not all appraised volume on timber sale permits is sold. DNR staff often reoffer a permit that hasn't been sold to try to accomplish planned disturbance. Reoffered permits do not count toward accomplishments for offering planned volume because they were already counted as accomplishments in a previous year. Most purchased permits are eventually harvested.

Proportion of average annual acres by stand exam disposition (FY 2019-2022)



*Expressed as a proportion of the average annual planned acres. Some acres on sold timber sale permits, and most harvested acres, are from acres appraised, offered, and sold in previous years

Prescriptions

During stand selection, DNR field staff develop preliminary prescriptions (i.e., plans for management actions) for stands on the 10-year stand exam list. Preliminary prescriptions are based on broad strategies known to be silviculturally appropriate for various forest cover types (e.g., even-aged management, uneven-aged management, thinning). For example, DNR land managers most frequently use prescriptions associated with even-aged management, such as clearcutting with reserves, to achieve goals for regenerating the most abundant cover types, such as aspen, which require full sunlight for young trees to grow. Other forest stands comprised of trees, such as maples, that grow in forest gaps under lower light conditions may benefit from uneven-aged management. These simplified assumptions are necessary during stand exam list modeling when we don't have the detailed information that is observed on-the-ground during field visits. DNR land managers subsequently develop actual prescriptions that describe specific treatment for a site after field visits. Actual prescriptions may vary from preliminary prescriptions depending on site conditions, resource management objectives, operational considerations, and policies (e.g., concerning endangered or threatened species).

During FY 2019-2022, a variety of prescriptions were applied to forest stands (**Table 5**):

- Even-aged regeneration harvest was the most commonly used prescription category (75% of appraised acres), including clearcut with reserves, seed tree, and shelterwood prescriptions.
- The second-most common prescription category was non-regeneration harvest (15% of appraised acres), predominantly thinning treatments in Norway pine, white spruce, oak, and northern hardwoods.

- The third-most common prescription category, uneven-aged harvest (6% of appraised acres), was applied most commonly in northern hardwoods and ash cover types.
- Other prescription categories accounted for 4% of appraised acres, including sanitation and salvage and non-timber product harvests. Sanitation and salvage harvest of tamarack in response to Eastern larch beetle was the most significant individual contributor to acres in these categories.

Overall, the proportion of actual even-aged, uneven-aged, and non-regeneration prescriptions was similar to the proportions of preliminary prescriptions by cover type. In some cases, however, the actual prescription differed from the preliminary prescription.

- Even-aged regeneration harvest prescriptions were used slightly more often than was assumed during planning (6% more often), particularly for hardwood cover types (ash, lowland hardwoods, northern hardwoods, and oak), white pine, and white spruce.
- Uneven-aged harvest prescriptions and non-regeneration prescriptions were used less (6% and 5%, respectively) than assumed during the planning process.

Differences between preliminary and actual prescriptions provide valuable information that can help inform and increase the accuracy of future forest resources planning work.

Table 5. Acres (planned and annual plan additions) by broad silvicultural strategies* by cover type from FY 2019-2022.

Cover Type	Even-aged harvest	Two-aged regen harvest	Uneven-aged regen harvest	Non-regeneration harvest	Salvage and sanitation	Non-timber product harvest
Ash	4,683	592	3,323	923	137	16
Aspen	66,477	473	451	264	355	0
Balm of Gilead	3,228	13	0			0
Balsam Fir	3,814	61	16	15	62	0
Birch	4,812	77	124	88	132	0
Black Spruce-Lowland	11,155	52		16	212	221
Black Spruce-Upland	1,018	0	0	17	0	0
Jack Pine	3,368	58	10	191	4	0
Lowland Hardwoods	495	9	598	98		0
Northern Hardwoods	3,391	448	4,064	1,845	125	7
Norway Pine	3,909	88	95	15,693	72	0
Oak	3,248	638	646	1,831	258	0
Offsite Aspen	17	0	0	0	0	0
Offsite Oak	19	0	30	0	29	0
Stagnant Cedar	33	0	8	0	0	0
Stagnant Spruce	44	0	0	0	0	0
Tamarack	7,486	179	101	16	1,084	0
White Cedar	92	0	6	0	0	0
White Pine	264	24	225	314	0	0
White Spruce	3,150	78	76	2,666	504	10
Totals	120,703	2,790	9,773	23,977	2,973	254

*Even-aged, two-aged, and uneven-aged harvests are used to regenerate a stand with one, two, or multiple age classes, respectively. Non-regeneration harvest is designed to enhance the growth, quality, vigor, and composition of the stand before the final harvest. Salvage and sanitation harvests selectively remove trees that are dead, injured, dying, or contributing to the spread of an insect infestation or disease. Non-timber product harvest involves harvesting of plant products that does not require the removal of live trees.

Current conditions context

Age Class Distributions

For even-aged managed cover types (e.g., aspen, spruce), the DNR's long-term goal has been to balance the acres in each age class up to rotation age while maintaining some acres in older age classes to provide older forest habitat at the landscape scale. For uneven-aged managed cover types (e.g., northern hardwoods), age class diversity is developed within stands to address multiple goals, including adjusting stand composition, developing wildlife habitat, promoting regeneration, and stand improvement.

It is too early in this planning period to detect the effects of the DNR's current strategic direction on age class distributions. However, we can look at a current snapshot of the DNR forest inventory to understand the range of conditions across DNR-administered lands statewide and to visualize how current conditions relate to long-term planning system goals (see Appendix A for age class distribution charts for major cover types).

In general, DNR-administered lands have a range of cover types and age classes that provide a variety of forest benefits, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity. For example, for wildlife, young forests provide higher stem densities that offer protection and forage availability, while older forests offer nesting cavities, more diverse complex understories, more downed logs and debris, and mature trees that provide nest sites, food (e.g., catkins, buds, acorns), and other habitat values.

The aspen cover type on DNR-administered lands statewide is relatively balanced after decades of work toward that goal, while most other cover types skew moderately to strongly older relative to the desired age class balance (**Table 6, Figure 10, Figure 11**). While these results present the current condition of DNR lands where timber harvest may be employed for forest management, our current strategic direction includes goals to maintain older age class distributions for many cover types on Fish and Wildlife-administered lands and in other sub-landscape areas with goals for mature forest (e.g., old forest management complexes around old growth stands). For example, we plan to examine forest stands on Division of Fish and Wildlife-administered lands when they are older, on average, compared to stands on Forestry-administered lands to develop an older age class structure (see the age of stands at planned examination section below).

Current age class distribution patterns are primarily the results of previous planning periods and associated decisions regarding the strategic direction. Factors outside of planned management decisions, such as natural disasters and market fluctuations, can also influence conditions reflected in forest inventory data. We will begin to see the effects of the current strategic direction on the age class distributions of DNR-managed forests toward the end of this planning period.

Table 6. Age class distributions for major cover types. These patterns are primarily the results of previous management plans and decisions. We will begin to see the effects of the current strategic direction toward the end of this planning period. Current age class distribution status is not summarized and is denoted “N/A” for cover types that are generally managed uneven-aged because stands of these types have highly variable stand structures (i.e., they could be managed even-aged or contain multiple age classes in one stand depending on stand composition, site conditions, and management objectives).

Cover Type	Current age class distribution status	Description
Even-aged		
Aspen	Balanced	<ul style="list-style-type: none"> Balanced to the standard DNR rotation age (40-50 years depending on ecological section and site index). 20% of the aspen cover type on DNR-administered forest lands is over the standard DNR rotation age (see the older aspen section of this report for more information). Fish and Wildlife (FAW)-administered lands have a greater proportion of older aspen acres (8.0% 60+ years old compared to 5.3% on Forestry (FOR)-administered lands), reflecting past decisions on age class goals and current rotation ages.
Balsam fir	Skewed to older age classes	<ul style="list-style-type: none"> The DNR’s rotation age for balsam fir (45-50 years old in most ecological sections) aligns with guidelines for this cover type to address extensive damage caused by spruce budworm. The balsam fir age class distribution reflects the challenge of achieving the desired disturbance level in this cover type.
Birch	Skewed to older age classes	<ul style="list-style-type: none"> The birch age class distribution lacks younger to intermediate age classes to replace aging and dying stands, especially on FAW-administered lands.
Black spruce lowland and upland	Balanced	<ul style="list-style-type: none"> The relatively balanced age class distribution of black spruce reflects a long history of management with limited opportunities to treat older acres.

Cover Type	Current age class distribution status	Description
Jack pine	Balanced	<ul style="list-style-type: none"> The jack pine cover type is managed as even-aged up to about 50 years old, depending on the ecological section. The age class distribution is relatively balanced.
Oak	Skewed to older age classes	<ul style="list-style-type: none"> The few acres in younger forest present concerns about regenerating and maintaining the oak cover type across the landscape. Oak is challenging to regenerate for a variety of reasons, including shade intolerance, invasive species impacts, competing vegetation, wildlife browse, and decreased sprouting in stands older than rotation age.
Natural origin red pine	Skewed to older age classes	<ul style="list-style-type: none"> Regeneration of this cover type has increased after a change to the DNR rotation age policy for red pine, which retains older rotation ages for natural origin red pine compared to planted red pine. On FAW-administered lands, one-third of the natural origin red pine acres are in one age class (91-100 years old).
Planted red pine	Skewed slightly to intermediate and older age classes	<ul style="list-style-type: none"> Planting efforts, especially 40-50 years ago, have resulted in many acres available for intermediate treatments. The FAW age class distribution skews older, with few acres in younger age classes, and peaks in the 41-50 and 71-80 classes.
Tamarack	Skewed to intermediate and older age classes	<ul style="list-style-type: none"> The average stand age is likely younger than the age class distribution implies because of stands that have succumbed to ELB mortality. Older trees are often left on site to serve as seed trees as stands regenerate.
White spruce	Skewed to older age classes	<ul style="list-style-type: none"> Many acres were converted to white spruce 40+ years ago. These plantations are being regenerated as mixed-species stands because they are more resilient to climate change and forest health issues.

Cover Type	Current age class distribution status	Description
Uneven-aged		
Lowland hardwoods	N/A	<ul style="list-style-type: none"> • The goals in lowland hardwood and ash stands are related to within-stand diversity rather than balancing age classes. • Primary goals include protecting site hydrology and increasing species diversity within stands, especially non-ash species, to make forests more resilient to the effects of emerald ash borer.
Northern hardwoods	N/A	<ul style="list-style-type: none"> • Goals within northern hardwoods stands depend on the species mix present. • The objective for some northern hardwood stands is to maintain or develop trees of all ages within stands. • Some northern hardwood stands are managed even-aged to increase species, such as oak, that need full sunlight to regenerate.
White pine	N/A	<ul style="list-style-type: none"> • White pine is less common as a cover type than as a component of other cover types. It is usually managed with multiple age classes per stand, but in some cases, it is managed as a single-aged plantation.
White cedar	N/A	<ul style="list-style-type: none"> • The majority of white cedar acres are over 100 years old, and one-third are over 150 years old. • While this cover type is relatively free of insect and disease issues, the age class imbalance with very few young and regenerating acres presents concerns for the future of this cover type.

Figure 10. Examples of age class distributions for even-aged managed cover types including aspen, birch, oak, and planted red pine. “Managed” refers to DNR-administered forest lands, excluding lands in areas such as state parks and SNAs and areas that do not produce merchantable timber. “Non-managed” refers to lands within areas such as state parks and SNAs or areas that do not produce merchantable timber.

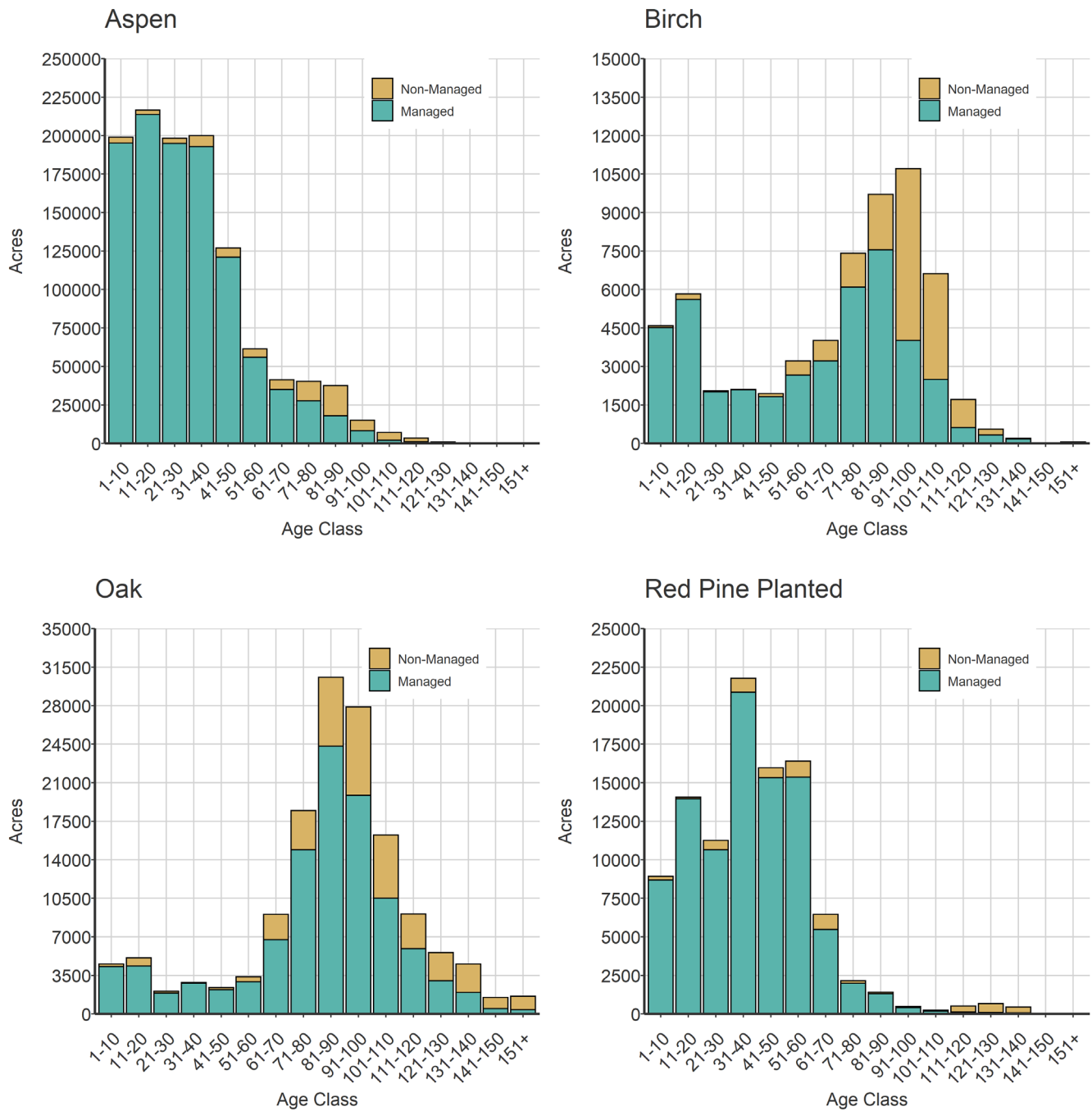
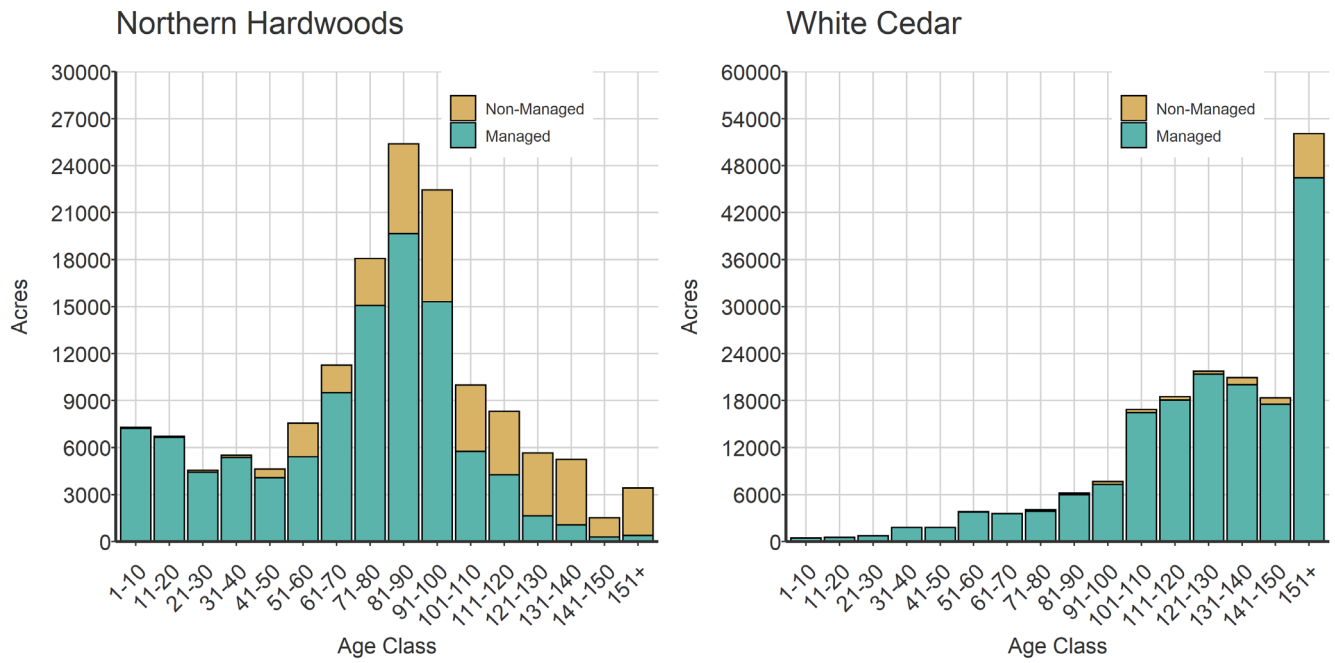


Figure 11. Examples of age class distributions for uneven-aged managed cover types including northern hardwoods and white cedar. “Managed” refers to DNR-administered forest lands, excluding lands in areas such as state parks and SNAs and areas that do not produce merchantable timber. “Non-managed” refers to lands within areas such as state parks and SNAs or areas that do not produce merchantable timber.



Case Study: Forest Productivity, Wildlife Habitat, and Biodiversity

Oak Release from Competing Vegetation in the Paul Bunyan and Smoky Hills State Forests

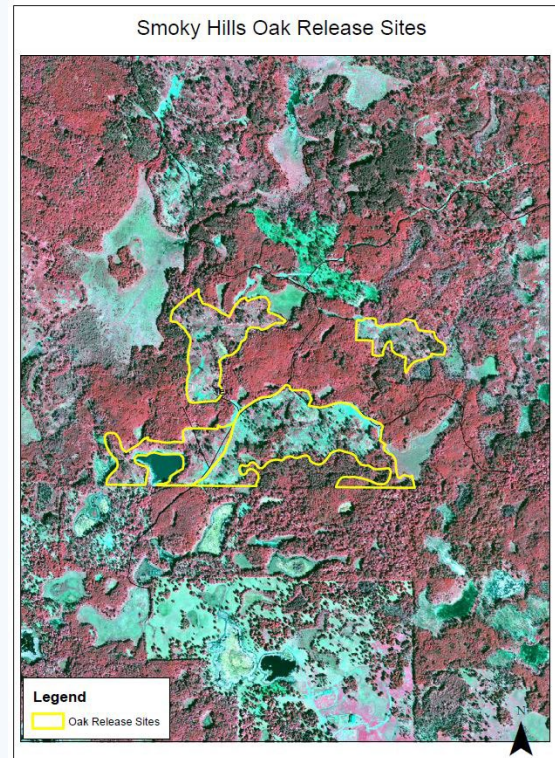
Management objectives:

- Increase the quantity and quality of oak
- Increase species diversity
- Develop and enhance wildlife habitat

Competition is a challenge to successfully regenerating oak trees, especially when they are mixed with aspen, which grows faster than oak. Aspen suckers and multiple oak stump sprouts can cause crowding, resulting in oaks developing poor form. Release treatments free young oak sprouts from competition by cutting or removing nearby vegetation and branches.

In 2018, DNR foresters treated 6- and 7-year-old aspen stands containing oak to increase the oak quantity and quality. The sites contained 10-50% oak volume from previous timber harvests. Oak stumps with multiple sprouts were thinned to the best one or two sprouts. Oak stump sprouts and acorn seedlings were released by cutting back competing aspen and hardwoods with brushsaws. Two years later, foresters monitored oak regeneration. One hundred fifteen oak trees per acre had been released, with 65% tall enough to outgrow their competition without further intervention.

A Conservation Partners Legacy Grant funded the project, and The National Wild Turkey Federation sponsored the grant. The Park Rapids Forestry Area completes approximately 200 acres of this type of release annually.



Competing vegetation is cut back so that oak stump sprouts can grow.



Older aspen

The current strategic direction includes maintaining at least 2.5% of the aspen cover type on DNR-administered forest lands as age 60 years old or older to provide older aspen habitat. Older aspen stands have complex, diverse understories and shrub layers, and provide a wide range of habitat benefits not found in younger stands. Gaps in the canopy caused by disease or disturbance provide woody debris for grouse drumming logs and invertebrate habitat. Older aspen trees support a variety of wildlife species dependent on the insects and cavities associated with decaying wood. For example, older aspen supports foraging and nesting habitat for woodpecker species from Minnesota’s smallest, the Downy Woodpecker, to the largest, the Pileated Woodpecker. In turn, cavities excavated by woodpeckers provide nesting and denning habitat for a range of mammals, including fisher, marten, and bats, and many bird species, including Wood Ducks, Northern Saw-whet Owls, and Black-capped Chickadees.

From a 2022 snapshot of DNR forest inventory data, 5.5% of the aspen cover type on DNR lands where planned timber harvest may be employed for forest management statewide is at least 60 years old, which is less than the proportion of older aspen in 2018 (7.5%) but more than double the minimum of 2.5% established as part of the strategic direction (**Table 7**). Older aspen is distributed across the state, representing 4-24% of the aspen cover type on DNR-administered lands in each ecological section. While the Northern Minnesota Drift and Lake Plains and Northern Minnesota and Ontario Peatlands sections have the lowest percentages of older aspen (4.6% and 4.8%, respectively), they contain over half of the state’s older aspen cover type by acreage (13,843 acres and 15,490 acres, respectively). Lands administered by the Division of Fish and Wildlife have a higher proportion of older aspen (8%) than Division of Forestry-administered lands (5.3%). Older aspen habitat is also present as a component of other cover types, within timber sale reserves, and on other DNR-administered lands. Across the DNR’s entire forest inventory, including lands unavailable for planned timber management (such as state parks), 9.7% of the aspen cover type is at least 60 years old.

Table 7. Summary of older aspen acres (at least 60 years old) within DNR-administered forest lands (excludes state parks, scientific and natural areas, etc.).

Ecological Section	Aspen acres < 60 years old	Aspen acres >= 60 years old	Total aspen acres	% >= 60 years old	% of all older aspen
Aspen Parklands	74,139	4,399	78,539	5.6%	7.7%
Northern Minnesota Drift and Lake Plains	289,289	13,843	303,132	4.6%	24.3%
Minnesota and Northeast Iowa Morainal	5,803	1,196	6,999	17.1%	2.1%
Northern Minnesota and Ontario Peatlands	330,002	16,490	346,491	4.8%	28.9%
Northern Superior Uplands	181,680	15,151	196,831	7.7%	26.6%
Paleozoic Plateau	660	214	874	24.5%	0.4%
Western Superior Uplands	96,305	5,758	102,064	5.6%	10.1%
Total	977,878	57,050	1,034,928	5.5%	100.0%

Forest patch size and age distributions

The DNR’s long-standing forest resource management planning goal has been to maintain large forested patches (areas of similar cover type and age) and increase average patch size over time on DNR-administered lands. Larger patches of various ages provide habitat value to many species. For example, young patches provide browse for species such as moose and support numerous bird species associated with early successional forest, including Chestnut-sided Warblers, Mourning Warblers, and Golden-winged Warblers. Larger, older patches provide benefits to species that require interior forest conditions, such as Goshawks, Red-shouldered hawks, and various songbirds. Importantly, today’s young patches will become the older patches of the future, as current older patches eventually become younger due to human or natural disturbance.

According to 2022 Forest Inventory Module (FIM) data (see **Appendix B** for patch size class distribution charts by ecological section):

- DNR-administered lands have a diversity of patch types, sizes, and ages.
- The average patch size on DNR lands statewide is 29 acres (**Table 8**). Most patches are smaller than 40 acres.
- Most patches are young to intermediate-age forests; older patches are rarer on DNR lands. In particular, there are relatively few large (>250 acres) older red and white pine (120+ years) and aspen (60+ years) patches, which is consistent with the DNR’s goal to balance acres across age classes up to rotation age in these cover types on DNR-administered lands.
- In some sections, particularly AP, MIM, and PP, most DNR lands occur in small patches surrounded by other ownerships, so the ability to increase patch size is limited.

As with cover type age class distributions, these results primarily reflect the effects of management decisions from previous planning periods.

Table 8. Average forest patch size (acres) by ecological section.

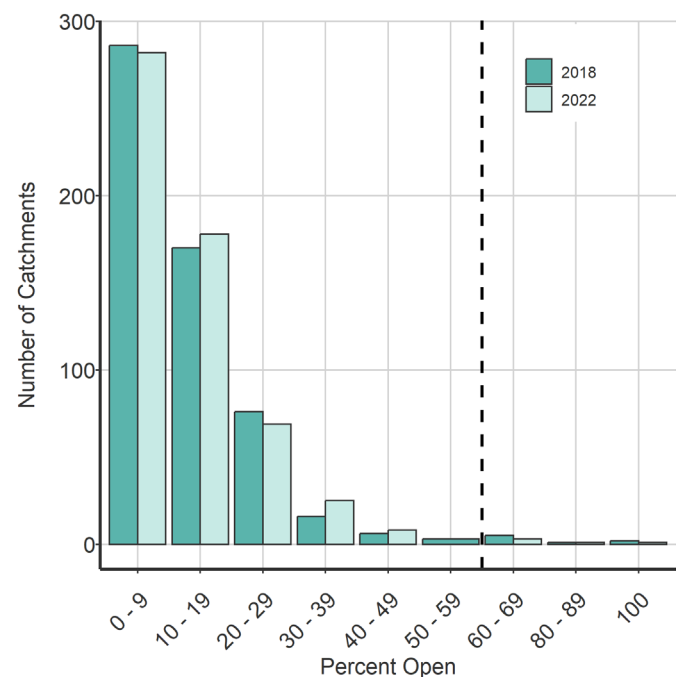
Section	Average Patch Size (acres)
Aspen Parklands	24
Minnesota Drift and Lake Plains	24
Minnesota Northeast Iowa Morainal	18
Northern Minnesota and Ontario Peatlands	38
Northern Superior Uplands	25
Paleozoic Plateau	29
Western Superior Uplands	36
Statewide	29

Watersheds

The amount of non-forested or young forest (less than 15 years old) land in a watershed is one factor correlated with adverse implications for water quality and quantity. If more than 60% of a watershed's area is non-forest or young forest (considered "open" condition), peak flows can increase due to faster snowmelt, creating the potential for increased erosion and sedimentation that can affect aquatic habitats.⁵ While there is no DNR policy or planning standard for applying this threshold to DNR-administered lands by watershed, during the STHA, the DNR assessed the proportion of DNR-administered lands in an "open" condition within 567 "priority watersheds" to provide information about potential contributions of DNR-administered lands to watershed health. Priority watersheds were defined as subbasin hydrologic units (ranging from 390,000-2.7 million acres; 1.3 million acres on average) that contain at least 500 acres managed by the DNR, representing at least 5% of the catchment area and including at least one of the following features: 1) a lake with outstanding or high biological significance, 2) a protected tributary or designated trout stream, 3) a lake of highest phosphorous sensitivity, or 4) a soil erodibility score of at most 58.

By 2022, the number of priority watersheds with more than 60% of DNR-administered land in an "open" condition decreased compared to the number in 2018 (**Figure 12**). Only five of the 567 priority watersheds assessed during the STHA had more than 60% of their DNR-administered land in an "open" condition in 2022. The DNR-administered land in all five of these watersheds was primarily non-forested (at least 75% non-forest cover types) and cannot change from the "open" condition. Similar to other metrics based on current inventory data, this coverage data should not be interpreted as resulting from the current strategic direction. However, the information does indicate that DNR-administered lands within watersheds have not increasingly become "open" under the current harvest rate, which has remained steady or slightly decreased over the last ten years (see Volume Scaled section above). Additionally, [Minnesota's Voluntary Site-Level Guidelines](#), which DNR staff are required to apply, are designed to maintain infiltration (e.g., through filter strips) to avoid or minimize potential increased flow, erosion, and sedimentation after harvest.

Figure 12. Number of priority watersheds (level 8 catchments) by the percent of DNR-administered land in the catchment that is considered "open" (non-forest or young forest). The dashed line shows the 60% "open" land adverse impacts threshold.



⁵ Verry, Elon S. 2000. Land fragmentation and impacts to streams and fish in the central and upper midwest. In: Proceedings, Society of American Foresters 2000 national convention; 2000 November 16-20; Washington DC. SAF Publication 01-02. Bethesda, MD: Society of American Foresters: 38-44

Incorporating multiple values in management

The DNR conserves and protects biodiversity and other forest values in many ways during forest management and planning. The following assessments are based on data currently available.

Rare species

During the first four years of this planning period, 460 stands out of 14,722 stands visited (3.1% of stands visited) were flagged with a comment as having a rare species present that could affect forest management plans.

- Stands with rare species comments were appraised at a higher rate than stands without rare species comments; they were altered at a lower rate and deferred at a higher rate (**Table 9**).
- Appraised acres with rare species comments were less likely to have an even-aged prescription and more likely to have a non-regeneration, two-aged regeneration, or uneven-aged regeneration harvest prescription (**Table 10**).

These results are likely due to several factors, including 1) DNR foresters and land managers designed management that removed less tree cover to provide habitat for or protect rare species and 2) rare species presence may be correlated with forest cover types typically managed with these harvest strategies (e.g., northern hardwoods). These differences suggest broad statewide patterns in the management approach for stands with rare species comments. For example, flexibility is exercised in decisions to defer planned stands and implement prescriptions that remove less tree cover more often where rare species are present. The DNR also protects rare species where they are likely to be found in managed stands by applying spatial buffers (reserves), avoiding ground disturbance, or altering the seasonality of management (see case studies below for examples).

Table 9. Stand exam accomplishments for acres visited on FY 2019-2022 annual stand exam lists with and without a rare species comment. See definitions of appraised, altered, and deferred in the Stand Exam Accomplishments section.

	% appraised	% altered	% deferred
No rare species comment	56%	25%	20%
Rare species comment	62%	13%	25%

Table 10. Broad silvicultural strategies in appraised acres and percent of appraised acres for stands visited on the FY 2019-2022 stand exam lists with and without a rare species comment.

Prescription Category	No rare species comment		Rare species comment	
	Acres	%	Acres	%
Even-aged harvest	110,448	76%	4,341	70%
Non-regeneration harvest	21,872	15%	1,162	19%
Uneven or Two-aged regen harvest	11,259	8%	658	11%
Salvage and sanitation	2,493	2%	64	1%

Case Studies: Endangered, Threatened, and Special Concern Species

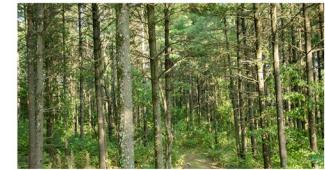
Example 1: Norway pine management in the Sand Dunes State Forest

Management objectives:

- promote stand growth and development
- retain visual quality
- protect federally endangered rusty-patched bumblebee and state-threatened Blanding's turtle habitat

DNR foresters, wildlife biologists, and ecologists worked together to design a timber harvest that included areas of small clearcuts, thinning, and reserves arranged to protect year-round bee habitat by limiting soil disturbance and to protect bee overwintering and turtle nesting habitat by restricting harvest timing. This site was appraised and will be offered on a future timber harvest permit.

Map of planned treatments



- DNR forest inventory stands
- Timber sale boundary
- Planned treatments**
- Clearcut with seasonal restriction to protect bee habitat
- Thinning with seasonal restriction to protect bee overwintering habitat
- Strip harvest disturbing less than .25 acres to protect year-round bee habitat
- Thinning

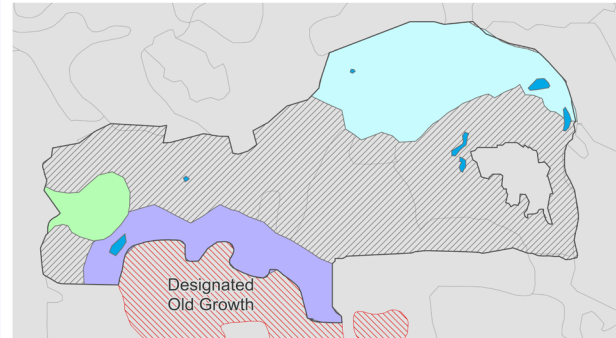
Example 2: Northern hardwoods management in the Fond du Lac State Forest

Management objectives:

- regenerate sugar maple and red oak and increase red oak
- protect a threatened fern, special concern salamander, and ephemeral wetlands
- support sugar maple tapping opportunities
- protect adjacent old growth

DNR foresters, wildlife biologists, and ecologists coordinated to develop a timber harvest prescription that includes reserving trees to protect rare species, wetlands, and old growth forest; clearcuts with reserves in portions of the stand to regenerate trees and increase diversity; thinning portions of the stand to maintain and improve sugar bush; and timing operations to protect the soil and reduce the risk of oak wilt. A local mill purchased the timber harvest permit for this site in 2023.

Map of planned treatments and old growth forest



- DNR forest inventory stands
- Timber sale boundary
- Ephemeral wetlands
- Designated Old Growth
- Planned treatments**
- Clearcut with reserves to regenerate and release oak and maple and protect wetlands and rare species
- Altered prescription to retain additional trees to buffer old growth forest from edge effects and wind
- Thinning to retain uneven-age structure favoring sugar bush and mature oak
- Reserve area

Age of stands at planned examination

Rotation ages (the age at which stands are planned for potential harvest) were applied during the development of the 10-year stand exam list to achieve desired age class distributions at the landscape scale. Rotation ages are based on the age at which tree species' growth rate has peaked, and they are an important factor influencing the next generation of trees' development. Not all stands are harvested at their rotation age. Stands older or younger than rotation age may be harvested depending on site conditions and management goals. Combined with timber volume offered on harvest permits annually, the DNR uses rotation ages to move the forest toward a desired age class distribution that will sustainably provide multiple benefits over time.

Non-school trust Fish and Wildlife-administered lands and several special management areas (SMAs)⁶ are managed based on older rotation ages compared to those applied to Forestry-administered and school trust lands. This approach of customized rotation ages is designed to develop age class distributions at sub-landscape scales that support the more mature forest habitats desired on these lands.

- Currently, Fish and Wildlife-administered lands and SMAs associated with older habitats are not typically being examined at their target rotation ages. Rather, they are scheduled for examination for potential even-aged management when they are 14-20 years older, on average, than their planned rotation age (**Table 11**).
- This is due to the age class structure of DNR-administered forest lands at the beginning of the planning period, with many stands well over rotation age. The DNR is examining and treating older stands, often well over rotation age, while maintaining or working toward the desired age class structure.

Several years may elapse between a stand examination and treatment. Stands examined within a few years of the rotation age will generally not be harvested before rotation age, and only then if the stand exam supports that harvest is appropriate for the site in its current condition.

⁶ School trust lands within Fish and Wildlife-administered lands and special management areas are not managed based on older rotation ages due to the statutory provisions governing DNR's management of those lands (see page 14).

Table 11. Difference in years between the average age when stands are scheduled for an examination and their rotation age for different land types. Stands included are from the 10-year stand exam list (FY 2021-2030) on cover types that are typically managed using even-aged prescriptions (see the Age Class Distributions section above for more information about even- and uneven-aged managed cover types).

Land Type ⁶	Difference (+/-) between age at stand examination and FAW/SMA rotation age*	Difference (+/-) between age at stand examination and standard FOR rotation age*
Fish and Wildlife-administered lands	+14 years	+18 years
Management opportunity areas	+15 years	+20 years
High Conservation Value Forest and globally rare native plant communities that require lower harvest disturbance	+20 years	+22 years
Forestry-administered lands	NA	+14 years

*FAW=Division of Fish and Wildlife; FOR=Division of Forestry; SMA=special management area.

Management Objectives

Foresters record site-level management objectives using a set of codes that express the intent behind management prescriptions. The DNR uses these codes to monitor how foresters incorporate multiple values and forest resource management planning system goals and strategies in site-level prescriptions. Analysis of the codes recorded during FY 2019-2022 shows that:

- Management prescriptions were designed to protect cultural resources, increase compositional and structural diversity, conserve biodiversity, and protect riparian areas on thousands of acres (**Table 12**).
- The most common management objective was to maintain a stand’s current species composition and age class structure (e.g., even- or uneven-aged) (69.5% of appraised acres with management objective codes identified).
- Many recorded codes are consistent with strategies for climate change adaptation, including codes for increasing structural diversity, protecting rare features, increasing long-lived conifers in riparian management areas, and increasing shade to trout streams.
- The objective to increase species composition within stands was recorded for nearly 70,000 acres from FY 2019-2022. DNR staff reported efforts to increase species diversity, most often in aspen, northern hardwoods, ash, Norway pine, lowland black spruce, oak, white spruce, tamarack, and birch cover types (see **Table 13** for examples).
- SFRMPs include short and long-term goals for cover type acres. Most plans include goals for converting a percentage (approximately 1% in this planning period) of the aspen cover type to other cover types over time. Codes recorded the intent to convert over 8,000 acres from one cover type to another in FY 2019-2022. The most common conversions (at least 200 acres) were:
 - Aspen to upland or lowland grass or brush (2,057 acres in the AP ecological section)
 - Aspen to oak (560 acres, mostly in the AP and MIM sections)
 - Aspen to Norway pine (358 acres, mostly in the MDLP, NMOP, and NSU sections)
 - Aspen to northern hardwoods (270 acres, mostly in the MDLP section)
 - Ash to aspen/lowland hardwoods (355 acres, primarily in the NMOP section)

- White spruce to white pine (303 acres, all in the NSU section)
- White spruce to Norway pine (255 acres, mostly in the NSU section)
- White spruce to aspen (202 acres, mostly in the NSU, NMOP, and WSU sections)

The management objective code data likely underreport how often multiple forest values are incorporated into management. For example, during this assessment, we found instances where management prescriptions accounted for rare species, but DNR staff did not record the code for protecting a rare plant or animal. Encouraging more comprehensive use of management objective codes was identified as an opportunity to improve in the second half of the planning period.

Table 12. Total appraised and altered acres in FY 2019-2022 per management objective code (management objectives are not recorded for deferred acres). Multiple codes can be applied to the same stand, so acres evaluated may be reflected in this table more than once.

Management objective code	Appraised Acres	% appraised acres	Altered Acres	% altered acres
Protect a known cultural resource	366	0.2%	41	6.0%
Maintain current composition and structure	106,154	69.5%	22,813	34.4%
Retain adequate residuals within a corridor	2,254	1.5%	496	0.7%
Increase within-stand species composition	69,639	45.6%	75	0.1%
Convert stand to another cover type	10,273	6.7%	609	0.9%
Change stand structural composition				
Increase stand structural diversity (multi-, uneven-, variable density)	17,635	11.5%	1,038	1.6%
Even-aged stand	9,588	6.3%	385	0.6%
Increase coarse woody debris (>6 inches diameter)	393	0.3%	2	0.0%
Conserve Biodiversity				
Maintain existing NPC composition and structure	23,654	15.5%	5,526	8.3%
Protect rare plant or animal location	942	0.6%	153	0.2%
Special management consideration for species or habitat	4,750	3.1%	534	0.8%
Protect a known rare native plant community	860	0.6%	92	0.1%
Use prescribed fire	718	0.5%	348	0.5%
Use less intensive timber stand improvement or site preparation	337	0.2%	7	0.0%
Retain native plant community older growth stage components	4,090	2.7%	221	0.3%
Patch management				
Maintain or increase patch size	1,806	1.2%	268	0.4%
Manage for smaller patches	709	0.5%	50	0.1%
Riparian management				
Increase long-lived conifers	2,940	1.9%	462	0.7%
Maintain shade to a trout stream	1,124	1.7%	222	0.3%

Table 13. Examples of management objectives recorded by foresters in FY 2019-2022 for increasing species within forest stands. For six cover types, the table below lists the five species that DNR staff most frequently reported attempting to increase within each cover type (statewide).

Cover type	Species to increase	Cover type	Species to increase
Ash	Aspen/Balm of Gilead Balsam fir White spruce Paper birch White cedar	Norway pine	Norway pine White pine Jack pine Paper birch Northern red oak
Aspen	Aspen White spruce White pine Burr oak Northern red oak	Oak	Northern red oak Burr oak White oak Aspen Basswood
Northern hardwoods	Northern red oak Burr oak White pine Sugar maple Paper birch	White spruce	Quaking aspen White spruce White pine Paper birch Norway pine

Planning Progress

In the STH Determination Report, the DNR identified its next steps in forest resources management planning. Since that report was published in 2018, the DNR has accomplished the following:

- Developed 10-year stand exam lists for all forested ecological sections for FY 2021-2030.
- Made significant progress updating SFRMPs:
 - Completed initial resource assessments for all seven ecological sections.
 - Developed guidance for management opportunity areas statewide and provided training to DNR staff.
 - Obtained local staff input on all seven SFRMPs, including input on:
 - maintaining or adjusting the proportions of each forest cover type in each ecological section considering several variables, including climate change adaptation
 - adding or revising forest management strategies concerning multiple natural resource values
 - adding or revising contextual information about natural resources issues in each ecological section
 - Obtained public and tribal input on the Northern Minnesota and Ontario Peatlands and Northern Superior Uplands SFRMPs.
 - Drafted the Western Superior Uplands, Northern Minnesota Drift and Lake Plains, Northern Minnesota and Iowa Morainal, Aspen Parklands, and Paleozoic Plateau SFRMPs. Tribal and public input opportunities are forthcoming for these SFRMPs. These plans are anticipated to be put into effect in 2024.

- Created the first statewide layer of management opportunity areas (sub-landscape areas that identify good opportunities to address habitat values that can be difficult to achieve at the stand level; see **Table 14**). Management opportunity areas are part of the SFRMPs.
- Developed new forest inventory and planning databases (4Trees). The DNR’s previous inventory database, the Forest Inventory Module (FIM), contained data on average conditions within a forest stand at the time of data collection. The new inventory system holds tree-level plot data that will allow the DNR to more accurately model forest development for future strategic planning work. This will address a limitation of our inventory identified during the STHA by the contractor for that project, Mason, Bruce & Girard.
- Made progress on completing and updating WMA unit plans for major units, which, going forward, will help inform forest management activities in these WMAs.

Table 14. Number of MOAs by type statewide.

MOA Type	Number
Deer Management/Winter Habitat	29
Interior Forest	2
Landscape	9
Moose Management	4
Old Forest Management Complex	90
Open Landscape Management	10
Owl	3
Patch	73
Ruffed Grouse Management	67
Upland-Lowland Interface	2
White Pine Management	2
Grand Total	289

Forest Certification

During FY 2019-2022, the DNR continued to maintain voluntary [forest certification](#) through the third-party certification organizations the Forest Stewardship Council and Sustainable Forestry Initiative. Maintaining forest certification signifies the DNR’s dedication to sustainable and responsible forest management. Forest certification provides the DNR and Minnesota citizens with a variety of [benefits](#). Forest certification audit results for DNR-administered lands can be viewed on our [DNR Forest Certification Audit Reports](#) webpage.

Conclusions

Results summary

The DNR's current sustainable forest management strategic direction for this planning period is an amalgamation of decisions designed to achieve the disturbance necessary to develop healthy, diverse forests and sustain them over time. Because timber harvest is a key tool for initiating the disturbance necessary to create and maintain diverse forests, an important component of the strategic direction is the DNR's determination of how much timber volume to offer to achieve the disturbance needed. This does not mean that the volume offered is the end in itself. Rather, using timber volume offered as a metric helps the DNR to ensure that harvest-related forest management actions align with objectives to promote wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity on state-administered forest lands. The following bullets summarize the results of this midpoint assessment using data currently available concerning DNR forest management during FY 2019-2022.

Overall assessment results

- On average, the DNR is advancing the overall sustainable forest management strategic direction across all tree species groups, offering within 1% of the total planned annual timber volume during FY 2019-2022.
- Volume offered for most tree species groups was within or slightly above the planned range in most years.
 - The DNR offered slightly more than the planned aspen range on average (+3%). Aspen is a component of nearly all other forest cover types, making it more difficult to control the precise volume offered for this species.
 - Mixed hardwood and pine volume offered were 24% and 6% below the respective planned volume ranges for those species groups. Actual yield has differed from model-estimated yield due to differences between conditions on the ground and modeling assumptions and challenges in modeling the appropriate timing for intermediate treatments, such as thinning.
- On average, over 99% of the volume expected from Division of Forestry-administered lands and 93% of the volume expected from Division of Fish and Wildlife-administered lands was offered during FY 2019-2022. Of the total expected volume, 88% was anticipated to come from Division of Forestry-administered lands, and 12% was anticipated to come from Division of Fish and Wildlife-administered lands.
- Timber volume offered was generally steady within ecological sections and species over FY 2019-2022 (see **Figure 3**).
- Seventy-two percent of the volume offered was sold, and 28% was unsold.
 - Aspen and pine had the highest sell rates (90+%)
 - Tamarack, spruce, and ash had the lowest sell rates (50-62%)
- Timber volume harvested in FY 2019-2022 was slightly lower on average compared to the average volume harvested from FY 2013-2018 on both Division of Forestry and Division of Fish and Wildlife-administered lands. Timber harvested in FY 2019-2022 was a mix of timber offered for sale during this planning period and the previous planning period.

- Increased offerings from ash and tamarack forests to address forest health threats did not increase the volume sold or harvested beyond what could be achieved by offering volume within the standard volume-offered ranges for those species (see the ash and tamarack pilot results section below for more detail).
- The acres on the 10-year stand exam list were generally sufficient to meet the DNR’s planned annual volume offered amount to achieve forest management objectives (except for mixed hardwoods and pine) while addressing various site conditions.
 - 51% of the acres examined ultimately were offered for harvest to meet forest management objectives
 - 49% of examined acres were not included on an offered timber sale permit because they were not appropriate to harvest due to current site conditions (e.g., the inventory did not match conditions on the ground or an endangered species was present) or objectives (e.g., it would be more silviculturally appropriate to harvest in the next planning period or harvest would not advance wildlife habitat objectives within a Wildlife Management Area)
- Current cover type age class distributions are the result of multiple factors, including past planning, management, natural disturbances, and markets. Age class distributions on DNR-administered land currently conform to desired distributions to varying degrees. The aspen cover type, in particular, is currently well-balanced, the result of decades of work toward that goal.
- The DNR continues to retain older aspen in state-managed forests. Statewide, 5.5% of the aspen cover type on DNR lands where planned timber harvest may be employed for forest management is at least 60 years old. This is more than double the minimum amount of older aspen the DNR determined must remain on DNR lands available for planned timber harvest to provide habitat for species that rely on older aspen, including woodpeckers, ducks, owls, songbirds, fisher, marten, and bats.
- The DNR is managing for multiple forest values, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity, while implementing the sustainable forest management strategic direction, which includes a strong commitment to managing for wildlife values on Fish and Wildlife-administered lands.
 - DNR-administered lands have a diversity of forest patch sizes and ages that provide for a range of species’ habitat needs.
 - On average, DNR staff examine forest stands for potential harvest when they are significantly older than their planned rotation age. The DNR is examining the oldest stands and working toward long-standing forest age class distribution goals, including goals for older age class distributions on Fish and Wildlife-administered lands and in other areas with goals for mature forests (e.g., old forest management complexes around old growth forests).
- DNR-administered lands within priority watersheds have retained forest cover above the threshold at which potential negative water quality impacts may be observed.
- Site-level prescriptions were designed to protect cultural resources, increase compositional and structural diversity, conserve biodiversity, protect rare species and native plant communities, maintain or develop wildlife habitat, and protect riparian areas on thousands of acres examined in FY 2019-2022. Many of these actions also aligned with climate adaptation strategies described by the Northern Institute of Applied Climate Science (NIACS), such as maintaining and increasing species projected to be capable of withstanding climate change and protecting rare native plant communities and species.
- The DNR continued to maintain forest certification through third-party certification organizations during FY 2019-2022, demonstrating the DNR’s commitment to sustainable forest management.

Ash and Tamarack pilot results

Volume offered for ash and tamarack has been above the planned volume offered ranges, yet sold and scaled volumes are within or below the planned volume ranges, showing that increased offerings of these species are not needed to satisfy market demand. The DNR has decided to discontinue the ash and tamarack pilot for the following reasons:

- Offering more than the standard planned volume range has not achieved increased harvest levels.
- Continuing to visit, appraise, and offer acres unlikely to be harvested costs the DNR staff time and money that could be directed to higher-priority work. Continuing the pilot would not be an effective use of public funds absent a substantial and unanticipated change in market conditions.

The DNR maintains the goal of managing ash and tamarack stands ahead of forest health issues and taking advantage of opportunities to do so as they arise. Unsold timber sale permits remain available for purchase. Ash and tamarack stands will be retained on the stand exam list, and the DNR retains the flexibility to offer additional ash and tamarack volume above their planned ranges if sufficient opportunities develop to accomplish management.

For ash and tamarack stands that are managed, the focus will continue to be:

- Diversifying forest stands so they remain forested in the event of heavy emerald ash borer mortality. Staff will continue to follow DNR guidance for managing ash stands.
 - Based on regeneration surveys and recently published case studies, red maple, silver maple, and swamp white oak planted bare root stock show promise for ash replacement in wet soil conditions.
 - If present onsite or nearby, quaking aspen and balsam poplar root sprouting and natural seeding of balsam fir and American elm can help offset anticipated water table fluctuations post-harvest or during active pest infestation.
 - Full stocking may take 15 years or more on the wettest sites.
- Supporting regeneration in tamarack stands affected by Eastern larch beetle by retaining seed trees during salvage harvests.
 - Reduce the need and costs of aerial seeding all sites by leaving intact or partially damaged clumps of tamarack in recently infested stands.
 - Understory advance regeneration may contribute to increases in tree density over time in sites not available for timber harvest but may require supplemental aerial seeding.
 - Full stocking may take 15 years or more on nutrient-poor sites.
- Reevaluating rotation ages for lower site index tamarack in future planning work.

Benefits to the State of Minnesota of implementing the statewide sustainable forest management strategic direction

- Increasingly balanced forest age classes and sustainably managed forests provide multiple benefits consistently over time, including wildlife habitat, biodiversity, wood supply and healthy natural resource economies, carbon storage, forest health, recreation, and water quality and quantity.

- Using a strategic, landscape-level approach allows the DNR to anticipate and strive to mitigate the effects of climate change and forest pests and diseases on Minnesota's forests, including by maintaining age class and species diversity.
- On Division of Fish and Wildlife-administered lands, continuing to develop a diverse mix of forest ages and species ensures the continued presence of varied forest habitats and wildlife species dependent on those habitats over time.
- Effective, multi-scale planning provides the flexibility to address multiple values important to Minnesotans in forest stands, using a variety of tools, including timber harvest when and where appropriate.
- Forest management contributes to supporting Minnesota's forest and outdoor recreation economies.
 - As of 2021, the estimated direct economic contribution of DNR-administered lands to Minnesota's forest economy includes over 14,000 jobs, \$10.2 billion in total economic effect, and a total effect of \$75.6 million in state and local taxes paid effect.
 - Outdoor recreation in Minnesota generates approximately \$9.9 billion in gross domestic product and 91,000 jobs. Top activities contributing to Minnesota's outdoor recreation that are influenced by forest management include fishing, hunting, trapping, hiking, and camping.⁷
 - Forest management that sustains healthy forests also promotes ecosystem benefits, such as clean water, that support the state's economy overall.
- Long-range planning by species and ecological section provides the forest industry with greater insight into the resources available on DNR-administered lands.
- Having 10-year stand exam lists covering the same fiscal years for all ecological sections of the state provides greater transparency for internal staff and external partners and stakeholders and affords the DNR administrative efficiencies.
- On average, DNR timber sales on school trust lands provided a net income of \$1.9 million annually paid to the Permanent School Fund.

Going Forward

The results in this report provide an opportunity to learn and adapt as we implement the DNR's Forest Resource Management Planning System for the second half of the planning period (FY 2024–2028) and prepare analyses for the next 10-year planning period. The following bullets outline adjustments and improvements the DNR will implement for the second half of the planning period.

- The DNR has discontinued the pilot to offer 30,000 additional cords of ash and tamarack because offering more volume did not produce the desired harvest levels for these species (see the ash and tamarack pilot results section). The DNR retains the flexibility to offer additional ash and tamarack volume if opportunities develop to accomplish management beyond the default planned volume offered ranges.

⁷ [Outdoor Recreation Satellite Account: 2021 – Minnesota](#). U.S. Department of Commerce Bureau of Economic Analysis.

- The DNR will complete SFRMPs that provide additional guidance on how to incorporate multiple values into management at the stand level. Once the plans are completed, DNR staff will receive training to implement them.
- The DNR continues to develop plans for major WMA units and the system of smaller WMAs. These plans articulate wildlife habitat objectives for these Fish and Wildlife-administered lands and identify how timber harvest and other tools will be used to achieve these objectives.
- DNR staff should review the strategies in existing SFRMPs and WMA unit plans and future updates and continue to apply them to site-level forest management where possible, including strategies for increasing average forest patch size and opportunities to coordinate on habitat projects across ownerships. SFRMP and WMA unit plan goals, including patch size, should be considered when developing the next stand exam list.
- DNR staff should also review the DNR's forest management policy system, which includes direction on how to balance among multiple forest values depending on the purpose of various forest lands while recognizing that the balance varies across different administrative land status types.
- DNR staff should take opportunities to regenerate cedar using the best available strategies, including information from DNR case studies on using strip and patch cuts to increase age class diversity in white cedar stands.
- Management objective code records are an important tool to document the goals of forest management activities at the site level. DNR staff should use these management objective codes more consistently and comprehensively.
- The DNR is working to improve volume estimates for hardwoods, especially in southeastern Minnesota, where we experienced the largest discrepancy between model estimates and conditions on the ground. Updated estimates will improve planning for the next planning period.
- The DNR continuously updates forest inventory data, which is entered into the new 4Trees inventory database. The DNR is also working on inventory enhancements using LiDAR, which will improve our ability to accurately model and plan for the next planning period.

The DNR will also improve forest coordination to ensure that it fully aligns with the DNR's intent. The directors and management teams of the DNR divisions involved in forest management coordination are working together to develop and implement a continuous improvement plan that has specific, actionable, and timely steps to achieve that improvement.

Finally, as stated in the STH Determination Report, the DNR intends to reassess the forest management strategic direction on a 10-year cycle. Before the end of this planning period, the DNR will evaluate available data and new analyses and consider stakeholder and partner perspectives to determine whether and how to update the strategic direction for the next ten years.

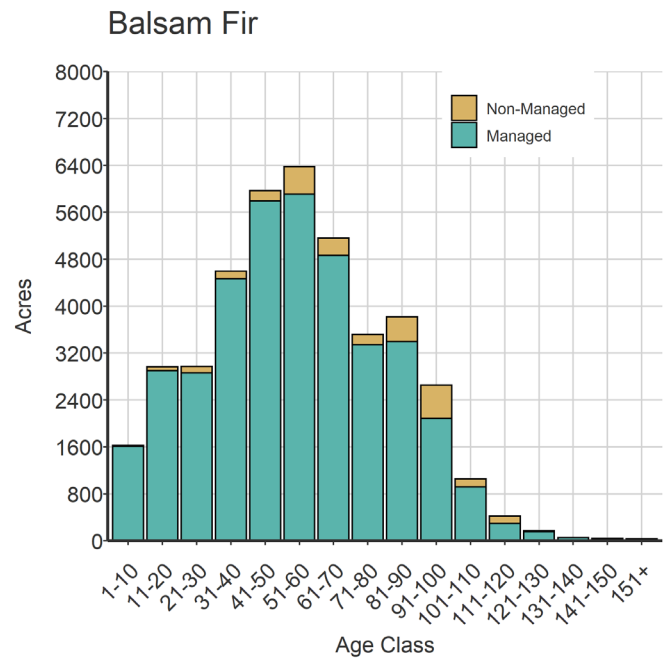
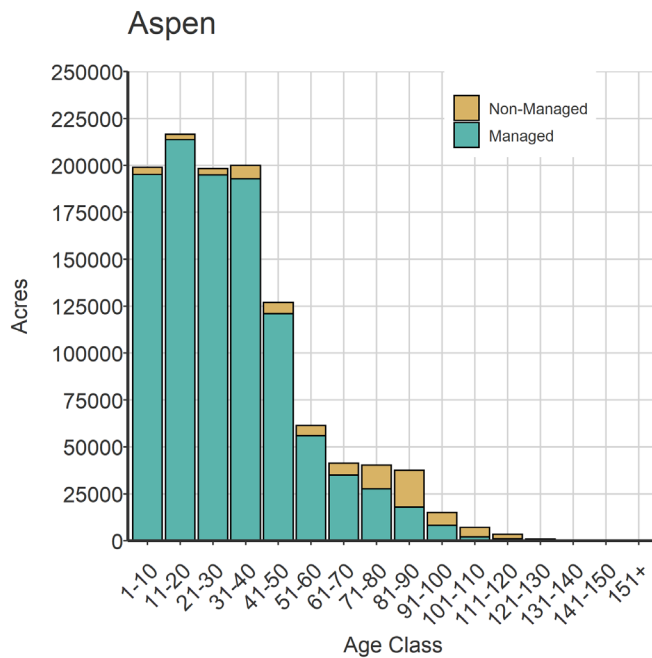
Appendix A. Age Class Distributions

The age class distribution charts in this appendix show the acres in 10-year age classes by cover type for DNR-administered forest lands that are available for planned timber management, as well as those that aren't (e.g., acres in State Parks or Scientific and Natural Areas). The DNR's long-standing goal for even-aged managed cover types has been to balance the acres in each age class up to the rotation age while maintaining some older forest habitat. Balancing age classes in these cover types is a foundational desired future condition of the DNR's forest resource management planning system.

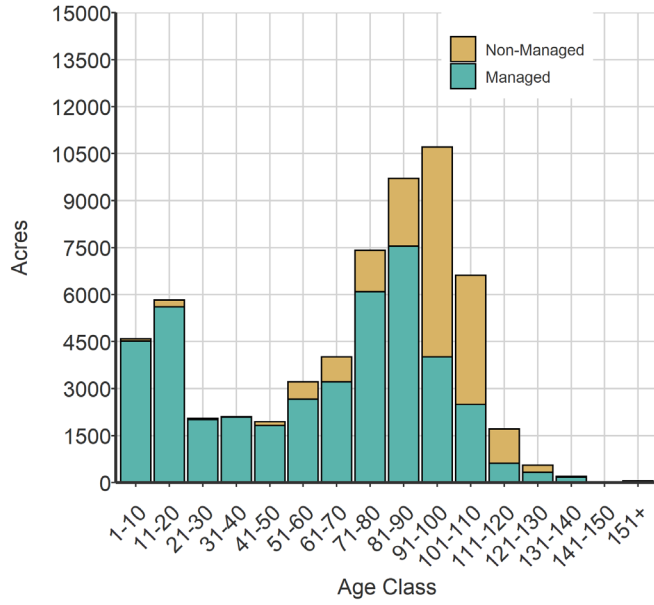
For uneven-aged managed cover types (e.g., northern hardwoods), age class diversity is developed within stands to address multiple goals, including adjusting stand composition, creating wildlife habitat, promoting regeneration, and improving stands. Most cover types are managed as either even-aged or uneven-aged; however, white pine can be managed using either strategy.

The charts in this appendix provide information about current natural resource conditions. They show the acres of each cover type by age class across all lands in the DNR forest inventory, distinguishing DNR-administered acres available for planned timber harvest (i.e., "managed") and those that are not ("non-managed"). "Managed" in the charts below refers to DNR-administered forest lands available for planned timber harvest, excluding lands in areas such as state parks and SNAs and areas that do not produce merchantable timber, which are referred to as "non-managed" in the charts. Approximately 91% of forested lands in the DNR inventory are available for planned timber management, which represents approximately 63% of all acres (forested and non-forested) in the inventory. These distributions result from previous plans and management decisions over several decades and are not effects of the current forest resource management planning system.

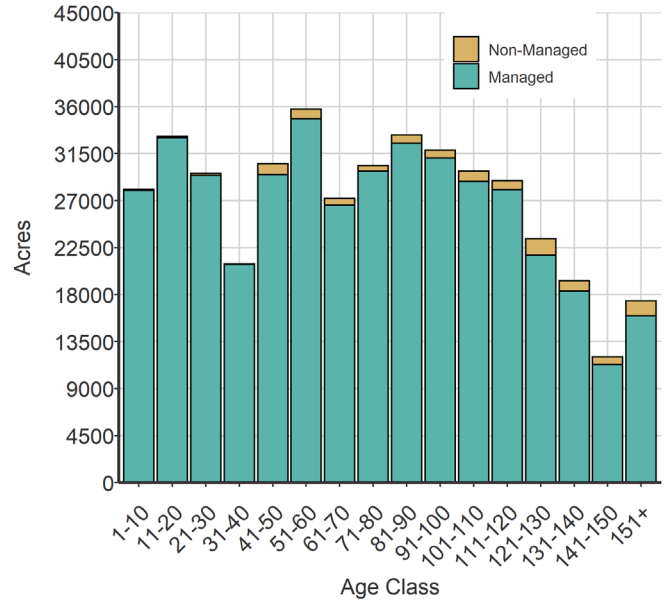
Even-aged-managed cover types



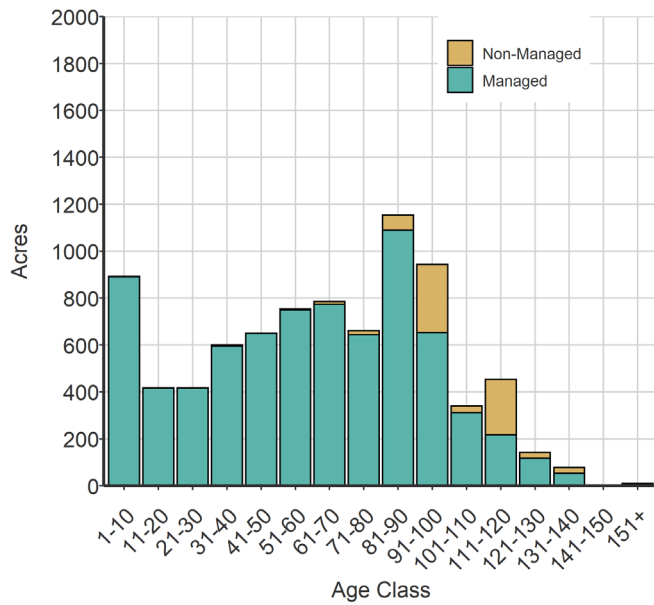
Birch



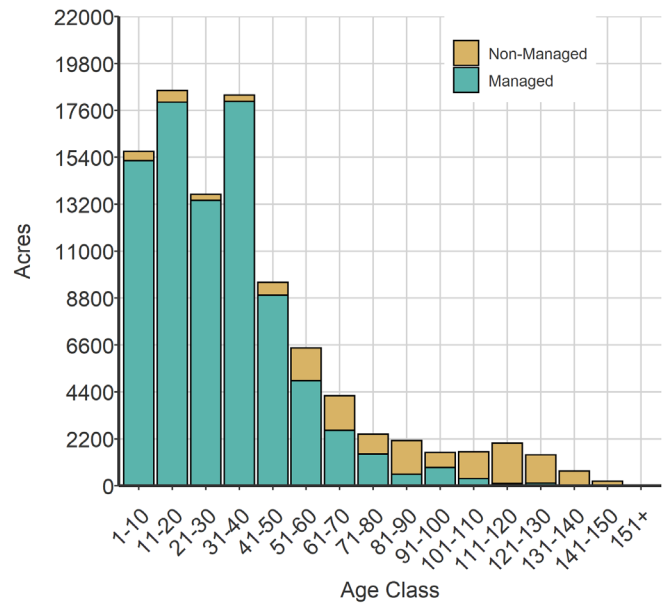
Black Spruce Lowland



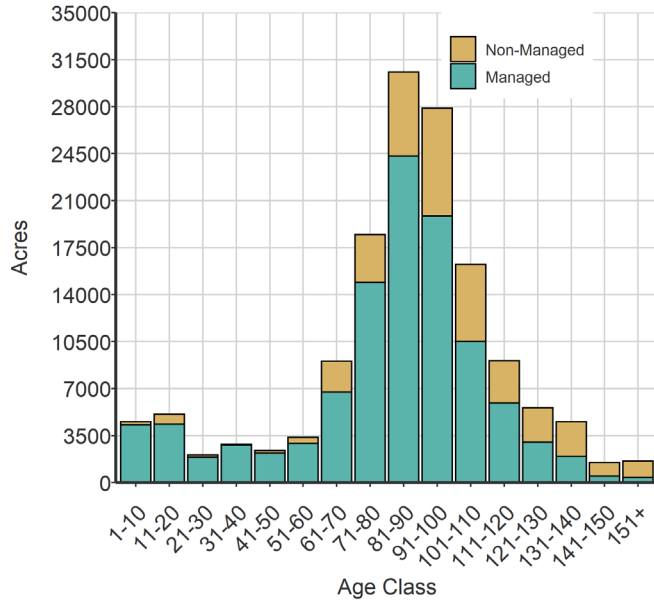
Black Spruce Upland



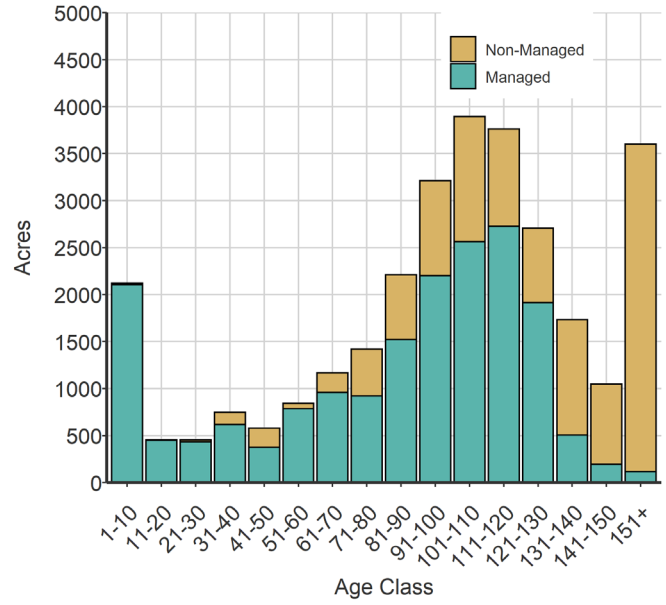
Jack Pine



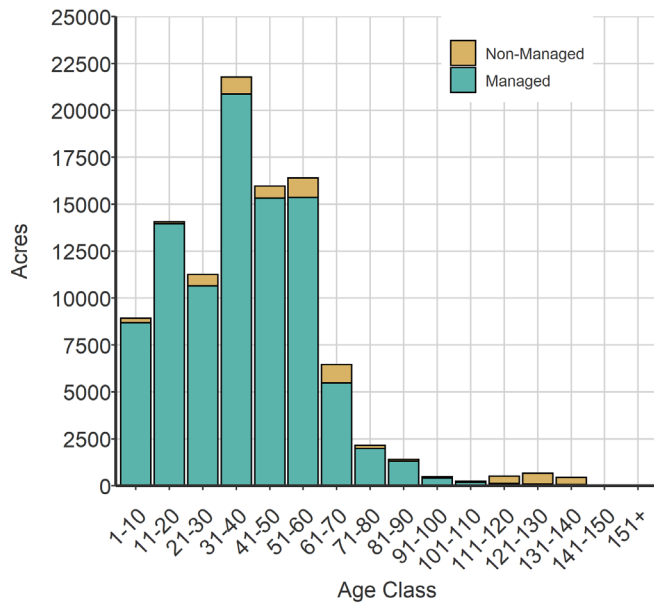
Oak



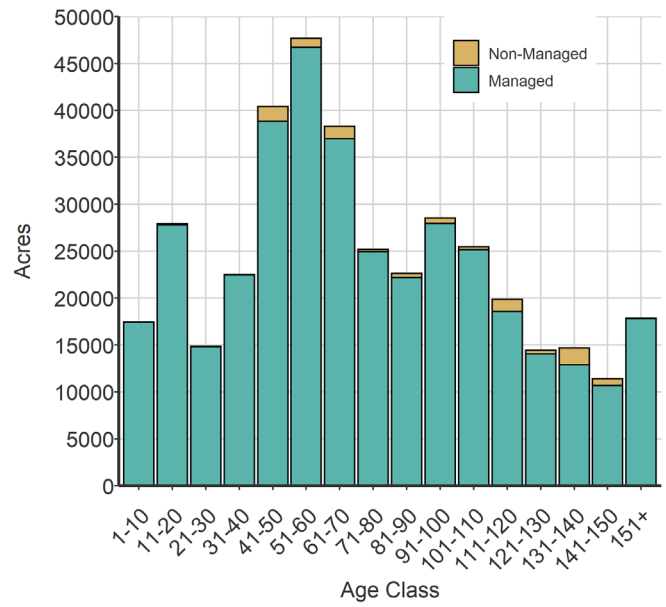
Red Pine Natural



Red Pine Planted

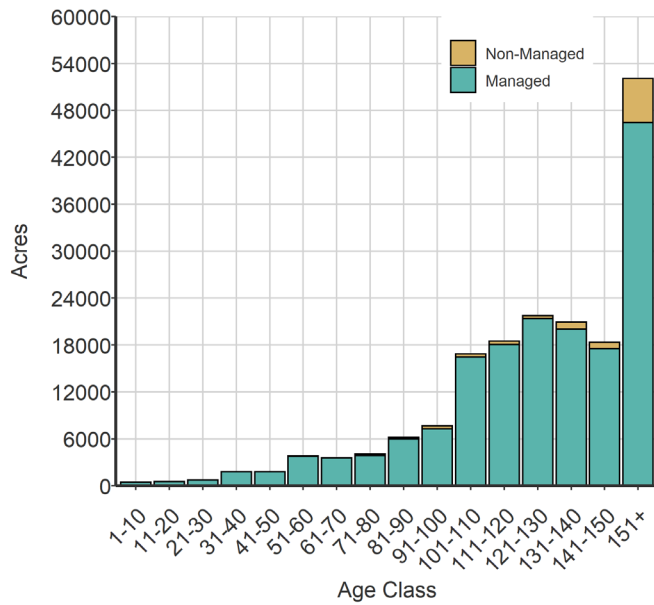


Tamarack

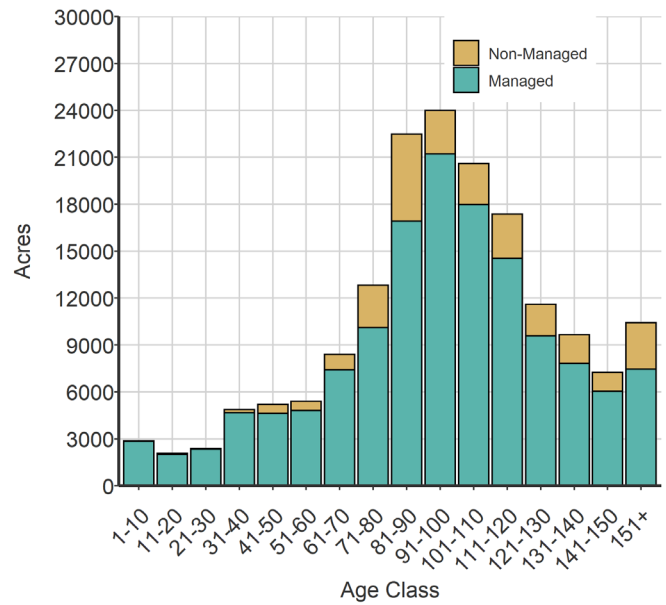


Uneven-aged-managed cover types

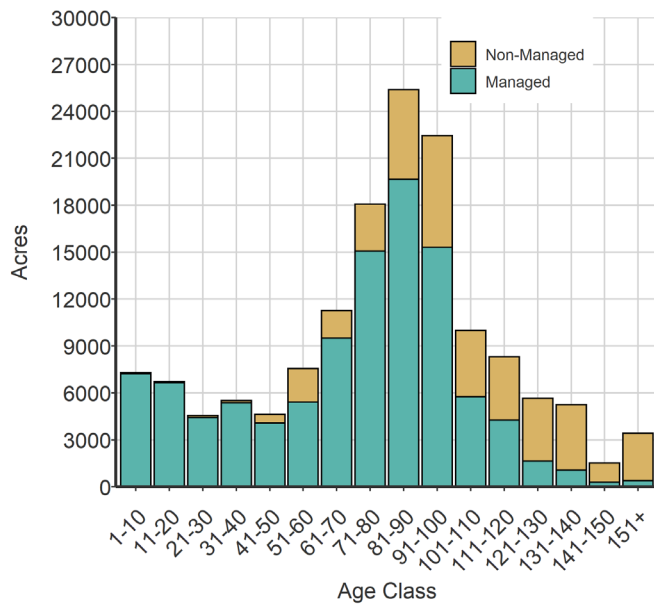
White Cedar



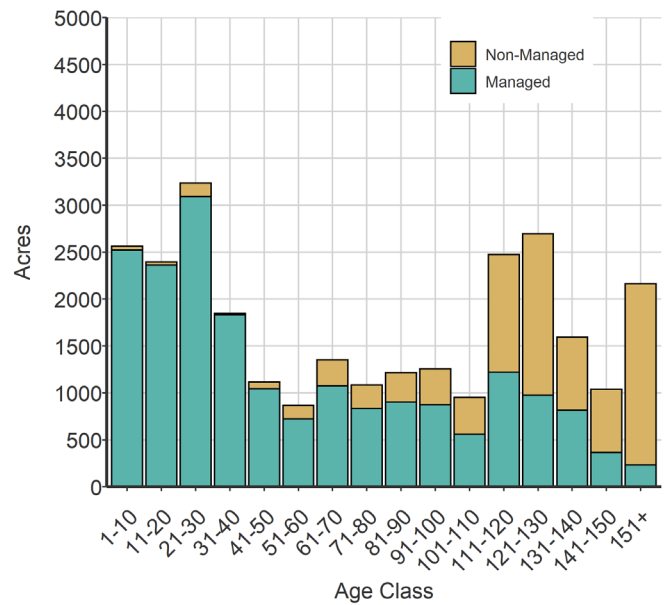
Ash/Lowland Hardwoods



Northern Hardwoods



White Pine

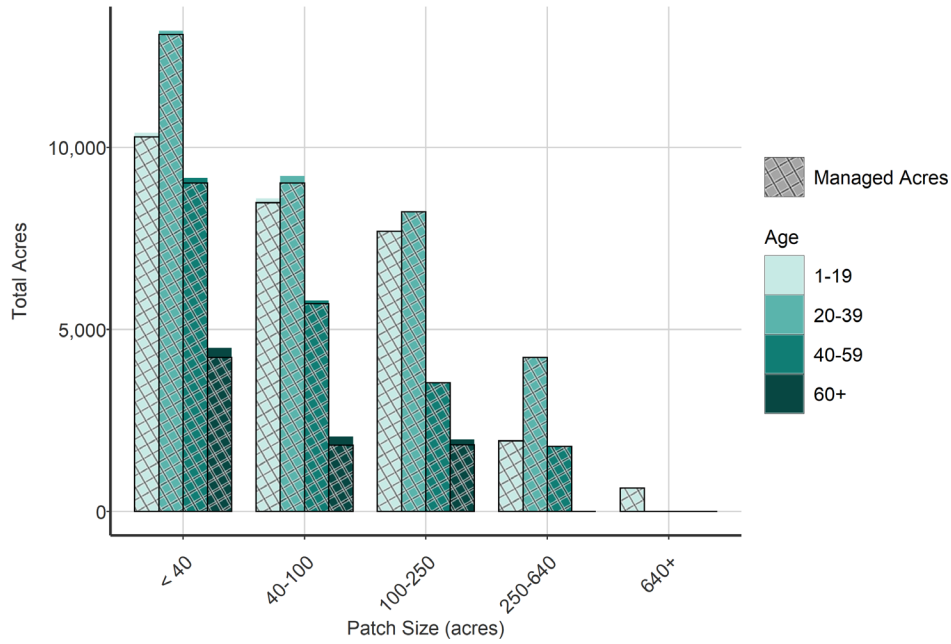


Appendix B. Patch size age and size class distributions by ecological section

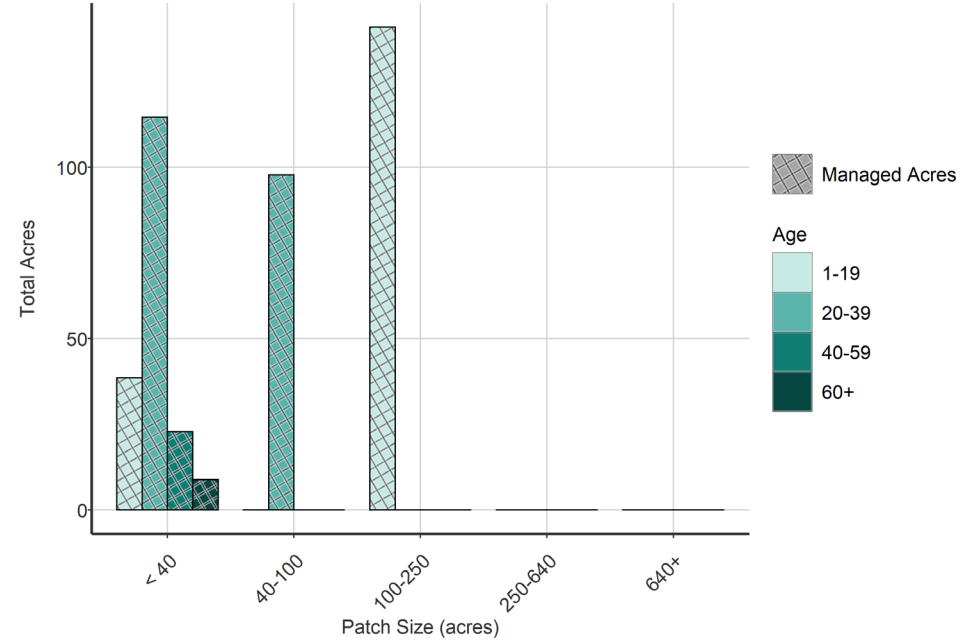
Forest patches in this appendix are defined as areas of similar age and forest cover type on DNR-administered land within ecological sections. The DNR's long-standing forest resource management planning goal has been to maintain large forested patches and increase average patch size over time on DNR-administered lands. However, the DNR does not have specific objectives for the number or area of large forested patches or average patch size. Patch size and age class information are presented here as context about current resource conditions by ecological section. These distributions result from previous plans and management decisions and are not effects of the current Forest Resource Management Planning System strategic direction.

Aspen Parklands

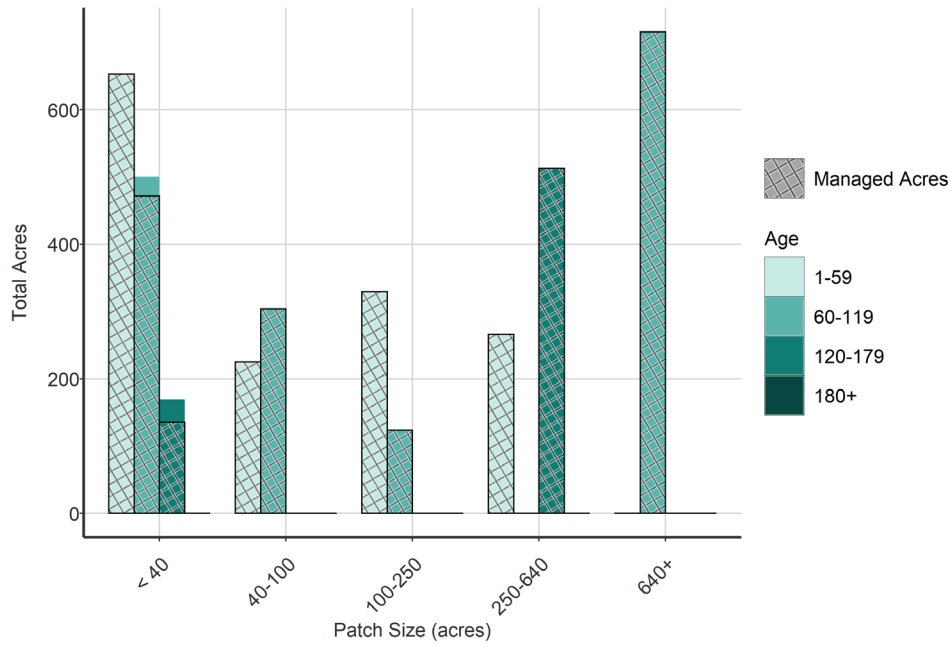
Aspen, Birch, Balm of Gilead



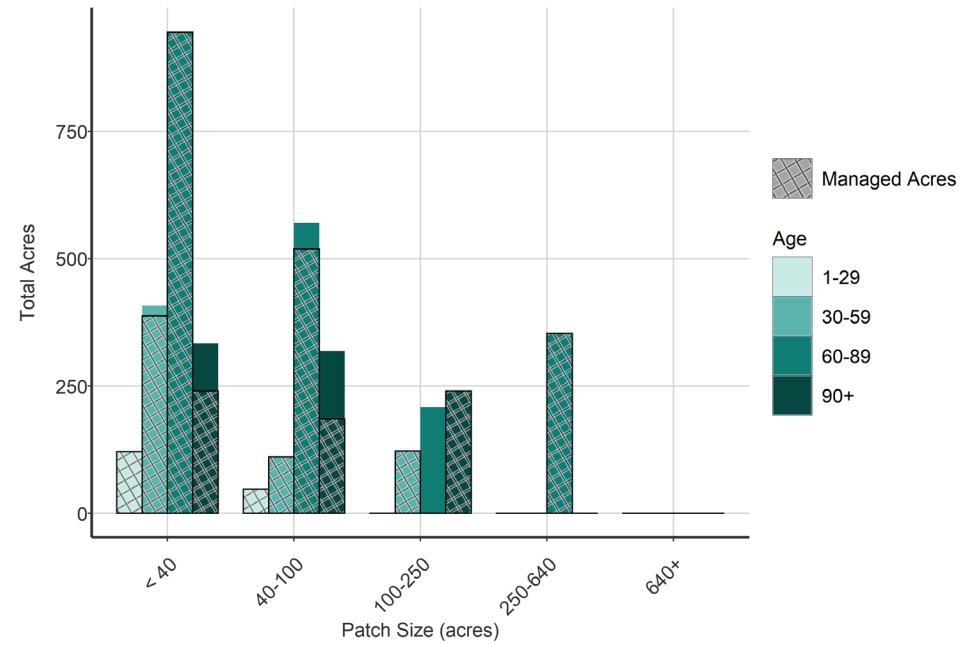
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

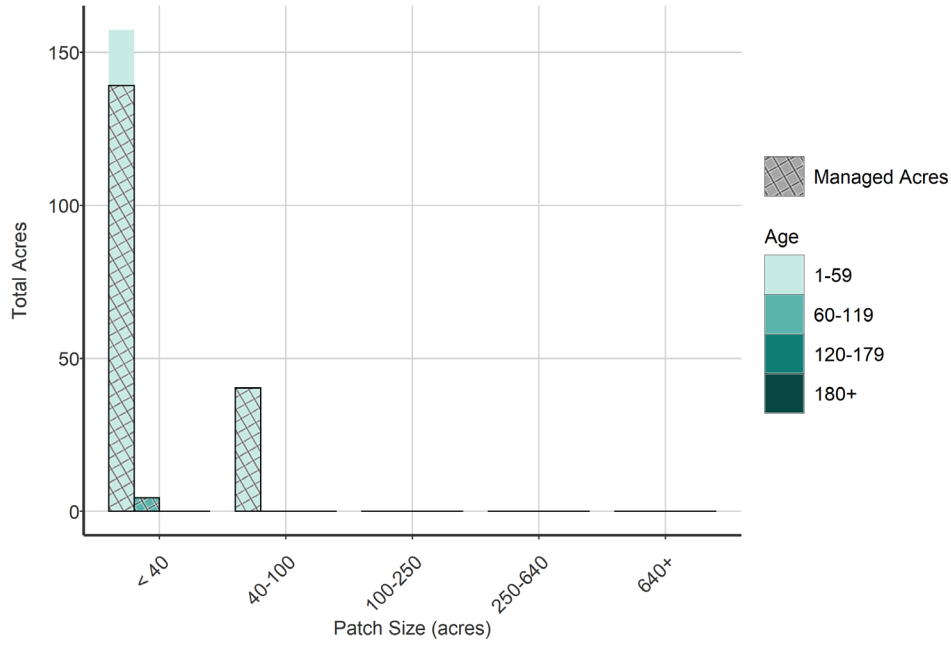


Ash, Lowland Hardwoods

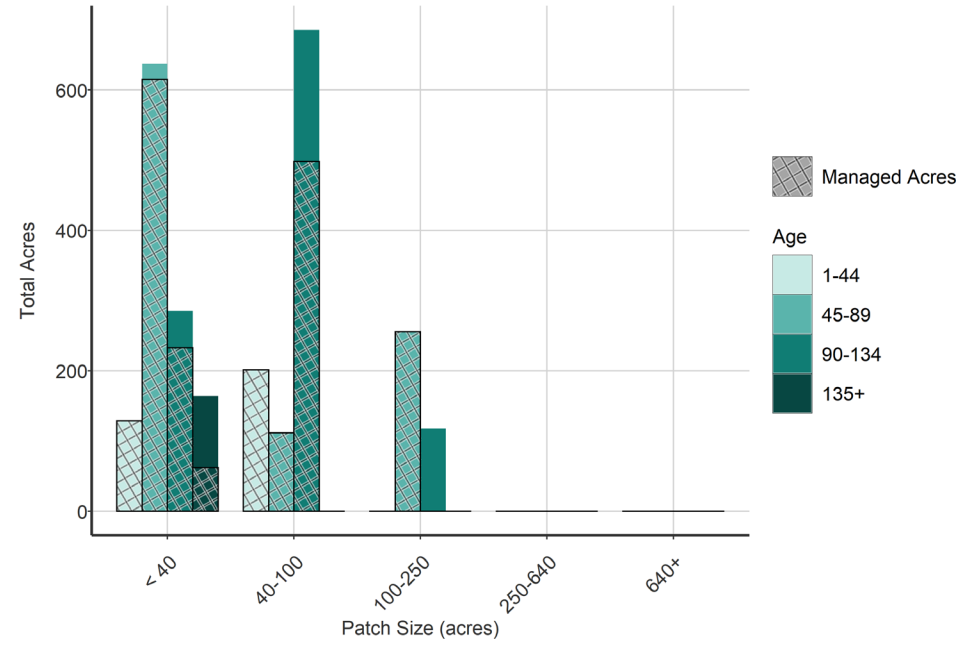


Aspen Parklands

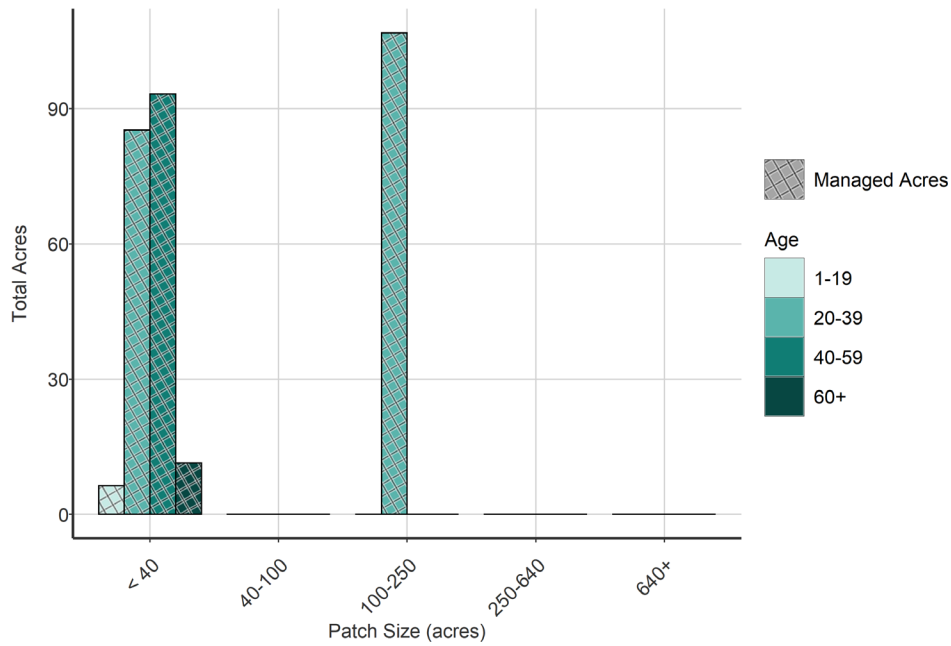
Red Pine, White Pine



Northern Hardwoods, Oak

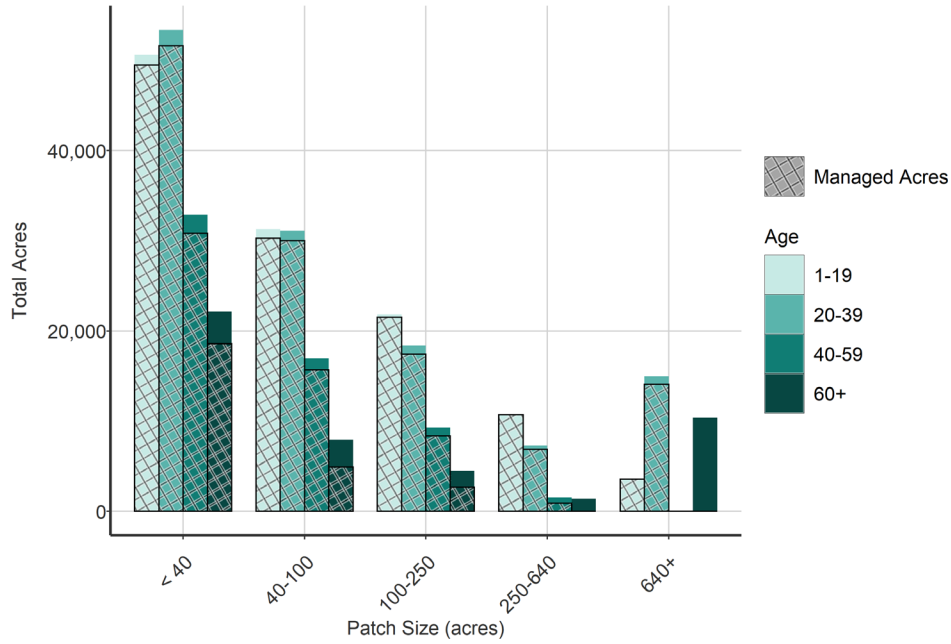


Balsam Fir, White Spruce

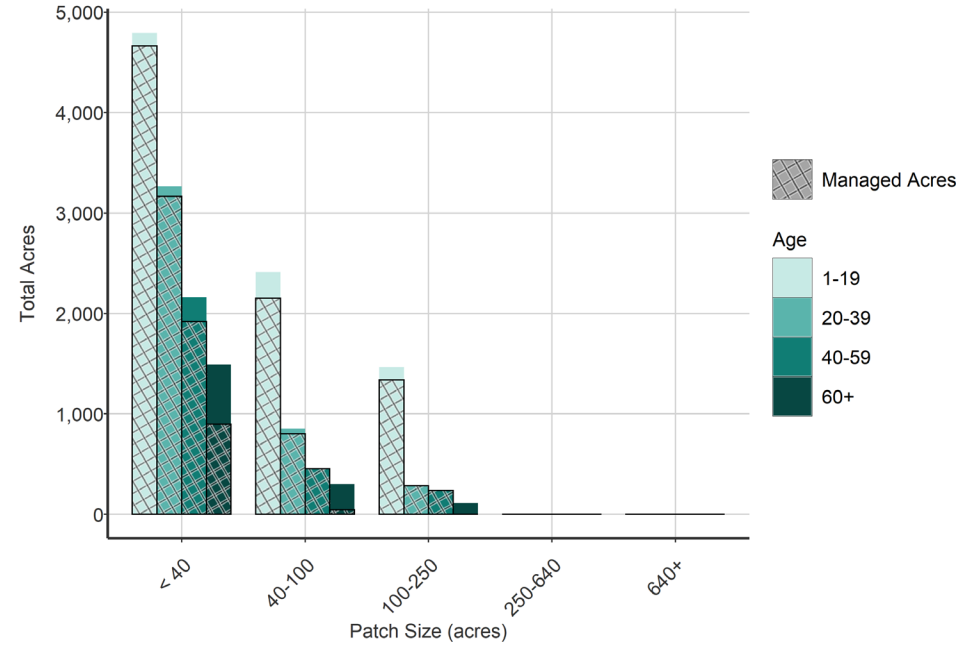


Northern Minnesota Drift and Lake Plains

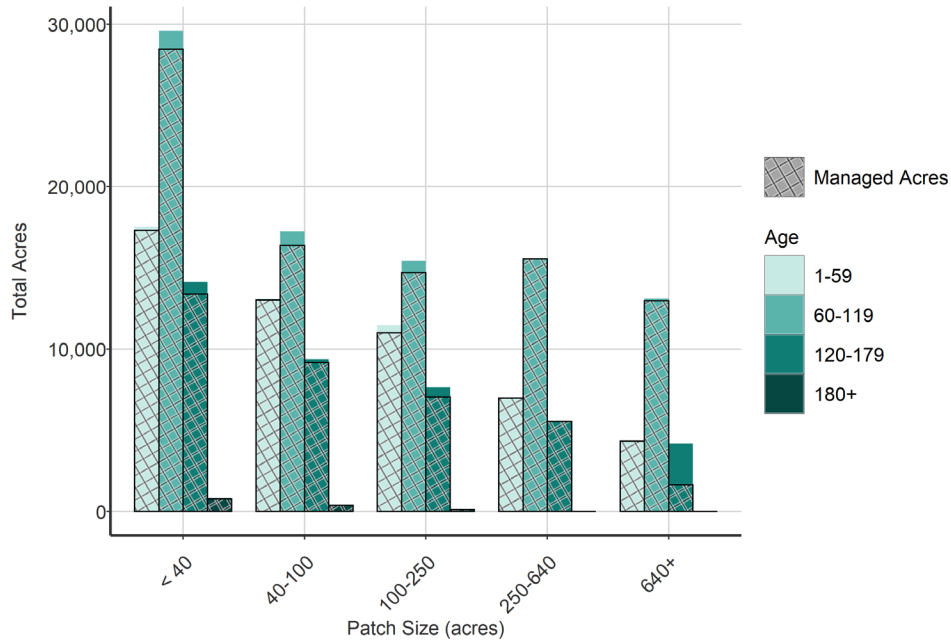
Aspen, Birch, Balm of Gilead



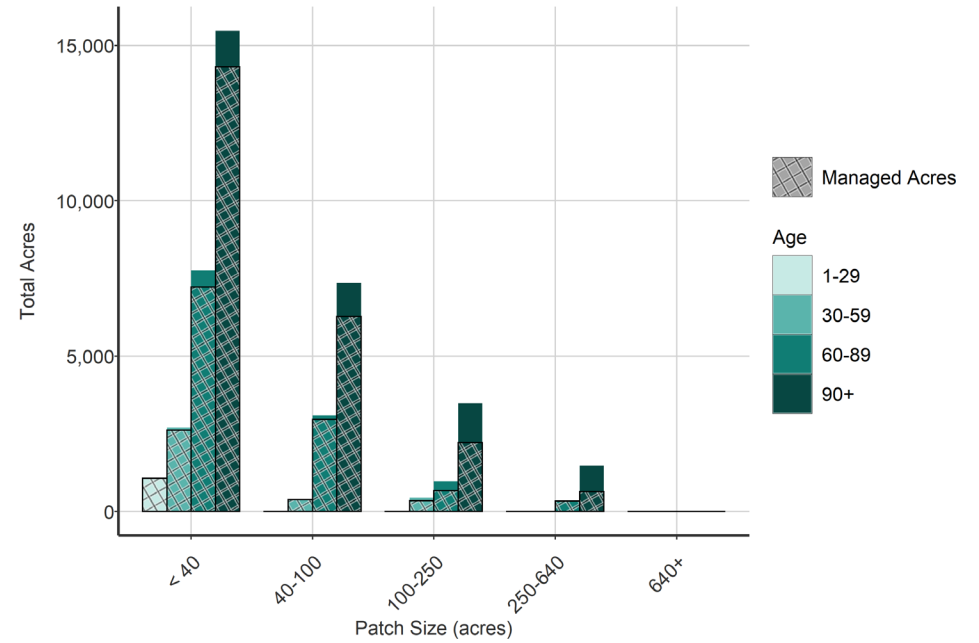
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

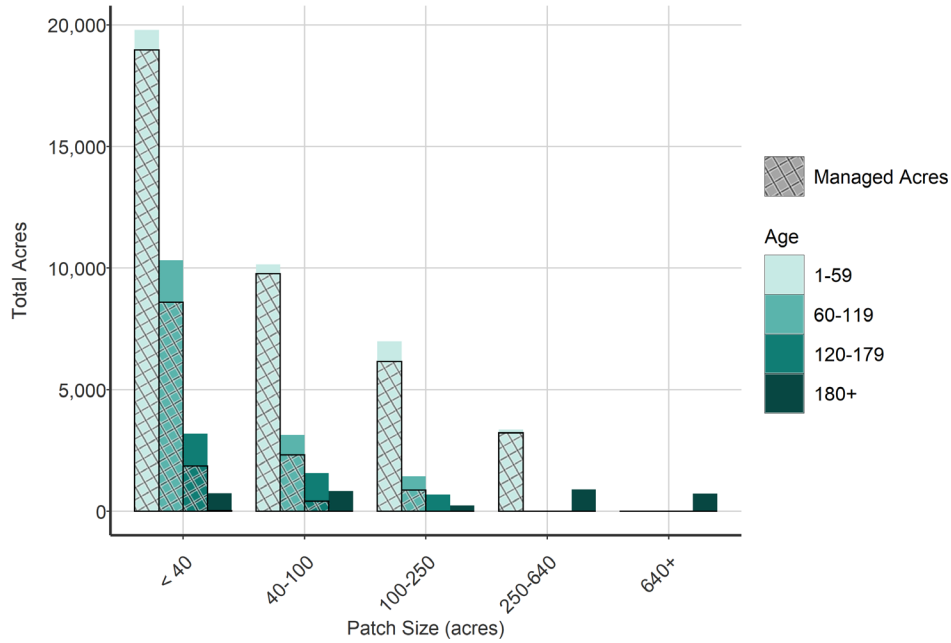


Ash, Lowland Hardwoods

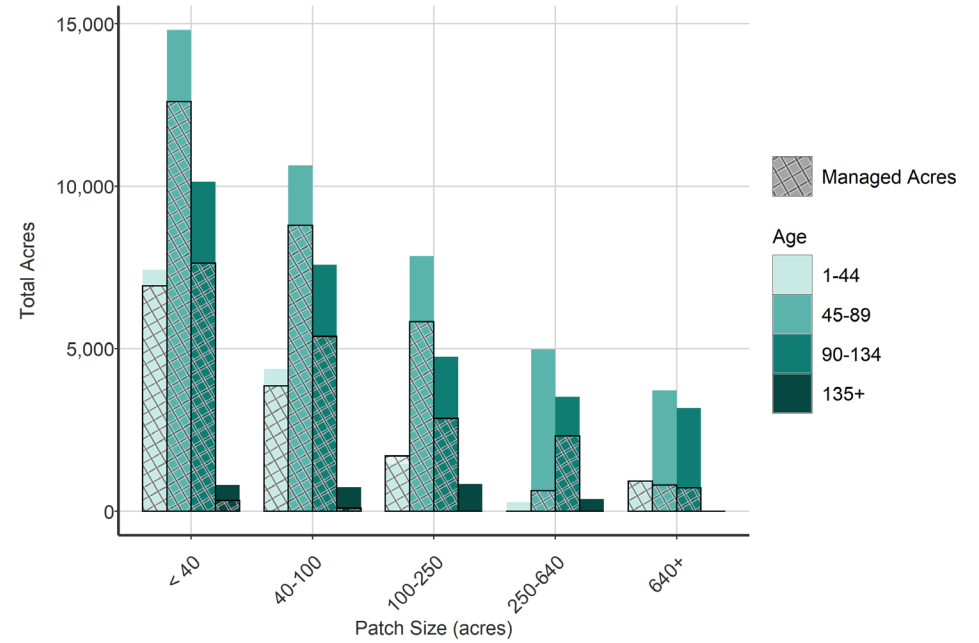


Northern Minnesota Drift and Lake Plains

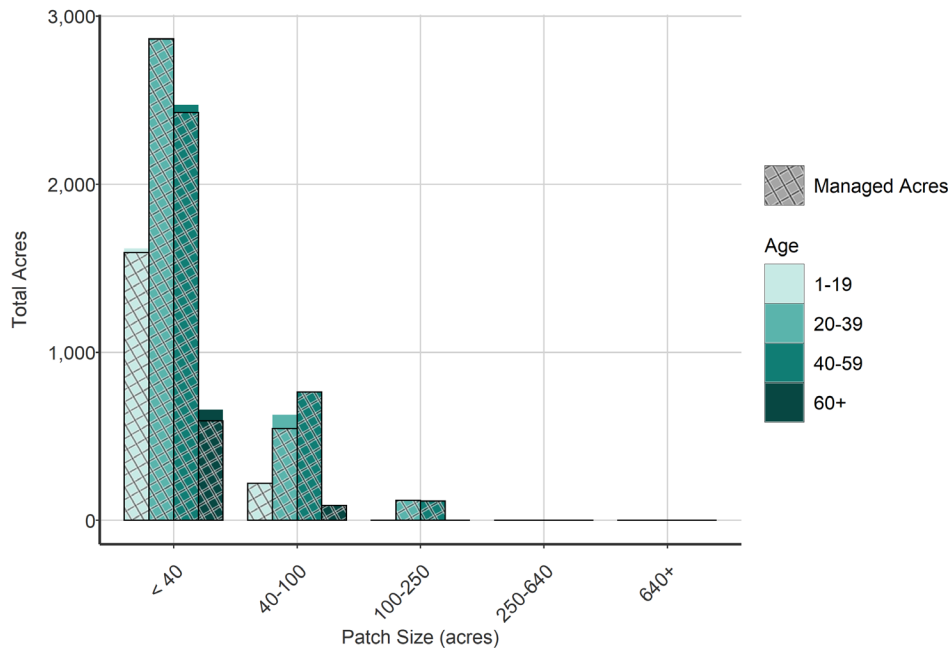
Red Pine, White Pine



Northern Hardwoods, Oak

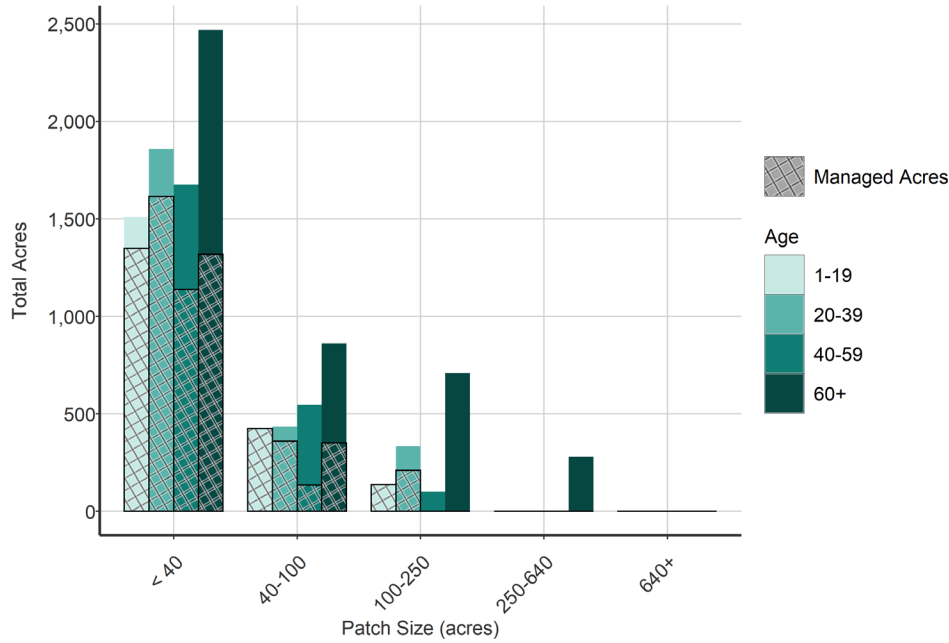


Balsam Fir, White Spruce

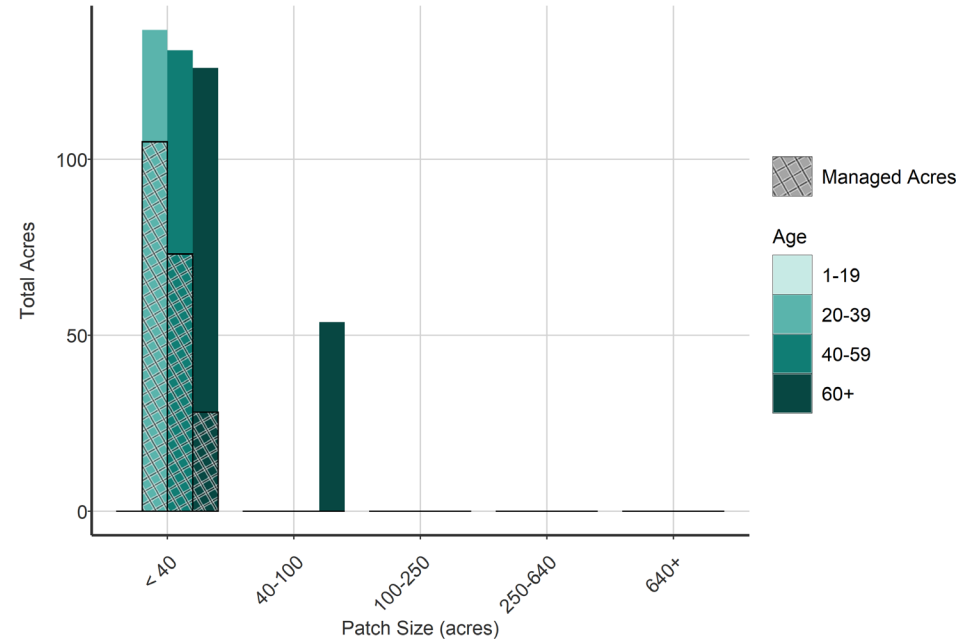


Minnesota and Northeast Iowa Morainal

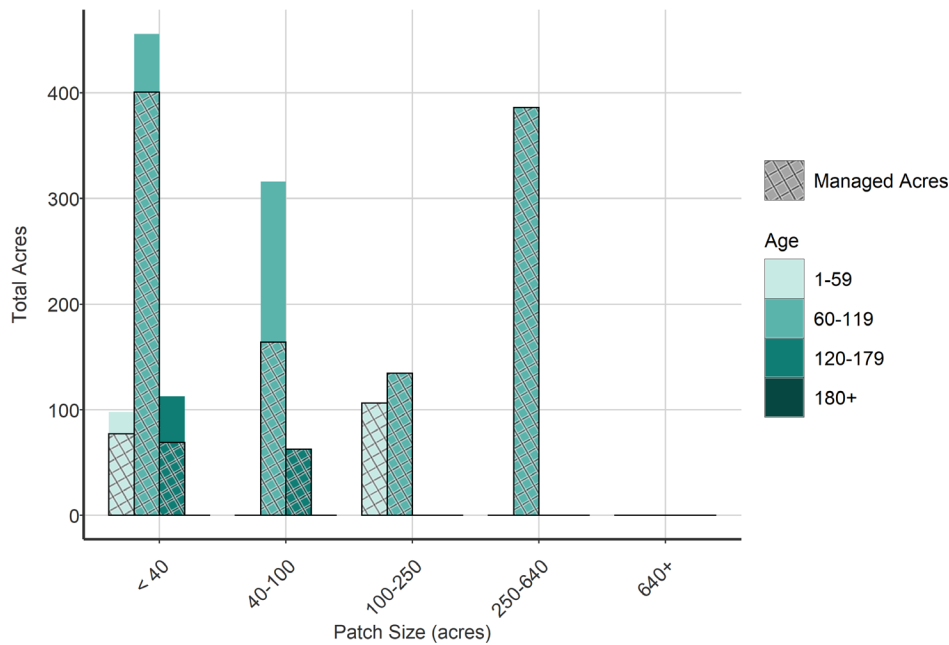
Aspen, Birch, Balm of Gilead



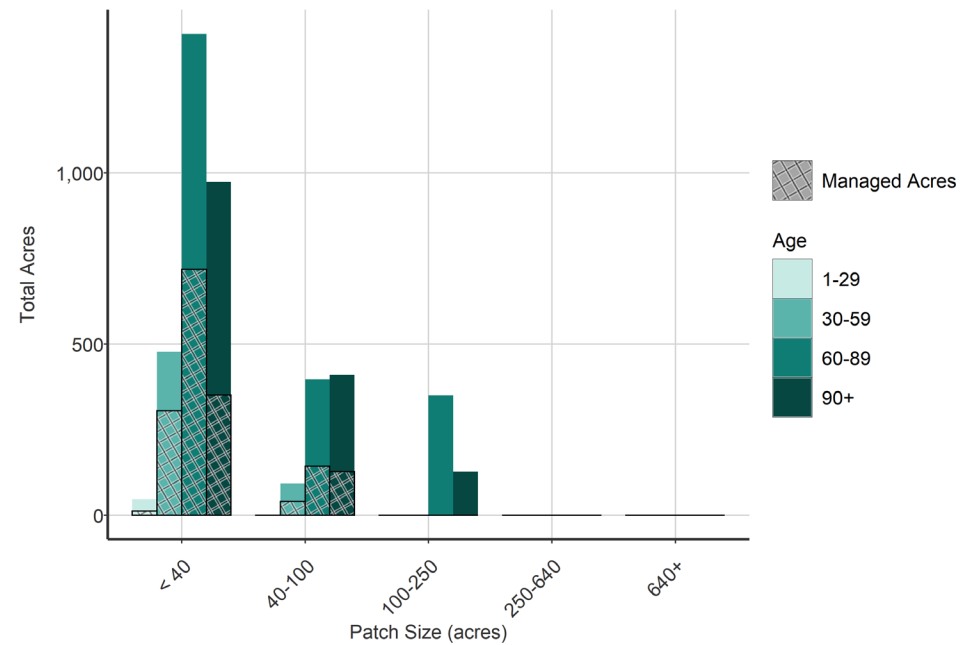
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

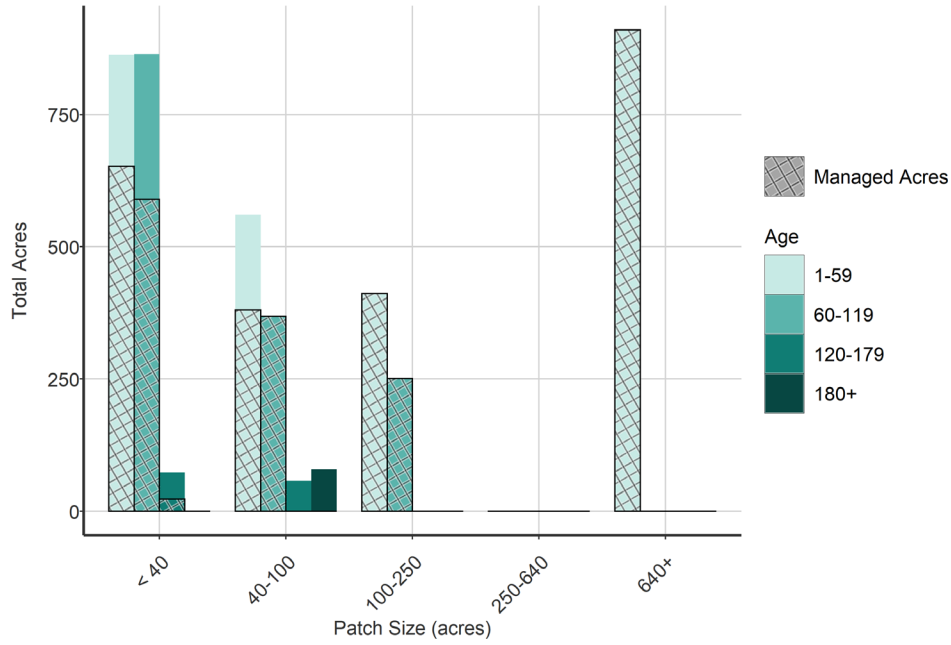


Ash, Lowland Hardwoods

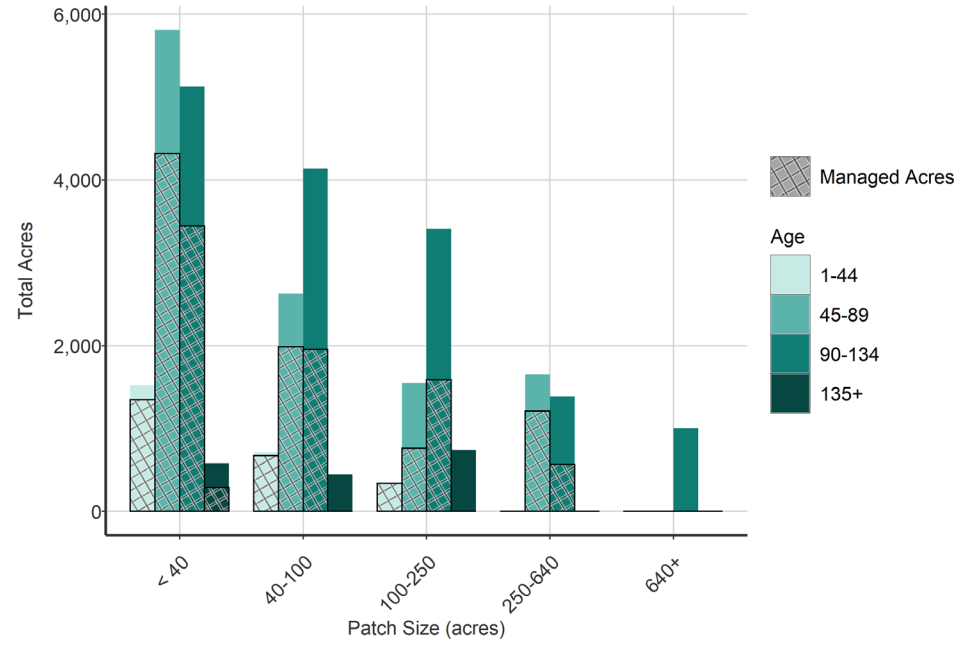


Minnesota and Northeast Iowa Morainal

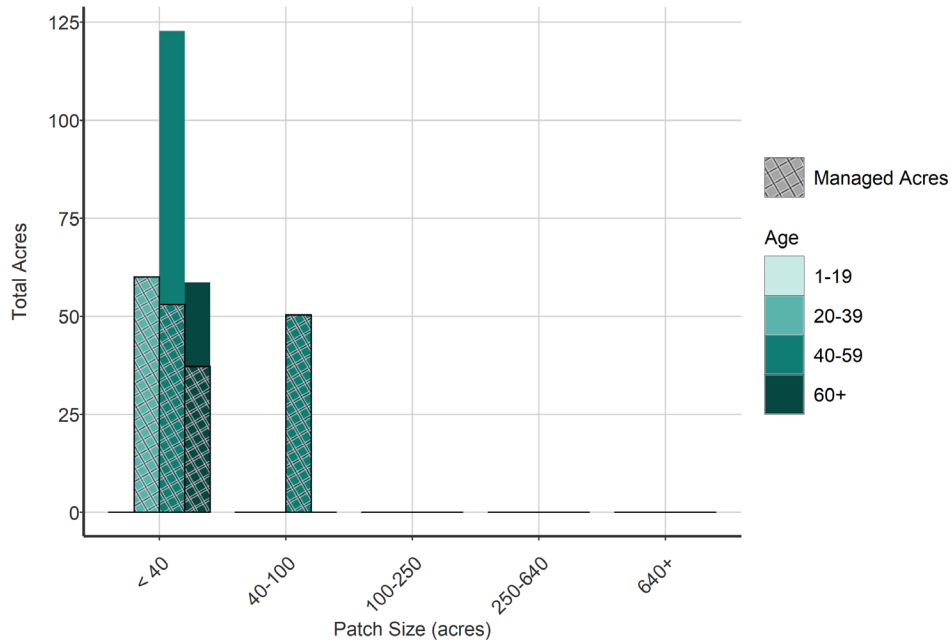
Red Pine, White Pine



Northern Hardwoods, Oak

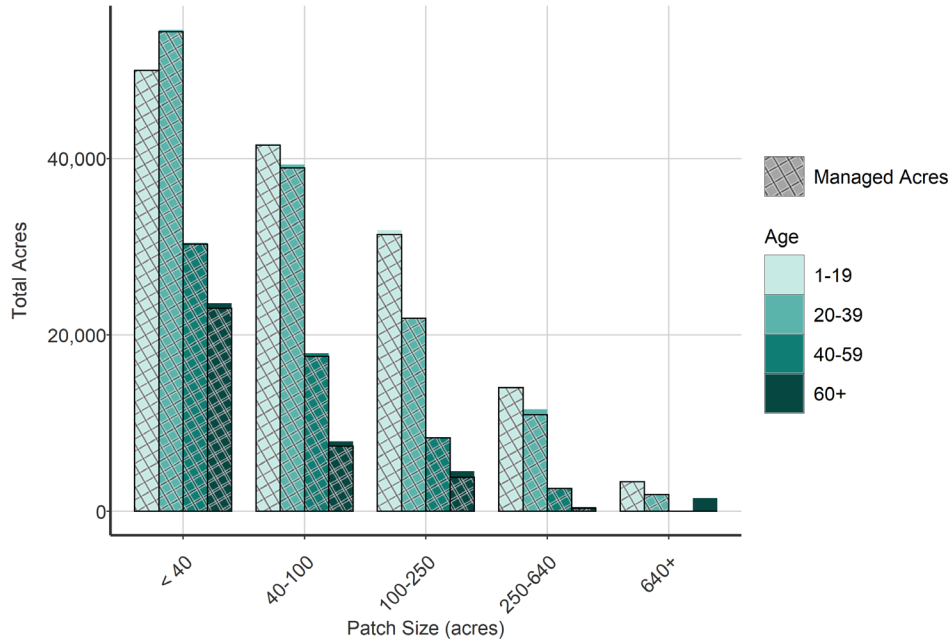


Balsam Fir, White Spruce

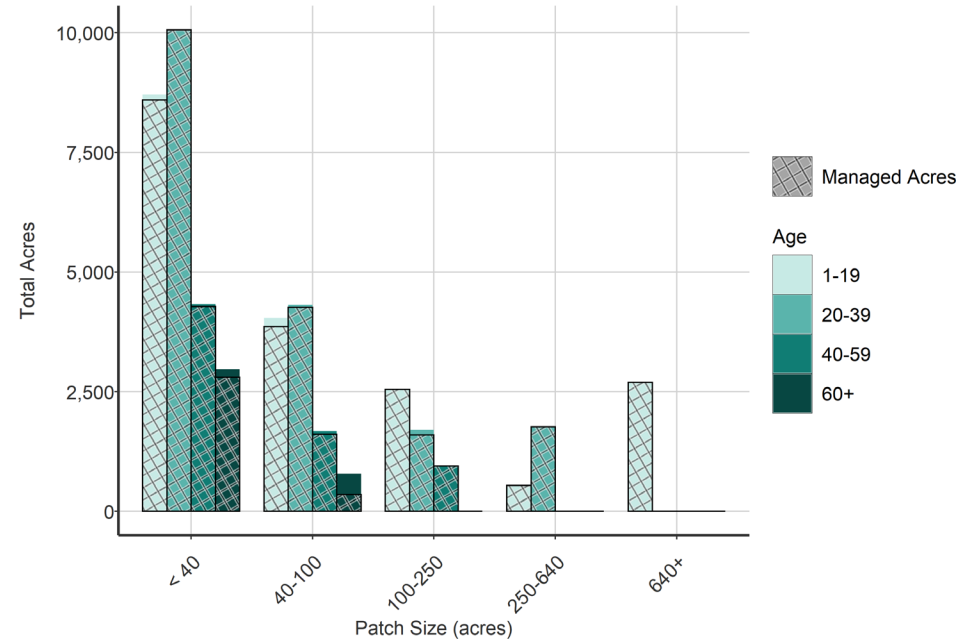


Northern Minnesota and Ontario Peatlands

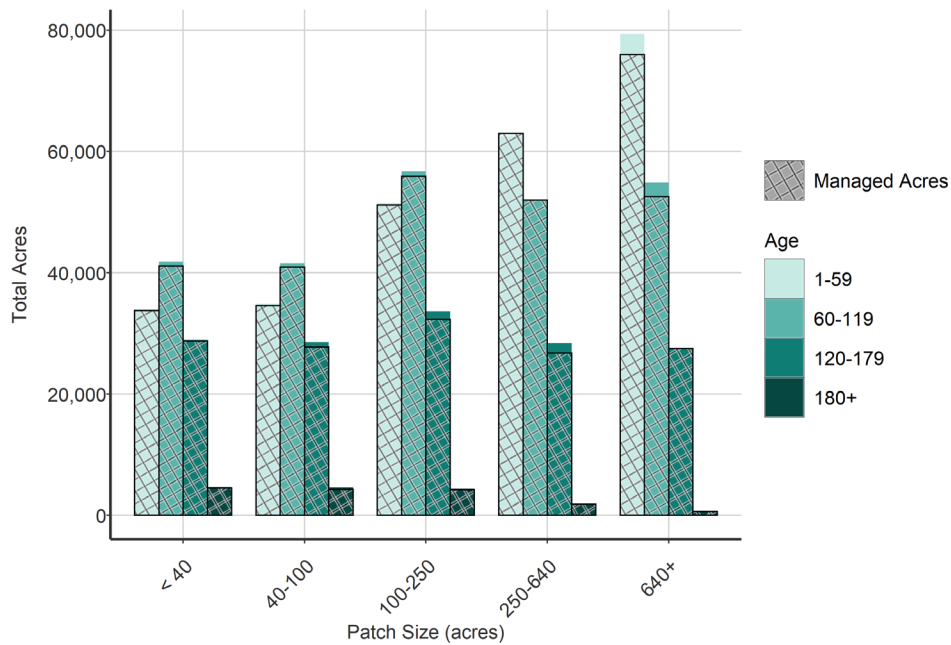
Aspen, Birch, Balm of Gilead



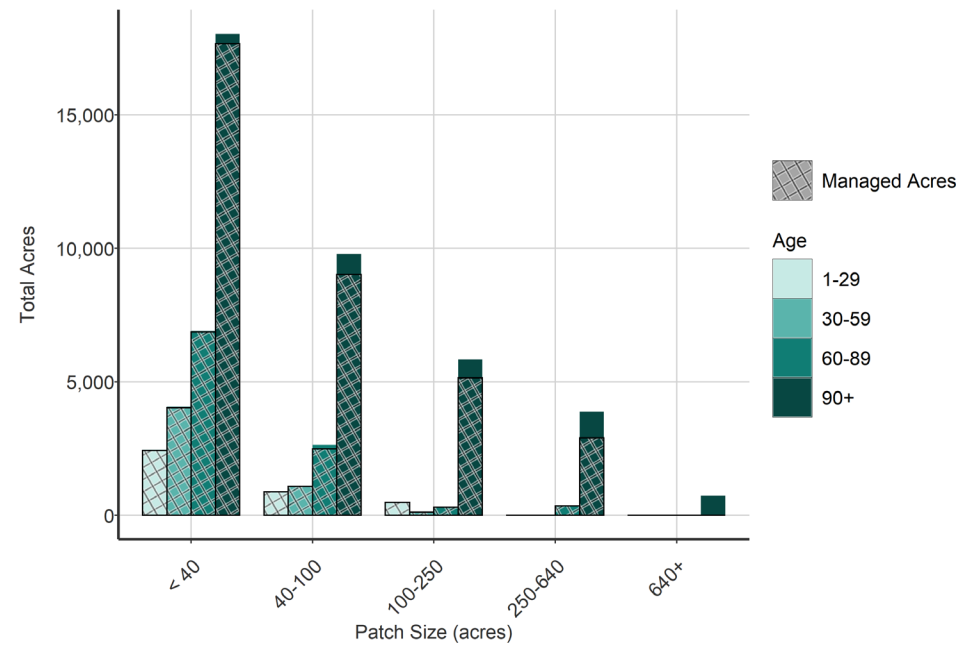
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

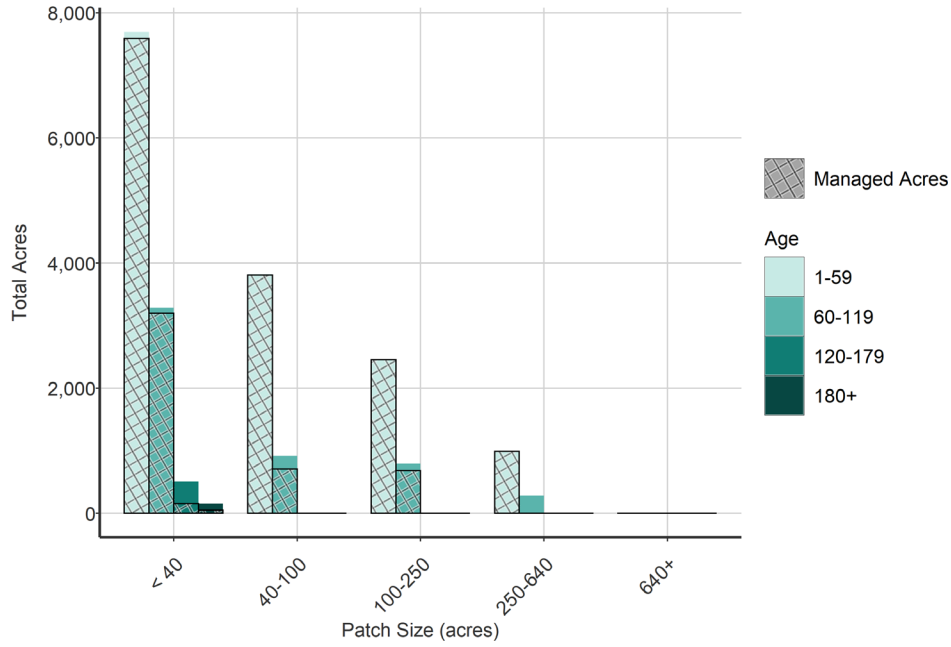


Ash, Lowland Hardwoods

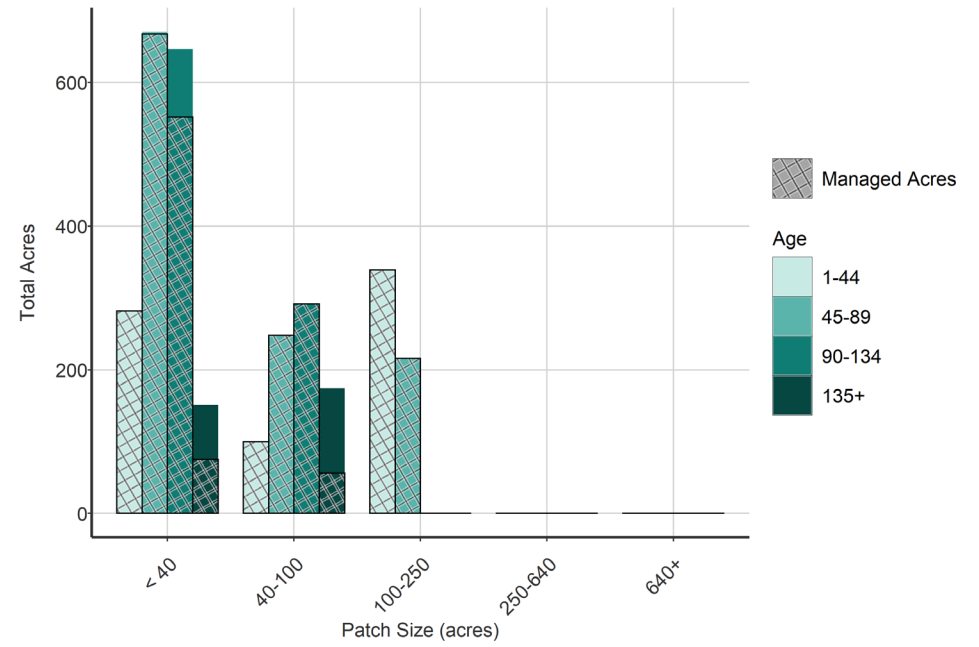


Northern Minnesota and Ontario Peatlands

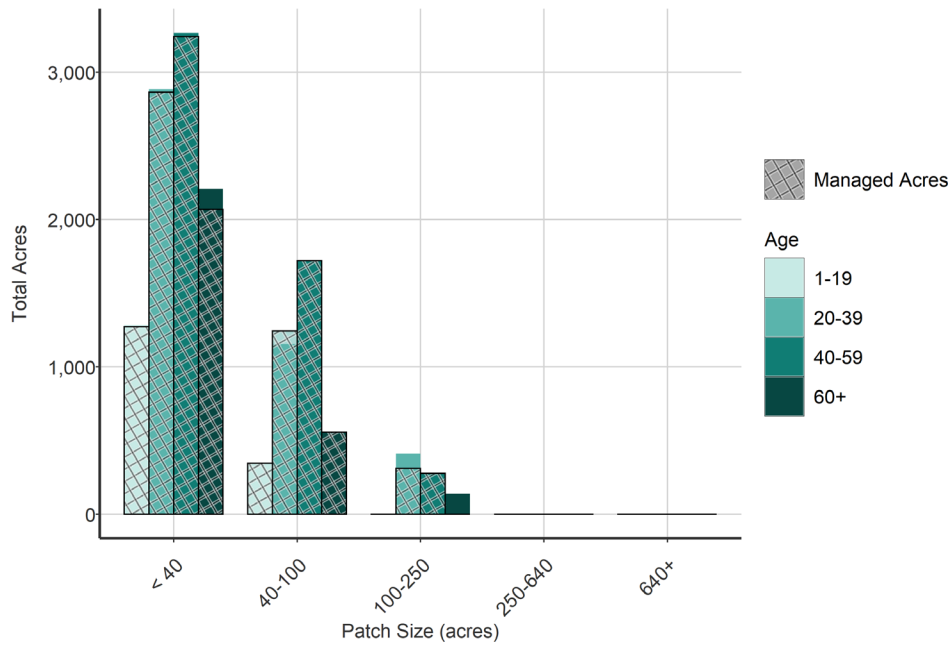
Red Pine, White Pine



Northern Hardwoods, Oak

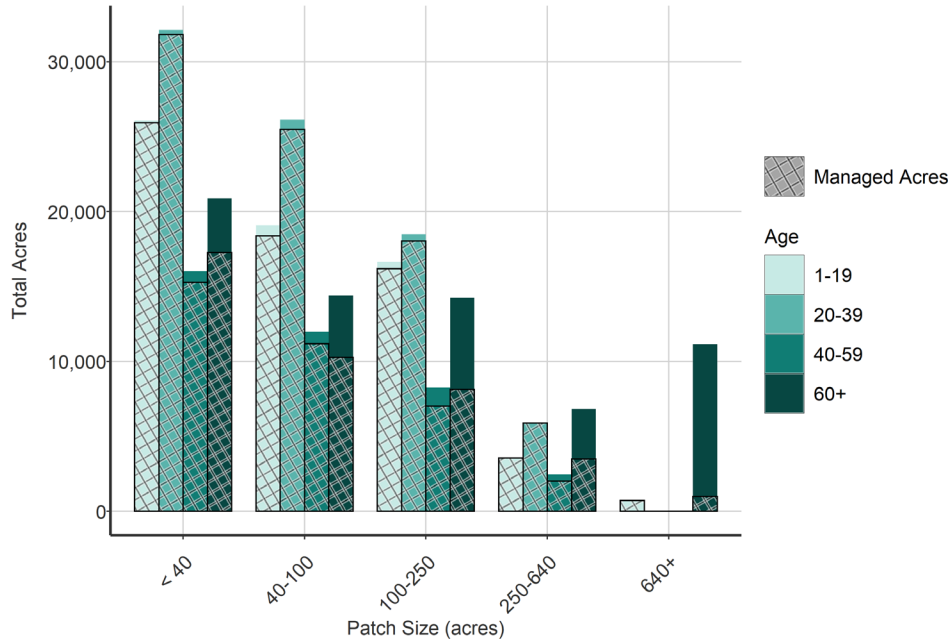


Balsam Fir, White Spruce

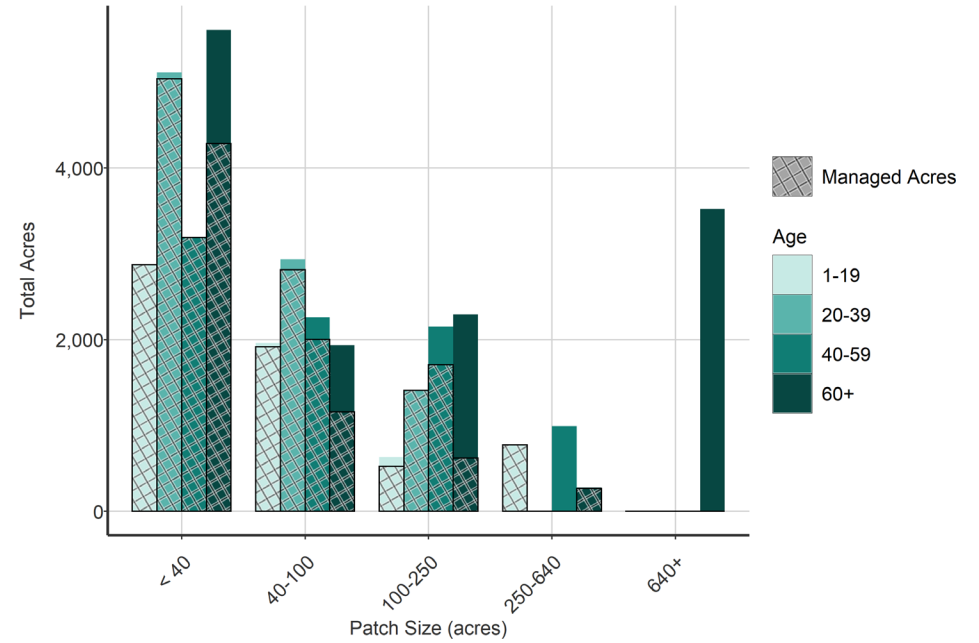


Northern Superior Uplands

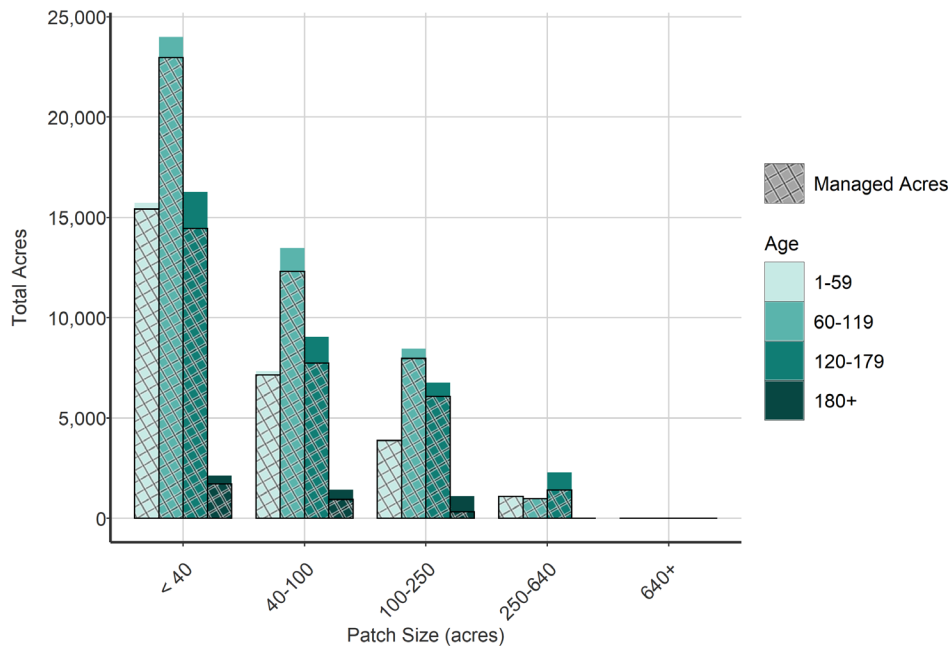
Aspen, Birch, Balm of Gilead



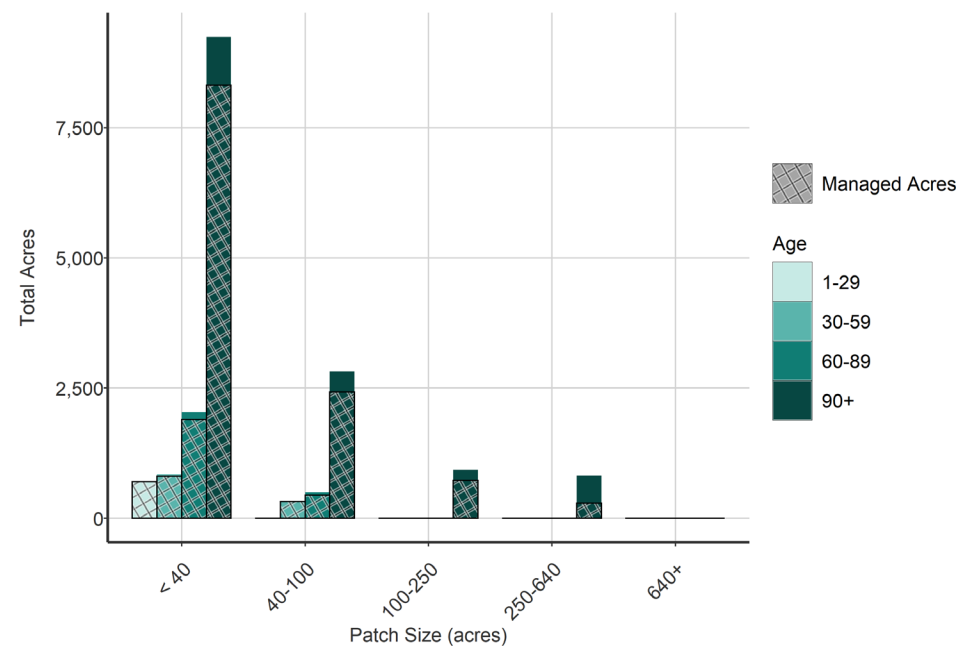
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

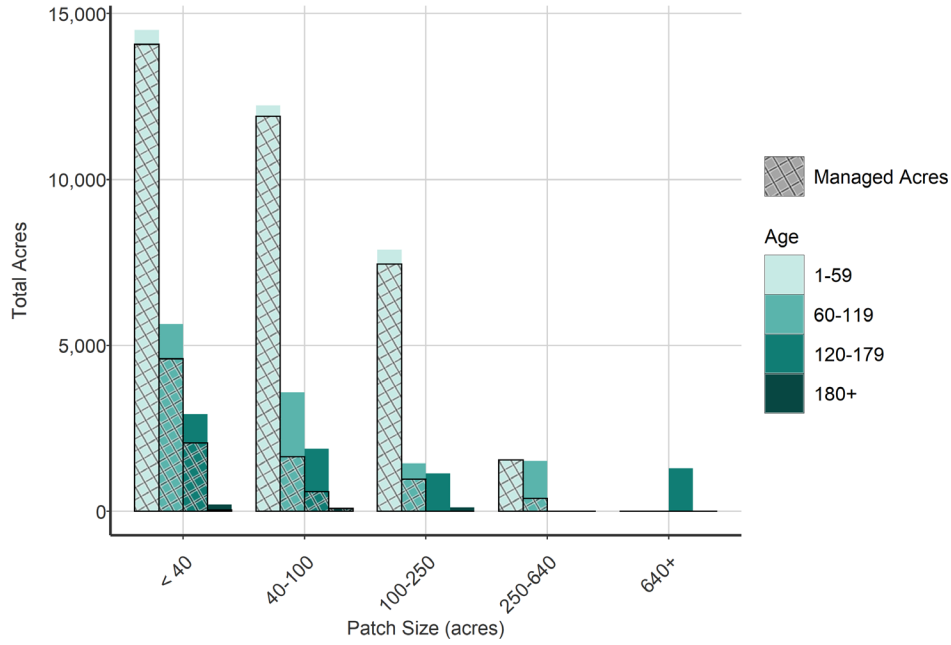


Ash, Lowland Hardwoods

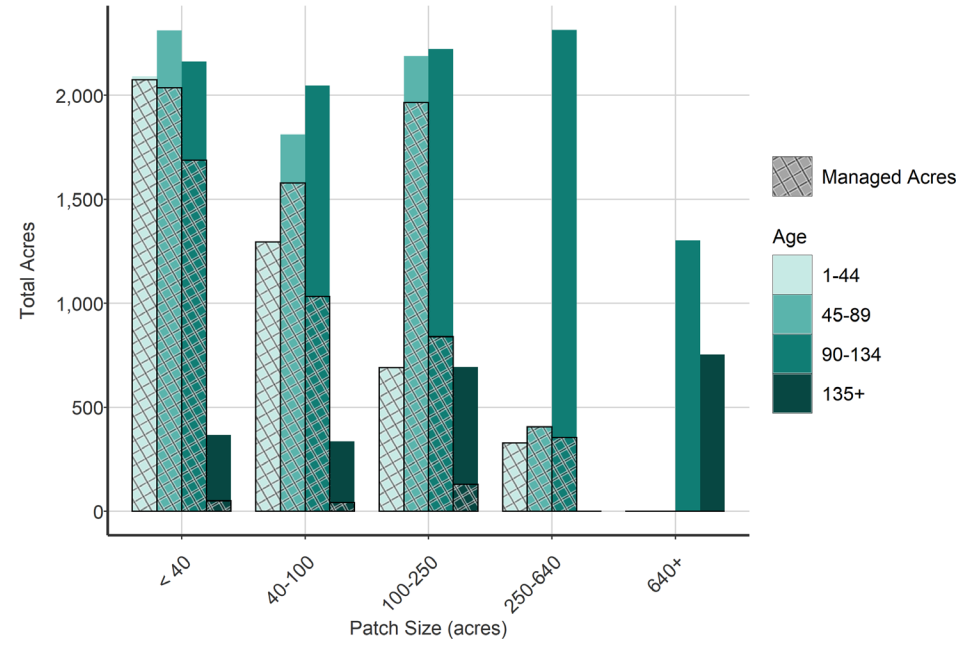


Northern Superior Uplands

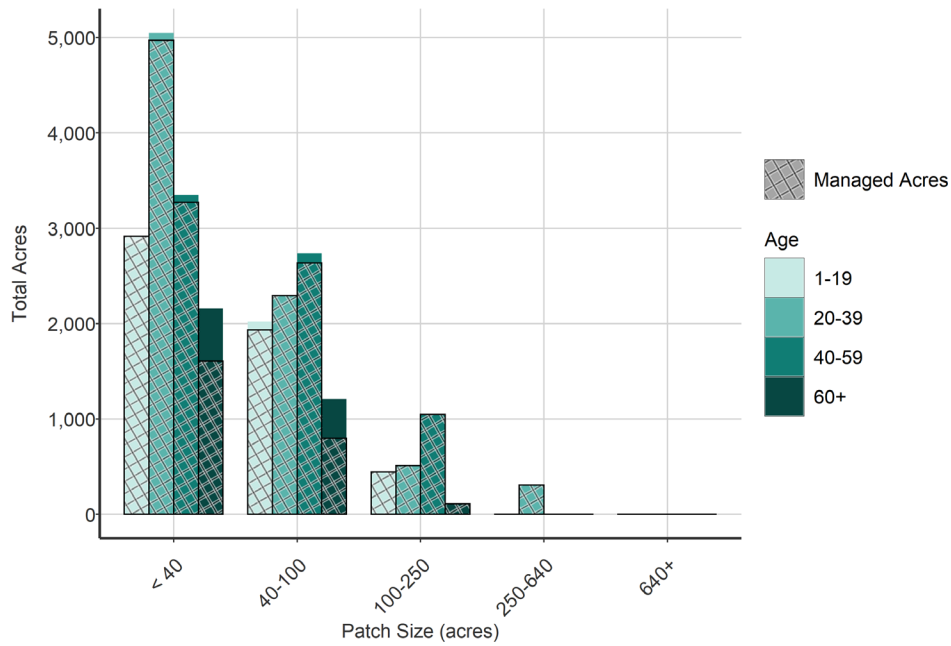
Red Pine, White Pine



Northern Hardwoods, Oak

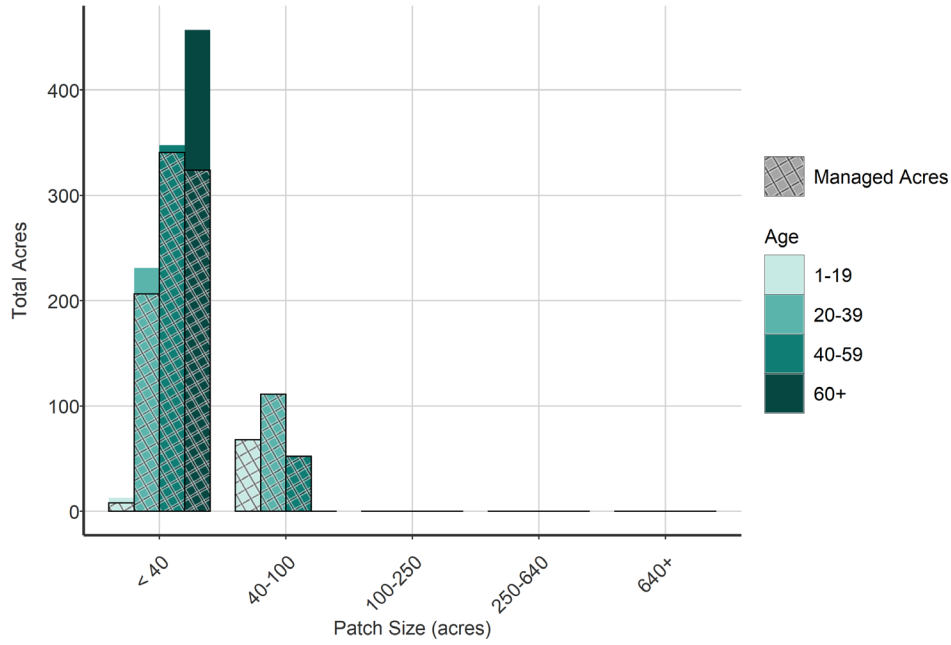


Balsam Fir, White Spruce

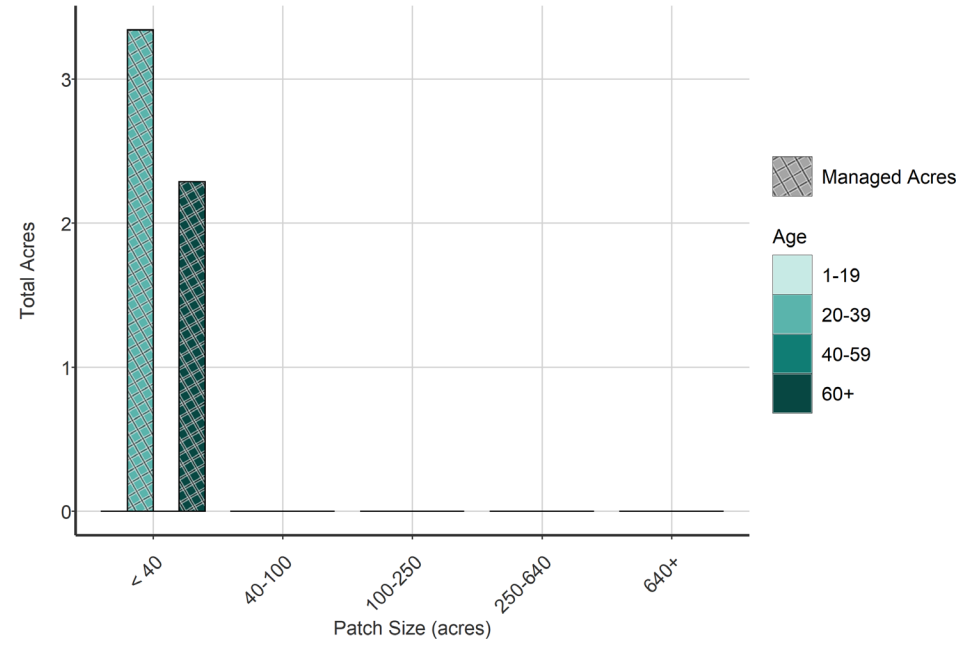


Paleozoic Plateau

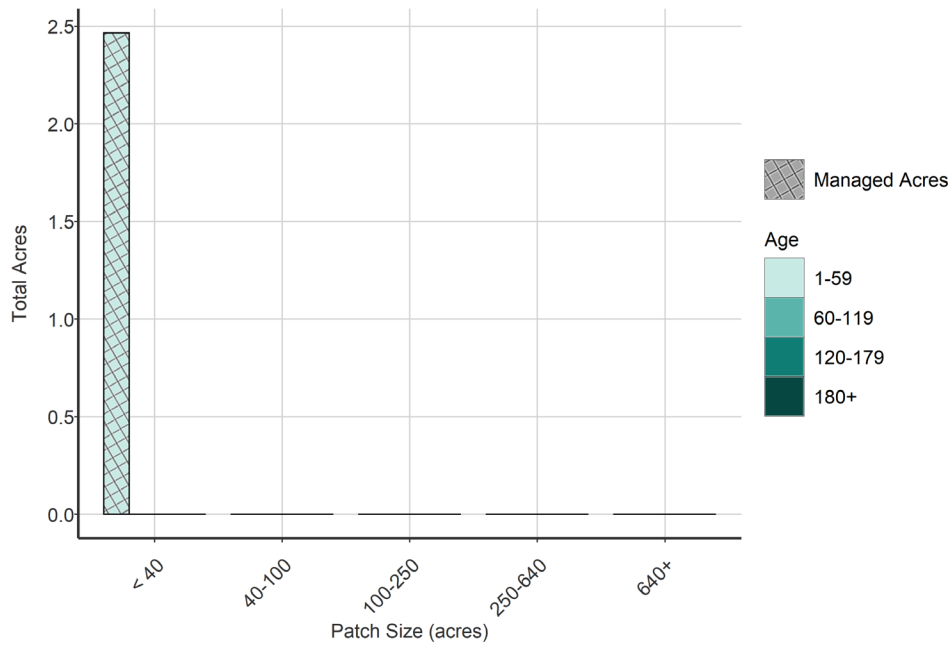
Aspen, Birch, Balm of Gilead



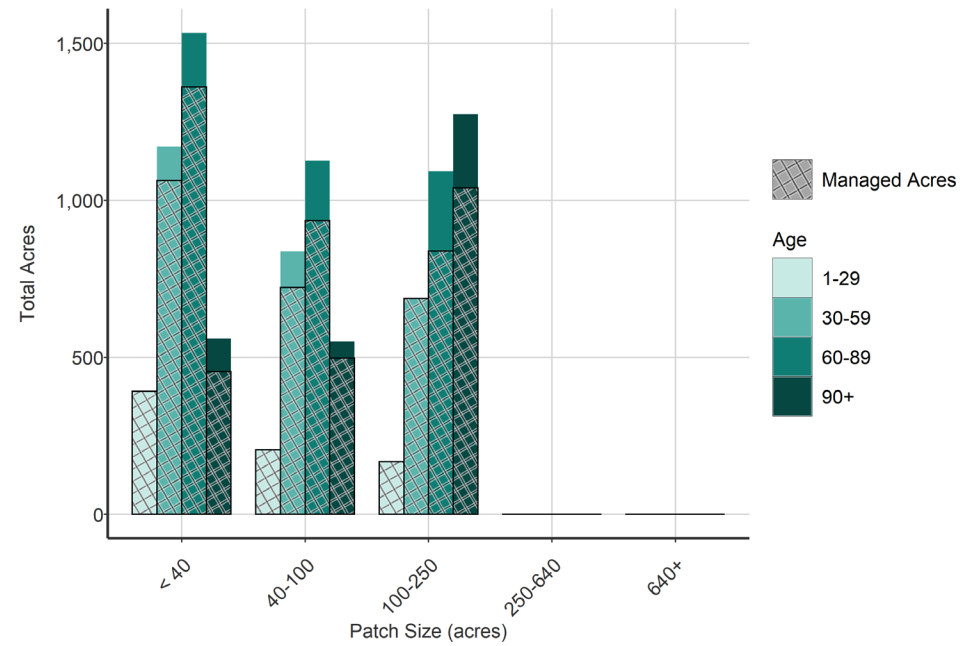
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

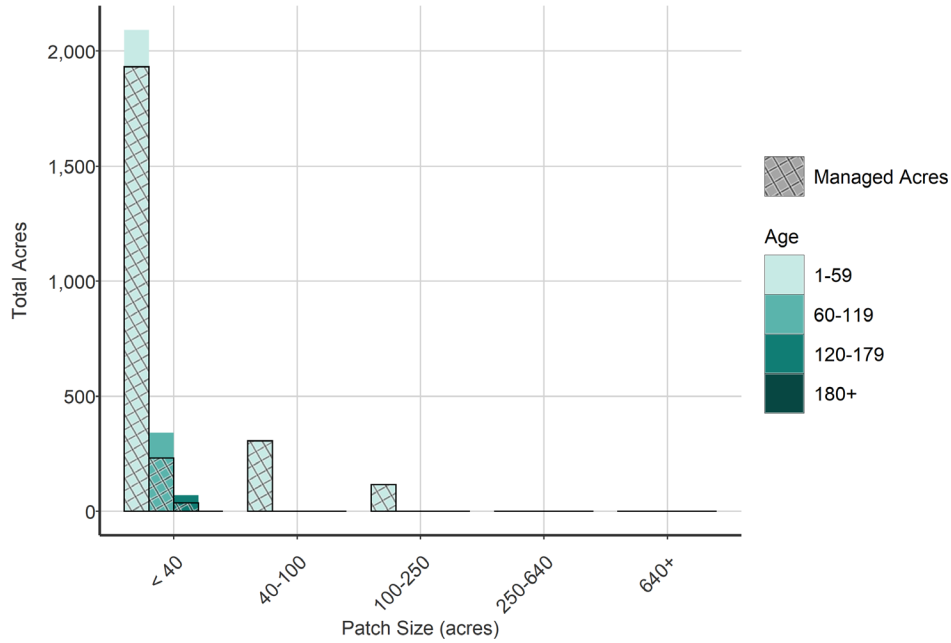


Ash, Lowland Hardwoods

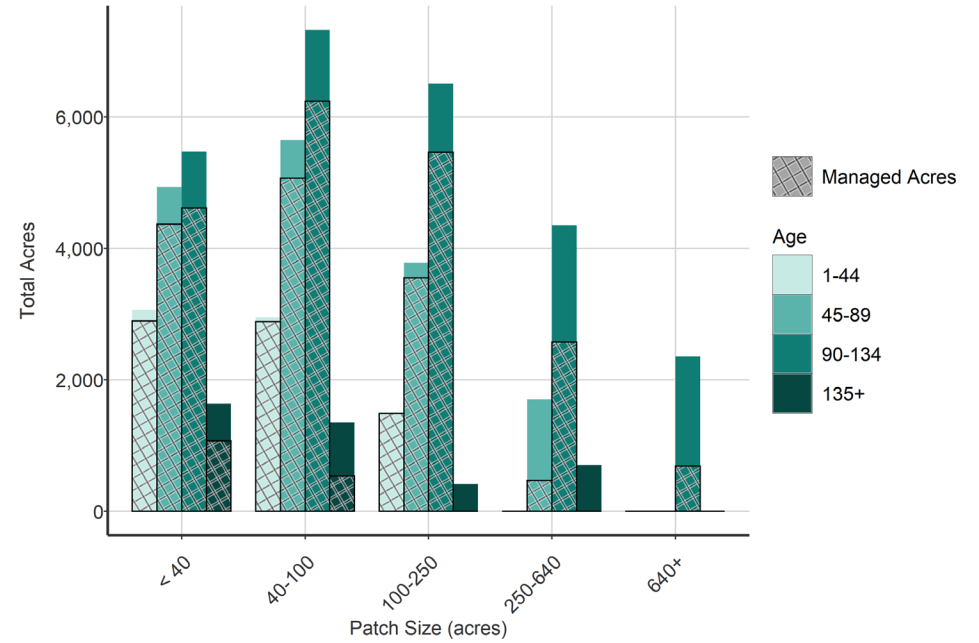


Paleozoic Plateau

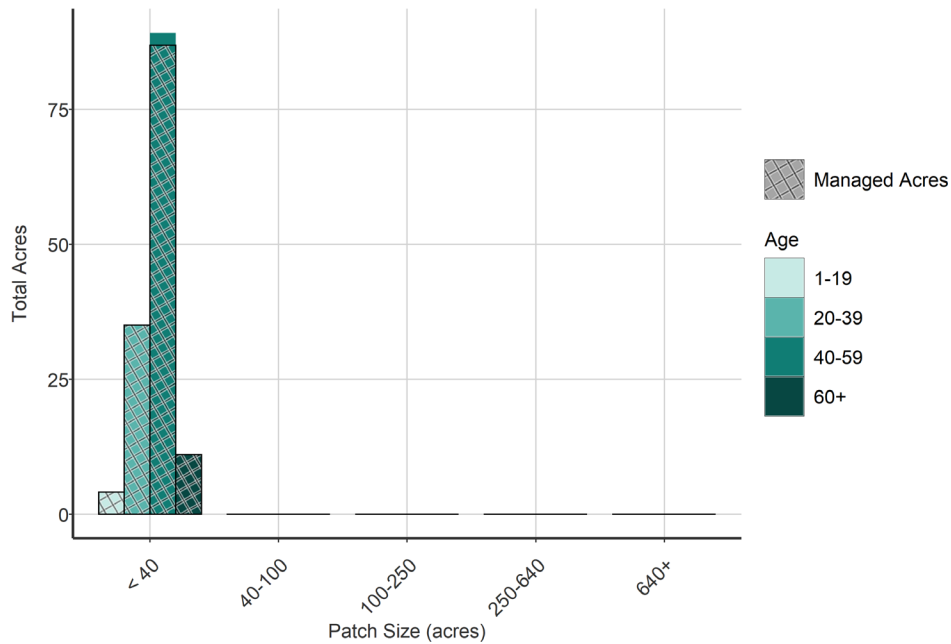
Red Pine, White Pine



Northern Hardwoods, Oak

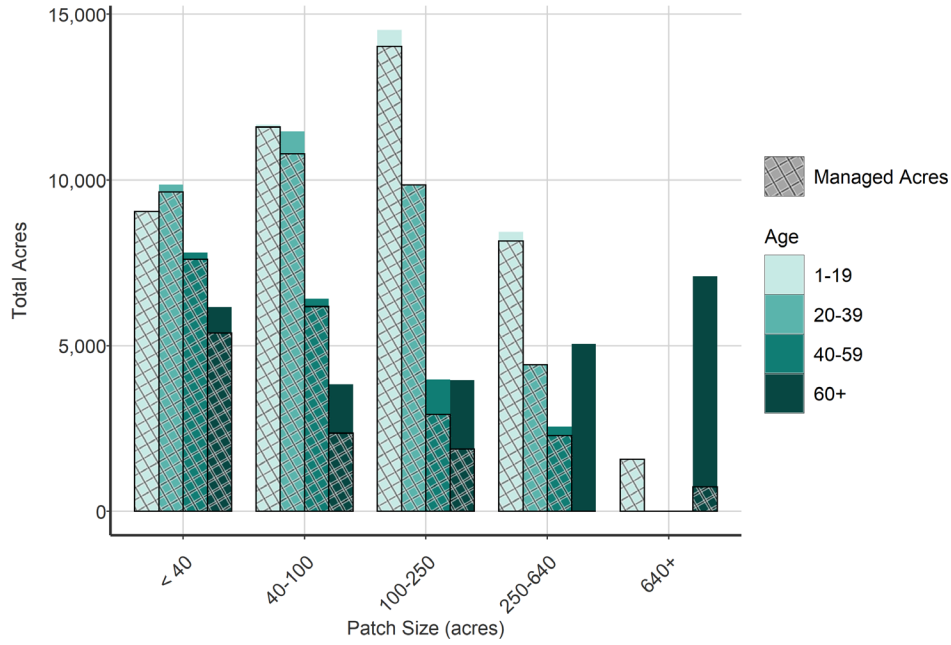


Balsam Fir, White Spruce

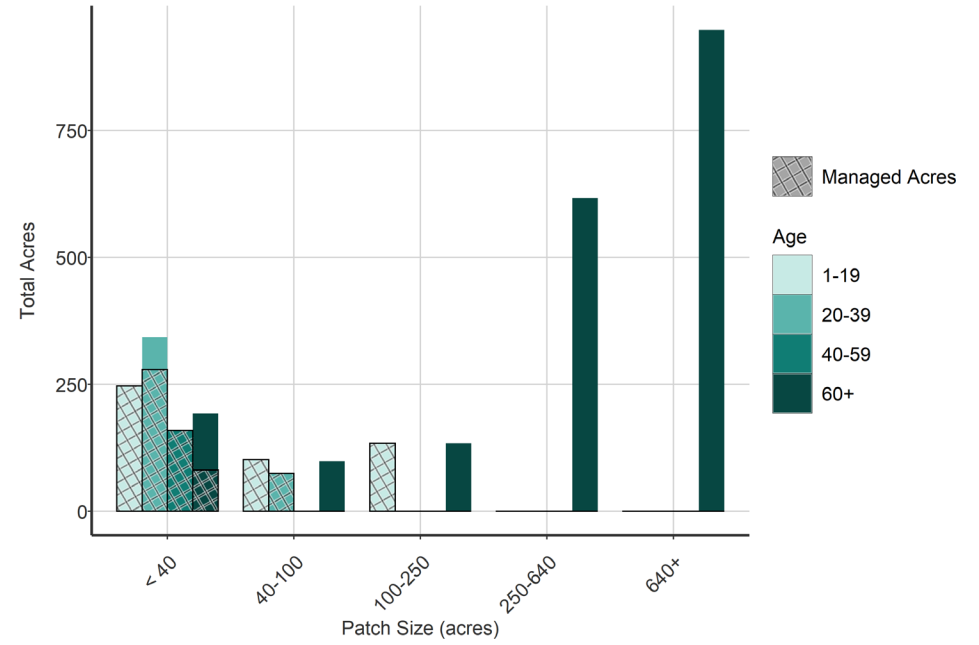


Western Superior Uplands

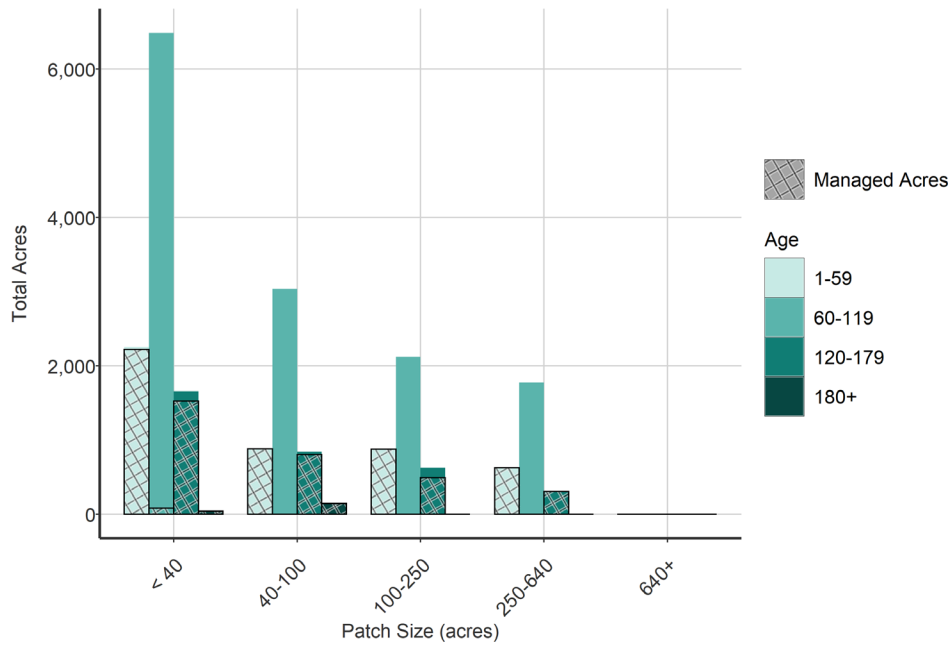
Aspen, Birch, Balm of Gilead



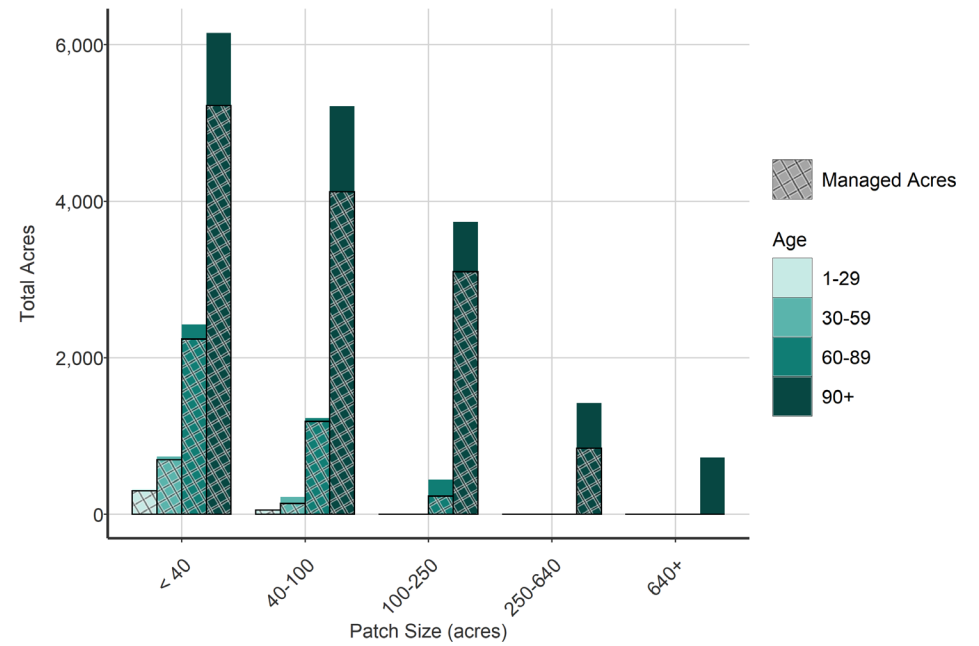
Jack Pine, Upland Black Spruce



Tamarack, White Cedar, Lowland Black Spruce

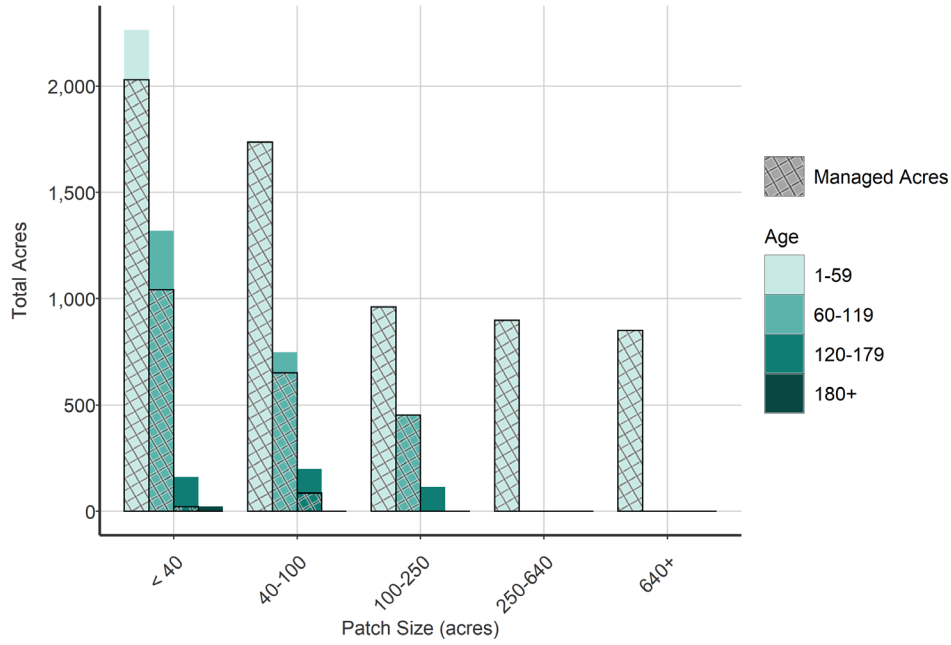


Ash, Lowland Hardwoods

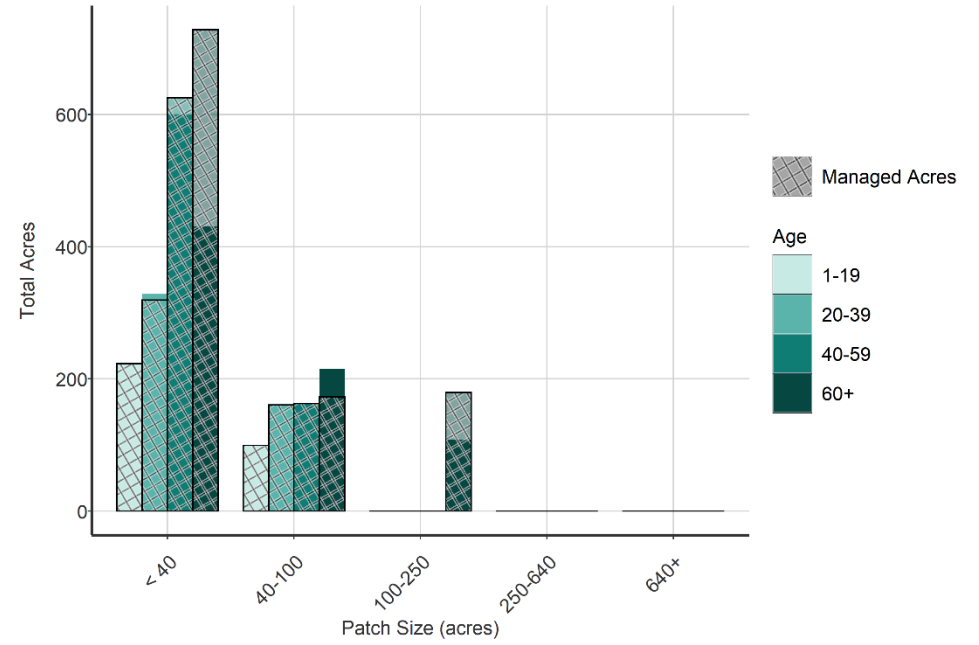


Western Superior Uplands

Red Pine, White Pine



Balsam Fir, White Spruce



Northern Hardwoods, Oak

