

City of Duluth

Forest Management Plan

2027-2037

APRIL 22, 2026

Cover image: Magney Snively Natural Area[1]

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Executive Summary

This plan addresses the entirety of Duluth's forested landscapes, from the trees lining city streets to the vast forested natural areas that define the city's ecological character. Two sections follow, both covering capabilities, management, and recommendations for development over the next decade. Section 1: Urban Trees covers intensively managed and inventoried trees mainly in the built environment. Section 2: Forested Natural Areas presents forests that are less manicured, more expansive, and managed primarily for ecological function, biodiversity, and watershed health. Together, these complementary pieces of Duluth’s canopy reflect the city's commitment to planning and stewarding its trees across the full gradient of land use, from the urban core to remote, wild forests.

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Downtown Duluth, 2021[3]

Section 1: Urban Trees

INTRODUCTION

The urban forest encompasses trees growing in managed, human-influenced settings across the city. Unlike the forested natural areas addressed in Section 2, urban trees are generally individually inventoried, actively maintained, and directly tied to the city's services. This section documents the current state of Duluth's urban forestry program, with an analysis of resources, procedures, operations, and opportunities for improvement and growth. The urban forest is organized into three broad categories, each with distinct growing conditions and management demands.

Definitions

1. Street Trees

Street trees are the most common category and are typically found growing between the curb and sidewalk (i.e. boulevard) in a space averaging five to ten feet wide. Outlier stretches of street trees can occur on as little as one-foot boulevards, while other areas exceed 15 feet.

The city's responsibility extends to all trees growing in the right-of-way (ROW), not just the boulevard. The ROW width can vary from street to street and within blocks. Many of these ROWs are not inventoried.

2. Park and Landscape Trees

Park and landscape trees occur in areas that are actively manicured, typically with turf grass ground cover. Some of these park and landscape trees border larger, unmanicured natural areas, leading to border zones that require flexible management.

3. Urban Trees

The final category of trees occurs in the heavily modified urban core. Examples include tree grates in downtown sidewalks, concrete planters in parks, landscaped gardens within parking lots and sidewalks, and other locations where growing a tree had to be intentional and embedded within the built environment, outside of areas immediately adjacent to streets.

Urban Tree Inventory

The urban tree inventory began in 2018, with staff documenting tree species, health, and measurements. This data heavily informs forestry management within the city. Data has been continually updated, including significant updates in 2022 and 2025. Results from the survey include 20,203 trees, 1,970 stumps and 7,874 plantable spaces (locations that could support a tree but do not currently). In total, 76% of trees are along streets, 19% are in parks, and 5% (roughly 1,000 trees) are urban trees in the built environment.

The inventory documents 37 tree species in urban areas. Maple composes 25% of the urban forest. Oak, basswood, spruce, elm, flowering crabapples, ash, pine and Japanese tree lilac bring the total to 76%. 27 additional species make up the final 24% of the city's forest, and the city has targeted planting efforts on this diverse cohort. In 2019, those species made up 10-15% of the urban forest (approximately ten percent less than in 2025).

The arrival of emerald ash borer (EAB) has had a large impact on tree diversity, as it effectively eliminates one option for planting and removes a significant contributor to the urban canopy. Formerly, ash comprised 14% of Duluth's urban forest. With removals due to EAB, the ash population is currently at 4% of the urban forest.

Results of the tree inventory as of 2025 are shown in Figure 1. Red threshold lines follow the 10-20-30 rule which suggests that no species, genus, or family should make up more than 10%, 20%, or 30% of the urban tree canopy, respectively. Following this rule can add resilience to the urban forest, buffering against mortality of a few abundant species. Duluth's urban forest is close to achieving this rule, with continued diversification aiding overall resilience.



Urban forestry work[5]

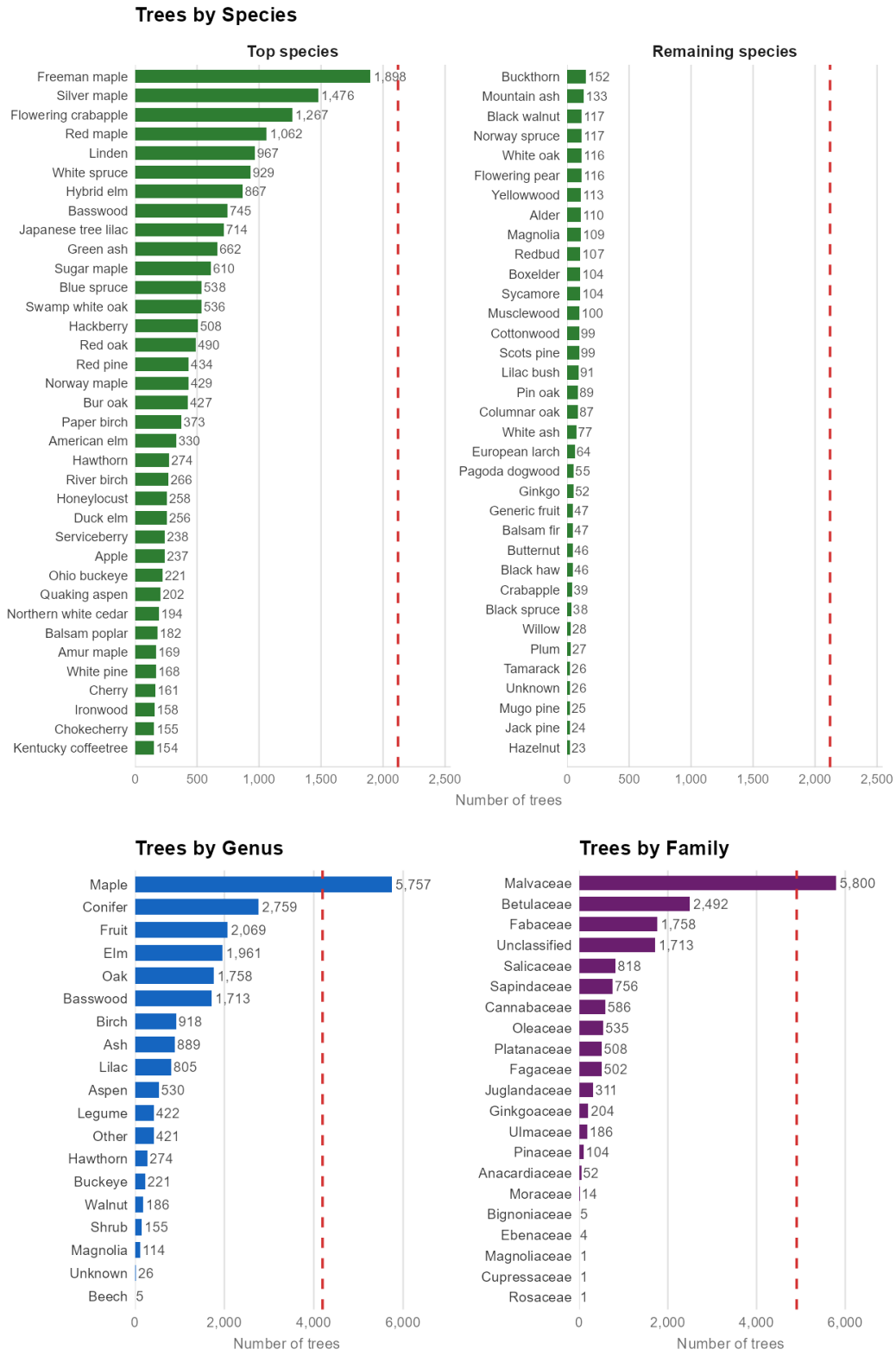

Figure 1: Urban trees by species, genus, and family. Red dashed line indicates 10-20-30 thresholds.

CAPABILITIES

Staff

All staff that manage the urban forest are housed in Park Maintenance, with 20 field employees. Four Park Maintenance staff and the forester are assigned to the forestry specialty work group. This group is assigned tree work including planting, pruning, injecting, monitoring, stump grinding, collecting inventory data, and removals.

Park Maintenance workers are also tasked with snow removal in the winter, which, depending on the amount of snowfall, can substantially reduce time available for pruning, ash removal, and other forestry work. This seasonal conflict is one of the program's primary operational constraints, discussed further in the Recommendations section.

Summer brings additional seasonal workers to Park Maintenance; two are typically assigned to Forestry. They provide support on recurring tasks like watering. A forestry aide has also been hired. This position is typically a student or recent graduate who works on updating and expanding the tree inventory.

Fleet

The current fleet inventory of forestry equipment includes a 62-foot bucket truck (purchased in 2010), two chip trucks (2005, 2006), two chippers (2014, 2021), one stump grinder (1995), and one log truck (2018). The chippers are planned to be replaced every seven years. Except for the log truck and chippers, replacements have generally stalled and will require future attention.

Funding

There are several sources of funding for forestry operations. Within Park Maintenance, most of the budget comes through the general fund and park levy, which generates salaries, benefits, equipment, and supplies.

Grants have supported significant projects in the past five years, most notably EAB mitigation. Three grants through the Minnesota Department of Natural Resources have funded removal of over 1,000 ash street trees, with high priority assigned to trees that were difficult to remove, near a known infestation, along busy roads, or otherwise high-risk.

The Tree Fund, established in Chapter 20, Section 23 of the Legislative Code, receives civil fines, penalties, judgments, and developer payments made in lieu of on-site tree replacement. Fees from tree service contractor licensing are also credited to the fund.

Legislative Code

Duluth’s commitment to its trees extends to legislative actions. Several sections of the city's legislative code govern trees, their maintenance, and the city's responsibilities for both public and private trees. Chapter 35, Article IV (Tree Regulations) is the primary source of guidance. Chapter 20 establishes the Tree Fund; Chapter 50 addresses tree accounting in development and replacement plans. Additional

provisions cover licensing and permits, trees as city property, solid waste, and prohibitions on fastening objects or animals to trees.

Section 35-26.1 recognizes that trees provide quantifiable benefits including increased property values, reduced stormwater runoff and erosion, noise buffering, aesthetic value, reduced energy costs from shade and windbreaks, and removal of air pollutants. The stated purposes of Article IV include promoting appreciation for trees and vegetation, protecting consumers of tree services, encouraging planting and maintenance, reducing construction damage, establishing a process for removing public trees to maintain views, and protecting trees from pests.

Key (though not exhaustive) provisions of Article IV, which the city forester is charged with enforcing, include a prohibition on damage to public vegetation; requirements for city staff to consult the forester before construction on city streets; a site review process for cutting public trees for views of Lake Superior, the St. Louis River Estuary, or the Duluth-Superior Harbor; forester authorization for removal of private trees threatening public safety or capable of spreading disease or insects; heritage tree nomination criteria and tracking; and misdemeanor and civil penalties for permit holders who damage public vegetation.

The Skyline Parkway Corridor Management Plan, adopted by City Council, additionally directs the city to maintain clear sightlines at formal overlooks through vegetation management.

In summary, the city has issued specific and enforceable items through Article IV, with the aim of protecting trees, viewsheds, and the public interest.



Arborists at work[5]

MANAGEMENT

Annual Work Schedule

Forestry activities shift throughout the year in response to weather, species-specific needs, and unplanned events. Spring is the primary tree planting season, which typically concludes by mid-June.

Summer duties include more routine tasks like injections, removals, and watering. Unpredictable events such as storms can create weeks of work. Stump grinding starts in summer and continues sporadically until winter.

Fall allows a second window of tree planting at roughly half the spring volume. Tree removals typically follow the second planting window. Ash removal had been a high priority, sometimes at the expense of other species and individual trees. 2024 was the first year since 2017 that the city spent a significant amount of time removing non-ash trees.

Winter is primarily pruning season, with work progressing east to west across all city streets. Two objectives are achieved through proper, timely pruning. First, clearance is ensured on roads and sidewalks from tree limbs as instructed by Section 35-29 in the City Code. Second, trees are trained into a form that will reduce the likelihood of premature failure and reduce future pruning load. Data prior to the winter of 2024-2025 showed trees receiving pruning on average every 7.6 years.

Emerald Ash Borer

EAB was first detected in Duluth in October 2015 and has thus experienced over a decade of management in Duluth. This insect kills ash trees in three to five years by disrupting the flow of water and nutrients through the stem. The city released its EAB Management Plan in November 2016, calling for removal of all ash trees under 12 inches in diameter, treating candidate ash trees over 12 inches once, but eventually removing most of the ash trees. At that time, approximately 2,400 ash trees were estimated in Duluth. Based on historic removal data, it is believed that closer to 3,200 ash trees were present in the city, not counting wooded ROW areas that add complexity and labor to certain projects.

As of February 2025, 835 ash trees remain in parks, boulevards, and ROWs. Since 2017, an estimated 15% of staff time has been dedicated to ash removal, not including stump grinding of ash. That time allocation must continue to address ash die-off and maintenance. 85 ash trees have been selected for long-term injection by adjacent homeowners and the city. City-funded, long-term injection is reserved for boulevard trees in strips at least 9 feet wide, with good structure, no utility conflicts, and preferably under 50 years old.

Tree Planting

One of the lessons from EAB is that species diversity buffers against future insect or disease problems. Duluth experienced modest diversification following Dutch elm disease. Records show that hybrid maple, swamp white oak, linden, and hybrid elms were added to the planting list at that time. In the wake of EAB, the response has been more comprehensive, with 19 species regularly planted on city

streets and parks, and at least 35 total species planted. Beyond species diversification, the city has developed a more systematic planting program. Where one or two species were historically planted on every block, often one on each side; current protocols include four species per block, two alternating on each side. The subsequent block is planted with four different species. This planting method minimizes potential pathogen damage while maintaining visual consistency.

Greenhouse

A greenhouse was purchased and built at Park Maintenance during the summer of 2024, with the goal of reducing tree acquisition costs. From 2019 to 2024, the average cost of a potted tree rose from $92 to $129, a 40% increase. During that same period, bareroot tree prices increased 20%. The expected annual output of the greenhouse is 200 trees, with projected savings of at least $10,000 per year.



EAB-damaged tree[1]

RECOMMENDATIONS

The following recommendations address the program's most pressing operational needs and long-term opportunities for growth.

Emerald Ash Borer

EAB has been a priority issue for the city for nearly a decade. The 2016 Management Plan was well-grounded in the best available science, and with EAB now present throughout the city and all untreated ash considered infected, the focus has shifted from planning to sustained harvest. Managing a large, ongoing removal program has seen Park Maintenance acquire additional capabilities and better equipment, with incremental upgrades paying significant dividends in both productivity and worker safety.

Equipment

The seven-year chipper replacement cycle is adequate. Covered storage for chippers and chip trucks could extend replacement to eight or nine years. Chip trucks, which are currently repurposed plow trucks, need a defined replacement timeline. A smaller-chassis, four-wheel-drive replacement would offer equivalent chip capacity while being easier to operate in variable conditions.

The stump grinder is 30 years old and shows significant wear. With nearly 2,000 stumps remaining, it is unlikely the machine will outlast the existing workload. Replacement is a near-term priority. The log truck and bucket truck (purchased in 2018 and 2010, respectively) do not require immediate replacement. The bucket truck needs repairs scheduled for 2025 and should be evaluated for replacement within the next ten years.

Tree Planting

Planting volume requires calibration against operational capacity. The city planted 726 trees in 2024, which strained staffing and logistics. A sustainable annual target is 500–600 trees. Approximately 10,000 locations are currently available for planting when combining open plantable spaces and future stump removal sites.

Every tree planted creates a long-term maintenance obligation: city protocols call for a minimum of three structural prunings within the first ten years. Planting faster than staff capacity increases the risk that trees miss critical early pruning, predisposing them to structural failure later in their life. Planting 500–600 trees annually allows the canopy to grow steadily while managing the demands of maintenance. Creating a large cohort of same-age trees that cannot receive timely care is counterproductive to long-term canopy health, regardless of near-term planting numbers.

The block-planting approach under current protocols, where an entire block is planted simultaneously with eight to sixteen trees, is significantly more efficient than the earlier practice of planting one to five trees per location and should be continued.

Pruning

Duluth has excelled in its pruning program. Research indicates that a five-to-seven-year cycle strikes the optimal balance between cost and canopy health. Many large municipalities struggle to achieve a ten-year cycle. The city has maintained a 7.6-year average cycle through the 2024–2025 season.

The primary threat to that performance is the conflict between pruning and snow removal in winter. In high-snowfall years like 2022–2023, the effective pruning cycle stretched to 17.1 years; in low-snowfall years like 2023–2024, it improved to 4.8 years. As the tree inventory grows, so does the pruning workload. Maintaining an appropriate cycle will require structural change. Some options include hiring arborists without snow removal assignments, increasing overall Park Maintenance staffing to accelerate snow response, and freeing arborists for pruning, or a hybrid of hiring and reassignment. Without intervention, cycle times will lengthen as the canopy expands and will be unable to recover from high snowfall years.

Tree Sourcing, Greenhouse

Open-market sourcing of potted and bareroot stock remains viable. Prioritizing cost-effective potted species and expanding bareroot use where site conditions allow will help control expenditures. The greenhouse ensures supply and controls costs. Small nursery stock ("liners") cost between 1% and 25% of a finished potted tree. Factoring in growing materials, producing trees in-house at under 50% of potted cost appears achievable. The liner market also offers a broader species selection than the retail nursery trade, which supports the city's continued emphasis on planting diversity. Refining the greenhouse system to consistently produce high quality trees at lower cost should be an ongoing priority.

Funding

The city should actively pursue funding beyond its operating budget through grants, partnerships, and emerging revenue streams. Grant applications should align with and support the activities outlined in this plan.

Carbon credits represent a promising emerging source. A carbon trading company manages much of the administrative process in exchange for credits generated by tree planting. Credits are calculated based on trees planted, species, predicted growth, and mortality, with payments distributed over 26 years and verified by a third party. The city plants enough trees on a three-year cycle to qualify for the program, allowing staggered applications that compound payment schedules over time and generate revenue for work the city would be conducting regardless.

CONCLUSIONS

The city has assessed its strengths and weaknesses in continuing its successful management of Duluth's urban trees. The department has shown resilience through staff shortages, emerald ash borer, and unexpected storm events. The city will continue to value urban trees, public interest, and safety. Table 1 presents a final summary of strengths, weaknesses, and opportunities for 2025-2030.

Table 1. Summary of strengths, weaknesses, opportunities for urban trees.

Strengths	***Needs Improvement***	***Opportunities***
Removal efficiency	Stump grinding	Carbon credits as income
Planting capacity and efficiency	New stump grinder	Greenhouse practices and production
Planted species diversity	Chip truck replacement	Personnel challenges to meet maintenance demands
Pruning cycle	Management of personnel hours around snow events	



Forest scene[1]


LEMCO
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Section 2: Forested Natural Areas

INTRODUCTION

Section 2 focuses on the forested natural areas forming the majority of Duluth's approximately 12,000 acres of public land. These areas differ from the urban forests addressed in Section 1 in scale, species composition, and management approach. They are less manicured, larger, and managed primarily for ecological function rather than municipal services. These forested natural areas provide essential ecosystem services, support critical wildlife habitat, and offer residents meaningful access to natural landscapes within the city limits.

Forested natural areas at the urban interface have many compounding threats to their viability. These include proximity to myriad, non-natural land uses such as roads, houses and industrial uses; degradation from edge effects; isolation amid a sea of urban land uses; and land conversion and habitat loss. Despite these threats, the City of Duluth prioritizes its natural areas through its Comprehensive Plan, zoning code, and collective values. The City's Comprehensive Plan (Imagine Duluth 2035) recognizes the city's open spaces as vital components of Duluth's culture and community, public health, recreation, and economic vitality.

This section guides management work through 2037, at which point an adaptive management review will assess emerging issues, land use changes, emergent funding, and administrative priorities.



Looking toward Magney-Snively Natural Area[2]

CAPABILITIES

Background

The city has variable management needs and conditions within its forests. Historically, Duluth lacked the staff to actively manage forested natural areas. The addition of a City Forester and a Natural Resources Coordinator in 2019 marked a shift toward targeted stewardship, and this plan formalizes that direction. Given limited resources, the city has prioritized management efforts into three categories: Designated Natural Areas, priority watersheds, and contiguous forests over 200 acres.

Forests in Duluth are dynamic ecosystems tucked between neighborhoods, lakes, and ridgelines. These natural areas offer a rare chance to manage urban land for biodiversity, resilience, and species conservation.

Current management is mostly limited to invasive species removal and tree planting, and almost all the work is grant-funded or reliant on partners. With increased funding and staff, the city could pursue targeted goals that fully consider biodiversity, habitat needs, and climate resilience. The city's Natural Resources Management Program Plan (2022) outlines achievable funding scenarios to implement more refined forest stewardship.

Partnerships and Staffing

The city depends on partners to implement management on its forested lands. In any given year, multiple partners are planning, constructing, or monitoring projects within Duluth's forests, annually investing millions of dollars in Duluth's forests. The city currently employs one full-time Forester and one full-time Natural Resources Coordinator. Several Park Maintenance staff are certified arborists, but their time is dedicated to urban tree planting and maintenance. The City's Natural Resources Management Program Plan identifies adequate staffing at three full-time employees for natural resources management. Until that capacity is reached, external partnerships remain essential to continued progress.

Partner-led Projects

Partner-led projects with a forestry component generally fall into five categories. Below each category follows a discussion of current activities within that focus area.

1. Forest Restoration and Tree Planting

University of Minnesota Duluth (UMD) students conduct research in forested areas and grow seedlings for assisted migration experiments. The Minnesota Land Trust coordinates NPC mapping, develops forestry prescriptions, and implements site-specific restoration in Designated Natural Areas, and is adept at securing funding for local priorities. The Nature Conservancy has planted millions of trees across northern Minnesota and has increasingly focused restoration efforts on smaller, high-priority sites within Duluth, with consistent long term stewardship follow-up. The Rajala Woods Foundation (a charitable arm of Minnesota Power/ALLETE) grows and plants white pine seedlings annually in the Amity Creek and Lester River watersheds. The Izaak Walton League's W.J. McCabe Chapter maintains a

restoration site along Knowlton Creek protecting a rare white pine-white cedar forest community. Both The Nature Conservancy and the Rajala Woods Foundation participate in the North Shore Forest Collaborative, whose goals align closely with Duluth's management priorities.

2. Under-Ash Planting and Ash Replacement

In anticipation of widespread ash mortality, the Minnesota Land Trust, Lake Superior National Estuarine Research Reserve, and the city are conducting under-ash planting in large ash stands, primarily in the western part of the city along the St. Louis River. City-wide NPC mapping data will allow more precise identification of black ash stands and enable targeted restoration in the most ecologically vulnerable areas.

3. Invasive Species Removal

The city supports and coordinates with the Duluth Invaders volunteer network, Hartley Nature Center volunteers, and St. Louis County and the Minnesota Department of Agriculture. The city provides tools and hosts an annual coordination meeting for the Duluth Invaders in cooperation with Hartley Nature Center. While volunteer engagement is strong, city capacity to support, train, and direct these efforts remains limited.



Volunteers burn brush piles[1]

4. Riparian Restoration

Riparian forest enhancement is often embedded within large stream restoration projects led by the South St. Louis Soil and Water Conservation District and Minnesota Trout Unlimited. Native tree and shrub planting is a standard component of every restoration design. Long-term maintenance remains a challenge, as planted trees sometimes remain in protective tubes and cages longer than necessary and follow-up capacity is limited.



Stream restoration and reforestation[1]

5. St. Louis River Area of Concern

The Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and the Fond du Lac Band of Lake Superior Chippewa have led large-scale aquatic and terrestrial restoration in the St. Louis River corridor, addressing ecological and cultural damage from past industrial use. This work has included restoration of St. Louis River Designated Natural Area lands including Chamber's Grove, Kingsbury Bay, and Grassy Point. The MLT–led Headwaters Partnership and the Lower St. Louis Habitat Work Group—of which the city is a member—are developing updated habitat restoration plans that include significant forestry components in its western natural areas.

Volunteers

Civic groups and individuals regularly contribute time and labor to Duluth's forested natural areas, primarily through invasive removal, tree planting, and litter pickup. The return of a dedicated Volunteer Coordinator—a position previously funded by the city but now vacant—would significantly improve the safety, training, consistency, and ecological impact of volunteer contributions.

This plan establishes a more strategic approach to volunteer engagement, directing tree planting efforts to three focal areas selected for accessibility, ecological need, and soil conditions amenable to planting:

1 · Amity / Lester Forest

Location	Between Seven Bridges Road and Lester River Road, far east Duluth
Access	Seven Bridges Road (west) – Lester River Road (east)
Target Species	White Pine · White Cedar · Aspen · River Birch
Goals	Create and enhance habitat for Species of Greatest Conservation Need; protect water quality in the Amity Creek and Lester River watersheds; increase conifer regeneration in the northeast portion of the city.

Note: *White pine and white cedar require protective caging due to heave deer browse pressure. Not all volunteer groups have the capacity to transport and install caging systems.*

2 · Kingsbury Forest

Location	Between Kingsbury Creek and Knowlton Creek, south of I-35.
Access	Knowlton Creek Blvd (south) · Superior Hiking Trail (north)
Target Species	Sugar Maple · Basswood · Paper Birch · Northern Red Oak
Goals	Increase riparian planting to shade two designated trout streams; improve forest resilience through species diversification; continued buckthorn management.

Note: *The city has invested substantially in invasive removal here over the past five years. Continued management requires ongoing buckthorn suppression until the seedbank is exhausted. Volunteer groups willing to pull buckthorn seedlings during planting events provide particularly valuable support.*

3 · Lower Mission Creek Riparian Area

Location	Far west Duluth.
Access	Parking lot at the end of 131st Ave W
Target Species	White Pine · Red Oak · Yellow Birch
Goals	Provide critical shade to a designated trout stream; enhance long-term ecological function of a restored riparian corridor.

Note: *Stream banks and channel were restored in 2019 following major flooding in 2012. The Nature Conservancy conducted volunteer planting events in 2024. Future planting should occur after spring runoff to ensure seedling survival and volunteer safety.*



Community involvement in stream sampling[1]

Funding

Management of Duluth's forested natural areas is almost entirely grant-funded. While the city contributes modest internal funds for invasive species work, the vast majority of restoration and stewardship work depends on competitive grants and strategic partnerships. Three core funding sources account for the bulk of forestry-related investment.

1. Clean Water, Land and Legacy Amendment

A 3/8-cent Minnesota sales tax increase funds the Outdoor Heritage Fund (OHF), administered by the Lessard-Sams Outdoor Heritage Council, and the Clean Water Fund. The Conservation Partners Legacy (CPL) program is the small-grants arm of the OHF. The city has received multiple CPL grants, including a current grant for acquisition and restoration at Amity Forest/Downer Park.

2. Environment and Natural Resources Trust Fund

Created by constitutional amendment in 1988 and reauthorized in 2024. This fund is supported by Minnesota Lottery proceeds and administered by the Legislative-Citizen Commission on Minnesota Resources (LCCMR). The key current LCCMR-supported project is the city-wide NPC mapping effort, coordinated by the Minnesota Land Trust.

3. Great Lakes Restoration Initiative (GLRI)

Federal funding supporting Great Lakes ecosystem restoration with an emphasis on water quality and habitat. The GLRI has been a consistent funding source for the city and its partners, especially in the St. Louis River Area of Concern. The Duluth Stream Corps currently holds a GLRI grant for tree planting in the Amity and Mission Creek watersheds, with work continuing through 2026.

Additional funding is occasionally secured through private foundations and other state and federal programs, but these sources tend to be smaller, less consistent, and more competitive than the three core funding sources.



Forests overlooking the St. Louis River Estuary[2]

MANAGEMENT

Goals

Large, contiguous forests create opportunities for landscape-scale habitat management that is rare in urban settings. Realizing that potential requires active and strategic management. Healthy forests are layered and varied, requiring a mix of age classes, varying disturbance regimes such as fire or selective thinning to promote regeneration, and structural complexity such as downed logs, snags, and regenerating understory.

Each of these features supports different stages of wildlife cycles. Brushy young forests offer nesting and foraging opportunities for songbirds and small mammals, while mature forests provide cover and foraging for wide-ranging species like wolves or bears. Managing for a mosaic of forest types, from early successional brush, to old-growth stands, creates diverse and resilient landscapes. With thoughtful management, Duluth's urban forests can sustain wildlife, including species of local and regional conservation such as the golden-winged warbler, spotted salamander, and bobcat.



Golden-winged warbler[2]

The Risk of Passive Management

Forests are often assumed to be self-sustaining and best left alone—a philosophy known as "benign neglect." Within a contemporary urban environment, where natural processes are blocked, fragmented, or overwhelmed by human impacts, benign neglect can produce poor outcomes.

In Duluth, unmanaged forests near roads, residential areas, and industrial zones typically suffer from edge effects, invasive species encroachment, erosion, and poor regeneration. Over time, these

pressures degrade ecosystem services including stormwater absorption and flood mitigation, shade and temperature regulation, carbon storage, soil stabilization, wildlife habitat, and aesthetic quality. This plan is designed to provide a framework for intentionally managing Duluth's forests to be resilient enough to handle the pressure from disrupted natural processes.

Adaptive Management

The city's natural resources management program previously lacked a city-wide framework since prior guidance documents were limited to the EAB Management Plan and site-specific plans for Designated Natural Areas. This plan provides an adaptive management framework, enabling organized and forward-looking management decisions. Adaptive management is a practical, evidence-based process that acknowledges uncertainty and builds learning into the management cycle. The steps are: identify a need; take action; monitor results; adjust based on outcomes. The approach allows the city to act within resource constraints and triggers additional funding pursuit if management outcomes fall short of goals.

Hartley Park Designated Natural Area illustrates this approach. In 2024, the city removed invasive buckthorn from a 10-acre red pine plantation with limited pine regeneration and poor species diversity. Prior attempts to secure a contractor for thinning had failed. An alternative approach was implemented. Invasives were cleared, pines were underplanted with native species, and volunteers were engaged to manage buckthorn resprouts for three to five years. The goal is for planted natives to reclaim the understory and to reduce the buckthorn seedbank over time. If that goal is not achieved within the target timeframe, the approach will be revised.



Mixed mesic hardwood forest[2]

Native Plant Community Mapping

A critical step toward adaptive forest management is understanding species assemblages on the landscape. Native Plant Community (NPC) mapping provides this ecological baseline. NPC classifications describe plant communities expected to occur under relatively undisturbed conditions based on soils, hydrology, and regional climate. Each NPC type carries a specific code. For example, MHn47a identifies a Mesic Hardwood Forest type in northern Minnesota associated with sugar maple and basswood. These communities are also assigned ecological condition rankings from A ("excellent") to D ("degraded").

NPC mapping was completed in 2025 for all four of Duluth's Designated Natural Areas, and our larger forested areas. Mapping was conducted using a mix of satellite imagery, LiDAR, and infrared data, which allows for classification of stand age, canopy structure, and potential species composition. Field verification was also conducted in select areas to ensure that prescriptions are based on site-specific conditions and ecological realities.

This information allows resource managers to compare existing conditions to reference conditions, develop targeted restoration strategies, identify areas of high conservation value, and track ecological change over time. Understanding how plant communities may shift in response to disturbance—for example, how EAB-driven loss of black ash may transition a WFn55 (Northern Wet Ash Swamp) site to a WFn74 (Northern Wet Alder Swamp), a community with lower ecological complexity and diminished hydrologic function—allows the city to plan proactively and prioritize restoration where ecological opportunities are greatest. Information about the Native Plant Community Mapping Project is located on the City of Duluth website.



White pines[1]

Priority Management Areas

For the purposes of this plan, active management means one of the following management actions have occurred in the past five years or is planned to occur in the next five years: invasives removal or treatment; dead/downed wood removal; tree planting; or managed disturbances such as prescribed burns.

With partner and financial support, the city actively manages approximately 800 acres as of 2026, or about 6%, of our forested natural areas:

Table 2. Actively managed forest land as of 2026.

Location	Managed Acres
Kingsbury Forest	230
St. Louis River Designated Natural Area	185
Hartley Park Designated Natural Area	160
Amity-Lester-Hawk Ridge Designated Natural Area	70
Downer/Amity Forest	50
Mission Forest	65
Magney-Snively Designated Natural Area	30



Underplanting of ash trees[1]

Given Duluth's current resource constraints on forested public land, the city has concentrated management in areas where ecological significance, partner activity, and past investments align. These priority areas fall into three categories.

1. Designated Natural Areas

Duluth has formally designated four ecologically significant areas for conservation and management: Hartley, Magney-Snively, St. Louis River, and Lester-Amity-Hawk Ridge Designated Natural Areas. Each has a tailored management plan reflecting its forest types, ecological values, and public uses and the City uses these Management Plans to guide its stewardship of these areas. The predominant forest types of each natural area are as follows:

Table 3. Designated Natural Area forest cover

Designated Natural Area	Primary Forest Type (NPC)
Hartley	MHn35b – Red Oak–Sugar Maple–Basswood
Magney-Snively	MHn47a – Northern Hardwood (Bluebead Lily) forest; one of the best examples in Minnesota
St. Louis River	MRu94a – Lake Superior Coastal Marsh; best example in Minnesota
Lester-Amity-Hawk Ridge	FDn43b – Aspen – Birch Forest

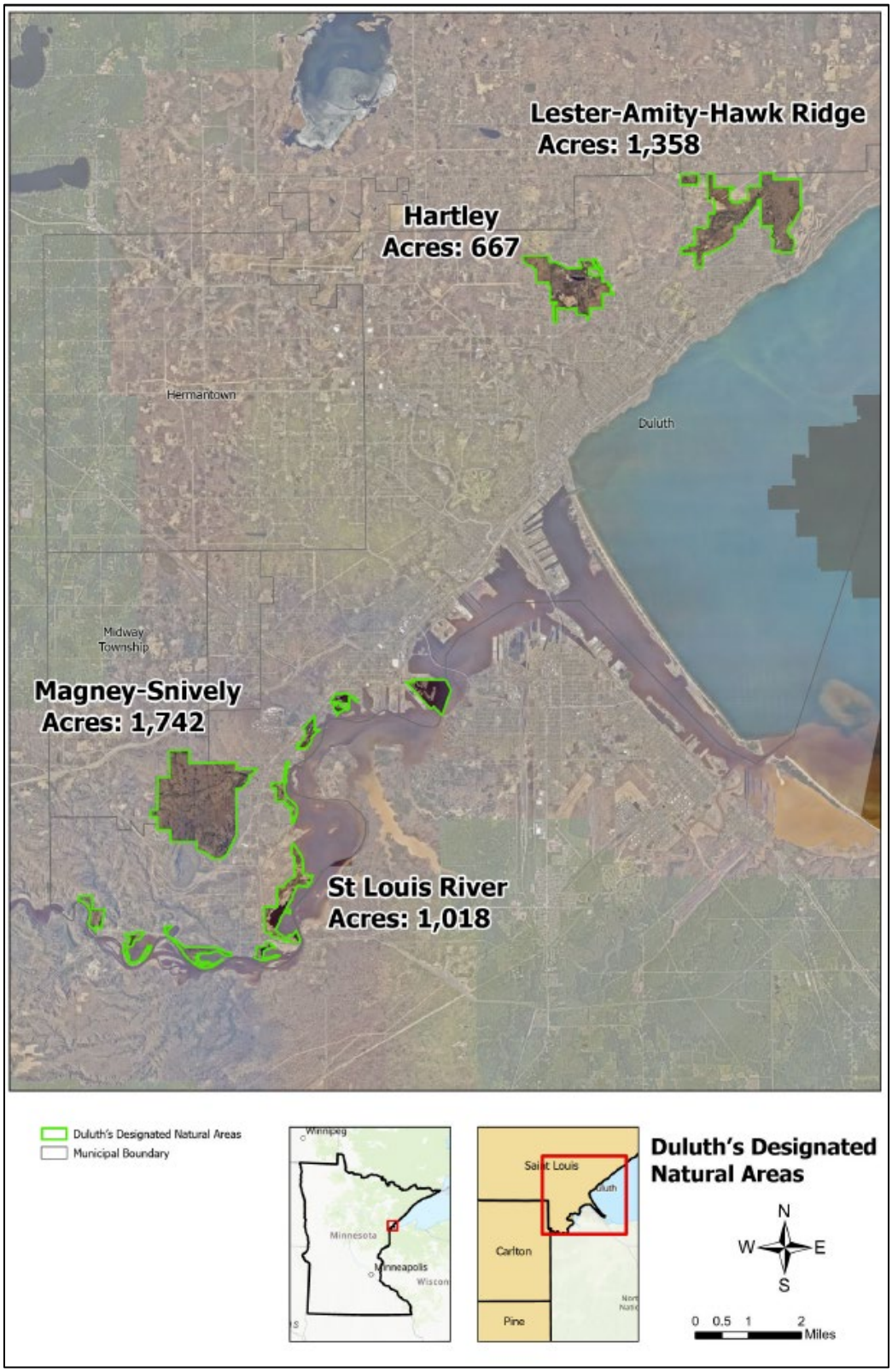

Figure 2: Duluth's Designated Natural Areas

2. Priority Watersheds

The City's Natural Resources Management Program has identified three watersheds as ecological priorities: Amity Creek, Tischer Creek, and Keene Creek. These designated trout streams, despite urban pressures, support native brook trout (*Salvelinus fontinalis*) populations which depend on healthy, forested watersheds. Each watershed has an active protection plan:

- Amity Creek – Section 319 Small Watershed Plan (federal)
- Tischer Creek – Roadmap to Resilience (local)
- Keene Creek – One Watershed, One Plan (state)

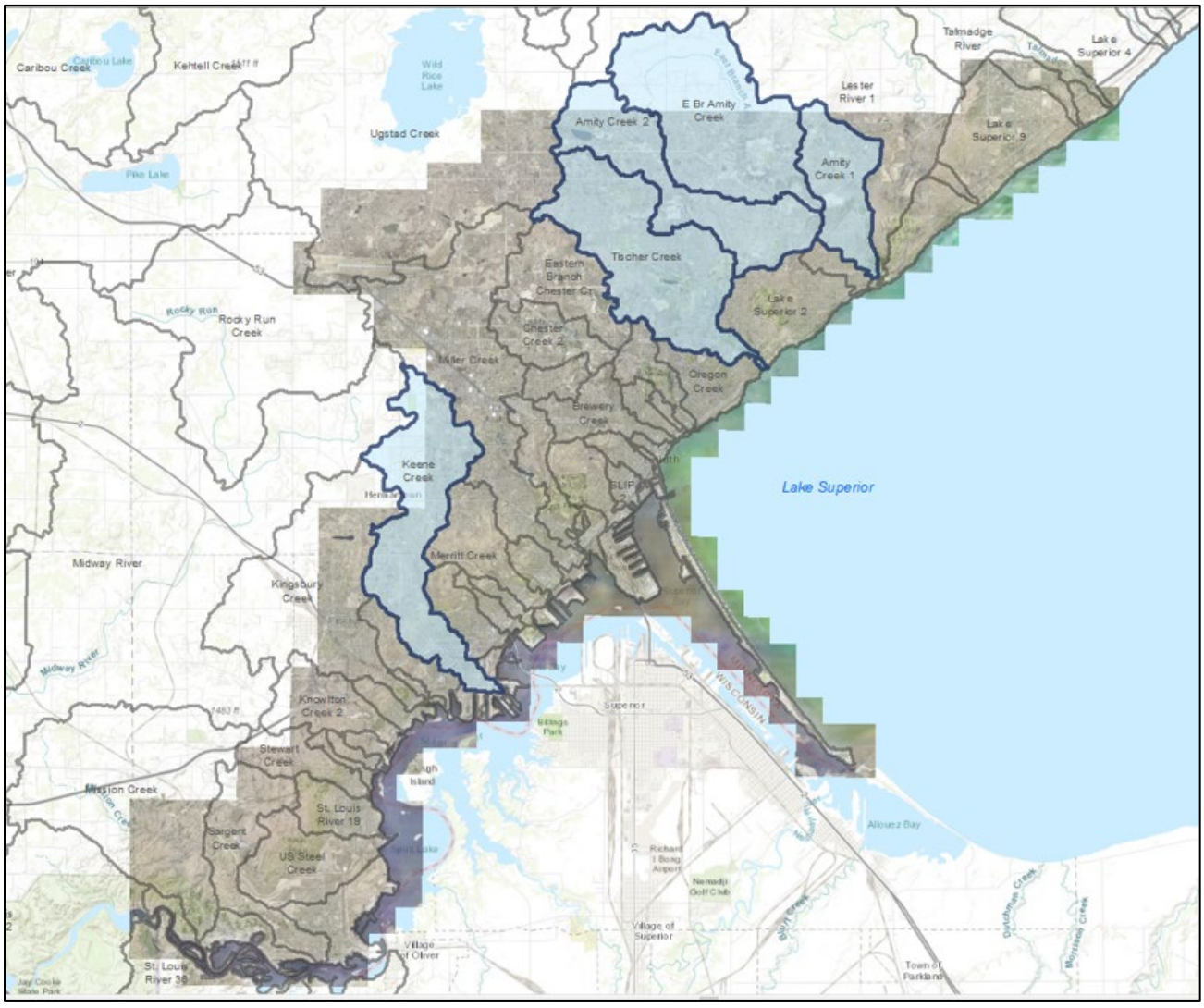

Figure 3: Duluth's Priority Watersheds

Beyond these three streams, 39 additional named streams bisect Duluth, draining into either the St. Louis River Estuary or directly into Lake Superior. The ecological literature consistently documents that forested watersheds support higher water quality than agricultural land cover. Riparian forests provide shade critical to cold-water fish, facilitate infiltration of stormwater and snowmelt, support food webs for aquatic and terrestrial species, and provide habitat connectivity and thermal refuge across the landscape.

An emerging riparian forestry concern in priority watersheds is white crack willow. White crack willows are hybrids between native and non-native species whose roots create dense mats that trap sediment, diverting stream flow from the natural stream channel, and smothering clean gravel beds that are essential for brook trout. This creates a significant communication issue. For years, outreach has emphasized riparian shade along designated trout streams. Removal of established white crack wilow trees may appear to conflict with that message. Removal must be paired with native species planting to maintain shade and bank stability. The city is collaborating with researchers at the University of Minnesota Duluth to study and address the impacts of white crack willow on streams.

3. Large Forested Areas

Four large, contiguous forest blocks are included among the City's forest management priorities: Mission Forest (also known as Frederick Rodney Paine Forest Preserve) (1,788 acres), Kingsbury Forest (363 acres), Piedmont Forest (1,250 acres), and Downer/Amity Forest (310 acres) (Figure 2). Although these areas are not Designated Natural Areas, they represent significant tracts of forest that require intentional, ongoing management to maintain their ecological health and prevent gradual decline.

Forestry prescriptions have been developed for two of these areas: Mission Forest and Piedmont Forest. A forestry prescription was also developed for the Lester-Amity-Hawk Ridge Designated Natural Area as part of the development of its Management Plan. These prescriptions describe the forest types present and provide stand-specific management recommendations (see Appendix 1). The City intends to develop additional prescriptions for Kingsbury and Downer/Amity Forests as time and funding allow.

Once prescriptions for Kingsbury and Downer/Amity Forests are completed, all of the City's large forested areas will have tailored management guidance through Designated Natural Area Management Plans (DNAPs), forestry prescriptions, and/or Native Plant Community information. Together, these resources will help guide the City's long-term stewardship of its forested lands.

This plan provides an overarching framework for recognizing and managing all of the City's forests. It serves as an umbrella plan for both Designated Natural Areas and other significant forested areas, acknowledging that each is supported by varying levels of management guidance through separate plans, prescriptions, and programs.

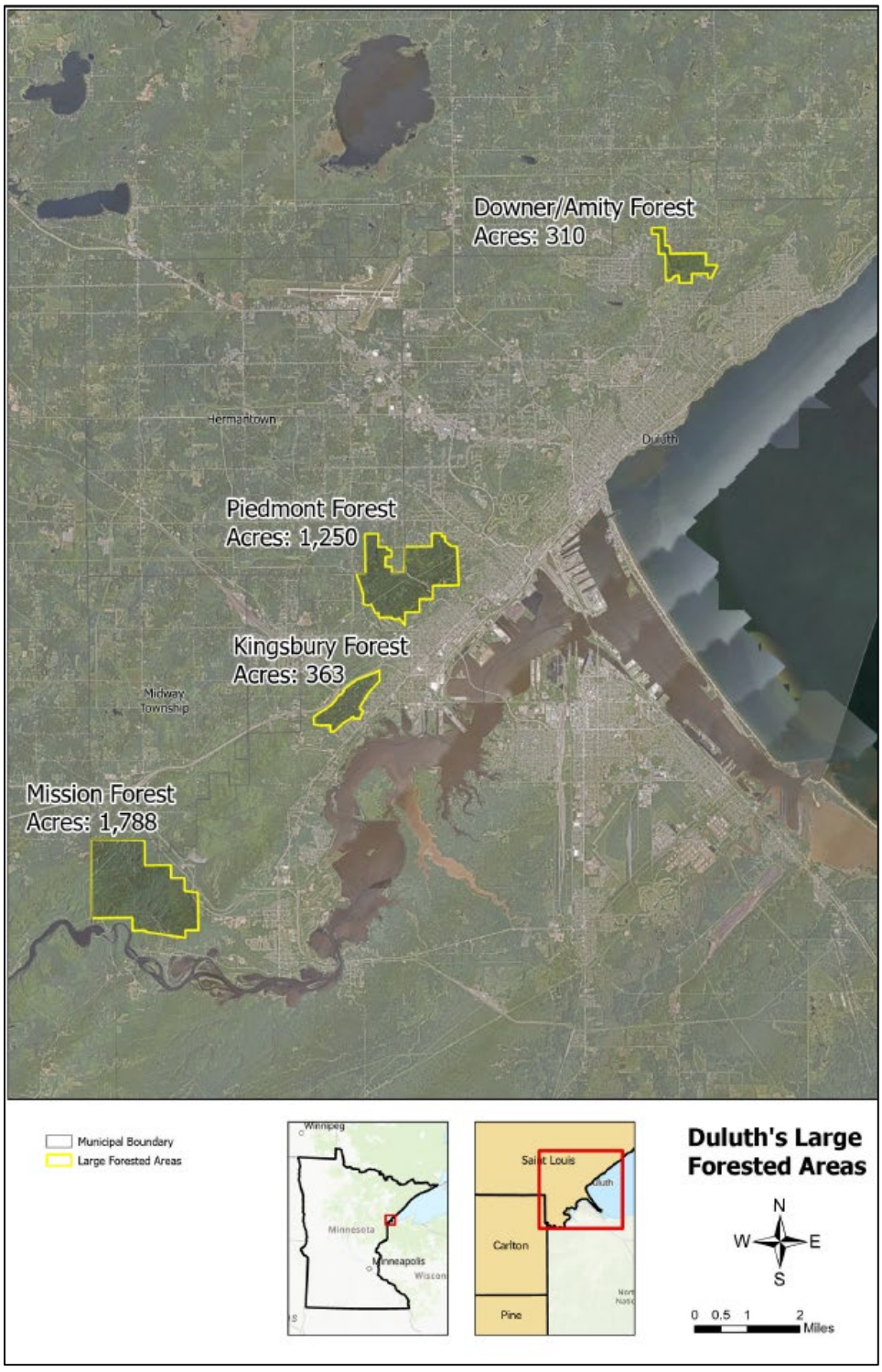

Figure 4: Duluth's Large Forested Areas

MONITORING

Monitoring is the foundation of adaptive management. Without consistent data collection, land managers cannot evaluate whether actions are achieving their goals, identify when adjustments are needed, or justify continued investment. The city does not currently have a systematic, city-wide monitoring program for its forested natural areas. Assessments are largely anecdotal or conducted opportunistically by field staff during other activities. While this informal approach captures some useful field observations, it does not generate the quantitative data needed to evaluate management effectiveness.

Monitoring should include both quantitative and qualitative data that is in a consistent format, stored and maintained in a database, and easily understood and used by managers and planners. NPC mapping is an example of standardized data collection, which allows the city to manage forests with the same terminology and understanding of ecology as other managers in Minnesota. Further examples include invasive species mapping, forestry activity, tree planting priorities, outcomes, and history, and land use history.

As a recent example of monitoring for adaptive management, in 2024, one acre of dead ash was removed and burned in the Amity Creek–Downer Park area, followed by planting of river birch, St. Croix elm, and swamp white oak. The city will monitor hydrology and tree vigor here over the next five years. If survivability and growth are favorable, this approach can be applied to black ash stands across the city. Should this process fail, an analysis of the conditions of failure will determine if variables like species selection or maintenance activities need modification.



Monitoring a hardwood swamp[2]

PRIORITY MANAGEMENT CONCERNS

To efficiently allocate available funding and staff time, the city has identified four priority concerns for our City Forests over the next five years.

1. Invasive Species: Buckthorn

Glossy and common buckthorn are among the most aggressive and persistent invasive species impacting Duluth's forested natural areas. These shrubs form dense understories that outcompete native vegetation, degrade wildlife habitat, and alter forest structure and regeneration. Buckthorn is well-established in Hartley Natural Area and Kingsbury Forest, while Magney-Snively remains largely unaffected to date.

Management involves cutting and treating the cut stump with glyphosate, with the slash chipped or burned on site. Because the seed bank remains, multi-year follow-up treatment with foliar spray, hand-pulling, or goat grazing is required to prevent re-establishment. Duluth's extensive trail network facilitates invasive spread and can complicate containment.

The city prioritizes buckthorn removal in sites where native plant communities remain relatively intact and restoration success has better odds. Follow-up treatments are prioritized for previously treated sites to protect past investments. The goal, subject to available funding, is annual treatment for three to five years at selected sites, paired with native planting to restore understory conditions.



Vernal pools at Hartley Park[2]

2. Emerald Ash Borer (EAB) and Ash Mortality

The city's EAB response plan, detailed in Section 1, focused on street trees and has not been implemented for forested natural areas. EAB has not yet penetrated most of northern Minnesota's forests, but Duluth has been in an EAB quarantine area since 2015, and eventual spread to forested areas is a certainty. Milder winters—historically a limiting factor for EAB through larval mortality—are allowing the beetle to survive and spread further north.

The ecological implications of widespread ash loss are particularly significant for black ash (*Fraxinus nigra*), a keystone species in wetland ecosystems. Black ash tolerates saturated soils in ways few other tree species can, creating hydrological conditions required by certain amphibians (spring peepers, wood frogs, blue-spotted salamanders) and providing preferred shelter and foraging habitat for pine marten, fox, and other mammals. Loss of mature black ash forests will negate significant carbon storage and eliminate a culturally important member of the forest long used by tribal nations for basket weaving.

Researchers at the USDA's Northern Research Station in Grand Rapids are evaluating replacement species for black ash wetlands. Swamp white oak and balsam poplar have shown the most promise. Swamp white oak is the leading candidate since it is climate-adapted, long-lived, wetland-obligate, and potentially pest-resistant. USDA researchers are also field-testing biological controls using parasitoid insects and have identified Lincoln Park in Duluth as a research site. The city is supporting the continuation of that study.

3. Lack of Regeneration Due to Deer Browse

Overabundant white-tailed deer populations are suppressing tree regeneration across Duluth's forested natural areas. Open, understory-free forests lack the structural complexity and regenerative capacity necessary for long-term ecological function. The impact is most severe on desirable conifers, particularly white cedar and white pine, which deer preferentially browse. Failure to regenerate these species risks a long-term shift toward open, grass-dominated stands with spruce and fir the only remaining conifers, neither of which is projected to perform well under a warming climate. Low-diversity forests are also more vulnerable to pest and disease outbreaks.

The city permits an annual archery hunt and has achieved deer population reductions as a result. However, browsing pressure remains high in many areas, and protective caging or bud-capping of conifer seedlings remains necessary to achieve meaningful survival rates.

4. Wildfire Risk and Fuel Load Accumulation

A prescribed fire, also known as a controlled burn, is intentionally set during prescribed conditions to reduce excess fuel loads, prevent larger, uncontrolled wildfires, and restore and maintain ecosystems. Prescribed fire use has gained traction in recent years as a management tool for Duluth's forests.

Several converging factors have increased wildfire risk in and around Duluth. Decades of fire suppression have contributed to the accumulation of hazardous fuel loads across the landscape. For example, a 2016

straight-line windstorm brought down hundreds of mature trees throughout the region, including eastern Duluth. Ongoing spruce budworm activity has also resulted in widespread balsam fir mortality, while emerald ash borer (EAB)-related ash mortality adds to the accumulation of dead and dying trees. These conditions, combined with a warmer, drier climate, are expected to further intensify wildfire risk. Notably, the last major wildfire in the Duluth area occurred in 1918.

The City is exploring prescribed fire as a land management tool to reduce fuel loads, control invasive species, and restore fire-dependent plant communities, such as jack pine woodlands. In partnership with the Duluth Fire Department, land management staff hope to develop a program that engages Fire Department personnel in conducting controlled burns within City natural areas and forests. This partnership would serve a dual purpose: advancing ecological and land management objectives while providing Fire Department personnel with valuable opportunities to build wildland fire skills and experience. Historically, prescribed burns in Duluth have been limited primarily to pollinator meadows. Expanding these efforts into forested natural areas could provide significant ecological benefits while also improving community wildfire resilience and public safety.



Prescribed burns can be an important management tool[1]

Conclusion and Five-Year Outlook

Duluth's forested natural areas are one of the city's most valuable ecological and cultural assets. They provide clean water, critical wildlife habitat, stormwater regulation, carbon storage, and access to nature within city limits. Without intentional stewardship, these values are at risk from invasive species, climate change, deer overbrowsing, and land use changes.

Over the past decade, Duluth has shifted from a reactive approach to an adaptive one, relying heavily on strategic partnerships and external grants to restore and protect forests. This model has enabled large-scale restoration projects, tree planting, invasive species removal, and ecological data collection that is needed for long term planning.

The next five years represent a critical juncture, with city-wide NPC mapping complete and targeted management plans now achievable. Projects in riparian restoration, buckthorn suppression, and ash replacement will be evaluated and refined through the adaptive management framework. The key priorities for 2027–2037 include:

- Expanding invasive species control, particularly buckthorn, in high quality or recently restored sites.
- Staffing of at least three natural resources professionals.
- Scaling up climate-resilient reforestation, especially in riparian and black ash-dominated areas.
- Developing and implementing forestry prescriptions for larger, contiguous forest blocks.
- Establishing basic monitoring protocols to support adaptive management decision-making.
- Strengthening volunteer program coordination.
- Maintaining and deepening partnerships with academic, non-profit, tribal, and agency collaborators.

With continued investment, regional cooperation, and community engagement, Duluth has the capacity to provide exemplary programs for urban forest restoration and management.

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4. City of Duluth

5. Clark Christenson

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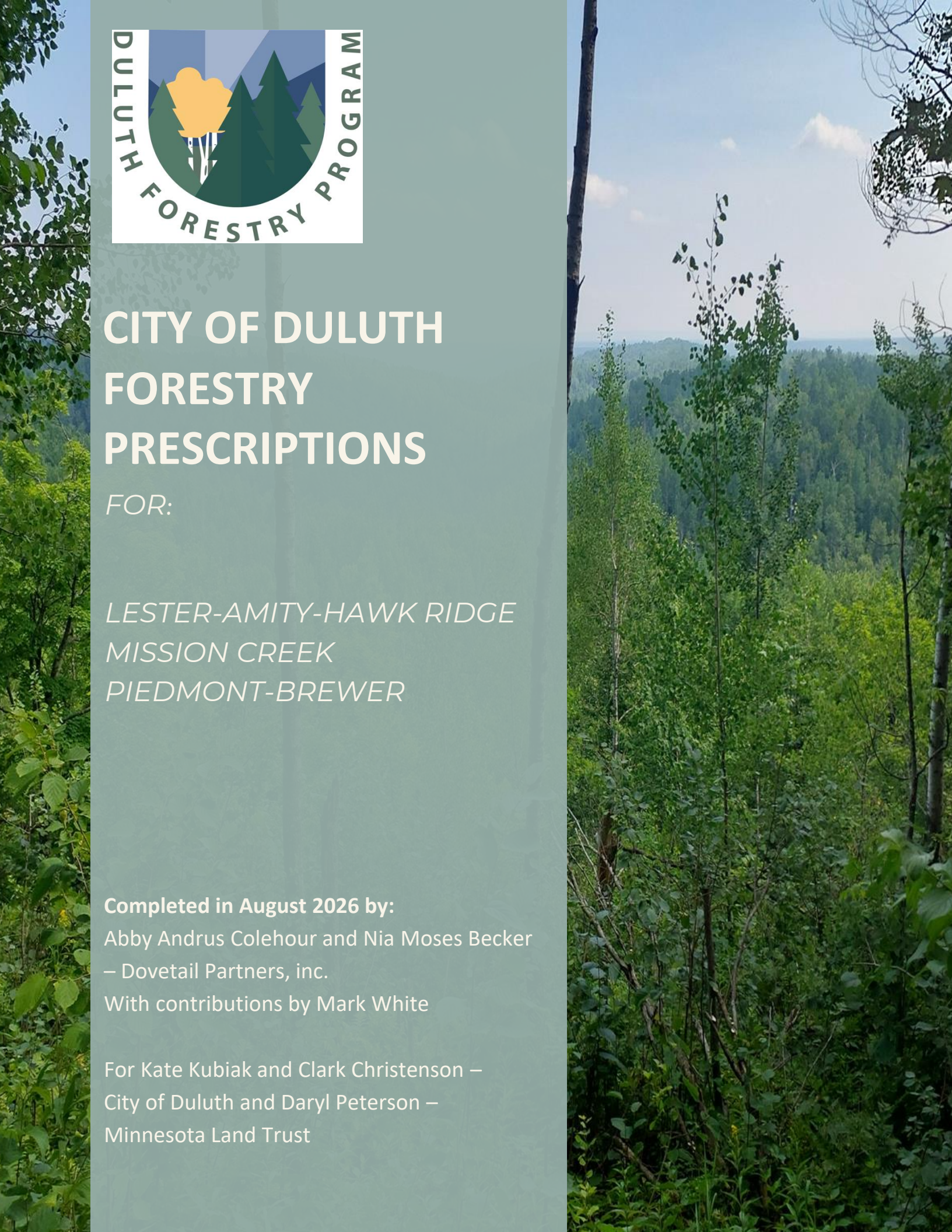

CITY OF DULUTH FORESTRY PRESCRIPTIONS

FOR:

LESTER-AMITY-HAWK RIDGE
MISSION CREEK
PIEDMONT-BREWER

Completed in August 2026 by:
Abby Andrus Colehour and Nia Moses Becker – Dovetail Partners, inc.
With contributions by Mark White

For Kate Kubiak and Clark Christenson – City of Duluth and Daryl Peterson – Minnesota Land Trust

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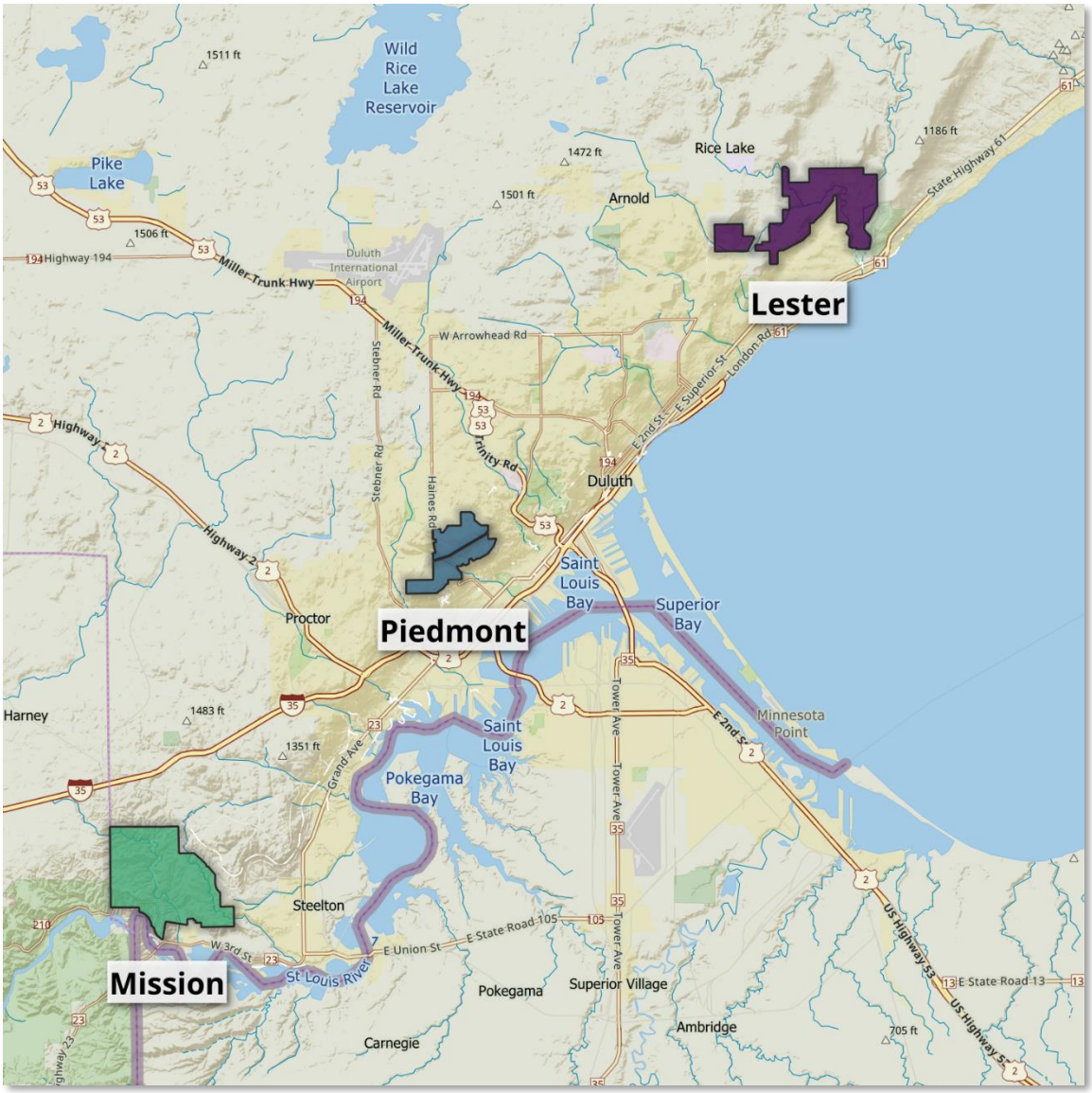
Section 1: Landscape Context

Geology, Soils, and Topography

The Piedmont-Brewer and Lester-Amity-Hawk Ridge land complexes are part of the Superior and Rainy Stony and Rocky Till Plains and Moraines Major Land Resource Area (093A). This area features a prominent northeast-oriented ridgeline that stretches across the length of Duluth and beyond. This geologic feature is composed of a diabase rock intrusion that formed during the lava flows of the Mid-Continent Rift System. Once exposed, this slow-cooling rock resisted weathering and erosion compared to surrounding volcanic rock, resulting in these extents of exposed rock outcrops tilted towards the rift axis. The remainder of the landscape in this MLRA was glaciated by numerous advances of the Superior, Rainy, and Des Moines glacial lobes during the Wisconsin glaciation as well as pre-Wisconsin glacial periods. The geomorphic surfaces are geologically very young (i.e., 10,000 to 20,000 years) and dominated by drumlin fields, moraines, small lake plains, outwash plains, and bedrock-controlled uplands. The resulting soils in this geologic context are diverse, including outcrops of bedrock at or near the surface, deeper glacial till deposits ranging from well-drained gravelly soil in creek floodplains to poorly drained, hydric clay-silt dominated soils (wetlands) in moraine depressions. Differences in plant communities are strongly influenced by this range of soil types.

Mission Creek, meanwhile, is located on the Major Land Resource Area of the Superior Lake Plain (092X). This landscape was shaped during the Late Wisconsin glacial period as glacial lobes advanced and retreated, creating moraines and deposits of lacustrine materials as glacial lakes formed and then drained. The soils at Mission Creek are over 95% of the silty-loam Udalfs-Eutrudepts complex, with the majority composed of steep slopes between 25-70% with less extreme slopes on the ridgetops and tributary drainages. Drainage for these soils is moderately well to well drained, with medium to very high runoff potential. The lower Mission Creek floodplain originates from alluvial material and is dominantly clayey with poorer drainage and more wetland associated plant communities.

Figure 1: Property Context Map



Climate and Climate Change

The average annual precipitation along Lake Superior's north shore is 26-32 inches (66 to 81 centimeters). About 65 percent of the precipitation falls as rain during the growing season (May through September) and about 21 percent falls as snow. The freeze-free period averages about 130 days and ranges from 97 to 150 days (USDA-NRCS, 2022[1]). The climate in Duluth's natural areas is strongly influenced by Lake Superior, resulting in cooler summers, warmer winters, and greater precipitation compared to more inland locations. In addition, steep slopes along the ridgeline result in downward

[1] United States Department of Agriculture (USDA), Natural Resources Conservation Service. 2022. Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin. USDA Handbook 296. Washington, DC.

frost movement, reducing freeze severity mid-slope. This climate supports a higher proportion of mesic hardwood forests than more inland regions.

Mean annual temperature Northeastern Minnesota increased by 3° F from 1951 – 2021 while annual precipitation increases ranged from 1% to 10% (Historical Climate Change).
While climate change presents uncertainty regarding future climate and weather patterns, significant warming over the remainder of the 21st century is inevitable, along with changes in precipitation including quantities, seasonal variability, and the frequency of extreme events. Climate modeling based on recently developed emissions scenarios estimates a 4.4° temperature increase and a precipitation decrease of 2.2 by mid-century (High Emissions Scenario for this region (CMIPS6 Climate Modeling). This scenario indicates a higher likelihood of moisture deficits where evapotranspiration exceeds precipitation leading to drought stress in tree populations. Earlier modeling efforts show greater temperature increases but show potential precipitation increases over the same period (CMIPS5 Climate Modeling).

Forest Types

Forest types in northern Minnesota can be described in multiple ways, depending on the geographic scale, emphasis on historic versus contemporary composition, compiling agency, and data sources. The primary references used in this plan were LANDFIRE[2], USDA's Ecological Site Descriptions[3], and the Minnesota DNR's Native Plant Communities classification system[4]. Each system has its own strengths and limitations. All of these sources were collated with the results of the present forest inventory to make management recommendations that align with the corresponding forest types. The summary of forest types for each property is included in Table 1. A more detailed breakdown of forest type is included for each forest stand description.

[2] LANDFIRE is a national database that was created by a collaboration of U.S. government agencies to assist land managers with decision-making related to wildfires and natural resource management. The data provided is at a coarse scale, meant for large landscape planning. https://www.landfire.gov/

[3] Ecological Site Descriptions are provided by the Natural Resource Conservation Service (NRCS) to support land managers in evaluating potential land use, response to management activities or disturbances, and long-term productivity. https://www.nrcs.usda.gov/getting-assistance/technical-assistance/ecological-sciences/ecological-site-descriptions

[4] The Minnesota DNR developed this native plant community classification system by analyzing field data https://www.dnr.state.mn.us/npc/classification.html. A separate inventory of NPCs in Duluth's natural areas was conducted by GEI Consultants in 2026 – see associated report for detailed accounting and descriptions.

Table 1: Primary Forest Types by Property (Landfire, USDA)

	LANDFIRE	USDA Ecological Site Descriptions
Lester	Biophysical setting: Boreal White Spruce-Fir-Hardwood Forest-Inland Succession Class: D (Late Development 1 – Closed) Succession Class description: Spruce-fir-cedar forest with canopy associates including quaking aspen, paper birch, white pine, bigtooth aspen, red pine, jack pine, white spruce, and eastern hemlock Maximum tree size class: Large (21-33" DBH)	F093AY013MN - Loamy uplands F093AY006MN - Depressional Wet Hardwood Forest 093AY009MN - Bedrock Controlled Upland Forest F092XY012WI - Moist Clayey Lowlands F092XY007WI - Wet Loamy or Clayey Lowlands
Piedmont	Biophysical setting: Laurentian-Acadian Northern Hardwoods Forest-Hemlock Succession class: Class E - Mid Development 2 - Closed Succession class description: Class E represents transition from fire response, early successional stands. Characteristic species are quaking aspen and paper birch in the upper canopy, sugar maple and basswood in the mid to upper canopy. Maximum tree size class: Medium (9-21” DBH)	F093AY009MN - Bedrock Controlled Upland Forest F093AY013MN - Loamy Upland
Mission Creek	Biophysical setting: Boreal White Spruce-Fir-Hardwood Forest-Inland Succession Class: D (Late Development 1 – Closed) Succession Class description: Spruce-fir-cedar forest with canopy associates including quaking aspen, paper birch, white pine, bigtooth aspen, red pine, jack pine, white spruce, and eastern hemlock Maximum tree size class: Large (21-33" DBH).	F093AY013MN - Loamy uplands F092XY015WI - Clayey Uplands

Table 2: Native Plant Communities by Property[5] (MN DNR)

Lester

NPC	Acres	Percent
FDn43b	429	29.0%
Disturbed	213	14.4%
MHn35b	179	12.1%
MHn46b	133	9.0%
MHn44a	84	5.7%
WFn55a	80	5.4%
FFn57a	69	4.7%
FDn33b	56	3.8%
ROn23a	44	3.0%
FDn43b1	43	2.9%
Developed	40	2.7%
RVx54a	32	2.2%
WFn74a	27	1.9%
RVx43a2	18	1.2%
MHn47a	13	0.9%
RVx32	8	0.5%
FDn33a1	5	0.4%
FDn43c	5	0.3%
WMn82b1	1	0.1%
FDn43a	0	0.0%
MRn93b	0	0.0%
Grand Total	**1479**	**100.0%**

Piedmont

NPC	Acres	Percent
MHn35b	296	44.4%
MHn47a	80	12.0%
WFn55a	79	11.9%
ROn23b	71	10.7%
MHn46b	52	7.8%
FDn43b2	46	6.9%
FPn73a	12	1.8%
Disturbed	11	1.7%
CTn24	10	1.5%
Developed	7	1.1%
ROn12b	2	0.2%
ROn23a	1	0.1%
Grand Total	**667**	**100.0%**

Mission

NPC	Acres	Percent
MHn35b	1116	58.9%
MHn44c	190	10.1%
MHn46b	160	8.5%
MHn44b	142	7.5%
MHn44a	62	3.3%
MHn44	39	2.1%
FFn57a	37	1.9%
RVx54a	32	1.7%
Disturbed	30	1.6%
FDn43b	18	1.0%
MHn47a	15	0.8%
RVx32	14	0.7%
MHn45b	12	0.6%
Developed	10	0.6%
WFn55a	7	0.4%
CTn11e	5	0.3%
WMn82b1	3	0.2%
CTn42d	1	0.0%
OW	1	0.0%
CTn11	0	0.0%
Grand Total	**1895**	**100.0%**

[5] Data Source: Shapefile associated with "Native Plant Community Data in the City of Duluth, MN" report by GEI Consultants, 2026.

Disturbance History

Historic Disturbance Regime

Lester and Mission: For the Boreal White Spruce-Fir-Hardwood Forest-Inland forest type[6], frequent windthrow and insect outbreaks (spruce budworm) are the most frequent disturbances. Infrequent catastrophic fires shape these forests, with fire frequency being influenced by the interaction of blowdowns, insects, and droughts. Windthrow is particularly common along lakeshore forests such as Lester and Mission Creek. Deer herbivory is noted as causing a regeneration failure of white cedar. This forest type can shift towards aspen and birch dominance following a fire event, or towards conifers (primarily white spruce, balsam fir, and white cedar, occasionally red pine and white pine) in the absence of fire.

Piedmont: For the Laurentian-Acadian Northern Hardwood Forests-Hemlock forest type[7], infrequent catastrophic windthrow from thunderstorm downdrafts or tornadoes every several generations of trees is an important disturbance shaping this forest type. Stand-replacing fire is infrequent and typically occurs after major blowdown events or periods of extreme drought. Generally, this forest type is fire-resistant and hosts fire-sensitive species. According to a research synthesis of this forest type in 2017, moderate severity wind storm events are fairly common in this forest type, occurring on roughly 2-5% of the landscape annually. Such wind events reset patches of the forest tens to a few hundred square meters in size to earlier successional stages, thereby regularly establishing new age cohorts. This type of disturbance is distinct from single-tree gap dynamics which result in very minor canopy openings enabling a few younger trees to rise to the canopy position, and from stand-replacing fires which reset the entire forest to an early successional state.

Recent Disturbance Events

Major disturbance events over the past couple hundred years are still evident on these landscapes. White pine, red pine, eastern hemlock, and other species were logged extensively by European settlers in the late 1800s and early 1900s, virtually eliminating the former dominance of these tree species, and in some cases even the seed source for future generations of these trees. Such extensive clearcutting reverted the landscape to an early successional stage characterized by aspen and birch dominance. Slash from these timber harvesting operations contributed to subsequent fire extent and severity. The Cloquet fire of 1918 burned hot and fast through much of Duluth, Cloquet, and the surrounding area, burning off not only vegetation but also much of the soil organic layer. A map that was reconstructed of the fire's perimeter shows the northern three-quarters of Lester as having burned, the southern two-thirds of Piedmont having burned, but Mission Creek left completely unscathed.

Other notable disturbances having locally specific impacts to the Duluth Area include a high wind event in 2016 that resulted in large-scale tree blowdown, particularly evident at Lester, and a historic flood event across the broader Duluth area in 2012 in which 7-10" of rain fell over the course of two days that washed out roads, culverts, and streambeds.

[6] Boreal White Spruce-Fir-Hardwood Forest – Inland. BpS Model/Description Version: Aug. 2020. Reviewed by Randy Swaty. US Forest Service Research and Development.

[7] Laurentian-Acadian Northern Hardwoods Forest - Hemlock. BpS Model/Description Version: Aug. 2020. Reviewed by Ron Deckert and Greg Nowacki, plus staff from Chequemegon-Nicholet National Forest. US Forest Service Research and Development.

Section 2: Forest Inventory Methods and Stands Summary

Forest Inventory

Plots were established at a cruise intensity of approximately one plot per 10 acres. Plot locations were established in a systematic grid, then navigated to using GPS to conduct the inventory. Plots were added as needed for smaller or heterogenous stands.

In each plot location, overstory tree characteristics were sampled using variable radius plots with 10 Basal Area Factor (BAF) prism. Metrics collected were plot number, tree species, diameter (DBH), live/dead and canopy position/crown class. For borderline trees, every other tree was recorded.

For understory characteristics, tree regeneration was sampled using 1/100th or 1/250th acre fixed radius plots, nested within the overstory plots. Trees under 6-ft tall were tallied as seedlings, with trees over 6-ft and under 5-inches DBH tallied as saplings. Using these same nested plots, a count for shrubs over and under 6-ft height and estimation of herbaceous plant cover class was obtained. Qualitative data collected included coarse woody debris amounts (Low, Medium or High), Invasive species (by species, Low, Medium or High), presence and notes of pests and disease, wildlife notes including species with excessive browse, notes on human impacts, and any other relevant management notes or observations. Data were collected between July 2025 and August 2026.

Site index

For each stand, site index was calculated for the dominant tree species and a secondary species. For dominant species, two or three specimens were collected depending on similarity of first two specimens, and one specimen was collected for secondary species. An increment borer was used to calculate number of tree rings, and a clinometer used to measure height at 50-m distance from the tree[8]. Site index was determined using site index curves from Carmean, Hahn, and Jacobs, 1989[9]. Data were collected between March and August 2026.

Table 3: Forest Inventory Summary for All Properties

Property	Total Stands	Plots	Acreage
Lester	17	165	1493
Mission	19	188	1955
Piedmont	8	69	667
Total	**44**	**422**	**4115**

[8] Huebschmann, Michael and Martin, Jeff. 1996. Lakes States Woodlands: Estimating and interpreting site index.
[9] Carmean, Willard H., Hahn, Jarold T., and Jacobs, Rodney D. 1989. GTR NC-128 Site index curves for forest tree species in the Eastern United States. USDA Forest Service, North Central Forest Experiment Station.

Section 3: Forest Health and Management Considerations

This section outlines the primary forest health concerns within the surveyed properties and a summary of current best management practices to address them.

Emerald Ash Borer

At the time of the present forest inventory (summer/fall 2025), Emerald Ash Borer (EAB) invasion is in an advanced stage at Lester and Piedmont, and in an early to mid-stage invasion at Mission. At Lester and Piedmont, significant stands of former black ash dominance have up to 80-100% mature tree mortality, and as little as 20% decline in the upper reaches of Mission Creek. Some mature trees exhibit epicormic or root crown sprouting. In general, there are still some individual living green and black ash trees, and very abundant black and green ash regeneration across all properties and stands. Emerald ash borer can infest trees as little as 1 inch in diameter, but tend to target larger diameter trees during early stages of invasion. In areas of significant tree loss at Lester and Piedmont, the loss of ash tree cover appears to be associated with an increased presence of speckled alder and buckthorn. Ash tree mortality can result in an elevated water table and possible transition from forested wetland to other wetland types. Loss of shade from forested cover can also change stream conditions (i.e. increase stream temperature) and therefore impact aquatic life.

EAB cannot be eradicated from the landscape. However, ash-dominant stands can be managed for resiliency to lessen the secondary ecological impacts. Slowing Ash Mortality (SLAM) utilizes multiple management strategies and is more effective than using individual management strategies alone. SLAM is used to slow the growth and spread of EAB during early to mid-infestation stages. Biocontrol with EAB parasitoids has shown limited potential for reducing the amount of EAB damage when used alone but can be combined with other strategies for greater impact. Insecticide injections can also suppress EAB populations and preserve seed trees, ensuring future seed sources. Ash seedlings are shade-tolerant, and ash is a prolific seed producer. Fostering the recruitment of ash seedlings that are present in the forest now can provide for future ash trees if conditions or technology changes. In addition, planting and encouraging a diverse tree species assemblage within riparian areas currently dominated by ash will ensure forest canopy and preserve wetland hydrology regardless of ash status. Leaving dead ash trees standing where they do not pose a hazard to infrastructure or trail users is recommended for wildlife habitat, coarse woody debris recruitment, and creating viable sites (tip-up mounds and nurse logs from fallen trees) for natural tree regeneration of species like yellow birch and white pine. However, if insecticides are used to preserve seed trees, it is recommended to also remove surrounding ash trees to reduce the surrounding EAB population.

Tree species to interplant in black ash swamps to maintain forested cover:

- *Priority species currently present:* Yellow birch, white spruce, white cedar, white pine
- *Additional species currently present:* Balsam poplar, basswood, red oak, sugar maple, red maple, balsam fir, quaking aspen, tamarack
- *Climate adaptation species:* Silver maple, bur oak, swamp white oak, box elder, American elm, hackberry, Eastern cottonwood
- *Historically present species:* Eastern hemlock

Table 4: Effectiveness of Management Options for Emerald Ash Borer in Black Ash Forests[10]

Management Option		Anticipated Effectiveness of Treatments to Achieve Specific Goals			
		Maintain canopy & vertical structure	Promote black ash regeneration	Directly protect black ash regeneration	Suppress EAB infestation
No intervention		Ineffective (--)	Ineffective (--)	Ineffective (--)	Ineffective (--)
Individual tree treatments	Systemic insecticide	Highly effective (+)	Highly effective (+)	Limited (-)	Highly effective (+)
	Classical biocontrol (non-native parasitoid releases)	Ineffective (--)	Ineffective (--)	Limited (-)	Limited (-)
	Ash tree removals (individual tree selection, row harvests, gap harvests)	Ineffective (--)	Highly effective (+)	Ineffective (--)	Limited (-)
Treatment combinations	Biocontrol + Systemic insecticides	Highly effective (+)	Highly effective (+)	Limited (-)	Highly effective (+)
	Tree removals + Systemic insecticides	Highly effective (+)	Extremely effective (++)	Ineffective (--)	Highly effective (+)
	Biocontrol + Tree removals	Ineffective (--)	Highly effective (+)	Limited (-)	Limited (-)
	Systemic insecticides + Biocontrol + Tree removals	Highly effective (+)	Extremely effective (++)	Limited (-)	Highly effective (+)

Ineffective (--) = unlikely to achieve goal; Limited (-) = studies have shown variable to poor results; **Highly effective (+)** = studies have consistently shown strong results; possible additive/synergistic effect; **Extremely effective (++)** = combining two highly effective treatments is likely to yield better results than a single treatment; greater additive/synergistic effect.

Source: McCullough D.G., Seigert N., Management Options for Emerald Ash Borer in Black Ash Forests. 2026

Disturbance, Succession, and Tree Regeneration

Forest types across Lester, Piedmont, and Mission vary but are nearly all in a transitional or mid-succession stage (averaging 35-75 years) with only occasional remnant or older trees. Active management can reverse or accelerate succession towards different stages. Supporting a range of successional stages provides a greater diversity of wildlife habitat niches and enables greater resilience at a landscape scale. In general, management goals in this plan recommend progression towards later successional forest stages and retention of large tracts of interior forest where possible, due to the

[10] Management options for emerald ash borer in black ash forests. Siegert, N.W. and D.G. McCullough. 2026. Michigan State University Extension. East Lansing, Michigan.

limited presence of older contiguous forests in the surrounding landscape. The following list summarizes management strategies associated with various desired successional states.

- *Early successional management* - Forest stands naturally reset to young forest conditions after a disturbance like flooding, fire, pests/disease, beaver activity, or major wind event. Young forests are typically dominated by quaking aspen, paper birch, balsam poplar, and jack pine (infrequent) in this area. Regeneration for early succession forests requires significant canopy gaps to stimulate aspen root re-sprouting, encourage growth of sun-loving seedlings, and expose bare soil for seed germination. Where appropriate, thoughtful silviculture and modern best management practices can mimic natural disturbance to create or maintain patches of young forest while minimizing negative impacts to mature forest habitats and the wildlife species that depend on them. Species that benefit from early succession stands include golden-winged warbler, American woodcock, grouse, sapsuckers, rose breasted grosbeak, snowshoe hares, deer, moose, turtles, and beaver.
- *Late successional management* - Late successional forests require longer periods of time without a canopy-altering disturbance. In these older forests, tree diameter increases while trees per acre decreases. Higher levels of coarse woody debris and snags create structural diversity and habitat niches for wildlife like porcupines, bats, woodpeckers, martens, flying squirrels, and salamanders. A greater component of the canopy composition is slow-growing, shade-tolerant species like sugar maple, white cedar, white pine, yellow birch, eastern hemlock, bur oak, red pine, white spruce and balsam fir. For these later-successional species to successfully establish on their own, a seed source must be present, and seedlings must survive into maturity. Lack of seed source due to past clear-cut logging and excessive deer herbivory make natural regeneration challenging across many of Duluth's natural areas (see Regeneration and Herbivory sections below). Active management to encourage late-succession forests include site preparation around seed trees, midstory mastication, tree planting and caging, and deer exclosures.
- *No management* – A hands-off approach allows the forest to naturally progress through succession without management intervention. This is appropriate where the stand already contains a diversity of desirable species and age classes, herbivory does not cause a major hindrance to seedling success, and invasive species do not overwhelm the midstory. Natural disturbances such as fire, flooding, insect outbreaks, and windstorms may revert a forest to an earlier successional state.

Conifer Regeneration

There is very little regeneration and recruitment of the late-successional conifer species historically present and expected in these forest types - white pine, red pine, white cedar, and eastern hemlock. Despite being some of the oldest trees on the property, there has been virtually zero white and red pine recruitment over the last ~100 years. Conifers (and other small-seeded trees) require a bare mineral soil seedbed for regeneration. Lack of disturbance and competing vegetation can prevent the establishment of seedlings, while shading from the canopy and browse by deer can prevent the recruitment of seedlings that do become established. Large, legacy conifers are present across the landscape and should be preserved as much as possible to continue to provide a natural seed source.

White spruce, and to a lesser extent balsam fir, have had success in regeneration. Both of these species are susceptible to spruce budworm and can cause elevated fire risk following mortality from spruce budworm outbreaks. However, neither of these species has become overabundant on landscape scale. Some isolated areas throughout each property have very dense stands of young white spruce or balsam

fir that should be thinned to reduce spruce budworm potential and release vigorous regenerating trees from competition. Other areas, such as slopes with northern aspects, natural white spruce regeneration could be encouraged as a deer-resistant species.

Management activities to address conifer regeneration

- Soil scarification to expose mineral soil within 700 feet of seed trees
- Prescribed surface burning to expose mineral soil within 700 feet of seed trees
- Direct seeding
- Tree planting and tree protection

Hardwood Regeneration

Black ash, green ash, and to a lesser degree quaking aspen are the most abundant species in tree regeneration layers in mesic hardwood stands across the three properties. While white-tailed deer browse on these species, the sheer numbers of seedlings may allow some to grow above browse levels. As mentioned in the EAB section, if effective EAB control methods are developed, maintaining some ash regeneration provides a source for future ash tree to access the canopy and produce seeds.

Most of the mesic hardwood stands across the three properties appear to be in young forest (0-55 years) or transition (55-95 years) where there is relatively high abundance of early successional tree species (quaking aspen, paper birch). Mid-tolerant and generally longer-lived hardwoods (red maple, red oak, yellow birch) along with species with higher shade tolerance (basswood, sugar maple) may be present in the canopy but are often poorly represented in the regeneration layers.

In Northern Mesic Hardwood Forests (MHn35), stand replacing wind and fire disturbances occurred infrequently with rotation periods greater than 1,000 years for wind and 970 years for fire. Moderate severity fire and wind that resulted in some tree mortality creating variable canopy openings occurred with a rotation period of 130 years. Silvicultural approaches that mimic these moderate severity disturbances along with browse protection and scarification treatments to increase seedling establishment could be used to increase successful establishment of mid-tolerant and shade tolerant hardwood species. Prescribed fire could also have a role in creating mineral soil seedbeds and reducing understory competition. If the objective is to establish cohorts of these species to replace existing canopy trees, then targeted planting along with brush saw release could be effective.

As many of the shade tolerant and mid-tolerant species are considered climate adaptive, managing for these species should serve to increase adaptive capacity.

Of the shade intolerant species (balsam, poplar, bigtooth aspen, quaking aspen, paper birch) (excluding ash species) quaking aspen is by far the most abundant in regeneration, subcanopy and canopy. Even-aged treatments including shelterwood and seed tree methods that create sufficient light can be used: however quaking aspen sprouting can overwhelm sites. Shelterwood systems with higher canopy cover retention (~40%) can damp down the sprouting response.

Given challenges to regeneration due to deer browse, non-native earthworms, and other factors, a long-term commitment to establishing desired species composition will be key to building resilience into these forests.

Herbivory

For stands in which a seed source is present, germination is successful, and conditions should theoretically support recruitment into sapling and mature states, herbivory may be a driving factor preventing regeneration. Controlling for deer browse is one immediate measure that can be taken to enable existing seedlings to recruit to the sapling stage where they are more likely to survive herbivory.

Management activities to address deer herbivory

- Encourage hunting - the City currently has a deer bow-hunting program. Continue the program, provide education and incentives to enable more hunters to access remote natural areas.
- Exclosures - install large fenced areas that deer cannot access. Alternatively, create natural brush deer barricades by cutting overly dense tree and shrubs in a manner that prevents deer entry. In several years, compare seedling and sapling quantities to assess effectiveness. If regeneration has not improved in exclosures, then other factors are driving regeneration problems.
- Rabbit exclosures - In a subset of exclosures, install finer mesh fencing 2' in height to exclude rabbits. Compare regeneration impacts to deer-only exclosures
- Rodent exclosures - excluding rodents will be more challenging, but if regeneration has not improved through deer and rabbit exclosures, consider experimenting with this.
- Deer repellent - scent based repellents make vegetation unpalatable or induce a fear response. This can be effective but must be reapplied multiple times a year.

Non-Native Earthworms

Non-native earthworms can cause significant changes to forest soils, inhibit the regeneration of many herbaceous, shrub, and tree species. In cases with extreme infestation, understory plant cover and tree regeneration are severely limited. By removing litter and mixing the organic layer with deeper horizons, soil bulk density can increase, resulting in reduced water holding capacity and fertility. Other impacts include increased soil temperature during the growing season along with less insulation from heat during the growing season and cold temperatures during the winter due to loss of leaf litter and duff. Impacts from earthworms are most severe for mesic hardwood forests with deeper organic soil layers, because earthworms consume and relocate the organic matter to deeper horizons. For more information see the USDA's summary on non-native earthworm impacts[11].

Buckthorn

Buckthorn is a persistent issue across Duluth's natural areas. Treatment recommendations depend on access constraints, size and extent of the population, and forest conditions. In some cases, an extensive invasive species presence can indicate an underlying issue with forest health such as past artificial disturbance (clearcut logging, soil disturbance, development activities like farming or road creation, etc), a soil nutrient imbalance (often nitrogen is too high), or forest health issue affecting native tree resilience. In addition to immediate buckthorn removal projects, underlying forest health issues should also be addressed to help reduce population rebounds and future invasion.

[11] https://www.climatehubs.usda.gov/hubs/northern-forests/topic/non-native-invasive-earthworms-midwest-and-eastern-united-states

Management activities to address buckthorn:

- Smaller Seedlings - for less established areas, hand pull to remove seedlings. Where possible, overplant a high density of native shrubs to shade out future seedlings emerging from the seedbank.
- Larger established areas of buckthorn will require mechanical, chemical, or biological treatment. Shrubs of up to a certain size can be mulched (depending on equipment capacity), with even larger trees best suited for chainsaw treatment. Pairing removal with herbicide application or goat browsing can improve the efficacy of the treatment and reduce the number of treatment entries.
- Goat browsing may be effective and is a publicly appealing alternative to herbicide treatment. It is recommended if the preservation of native plants is not a concern (goats will eat many plants), as in a buckthorn monoculture. Goat browsing tends to be most successful after an initial mastication of mature plants, and with a longer duration browsing period or repeated entries to starve out resprouting buckthorn stumps and exhaust the seed bank.
- Reduce dispersion of new plants
    - Bike trails and powerlines are systems for dispersions. High traffic trails and disturbed areas were observed to have more invasives. Monitor these areas and remove new infestations as they occur.
    - Install boot brushes and bike cleaning stations to prevent further seed dispersal and establishment.
    - Birds are a common source of seed dispersal. Monitor areas with high bird activity for new invasions and focus removal efforts here

Birds

The Duluth area has a rich bird population including Lake Superior and St. Louis River Estuary waterfowl, summer nesting birds, spring and fall migrating birds, overwintering residents, and occasional visiting boreal birds like owls from Canada. The buffering effect of Lake Superior provides suitable conditions for many birds, while the north shore ridgeline offers air currents supportive to hawk and other bird migration. Birds play many important roles in forest ecosystems, but their populations have declined by 1.2 billion birds since 1970[12] due to habitat loss, invasive species like emerald ash borer, climate change, and other factors. Of the 250 bird species in Minnesota, 150 species nest in forests[13]. While different species and life stages of birds require different habitat features, some preferring vast extents of mature interior forest and others preferring early successional or edge habitats, some key structural elements can be incorporated into forest management practices to support a diversity of bird species.

[12] North American Bird Conservation Initiative. (2019). State of the Birds 2019. stateofthebirds.org/2019

[13] Forestry for Minnesota Birds. 2025. Lead Author: Nelson, Christian with numerous other contributors. Forest Stewards Guild, American Bird Conservancy, and University of Minnesota's Natural Resources Research Institute. https://www.dovetailinc.org/portfoliodetail.php?id=68067874c2d00

Table 5: Overview of Key Habitat Structures and Importance for Minnesota Bird Species.
Source: "Forestry for Minnesota Birds" guidebook[13]

Vertical structure diversity/canopy cover	Vertical structure diversity, or differing levels of canopy cover in the over-, mid-, and understory, provides habitat to many forest breeding birds.
Horizontal structure diversity	Diversity in horizontal structure, or the arrangement of species and woody structure on a plane parallel to the ground, provides habitat to many forest breeding birds.
Canopy gaps ("gaps")	Create canopy openings that allow sunlight to penetrate down to the forest floor to help regenerate desired tree species and to diversify habitat for forest breeding birds.
Native biodiversity/ invasive species	Manage to create a diversity of native forest plants to ensure that birds have available food sources, including insects and mast. Eliminate invasive plants that may interfere with tree and shrub regeneration.
Large-diameter trees	Provides structural elements for nesting, roosting, perching, and feeding habitat for many forest breeding birds. Can become large snags, cavities, and down woody material over time.
Conifer inclusions	Retain or create clusters of conifer trees, for habitat, winter shelter, and to increase forest resilience to climate change and other stressors.
Snags or cavity trees	Provides structural elements for nesting, roosting, perching, and feeding habitat for many forest breeding birds.
Downed woody material	Provides structural elements for ground nesting birds as well as habitat for invertebrate food sources.
Leaf litter and duff	An adequate layer of duff is essential to ground-nesting birds and invertebrate populations; in oak-dominated hardwood forests, it may hinder natural oak regeneration.
Riparian and wetland forests	Water features, including seasonal ephemeral ponds, and the surrounding vegetation provide beneficial habitat elements for forest bird breeding and migrating birds.

Lester (Hawk Ridge) – According to the nomination letter to the Duluth Natural Areas Program[14], 60% of birds listed in Minnesota Birds of Greatest Conservation Need were documented during Hawk Ridge monitoring efforts. Over 200 bird species are documented annually in the natural area for nesting, foraging, and migratory habitat including raptors and passerines. Land management decisions should be made to benefit the bird populations depending on these landscapes. The extensive research and education programs at Hawk Ridge and associated publications are an asset and should be referenced as companion resources when making land management decisions.

[14] Nomination of Lester-Amity-Hawk Ridge Natural Area to the Duluth Natural Areas Program. April 2025. Hawk Ridge Bird Observatory, Minnesota Land Trust, South St. Louis County Soil and Water Conservation District, Minnesota Trout Unlimited.

Mission Creek – A bird use survey in Magney-Snively[15] - an adjacent and similar natural area to Mission Creek - found that forest interior and canopy-associated birds were the most abundant birds using the site, and that the forest was most important as early season breeding and spring migratory habitat. Canada Warbler, Golden-Winged Warbler, and Wood Thrush were species of conservation significance found on the site. The report summarized: "Management actions that prioritize retention of mature hardwood forest, maintenance of well-developed shrub and subcanopy layers, protection of riparian corridors and seasonal wetlands, and proactive adaptation of ash-dominated forested wetlands are likely to provide the greatest benefit."

Trout Streams

All three properties host designated trout streams[16], listed as such due to their cool water temperatures and presence of coarse streambed sediments. Designated trout streams are required through state regulation to have a buffer of perennial vegetation or other approved water quality management practice. Preserving shaded forest cover along seasonal waterways and tributaries, reducing erosion along streams, enhancing aquatic structural diversity and other habitat features within stream corridors, and preventing pollution will all help preserve trout stream integrity.

Lester trout streams: Lester River, Amity Creek, East Branch Amity Creek
Piedmont trout streams: Merritt Creek
Mission trout streams: Mission Creek, Sargent Creek

White Pine Blister Rust

White pine blister rust (WPBR) is caused by *Cronartium ribicola* J.C Fischer, a basidiomycete fungus. The *C. ribicola* life cycle alternates between pines of the subgenus *Strobus*, creating perennial cankers, and *Ribes* L. species (gooseberries, currants), where it produces a foliar disease. WPBR is common in northeastern Minnesota and limits regeneration by killing young white pine, and larger trees can be killed as branch dieback proceeds over time. WPBR originated in Asia and came to North America in the late 19th century.

The lack of sufficient moisture limits the distribution of WPBR. WPBR is more prevalent in areas that have either low daily maximum temperatures or long cool periods during the day. At the macroclimatic scale, WPBR tends to increase with latitude, elevation, and proximity to cold water bodies (e.g., Lake Superior) (WPBR Risk Factors).

At the mesoscale, WPBR is more prevalent at higher elevations and less common in broad river valleys. Night breezes near the Great Lakes are important as carriers of WPBR sporidia. Cool air moves off the land surface, collecting WPBR sporidia from *Ribes*. This cool air hits warmer air above the lake surface, creating a backflow over the land surface. The spores are deposited in a band from 10 to 7 mi. from the lakeshore. Night air movement patterns also match the distribution of WPBR adjacent to swamp forests. At the microscale, small canopy openings retain moisture and remain cooler longer than closed canopy or larger openings and are more susceptible to WPBR infection. Cold air moves downslope and accumulates in narrow valleys or depressions, creating favorable conditions for WPBR infection.

[15] Grinde, A., Siebers, R. 2026. Magney–Snively Natural Area: Management and Avian Monitoring Report, 2024–2025. Natural Resources Research Institute, University of Minnesota Duluth, Technical Report NRRI/TR-2026/43.
[16] https://www.dnr.state.mn.us/fishing/trout/map.html

WPBR infections primarily take place below nine feet above ground level as cool-moist conditions favorable to infection are most common in this zone. Pruning branches below nine feet is an effective way to limit infection (WPBR Pruning). Pruning eliminates branches with the highest risk of infection and branches that are already infected. Pruning should be avoided during spring when new shoot growth begins. Tree bark can also be damaged. Pruning can begin on the lowest branches when trees are 4-6 years old.

Section 4: Management Goals, Strategies, and Actions

Management Goal Summary

1. *Ecosystem function:* Protect and enhance water quality, soil integrity, and wildlife habitat
2. *Regeneration:* Ensure healthy forest regeneration and accelerate forest succession towards late-stage native tree composition
3. *Restore/enhance native plant communities:* Manage for revitalization of native plant communities, remove invasive species, and reintroduce native vegetation where it is lacking
4. *Forest resilience:* Support forest resilience in the face of climate change and disturbances such as windstorms and wildfire
5. *Recreation:* Support recreational uses and enhance recreational user experience

Goal 1 ECOSYSTEM FUNCTION

Protect and enhance water quality, soil integrity, and wildlife habitat

Strategy 1.1 Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality

Action 1.1.1 Systemic insecticide treatment into mature female ash trees during early-stage invasion to protect seed trees for future ash regeneration. Girdle ash trees to attract EAB in combination with systemic insecticide injection to adjacent trees

Action 1.1.3 Biocontrol of EAB through release of parasitoid wasps

Action 1.1.4 Underplanting - Plant replacement trees where ash decline and mortality is advanced

Strategy 1.2 Stabilize erodible soil along wetland, stream and riverbanks

Action 1.2.1 Seed fast-growing trees on eroded banks where tree cover is desired

Action 1.2.2 Seed fast-growing native grasses and forbs on eroded banks where tree cover is not deemed critical

Strategy 1.3 Increase complexity of forest structure to encourage bird, bat, and pollinator habitat

Action 1.3.1 Retain snags at a density of 5-10 snags/acre for wildlife habitat, particularly large diameter trees (>12" DBH) and hardwood species
Action 1.3.2 Allow aging trees to decay in place, contributing coarse woody debris and standing deadwood and cavities
Action 1.3.3 Gap selection and shelterwood treatments to improve priority nesting and foraging areas

Strategy 1.4 Encourage bird and pollinator food sources

Action 1.4.1 Plant native flowering and fruiting shrubs
Action 1.4.2 Maintain establishing vegetation through watering, pruning, mulching, etc
Action 1.4.2 Prescribed burning or coppicing to stimulate forage production

Goal 2 REGENERATION

Ensure healthy natural forest regeneration and accelerate forest succession towards late-stage native tree composition

Strategy 2.1 Create canopy openings to allow sunlight to reach forest floor

Action 2.1.1 Single tree selection
Action 2.1.2 Gap selection
Action 2.1.3 Shelterwood harvest
Action 2.1.4 Crop (seed) tree release
Action 2.1.5 Girdle trees surrounding seed producing trees of interest
Action 2.1.6 Commercial harvest

Strategy 2.2 Reduce competition in mid-story

Action 2.2.1 Mulch/masticate shrub layer
Action 2.2.2 Remove buckthorn

Strategy 2.3 Promote natural regeneration in vicinity of seed-bearing trees

Action 2.3.1 Monitor for seed producing trees of interest
Action 2.3.2 Site preparation - Prescribed burning
Action 2.3.3 Site preparation - Mechanical soil scarification

Strategy 2.4 Artificial regeneration

Action 2.4.1 Plant trees
Action 2.4.2 Disperse tree seeds

Strategy 2.5 Protect seedlings and saplings (natural or artificial regeneration)

Action 2.5.1 Cage/bud cap individual trees
Action 2.5.2 Large area deer exclosure - natural materials or fence
Action 2.5.3 Encourage deer hunting

Goal 3 RESTORE/ENHANCE NATIVE PLANT COMMUNITIES

Manage for revitalization of native plant communities, remove invasive species, and reintroduce native vegetation where it is lacking

Strategy 3.1 Buckthorn removal

Action 3.1.1 Hand pull seedlings up to 1" diameter
Action 3.1.2 Hand cut or chainsaw stems >1" diameter
Action 3.1.3 Masticate or mulch dense stands of buckthorn
Action 3.1.4 Follow-up foliar herbicide treatment after initial removal
Action 3.1.5 Prescribed grazing on resprouts after initial removal

Strategy 3.2 Prevent introductions of aggressive introduced plants

Action 3.2.1 Monitor and remove invasive plants at first detection (Early Detection Rapid Response)
Action 3.2.2 Install boot brushes at trailheads
Strategy 3.3 Re-establish native vegetation
Action 3.3.1 Seed native grasses and forbs
Action 3.3.2 Plant native shrubs and/or trees
Strategy 3.4 Restore and maintain fire-dependent plant communities
Action 3.4.1 Prescribed burning
Strategy 3.5 Transition tree plantations to native forest composition
Action 3.5.1 Thin overly stocked tree plantations, sell commercially when possible or remove offsite
Action 3.5.2 Remove non-native tree species, sell commercially when possible or remove offsite
Action 3.5.3 Interplant diverse native trees suitable to site conditions

Goal 4 FOREST RESILIENCE

Support forest resilience in the face of climate change and disturbances such as windstorms and wildfire

Strategy 4.1 Support health of retained trees
Action 4.1.2 Thin overstocked mature trees (shelterwood harvest)
Strategy 4.2 Reduce hazardous fuel load to reduce wildfire risk and severity
Action 4.2.1 Thin and remove overcrowded balsam fir or white spruce
Action 4.2.2 Thin and remove above ground dead/down woody debris (lacking soil contact) that creates a fuel ladder into tree canopies
Action 4.2.3 Woody debris processing through biochar creation, pile burning, or off-site chipping
Action 4.2.4 Prescribed burning
Strategy 4.3 Introduce native tree species and genotypes better suited for future climate scenarios – tolerant of prolonged drought, extreme heat events, increased storm severity, heavy rainfall, increase wildfire severity, etc.)
Action 4.3.1 Plant currently occurring species whose range naturally extends further south - red oak, bur oak, white pine, yellow birch, basswood, sugar maple, red maple, silver maple
Action 4.3.2 Plant currently occurring northern conifers at the southern end of their range only in climate resilient sites (protected from extreme heat, drought, wind) - black spruce, white spruce, jack pine, tamarack, white cedar
Action 4.3.3 Select seeds of currently occurring species from slightly more southern stock
Action 4.3.4 Assisted migration - Introduce species native to adjacent regions with slightly warmer climates – white oak, swamp white oak, black cherry, American elm, bitternut hickory, eastern cottonwood, hackberry, river birch, etc.

GOAL 5 RECREATION

Support recreational uses and enhance recreational user experience
Strategy 5.1 Maintain trail functionality
Action 5.1.1 Cut and remove weakened or dead trees along trails
Strategy 5.2 Manage for open or partially open ("park-like") understory conditions
Action 5.2.1 Mulch/masticate dense shrubs
Action 5.2.2 Prescribed burning
Action 5.2.3 Prescribed grazing
Strategy 5.3 Manage viewsheds at key viewpoints
Action 5.3.1 Cut tall vegetation
Action 5.3.2 Remove accumulated woody debris

Section 3: Lester-Amity-Hawk Ridge Designated Natural Area (Lester)

Figure 2: Lester Stands Map

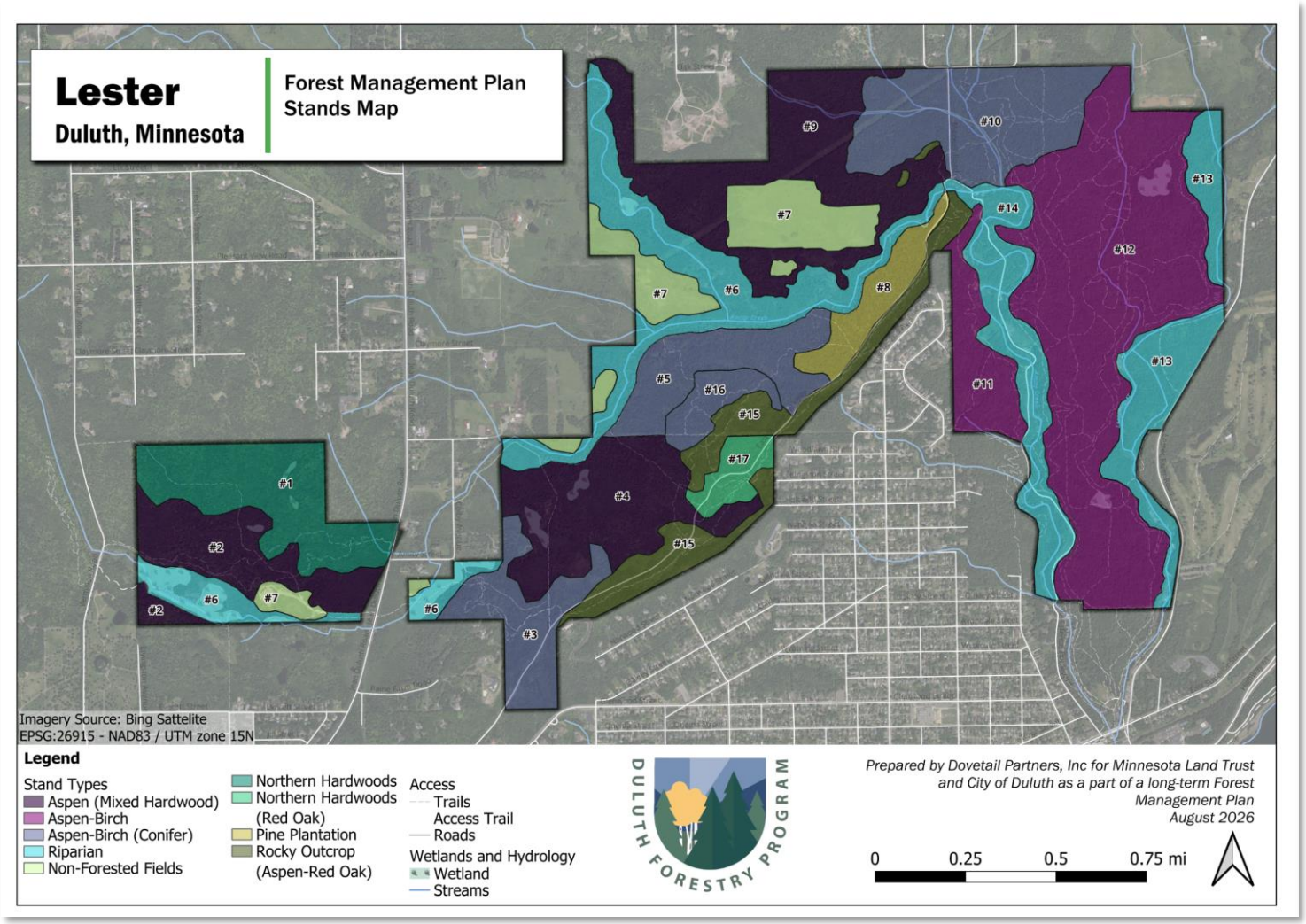
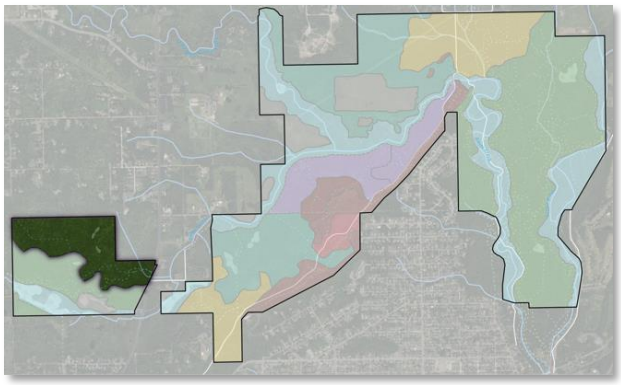


Table 6: Lester-Amity-Hawk Ridge Stand Attributes

Stand #	Forest Type	Acres	Soil Prima	NPC Primary	Avg DBH (in)	SE DBH (in)	Avg Basal Area (ft2/ac)	SE Basal Area (ft2/ac)	SiteIndex1	SiteIndex1_species	SiteIndex2	SiteIndex2_species	Total Plots
1	Northern Hardwoods	88.5	F141D	MHn35b	10.1	0.6	105	13.3	77.5	Quaking Aspen	50	Sugar Maple	10
2	Aspen (Black Ash, Northern Hardwoods)	69.5	F141D	MHn35b	9.6	0.9	110	9.5	77.5	Quaking Aspen	50	Sugar Maple	7
3	Aspen-Birch (Red Pine)	56	F147D	FDn43b	9.8	1.1	93	19.2	53.0	Quaking Aspen	52.7	Red Pine	6
4	Aspen-Birch (Red Maple)	103.6	F147D	WFn55a	8.1	0.9	56	10.1	68.5	Quaking Aspen	57	Red Maple	9
5	Aspen-Birch (Plantation)	60.3	F147D	Disturbed/ FDn43b1	8	1	129	12.8	74.0	Quaking Aspen	56.5	Red Pine	7
6	Riparian	147.9	E9E	FFn57a / MHn46b	7.4	0.5	96	10.5	71.5	Quaking Aspen	58	Paper Birch	20
7	Non-Forested Field	84	E3A	Disturbed					n/a	n/a	n/a	n/a	0
8	Pine Plantation	31.9	F147D	Disturbed	11.6	0.9	146	17.5	72.5	Quaking Aspen	51.5	Red Pine	8
9	Aspen-Birch (Red Maple)	136.7	E3A	MHn44a / MHn46b / FDn43b	8.8	0.5	98	10.8	63.0	Quaking Aspen	49	Sugar Maple	16
10	Aspen-Birch (Balsam Fir)	109.7	E23F	FDn43b	8.8	0.6	136	15.7	72.0	Quaking Aspen	62	Balsam Fir	11
11	Aspen-Birch	42.7	E15A	FDn43b / MHn44a	9.1	0.7	107	12.7	61.5	Quaking Aspen			7

12	Aspen-Birch	294.5	E3B	FDn43b	9.8	0.4	116	6.1	80.5	Quaking Aspen	62	Paper Birch	32
13	Aspen-Birch (Riparian)	75.9	E11E	FDn33b / FFn57a	9.2	0.6	110	12.6	61.0	Aspen	47	Paper Birch	5
14	Developed/Riparian	74.7	E23F	Developed / Disturbed / FDn33b	8.9	1	107	19	71.5	Quaking Aspen	58	Paper Birch	10
15	Rocky Outcrop (Aspen-Red Oak)	74.2	F160F	ROn23a	4.8	1.2	46	13.1	53.5	Red Oak	54	Jack Pine	7
16	Aspen-Birch (Balsam Fir)	21.5	F160F	FDn43b1	6	0.4	100	14.4	67.0	Quaking Aspen	65	Paper Birch	5
17	Northern Hardwoods (Red Oak)	19	F160F	MHn35b	10.1	0.6	134	14.3	44.3	Red Oak			5

Stand 1 Northern Hardwoods





Stand Characteristics

Forest Type: Northern Hardwoods

Size: 88 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	72.2	81.93%
MHn47a	7.9	8.93%
MHn46b	4.2	4.78%

Ecological Site (USDA):

- F093AY013MN - Loamy Uplands
- F093AY006MN - Depressional Wet Hardwood Forest

Dominant Soils:

- ∉ F141D (50%), F139F (37%), F140B (8%)
- ∉ Silt loam, sandy loam
- ∉ Well drained to very poorly drained depressions

Successional Stage: Young forest (0-55 years) beginning to transition to mature forest

Average Diameter (DBH): 10.1" (SE=0.6)

Average Basal Area: 105 ft^2/ac (SE=3.3)

Snags per acre: 87 medium (6-11" DBH), 1.5 large (>12"), mostly quaking aspen, bigtooth aspen, and black ash

Coarse woody debris: Medium to high

Wildfire risk: Low

Invasive Species: Moderate to high - buckthorn is established in parts of the stand

Pests & Disease: Emerald ash borer is well-established, dead and dying ash are present

Current Condition: This is a rich mixed hardwood forest on a slightly south-facing slope with black ash-dominant wet depressions occurring throughout. Red oak is the dominant canopy tree (12-26" DBH), complemented by co-dominant bigtooth aspen, quaking aspen, sugar maple, and paper birch, and black ash dominating the lower lying areas. Sugar maple is the most common intermediate tree, and is present in all levels of the canopy structure. Regeneration is dominated by black and green ash, with quaking aspen, sugar maple, and red oak also common, and less basswood, paper birch, red maple, and balsam fir. In this forest type, white pine, yellow birch, and white spruce would be expected but have not been detected likely due to lack of seed source. Buckthorn is established in the understory, along with moderately dense beaked hazel, red-osier dogwood, and guelder-rose (*Viburnum opulus*). Bluejoint, sedges, bracken fern, currant, and bush honeysuckle are common in the understory.

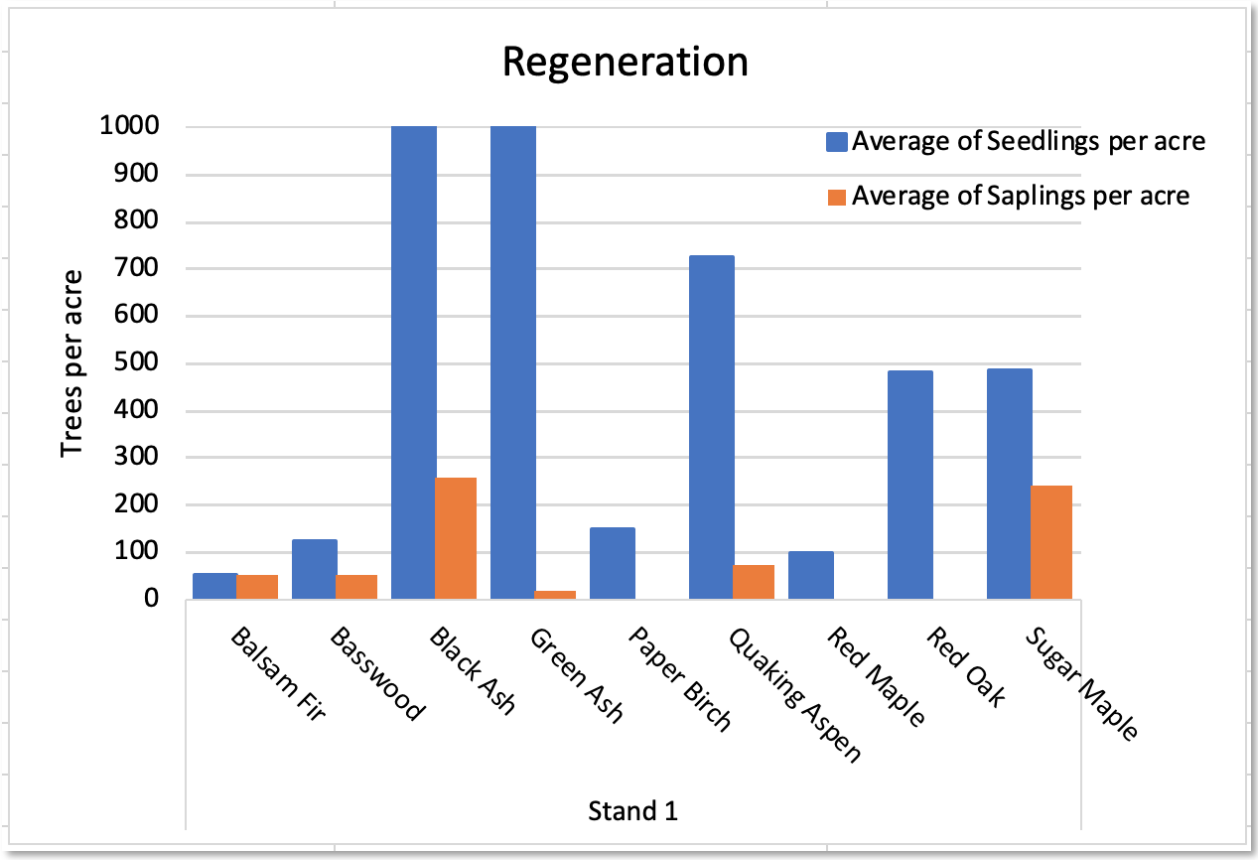
Current Recreational Uses or Management:
A snowmobile trail and hiking trail pass through the stand. Recreational activity is generally lower compared to other areas of the property.

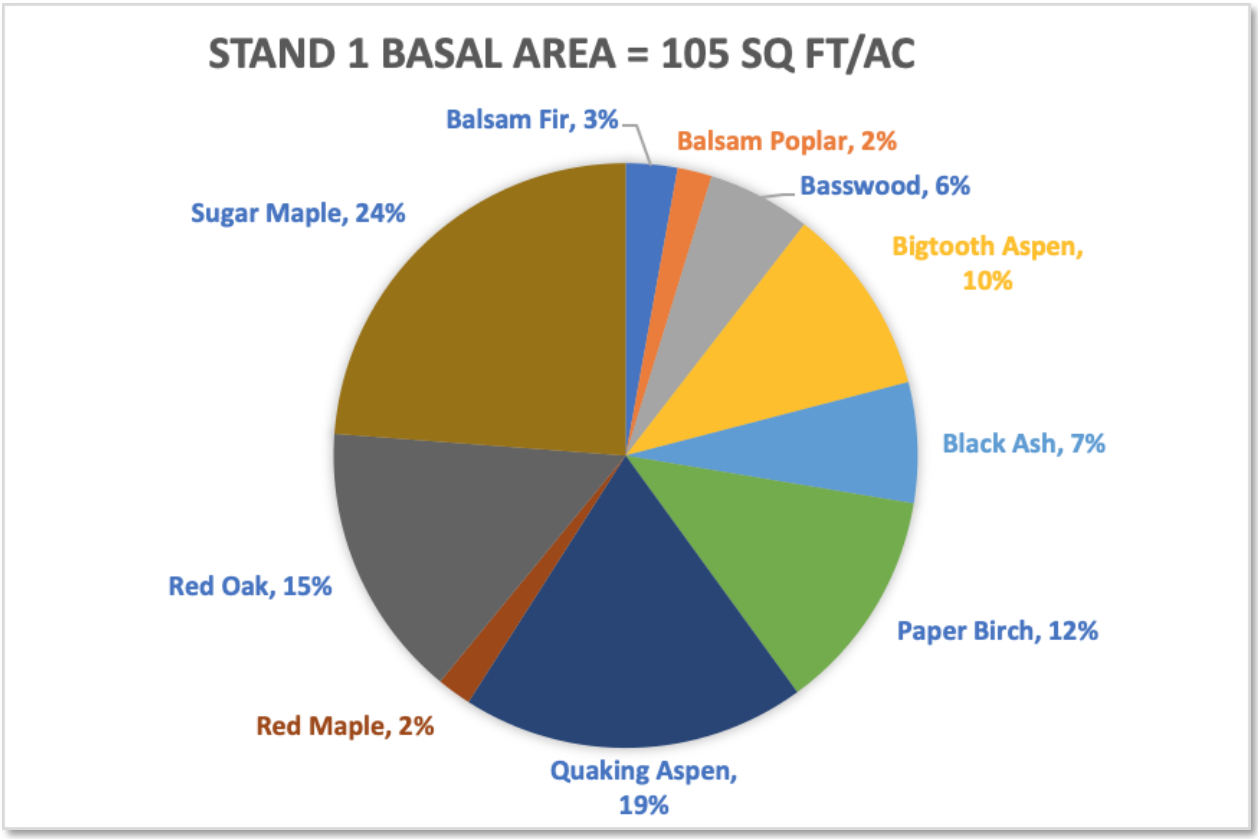
Adjacent land use concerns:
This stand borders private land on three sides

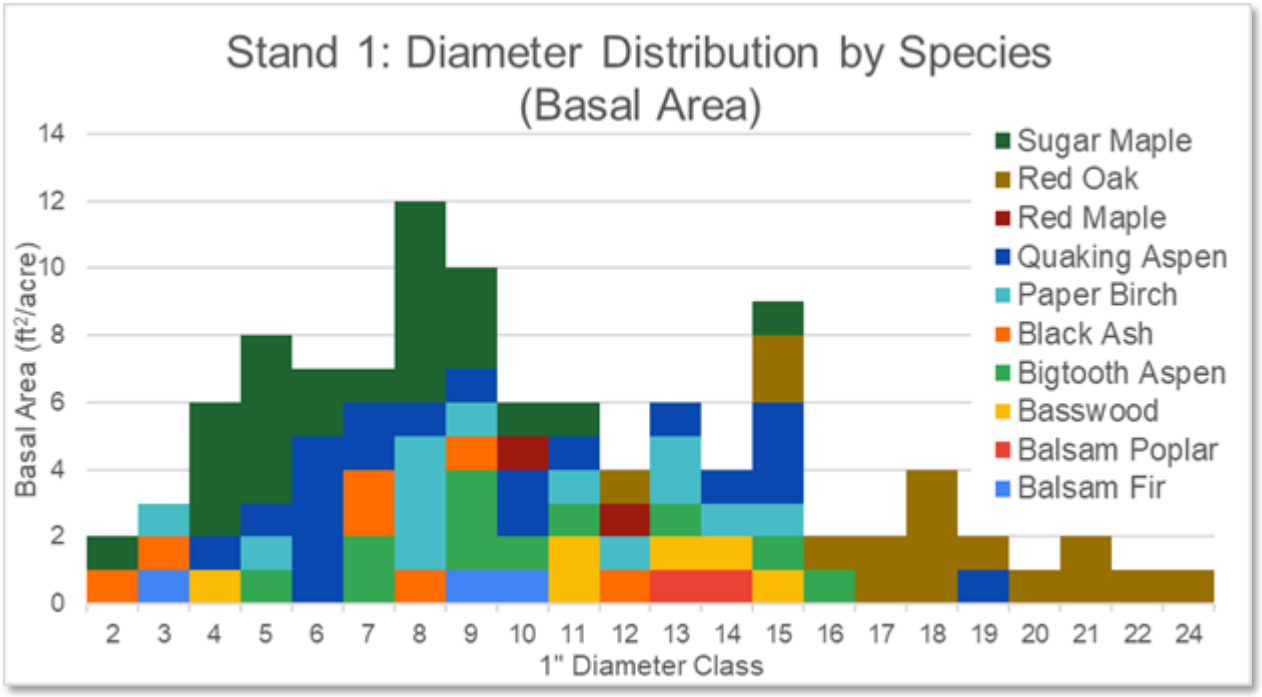
No action result (10-20 years): Buckthorn may become problematic, especially in areas with ash and eventually aspen as these species die out due to EAB or age. Depressions may transition from forested to shrubby or non-forested due to shortage of seed sources to recruit other wet forest species and flooded conditions.

Management Goals, Strategies, and Actions

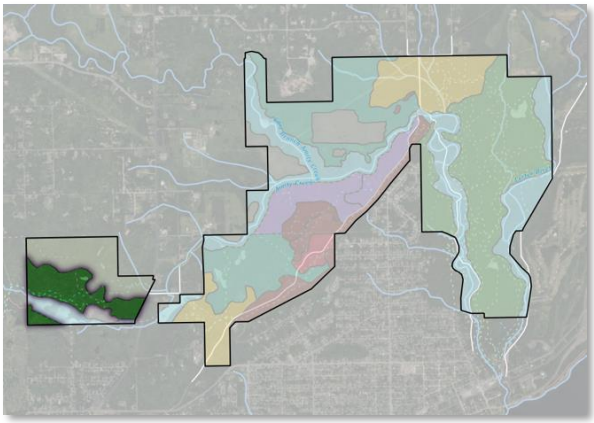
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Regeneration	Artificial regeneration	Disperse tree seeds	
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Assisted migration - Introduce species native to adjacent regions with slightly warmer climates	


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Basswood
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
Stand 1


STAND 1 BASAL AREA = 105 SQ FT/AC
Balsam Fir, 3%
Balsam Poplar, 2%
Basswood, 6%
Bigtooth Aspen, 10%
Black Ash, 7%
Paper Birch, 12%
Quaking Aspen, 19%
Red Maple, 2%
Red Oak, 15%
Sugar Maple, 24%


Stand 1: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 24
1" Diameter Class
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Black Ash
Bigtooth Aspen
Basswood
Balsam Poplar
Balsam Fir

Stand 2 Aspen (Black Ash, Northern Hardwoods)





Stand Characteristics

Forest Type: Aspen (Black Ash, Northern Hardwoods)

Size: 70 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	40.9	58.78%
MHn46b	12.8	18.42%
WFn55a	6.7	9.62%
MHn47a	5.0	7.21%

Dominant Soil:

- F141D (58%): Ahmeek-Normanna-Cathro, depressional, complex, pitted, 0 to 25 percent slopes. Silt loam, loam over gravelly sandy loam at 4". Well drained to moderately well drained with very poorly drained depressions (15%).
- F135A (12%): Hermantown-Canosia-Giese, depressional, complex, 0 to 3 percent slopes. Silt loam and loam over gravelly sandy loam at 5-7". Somewhat poorly drained to very poorly drained.
- GP (7%): gravel pit

Ecological Site (USDA): F093AY013MN Loamy Uplands, F093AY006MN - Depressional Wet Hardwood Forest

Successional Stage (MDNR): Young forest (0-55 years) beginning to transition to mature forest

Average Stand Diameter (DBH): 9.6" (SE=0.9)

Average Stand Basal Area: 110 ft^2/ac (SE=9.5)

Snags per acre: 26 medium (6-11" DBH), 2 large (>12" DBH), mostly aspen

Coarse woody debris: Medium to high

Wildfire risk: Low

Invasive Species: Moderate, buckthorn and honeysuckle are present, but not well-established.

Pests & Disease: EAB present, with trees showing top dieback and epicormic sprouting

Current Condition: This stand is a similar wet-mesic forest with depressions like Stand 1, except quaking aspen (majority 3-8" DBH) and bigtooth aspen (6-11" DBH) are more dominant and oak is less prevalent. Sugar maple is common as an intermediate, subcanopy, and regenerating tree. Paper birch, red oak, basswood, balsam fir, and red maple are also components of the canopy, subcanopy, and regenerating layers. Beaked hazel and buckthorn are the dominant shrub layer species, along with dogwoods. Bush honeysuckle, bracken fern, large-leaved aster, and lady fern are common in the understory. Beaver activity was noted with dams and lodges present in the wetland adjacent to this stand.

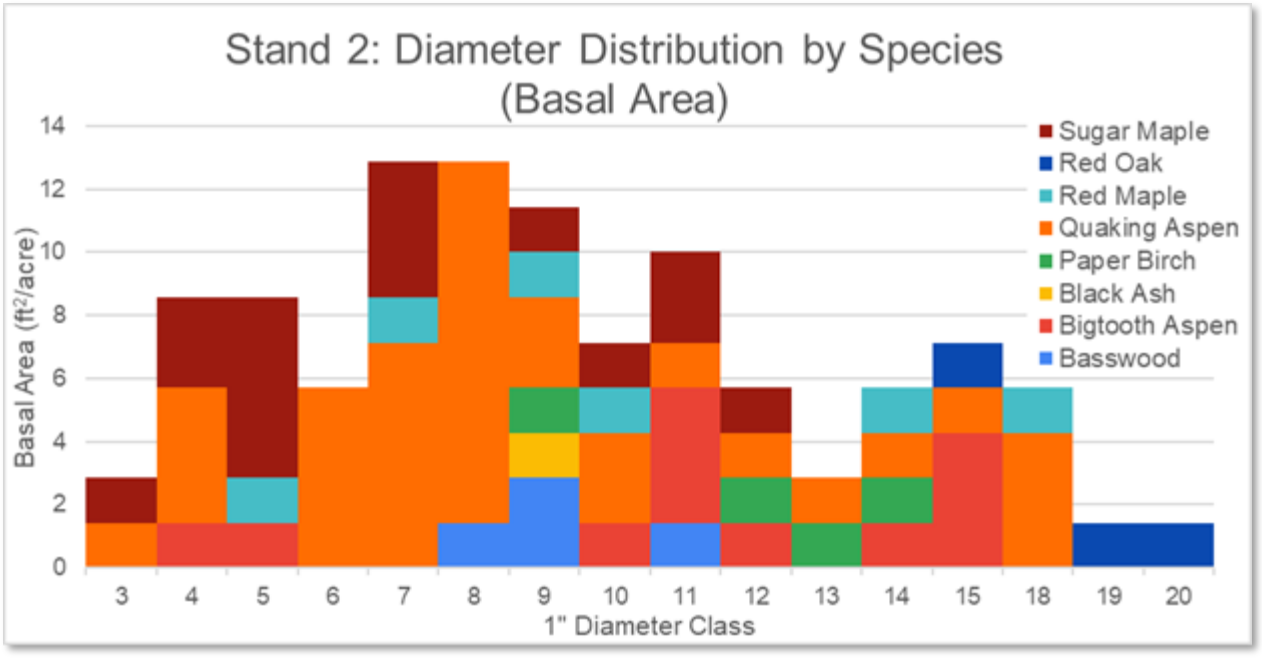
Current Recreational Uses or Management:
A snowmobile trail, mountain bike trail, and hiking trail pass through the stand. Recreational activity is generally lower compared to other areas of the property.

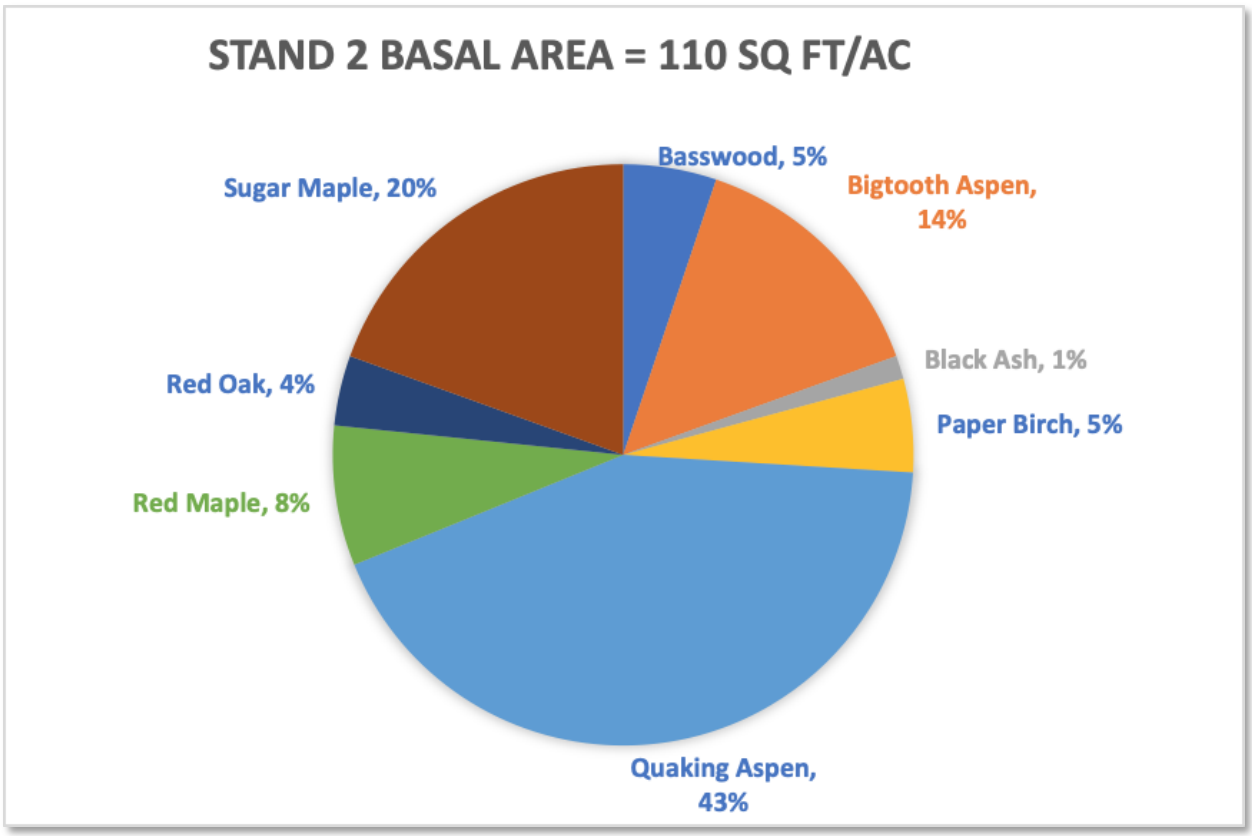
Adjacent land use concerns:
This stand borders private land to the west

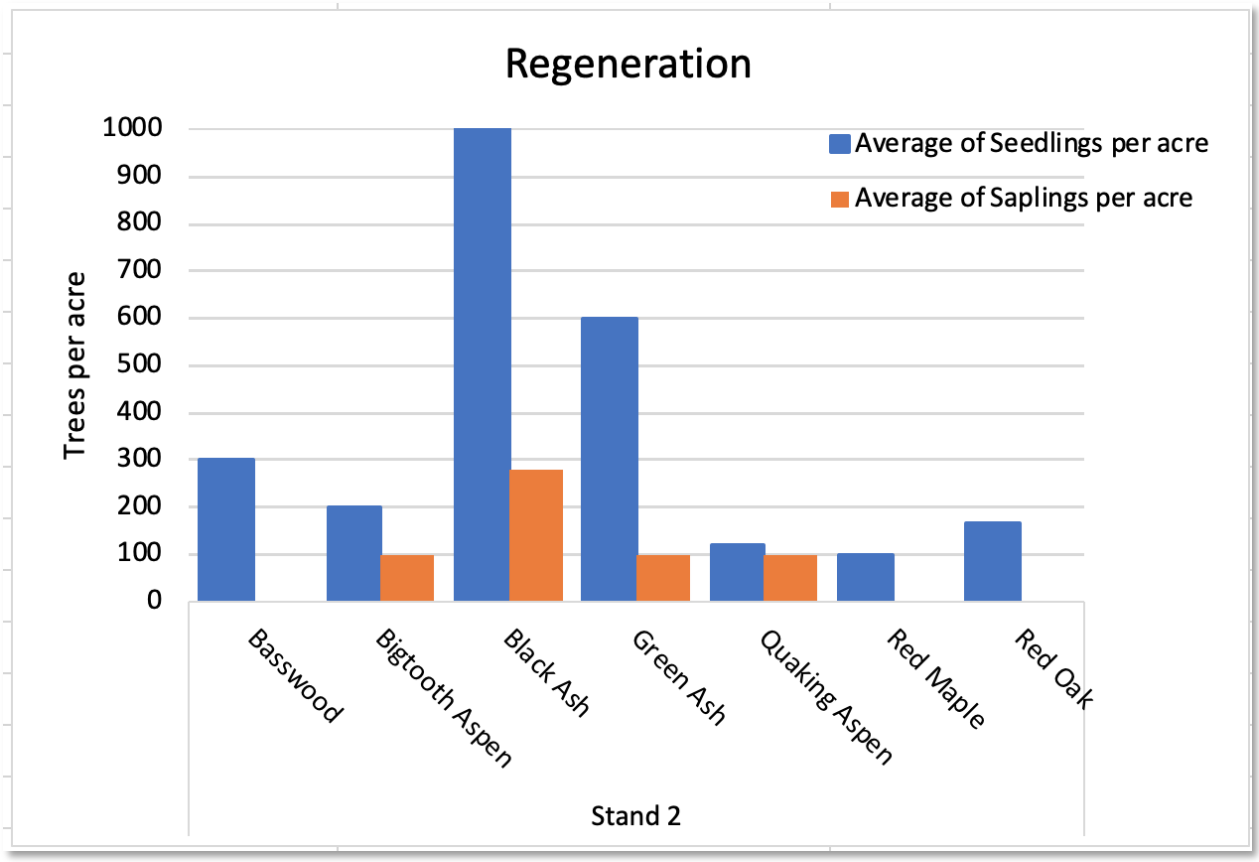
No action result (10-20 years): Buckthorn may become problematic, especially in areas with ash and eventually aspen as these species die out due to EAB or age. Depressions may transition from forested to shrubby or non-forested due to shortage of seed sources to recruit other wet forest species and flooded conditions.

Management Goals, Strategies, and Actions

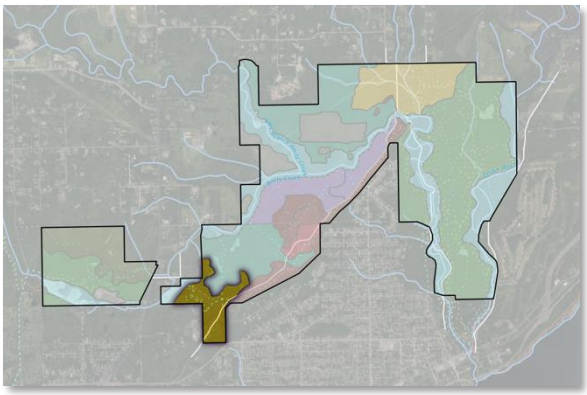
Goal	Strategy	Action	Notes
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Gap selection	Gap widths at least 1-2x height of trees; cut during dormant season. Target aspen.




STAND 2 BASAL AREA = 110 SQ FT/AC
Basswood, 5%
Bigtooth Aspen, 14%
Black Ash, 1%
Paper Birch, 5%
Quaking Aspen, 43%
Red Maple, 8%
Red Oak, 4%
Sugar Maple, 20%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Basswood
Bigtooth Aspen
Black Ash
Green Ash
Quaking Aspen
Red Maple
Red Oak
Stand 2

Stand 3 Aspen-Birch (Red Pine)





Stand Characteristics

Forest Type: Aspen-Birch (Red Pine)

Size: 54 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn43b	26.0	47.87%
MHn35b	12.1	22.22%
Disturbed	5.3	9.69%
WFn74a	4.1	7.52%

Dominant Soil:

- F147D (66%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.
- F160F (21%): Rock outcrop-Mesaba-Barto complex, 18 to 60 percent slopes. Gravelly sand loam over bedrock between 0-28". Well drained.
- F112D (12%): Forbay-Augustana complex, 3 to 18 percent slopes. Loam to 79” depth. Well drained to moderately well drained.

Ecological Site (USDA): F093AY013MN Loamy Uplands, F093AY006MN - Depressional Wet Hardwood Forest, F093AY009MN - Bedrock Controlled Upland Forest

Successional Stage (MDNR): Transitional forest (35-55 years)

Average Stand Diameter (DBH): 9.8” (SE=1.1)

Average Stand Basal Area: 93 ft2/ac (SE=19.2)

Snags per acre: 3 medium (6-11” DBH), 2 large (>12” DBH)

Coarse woody debris: Medium

Wildfire risk: Moderate due to fire-dependent characteristics, Skyline parkway, and proximity to residential and research areas

Invasive Species: Buckthorn is high but in isolated patches, including a several-acre stand of mature buckthorn monoculture

Pests & Disease: Emerald ash borer has caused near total mortality of ash trees. Red pines appear stressed with possible secondary bark beetle impacts.

Current Condition: This is a diverse site spanning the entire slope of the southwestern portion of the Hawk Ridge ridgeline. The soil ranges from very deep loam to exposed bedrock, resulting in variable water and nutrient availability and therefore high stress and variable tree composition. Drier exposed portions of the site are dominated by planted red pine (average 6-14” DBH) with young quaking aspen and balsam

poplar (majority 3-5" DBH with some 6-14" DBH), occasional jack pine, paper birch, and red oak in adjacent non-planted areas. These are fire-dependent characteristic mature forests, with the understory layer mostly a diverse array of shrubs including red-osier dogwood, beaked hazel, mountain ash, nannyberry, serviceberry, *Prunus* spp., and hawthorn. In the deeper and wetter soils of this stand, dead/dying black ash and speckled alder swamps dominate along with a notable stand of very mature (4-6" DBH) monoculture of closed-canopy buckthorn with no other tree cover and little evidence of a native plant community. Alder dominance is well established in the wake of ash decline. Regeneration is strongly dominated by black and green ash seedlings with a low rate of recruitment to the sapling stage. Other species show a similar trend of high seedling establishment but low recruitment to sapling stage - paper birch, quaking aspen, red maple, red oak, and smaller amounts of red pine and balsam fir. White pine and white spruce would be expected in this forest type but are not present, likely due to lack of seed source. The legacy of human disturbances combined with the effects of a harsh environment are apparent in the stand. While the recruitment of fire-intolerant species like red maple and ash indicates succession towards hardwood, the high rate of failure and historic fire-influenced characteristics suggests that the stand may benefit from reintroduction of surface fires and management for a fire-dependent ecosystem.

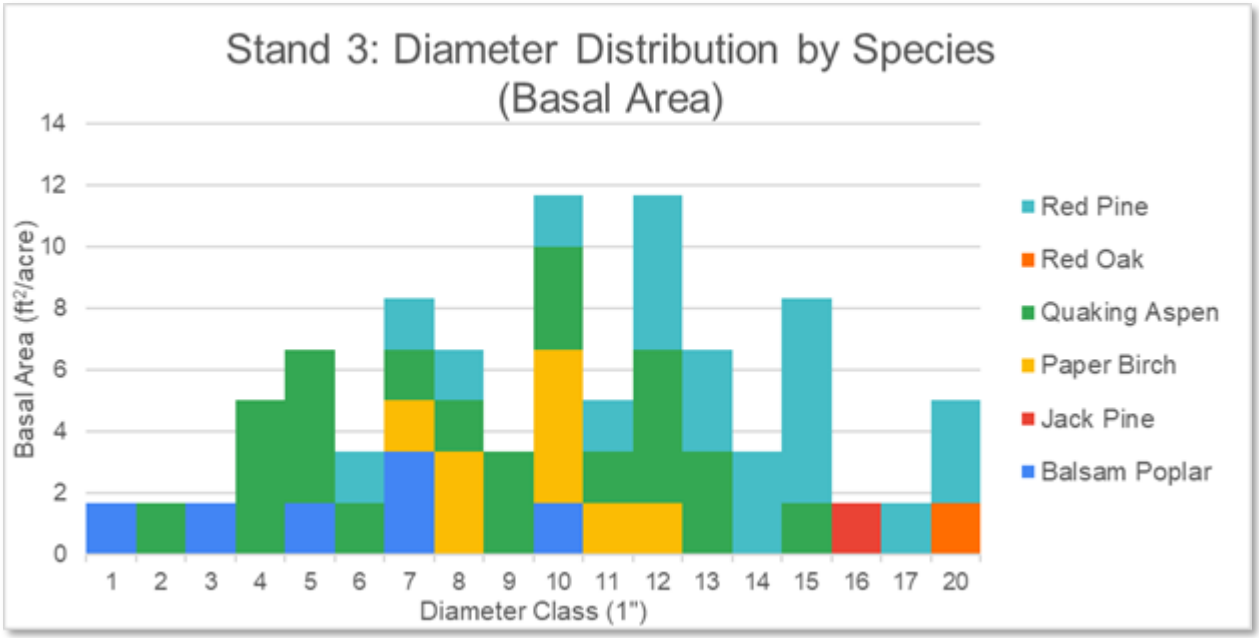
Current Recreational Uses or Management:
Skyline Parkway bisects the stand. A snowmobile trail and hiking trail passes through the stand.

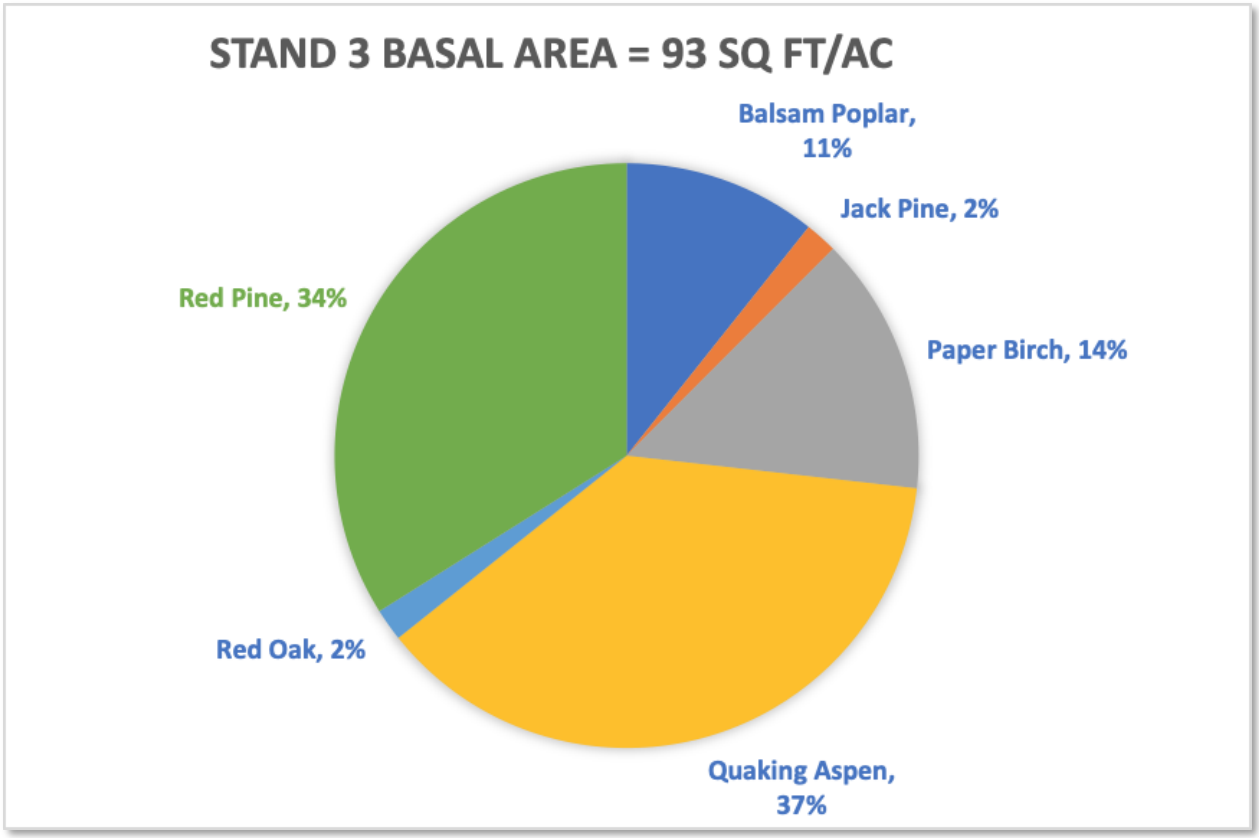
Adjacent land use concerns: Private lands on three sides of the unit, including a dense residential neighborhood to the south.

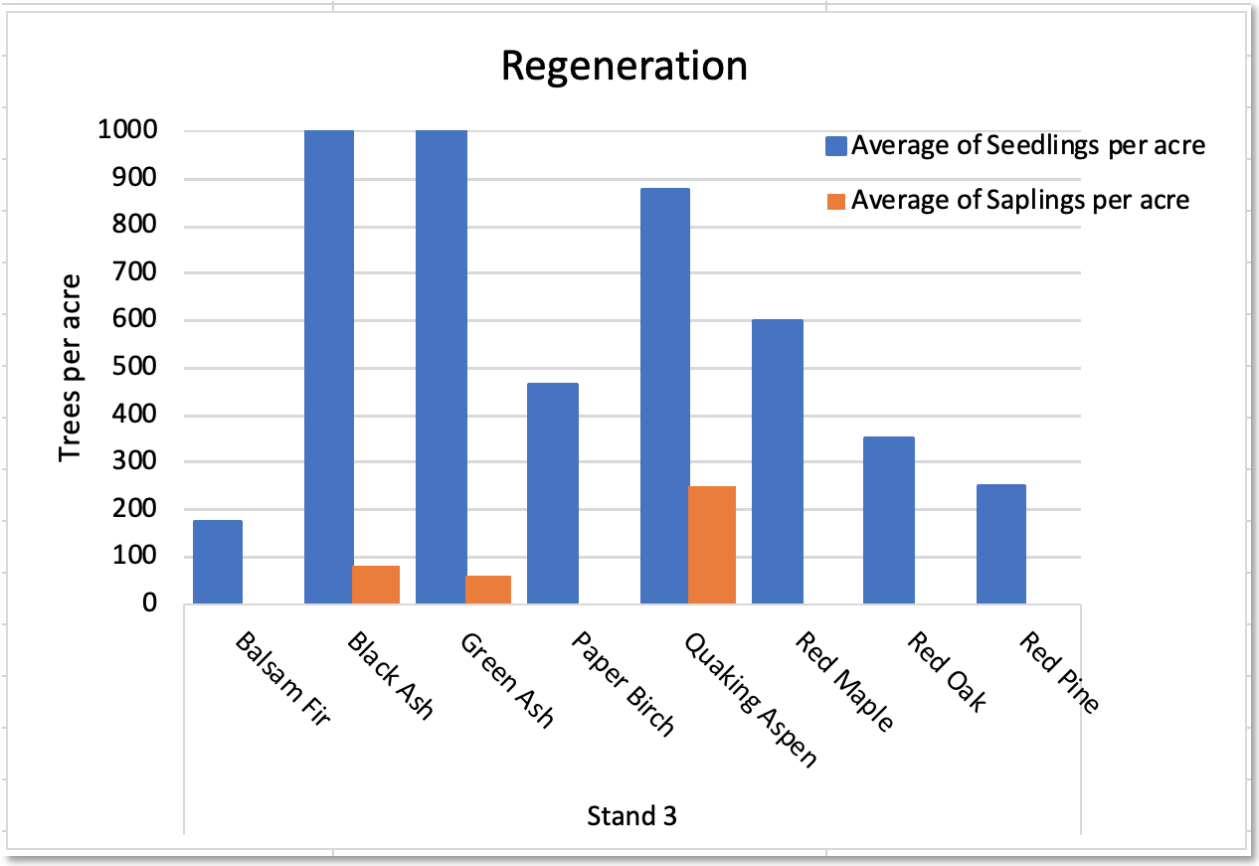
No action result (10-20 years): The stand may continue to transition toward aspen and red maple, and possibly white spruce if seeds are able to disperse from nearby mature trees. The stand is vulnerable to drought and heat stress due to thin soils over bedrock, which may make regeneration for many species challenging, leaving aspen, birch, and drought-hardy understory trees dominant. Buckthorn is likely to expand significantly at the expense of native shrubs and native tree recruitment. Ash stands will likely convert to shrub or non-forested swamps.

Management Goals, Strategies, and Actions

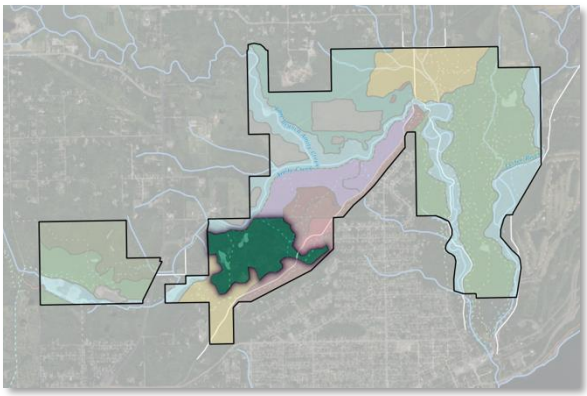
Goal	Strategy	Action	Notes
Restore/enhance native plant communities; Regeneration	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Restore/enhance native plant communities	Restore and maintain fire-dependent plant communities	Prescribed burning	Pine patches


Stand 3: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 20
Diameter Class (1")
Red Pine
Red Oak
Quaking Aspen
Paper Birch
Jack Pine
Balsam Poplar


STAND 3 BASAL AREA = 93 SQ FT/AC
Balsam Poplar, 11%
Jack Pine, 2%
Paper Birch, 14%
Red Pine, 34%
Red Oak, 2%
Quaking Aspen, 37%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Red Pine
Stand 3

Stand 4 Aspen-Birch (Red Maple)





Stand Characteristics

Forest Type: Aspen-Birch (Red Maple)

Size: 104 acres

NPC (MDNR)	*Acres*	*% of stand*
WFn55a	40.3	38.86%
FDn43b	15.6	15.10%
WFn74a	14.0	13.53%
FDn43b1	13.2	12.71%

Dominant Soil:

- F147D (82%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.
- F160F (9%): Rock outcrop-Mesaba-Barto complex, 18 to 60 percent slopes. Gravelly sand loam over bedrock between 0-28". Well drained.
- F135A (7%): Hermantown-Canosia-Giese, depressional, complex, 0 to 3 percent slopes. Silt loam and loam over gravelly sandy loam at 5-7". Somewhat poorly drained to very poorly drained.

Ecological Site (USDA): F093AY013MN Loamy Uplands, F093AY006MN - Depressional Wet Hardwood Forest, F093AY009MN - Bedrock Controlled Upland Forest

Successional Stage (MDNR): Young forest (0-75 years)

Average Stand Diameter (DBH): 8.1" (SE=0.9)

Average Stand Basal Area: 56 ft2/ac (SE=10.1)

Snags per acre: 54 medium, many paper birch (6-11" DBH), 5 large (>12" DBH), mostly ash and aspen

Coarse woody debris: Medium to high

Wildfire risk: Low

Invasive Species: Moderate - buckthorn is typically present in low amounts, but high in isolated areas

Pests & Disease: EAB is established with overstory mortality present

Current Condition: This stand is similar to Stand 3 in being a mosaic of shallow bedrock soils and deeper loamy soils, with variable water retention and therefore a forest composition ranging from fire-influenced on exposed dry sites to wet forested and herbaceous swamps in depressions. Stand 4 is generally flatter, richer, and wetter than Stand 3. Young (3-11" DBH) quaking aspen and red maple (6-14" DBH) dominate

the sparse and inconsistent overstory, with paper birch (3-11" DBH) and bigtooth aspen (3-8" DBH) as co-dominants and balsam fir (3-5") emerging in the intermediate layer. Emerald ash borer has caused a near-total ash mortality in wet forested areas, leaving speckled alder as strongly dominant, making any effort at ash underplanting challenging. Black and green ash is retained as a dense regeneration layer, with some successful establishment of black ash to saplings. Quaking aspen, balsam fir, and bigtooth aspen make up the remainder of a modest sapling cohort. Quaking aspen seedlings are also very prevalent, and small amounts of paper birch, red maple, and red oak that have not recruited to the sapling age. Other than dense areas of speckled alder, the shrub layer is moderate and consists of beaked hazel, buckthorn, dogwoods, and serviceberry. Bluejoint is common in the understory, along with goldenrod and bush honeysuckle. Despite the presence of fire-dependent plant communities, returning fire to this stand may not be a priority nor practical due to prevalence of fire-intolerant species, difficulty to access with equipment, and generally swampy conditions.

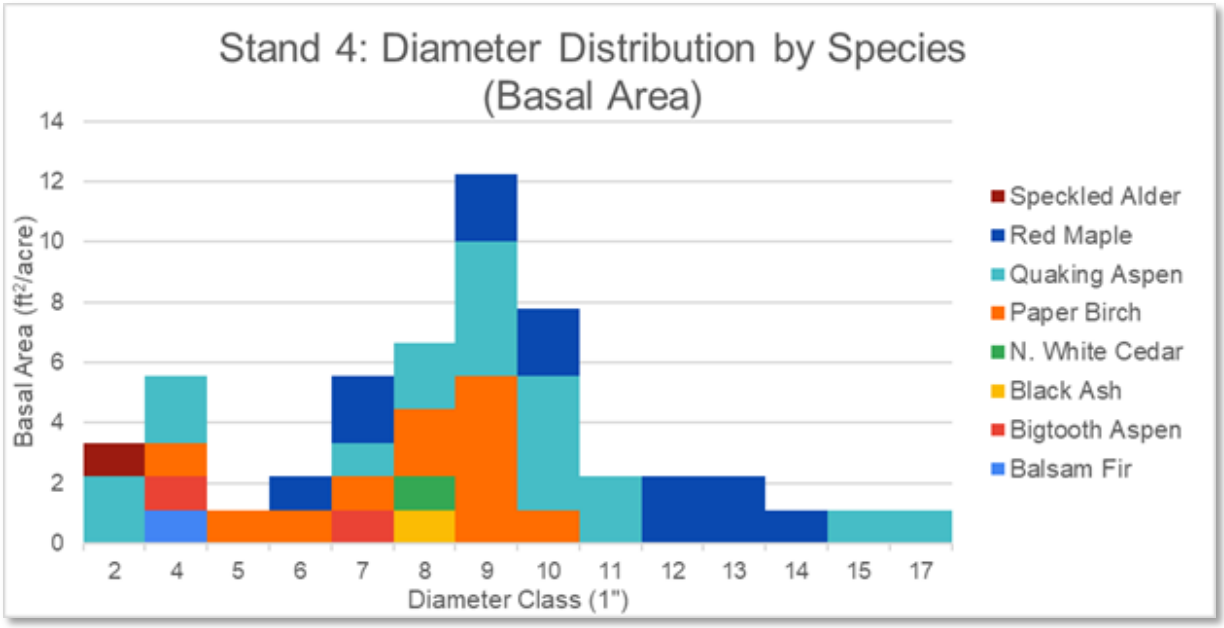
Current Recreational Uses or Management:
A snowmobile trail and a hiking trail pass through the stand. A primary hawk research facility is located in the southern section of the stand, with associated vegetation clearing surrounding it and throughout the stand.

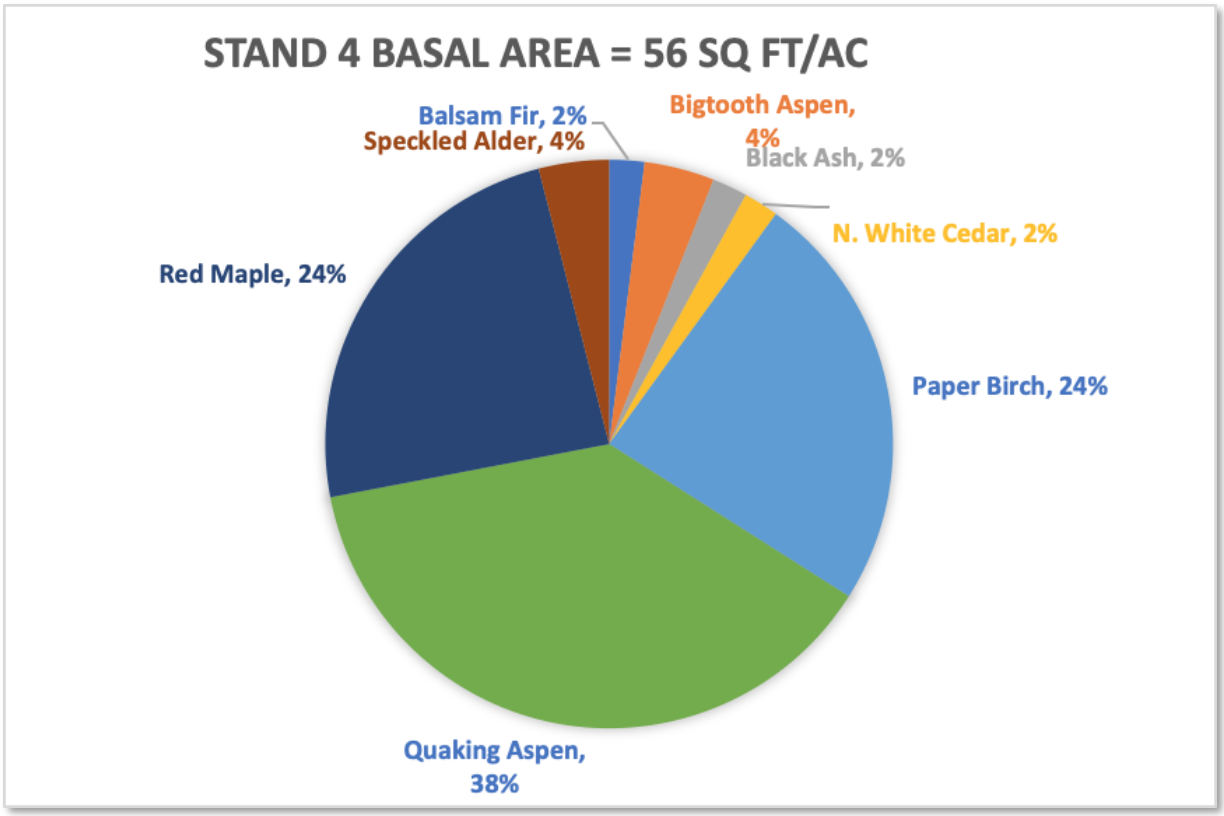
Adjacent land use concerns: N/A

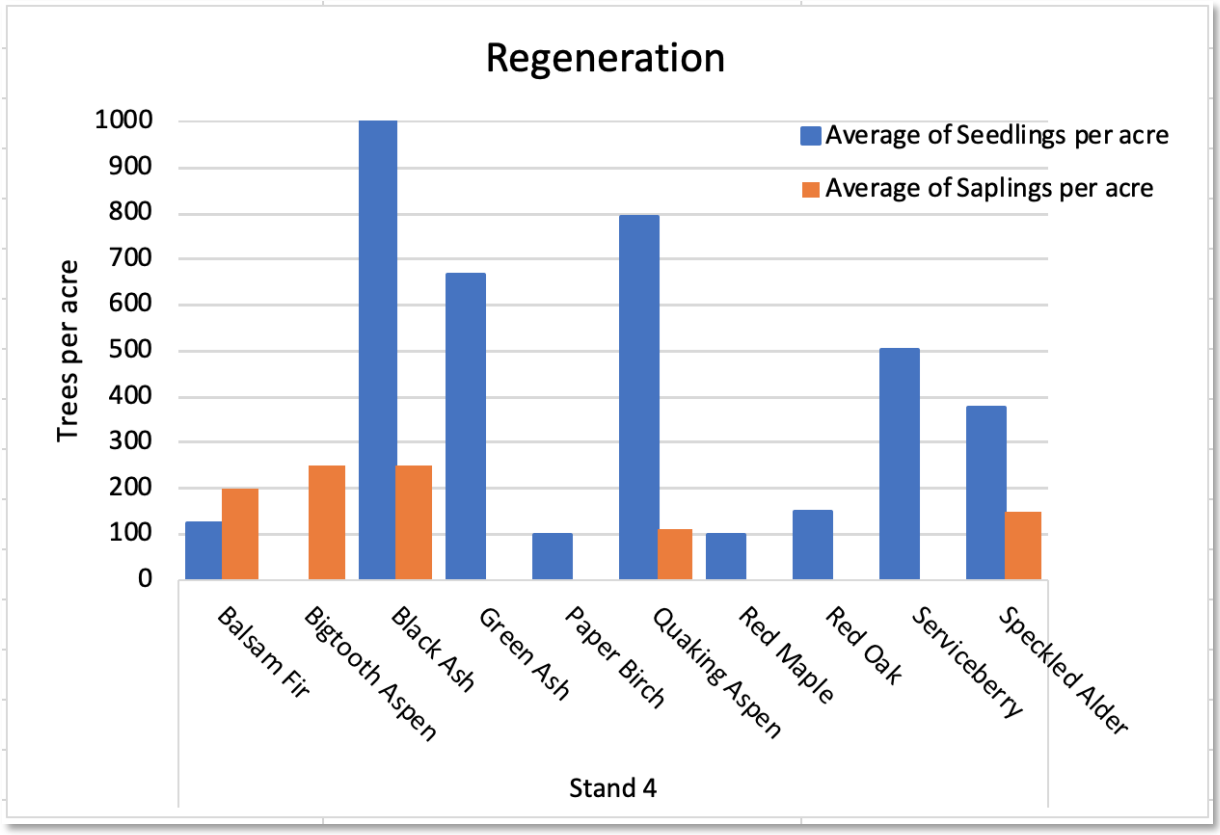
No action result (10-20 years): The stand is likely to continue to persist in a fairly consistent state. Balsam fir and red maple may become more dominant as aspen and birch age out. Due to variable water retention in the soil, flooding or drought events may cause excess and rapid tree mortality leading to dramatic changes to successional state and possibly composition. Buckthorn is likely to expand significantly at the expense of native shrubs and native tree recruitment. Ash stands will likely convert to shrub or non-forested swamps.

Management Goals, Strategies, and Actions

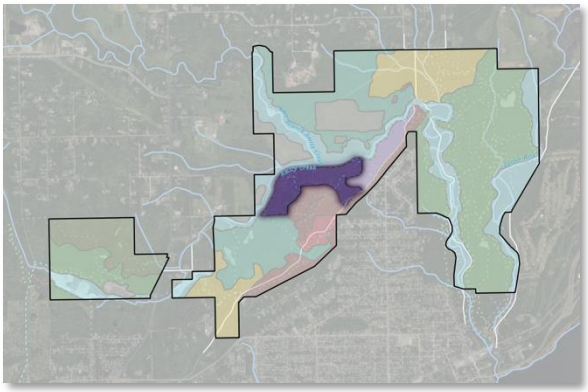
Goal	Strategy	Action	Notes
Restore/enhance native plant communities; EAB restoration	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Underplanting - Plant trees other than ash where ash decline and mortality is advanced	
Regeneration	Reduce competition in midstory	Mulch/masticate shrub layer	Mastication in strips of overabundant shrubs (up to 30% of stand at one time). Target alder, buckthorn


Stand 4: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
14
12
10
8
6
4
2
0
2 4 5 6 7 8 9 10 11 12 13 14 15 17
Diameter Class (1")
Speckled Alder
Red Maple
Quaking Aspen
Paper Birch
N. White Cedar
Black Ash
Bigtooth Aspen
Balsam Fir


STAND 4 BASAL AREA = 56 SQ FT/AC
Balsam Fir, 2%
Speckled Alder, 4%
Bigtooth Aspen, 4%
Black Ash, 2%
N. White Cedar, 2%
Red Maple, 24%
Paper Birch, 24%
Quaking Aspen, 38%



Stand 5 Aspen-Birch (Plantation)





Stand Characteristics

Forest Type: Aspen-Birch (Plantation)

Size: 60 acres

NPC (MDNR)	*Acres*	*% of stand*
Disturbed	31.7	52.60%
FDn43b1	15.9	26.38%
FDn43c	4.7	7.86%
MHn46b	4.0	6.60%

Dominant Soil:

- F147D (94%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.

Ecological Site (USDA): F093AY013MN Loamy Uplands, F093AY006MN - Depressional Wet Hardwood Forest

Successional Stage (MDNR): Modified, with characteristics of both mature (55-95 years) and transitional (35-55 years)

Average Stand Diameter (DBH): 8.0"; SE 1.0"

Average Stand Basal Area: 129 ft2/ac: SE 12.8 ft2/ac

Snags per acre: 49 medium (6-11" DBH), many conifer (black spruce) and black ash

Coarse woody debris: High

Wildfire risk: High due to fuel loading from blowdown and dense living and dead balsam fir and white spruce

Invasive Species: Low to moderate, buckthorn and honeysuckle present sporadically throughout stand

Pests & Disease: Emerald ash borer has caused significant ash mortality

Current Condition

This stand has similar topographic and soil characteristics as Stand 4, but clearly has a different management history with extensive over-mature or failed tree plantations and more modified native plant communities indicating a likely history of tilling and cultivation. Distinct stands of planted red pine (15-20" and 6-8" DBH) and black spruce (6-12") are fairly or in need of thinning. Young aspen (majority <5" but occasionally up to 20" DBH) with fewer paper birch (3-11" DBH) occur on the outskirts or within canopy gaps of planted stands. Balsam fir and white spruce (3-8" DBH) are becoming established as intermediate trees in the understory. Black ash, balsam poplar, and speckled alder are also present, although many black ash have died. The stand has many dead and downed trees from failed plantings and blowdown. Regeneration is strong, with half black ash and the remainder quaking aspen, balsam fir, and lesser amounts of balsam poplar, paper birch, red oak, and white spruce. Shrub layer is moderately dense with buckthorn, beaked hazel, and serviceberry. White and red pine are ecologically appropriate to the site but are uncommon as naturally occurring trees. The ecological history and trajectory is difficult to read but trends towards fire-dependent and may be more fully expressed through reintroduction of surface burning.

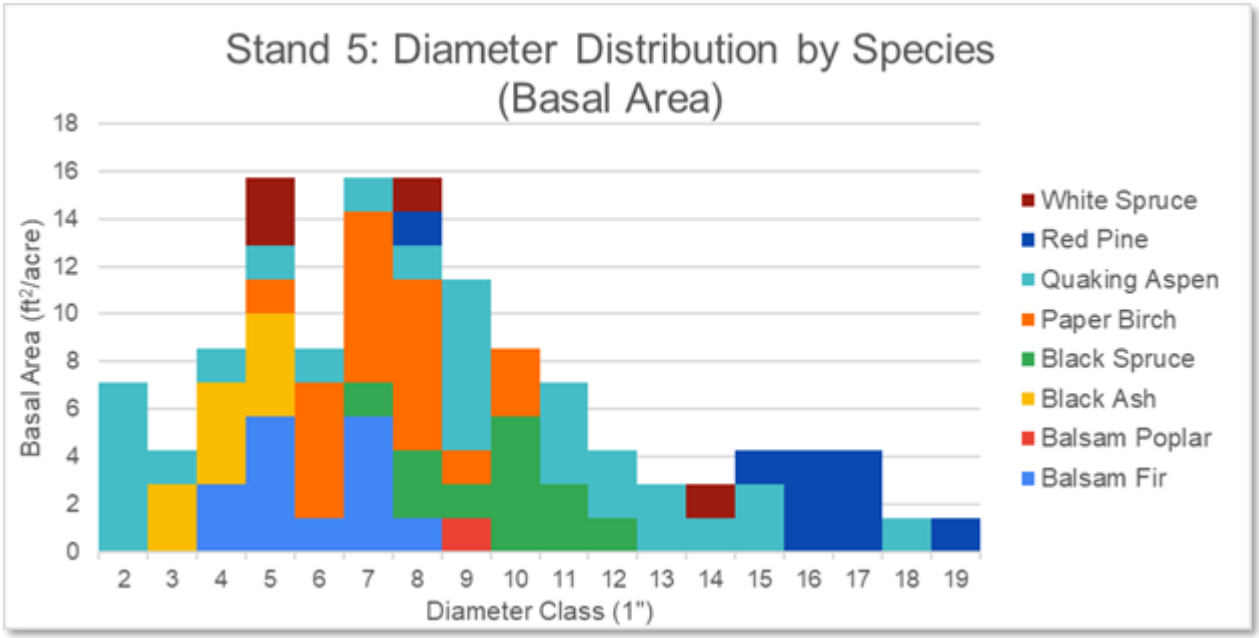
Current Recreational Uses or Management: A couple of hiking trails pass through the unit. The northern boundary of the unit is defined by the Amity Creek/Duluth Traverse trail.

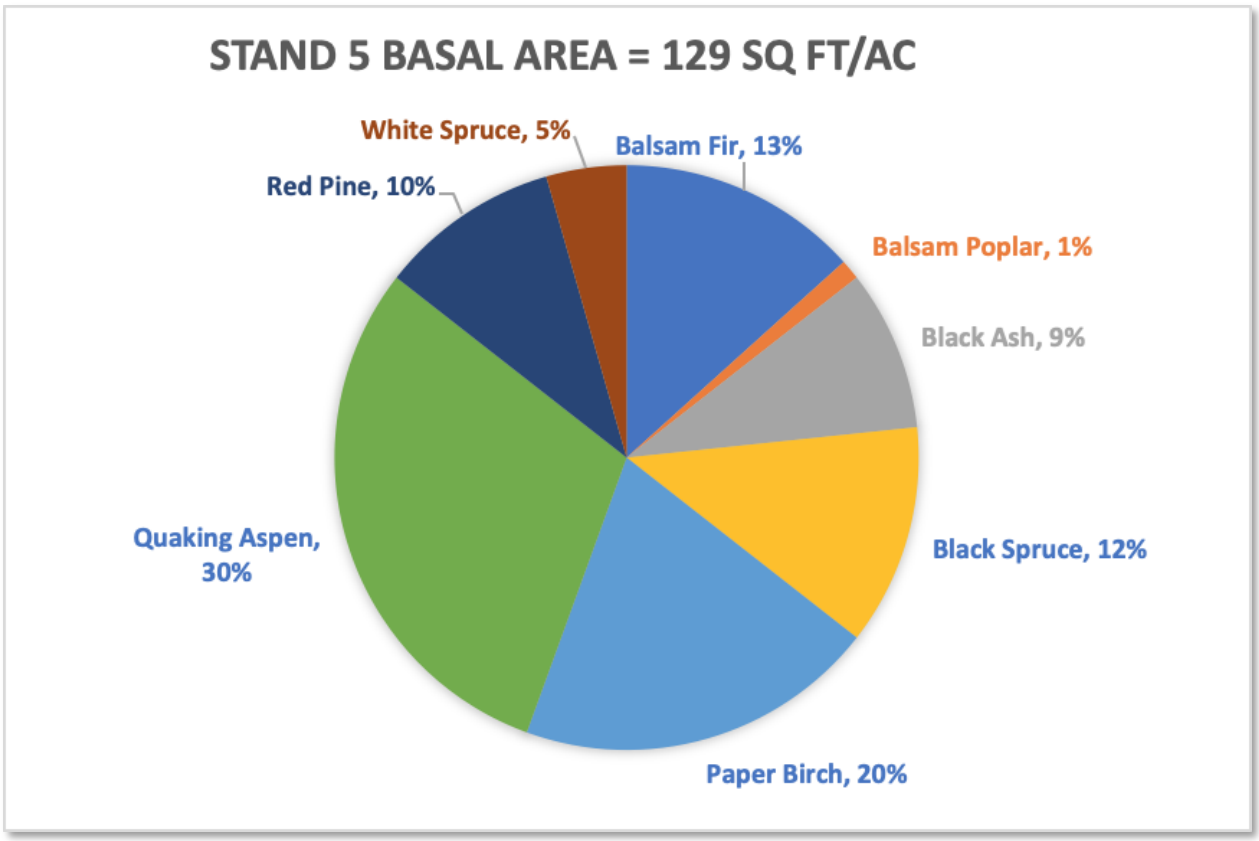
Adjacent land use concerns: Water tower is present in on the eastern boundary of this unit, as is Skyline Parkway

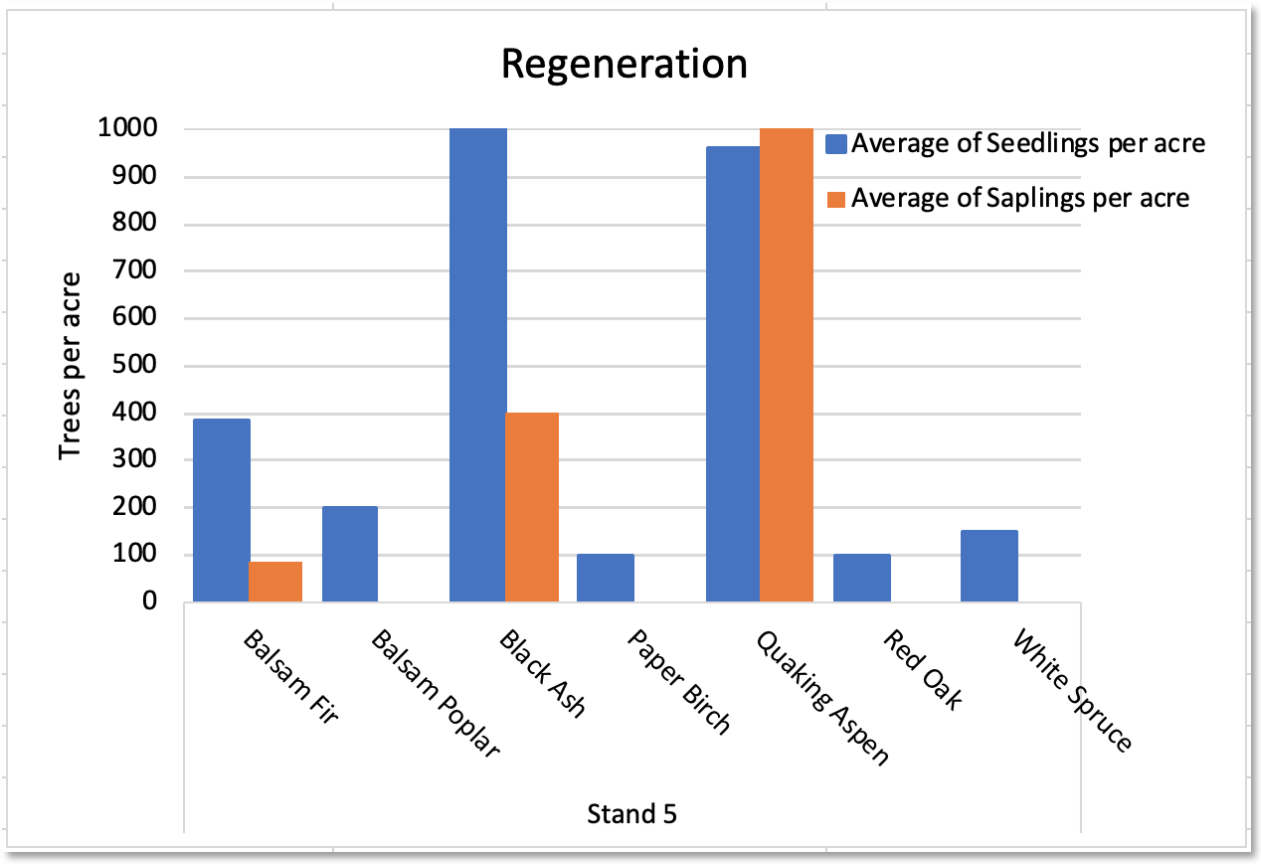
No action result (10-20 years): Some aspen will continue to recruit. Planted conifers will continue to age out and fail due to overcrowding, increasing hazardous fuel load. Black ash will continue to fail and may be replaced by white spruce and balsam poplar, or possibly wet areas will convert to speckled alder or grass-dominant wet meadows.

Management Goals, Strategies, and Actions

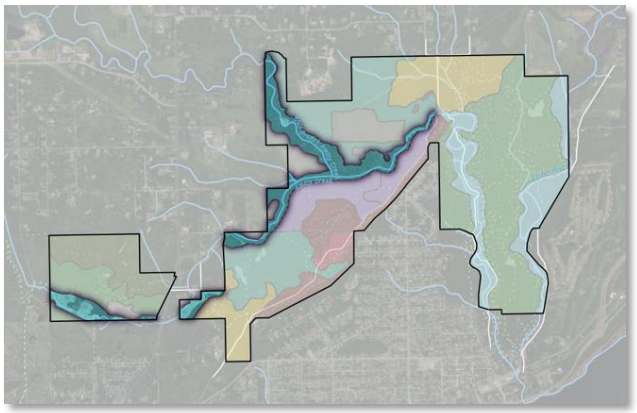
Goal	Strategy	Action	Notes
Forest resilience	Reduce hazardous fuel load to reduce wildfire risk and severity	Thin and remove overcrowded balsam fir or white spruce; Thin and remove above ground dead/down woody debris (lacking soil contact) that creates a fuel ladder into tree canopies; Woody debris processing through biochar creation, pile burning, or off-site chipping	Slash and storm damage tree removal
Restore/enhance native plant communities; Regeneration	Restore and maintain fire-dependent plant communities	Prescribed burning	Site preparation before tree planting
Forest resilience	Support health of retained trees	Thin overstocked mature trees (shelterwood harvest)	Retain most vigorous individuals of desired species, commercial harvest where possible
Regeneration	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Assisted migration - Introduce species native to adjacent regions with slightly warmer climates	
Regeneration; Restore/enhance native plant communities	Artificial regeneration	Plant trees	Plant long-lived moisture tolerant species


Stand 5: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
18
16
14
12
10
8
6
4
2
0
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Diameter Class (1")
White Spruce
Red Pine
Quaking Aspen
Paper Birch
Black Spruce
Black Ash
Balsam Poplar
Balsam Fir


STAND 5 BASAL AREA = 129 SQ FT/AC
White Spruce, 5%
Balsam Fir, 13%
Red Pine, 10%
Balsam Poplar, 1%
Black Ash, 9%
Quaking Aspen, 30%
Black Spruce, 12%
Paper Birch, 20%


Regeneration
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Average of Seedlings per acre
Average of Saplings per acre
Balsam Fir
Balsam Poplar
Black Ash
Paper Birch
Quaking Aspen
Red Oak
White Spruce
Stand 5

Stand 6 Riparian





Stand Characteristics

Forest Type: Riparian

Size: 147 acres

NPC (MDNR)	*Acres*	*% of stand*
FFn57a	48.6	33.02%
MHn46b	30.6	20.77%
Disturbed	25.6	17.41%
MHn35b	23.0	15.64%

Dominant Soil:

- E9E (23%): Miskoaki-Fluvaquents, frequently flooded, complex, 0 to 45 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.
- E8D (15%): Amnicon-Fluvaquents, frequently flooded, complex, 0 to 18 percent slopes. Silt loam, silty clay loam over clay at 13" or stratified silt loam to gravelly clay loam at 11". Well drained.
- E23F (12%): Miskoaki-Udifluvents, flooded, complex, 1 to 45 percent slopes. Silt loam, silty clay loam over clay at 6"; sandy loam, stratified very gravelly sandy loam. Well drained to somewhat poorly drained.
- F148F (8%): Ahmeek-Rock outcrop-Fluvaquents, frequently flooded, complex, 0 to 50 percent slopes. Silt loam over gravelly sandy loam at 4" or mucky silt loam over stratified silt loam to gravelly loamy coarse sand at 6" or bedrock. Well drained to poorly drained.
- E11E (7%): Miskoaki-Rock outcrop complex, 18 to 70 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.
- GP (7%): gravel pit

Ecological Site (USDA): F092XY015WI - Clayey Uplands, F092XY007WI - Wet Loamy or Clayey Lowlands, F092XY004WI - Seasonally Dry Floodplains (35%)

Successional Stage (MDNR): Young forest (0-55 years) approaching transitional forest (55-95 years)

Average Stand Diameter (DBH): 7.4”; SE 0.5”

Average Stand Basal Area: 96 ft2/ac; SE 10.5 ft2/ac

Snags per acre: 48 medium, mostly ash (6-11” DBH), 5 large (>12” DBH)

Coarse woody debris: High to medium

Wildfire risk: Low

Invasive Species: Variable, buckthorn present throughout, problematic in some areas

Pests & Disease: EAB widely established, dead and dying trees present

Current Condition: This floodplain forest with hardwood terraces spans a long stretch throughout the property encompassing banks and floodplains of Amity Creek and East Branch Amity Creek. This area is generally level, unlike the steeply eroding banks of lower Amity Creek (Stand 14). Quaking aspen, paper birch, and balsam poplar dominate the canopy, which ranges from open to closed. The majority of canopy trees are 3-5" DBH, with fewer larger trees up to 20" and occasional larger black willow. Black ash was recently an important canopy tree but has declined significantly due to emerald ash borer. Balsam fir and white spruce are establishing as intermediate trees. The regeneration layer is of the same general composition, with numerous black ash and the addition of occasional red pine, scotch pine, red maple, and red oak, and planted and caged white cedar and white pine. Speckled alder is common, along with beaked hazel, buckthorn, serviceberry, and occasional mountain maple and Prunus spp. Ostrich fern is monoculture in some locations. Bluejoint, goldenrod, and horsetail are also common. The upper reaches of both creek branches have high beaver activity including dams, felled trees, and pooled water with associated wetland communities.

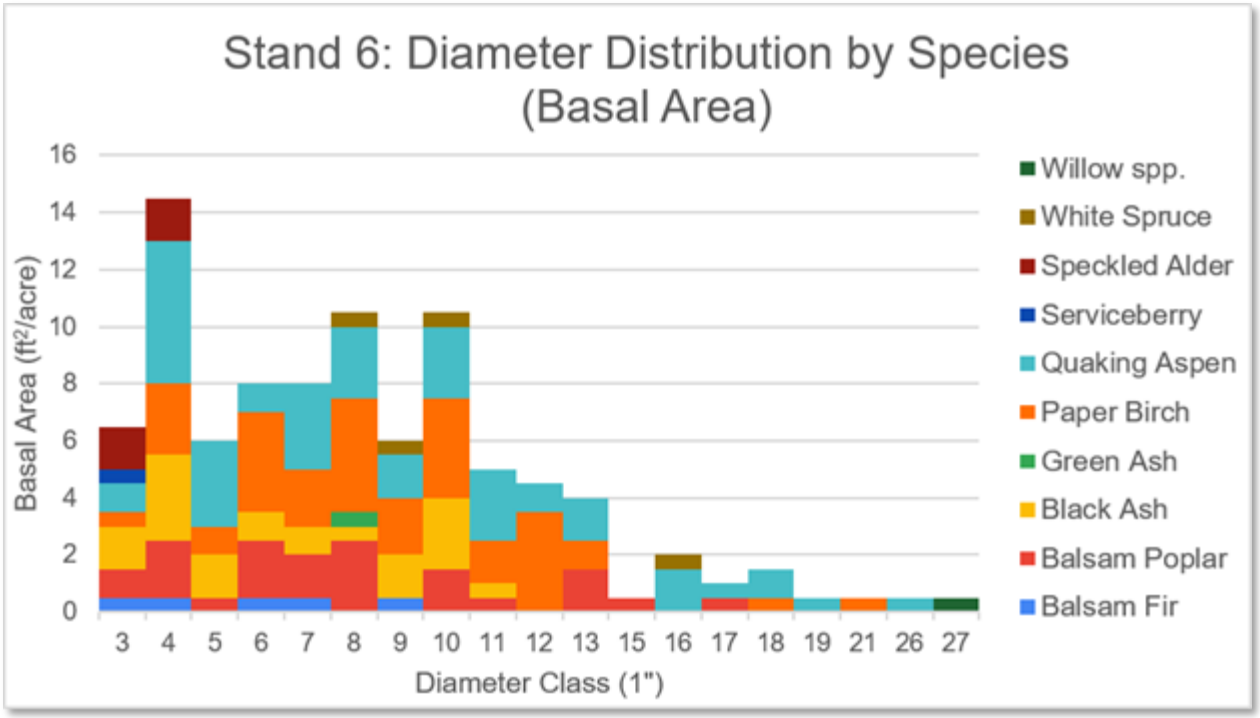
Current Recreational Uses or Management:
Recreational trail along the southern edge of stand. Sections along Amity Creek have planted and caged white pine, white cedar, and other seedlings. The far western section west of Jean Duluth Rd has been impacted through gravel extraction.

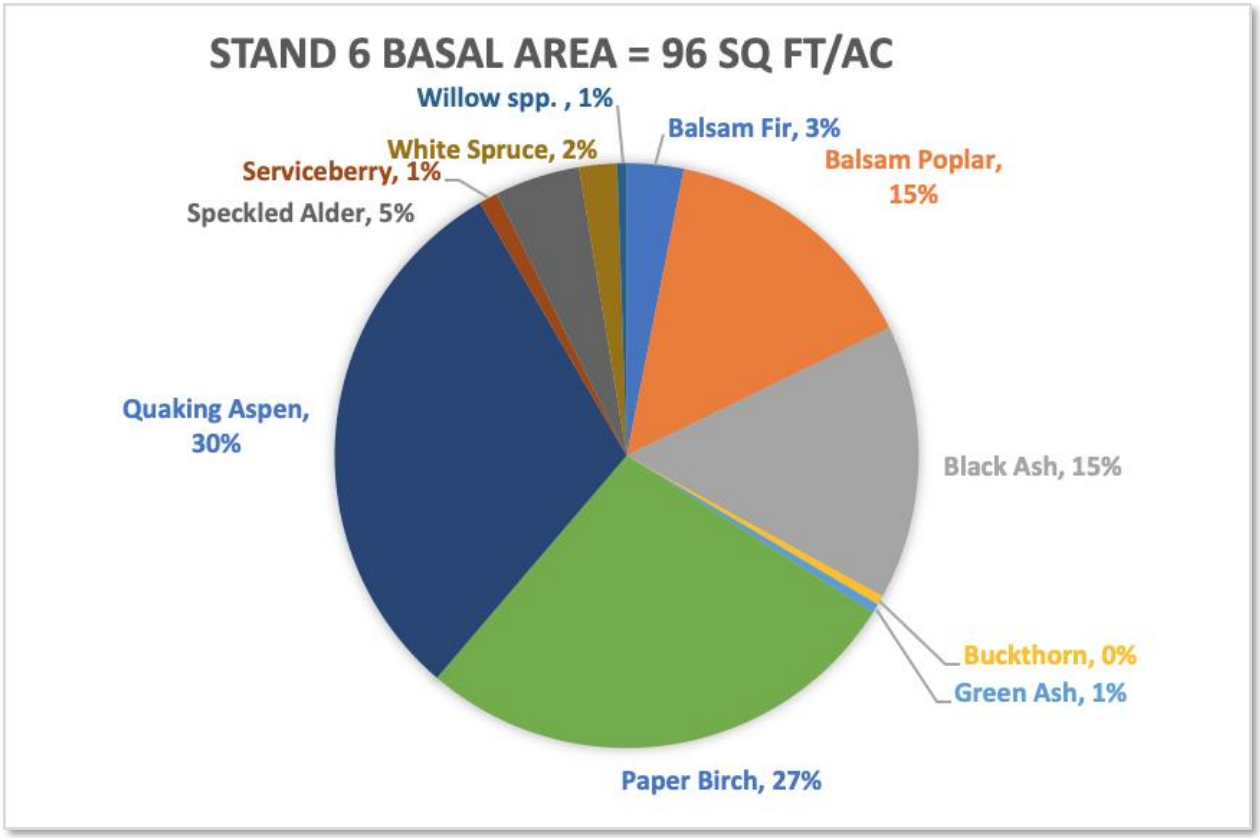
Adjacent land use concerns:
The Vermillion Road crossing upstream of beaver dams on Amity Creek may be impacted by beaver activity.

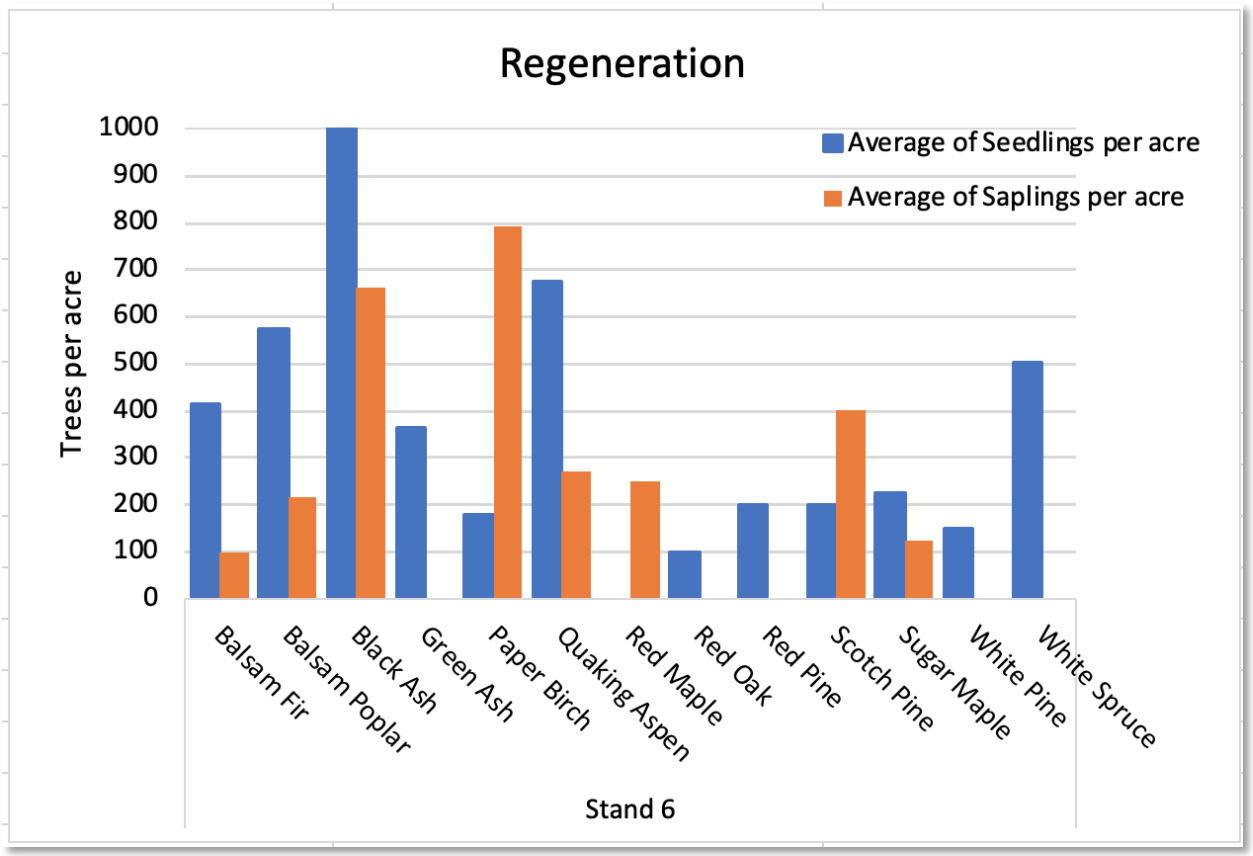
No action result (10-20 years): Emerald ash borer will continue to kill ash, causing possible transition to non-forested wetlands in some places. Balsam poplar, paper birch, and quaking aspen will continue to recruit. White spruce and balsam fir will become more established over time.

Management Goals, Strategies, and Actions

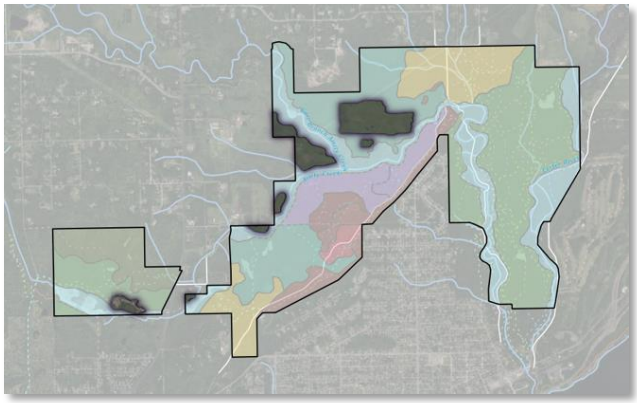
Goal	Strategy	Action	Notes
Restore/enhance native plant communities; Ecosystem function	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Underplanting - Plant trees other than ash where ash decline and mortality is advanced	


Stand 6: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
16
14
12
10
8
6
4
2
0
3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19 21 26 27
Diameter Class (1")
Willow spp.
White Spruce
Speckled Alder
Serviceberry
Quaking Aspen
Paper Birch
Green Ash
Black Ash
Balsam Poplar
Balsam Fir


STAND 6 BASAL AREA = 96 SQ FT/AC
Willow spp. , 1%
Balsam Fir, 3%
White Spruce, 2%
Serviceberry, 1%
Balsam Poplar, 15%
Speckled Alder, 5%
Quaking Aspen, 30%
Black Ash, 15%
Buckthorn, 0%
Green Ash, 1%
Paper Birch, 27%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Red Pine
Scotch Pine
Sugar Maple
White Pine
White Spruce
Stand 6

Stand 7 Non-Forested Field





Stand Characteristics

Forest Type: Non-Forested Field

Size: 84 acres

NPC (MDNR)	*Acres*	*% of stand*
Disturbed	73.6	87.68%
Developed	7.6	9.09%

Dominant Soil:

- E3A (61%): Cuttre complex, 0 to 3 percent slopes. Silt loam, silty clay loam, over clay at 5-8". Somewhat poorly drained to poorly drained.
- E2B (9%): Cuttre-Fluvaquents, frequently flooded, complex, 0 to 8 percent slopes. Silt loam or silty clay loam over clay at 8" or stratified silt loam to gravelly clay loam at 11". Somewhat poorly drained to very poorly drained.
- GP (8%): gravel pit
- F111B (7%): Augustana-Hegberg complex, 1 to 8 percent slopes. Loamy and/or silty material over friable loamy till over dense loamy till. Moderately well drained to somewhat poorly drained.

Average Stand Diameter (DBH): N/A

Average Stand Basal Area: N/A

Snags per acre: N/A

Coarse woody debris: Low to none

Wildfire risk: Moderate, fine flashy fuels abundant (grass)

Invasive Species: Non-native pasture grasses and herbaceous plants

Pests & Disease: N/A

Current Condition: This stand combines six distinct areas that are non-forested and primarily non-native. This includes one active gravel pit west of Jean Duluth Rd, three maintained fields that appear to be horse pastures utilized by neighboring private landowners, and one large rectangular field with a history of tree nursery and possibly other forms of cultivation. This latter field and the edges or drainages of some of the other fields have patches of small tree and shrub cover such as willow, dogwood, young white spruce, non-native spruces, and aspen. If allowed to proceed with no management, they are likely to become afforested with aspen, spruce, and other native species. However, their current openness offers opportunities to diversify land cover or support local enterprises.

Current Recreational Uses or Management:
City use, horse pasture, potentially a solar installation. Evidence of a former tree nursery in the large rectangular field. A high-voltage electric transmission line runs through the largest field.

Adjacent land use concerns:
Neighboring private landowners utilizing boundary fields for horse pasture or horse trails.

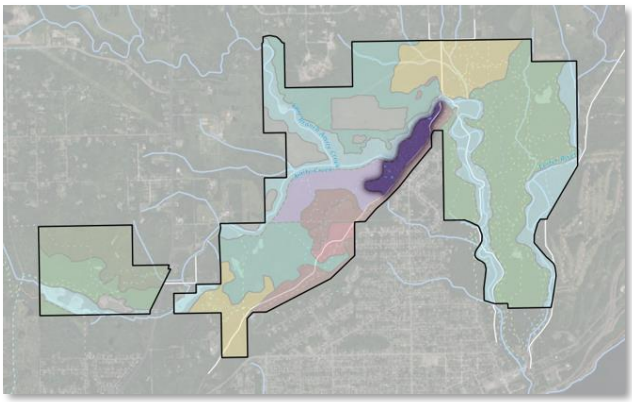
No action result (10-20 years): In northernmost two fields, succession will result in afforestation of nearby pioneer tree species (aspen, alder) or non-native seed trees already present. Horse pasture fields will likely continue to be maintained as open meadows if landowners continue activities. Gravel pit, if not managed for invasive species, may result in new populations of pioneer invasive plants entering from equipment or taking advantage of disturbed conditions.

Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Restore/enhance native plant communities; Ecosystem function	Re-establish native vegetation; Encourage bird and pollinator habitat	Seed native grasses and forbs	Possibility of solar installation in portions of unit
Restore/enhance native plant communities	Restore and maintain fire-dependent plant communities	Prescribed burning	Conduct in dormant season
Restore/enhance native plant communities	Prevent introductions of aggressive introduced plants	Monitor and remove invasive plants at first detection (Early Detection Rapid Response)	City workers or volunteer stewards

No tree inventories were conducted in the non-forested units

Stand 8 Pine Plantation





Stand Characteristics

Forest Type: Pine Plantation

Size: 32 acres

NPC (MDNR)	*Acres*	*% of stand*
Disturbed	29.8	93.46%
Developed	2.0	6.25%

Dominant Soil:

- F147D (88%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.

Ecological Site (USDA): F093AY013MN Loamy uplands, F093AY006MN - Depressional Wet Hardwood Forest, 093AY009MN - Bedrock Controlled Upland Forest

Successional Stage (MDNR): Young forest (0-55 years) emerging through planted mature forest (55-95 years), characteristics of mixed stages

Average Stand Diameter (DBH): 11.6" (SE=0.9)

Average Stand Basal Area: 146 ft2/ac (SE=12.8)

Snags per acre: 68 medium (6-11" DBH), 5 large (>12" DBH)

Coarse woody debris: High to medium

Wildfire risk: Moderate due to flashy fine fuels (grass) and high fuel loading with dead, dying and overcrowded trees

Invasive Species: Scots pine highly dominant in the overstory, buckthorn presence is limited

Pests & Disease: EAB present; Red pine appear stressed due to bark beetles

Current Condition: This stand has similar topographic and soil characteristics to stands 4 and 5 in being a mix of well drained loamy hardwoods and saturated boggy soil with lowland forest characteristics. However, almost the entire stand is a planted pine stand with a mix of red pine (averaging 9-11" DBH) and Scotch pine (averaging 12-14" DBH). Quaking aspen is sparsely present at all growth stages with abundant regeneration, primarily near stand edges. Paper birch, balsam poplar, white spruce and balsam fir occur as intermediate or regenerating trees. Black ash regeneration is excessive, though mature ash is limited in number. Beaked hazel, speckled alder, mountain maple, and round-leaved dogwood are common in a moderately sparse shrub layer. Herbaceous layer in pine-dominated areas is primarily grass and thatch.

Current Recreational Uses or Management:
The stand was clearly planted for pine silviculture. Stand health ranges from decently healthy (live crown >30%) to

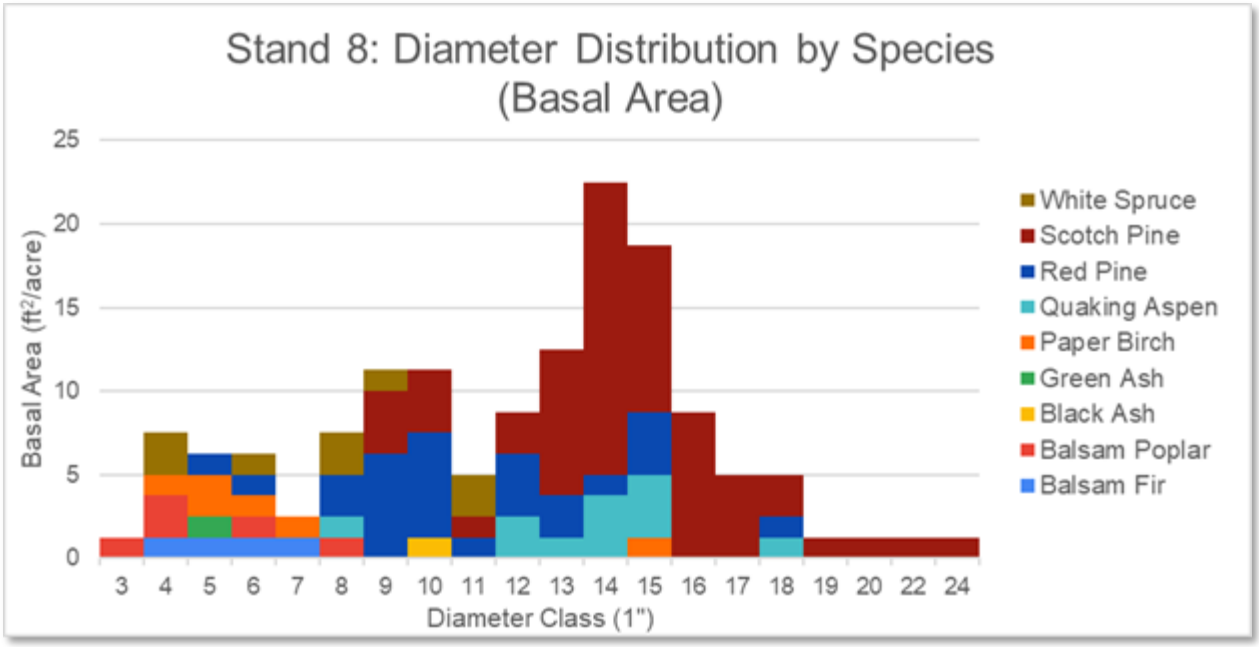
Adjacent land use concerns:
Road impacts from Skyline Parkway; high recreation use

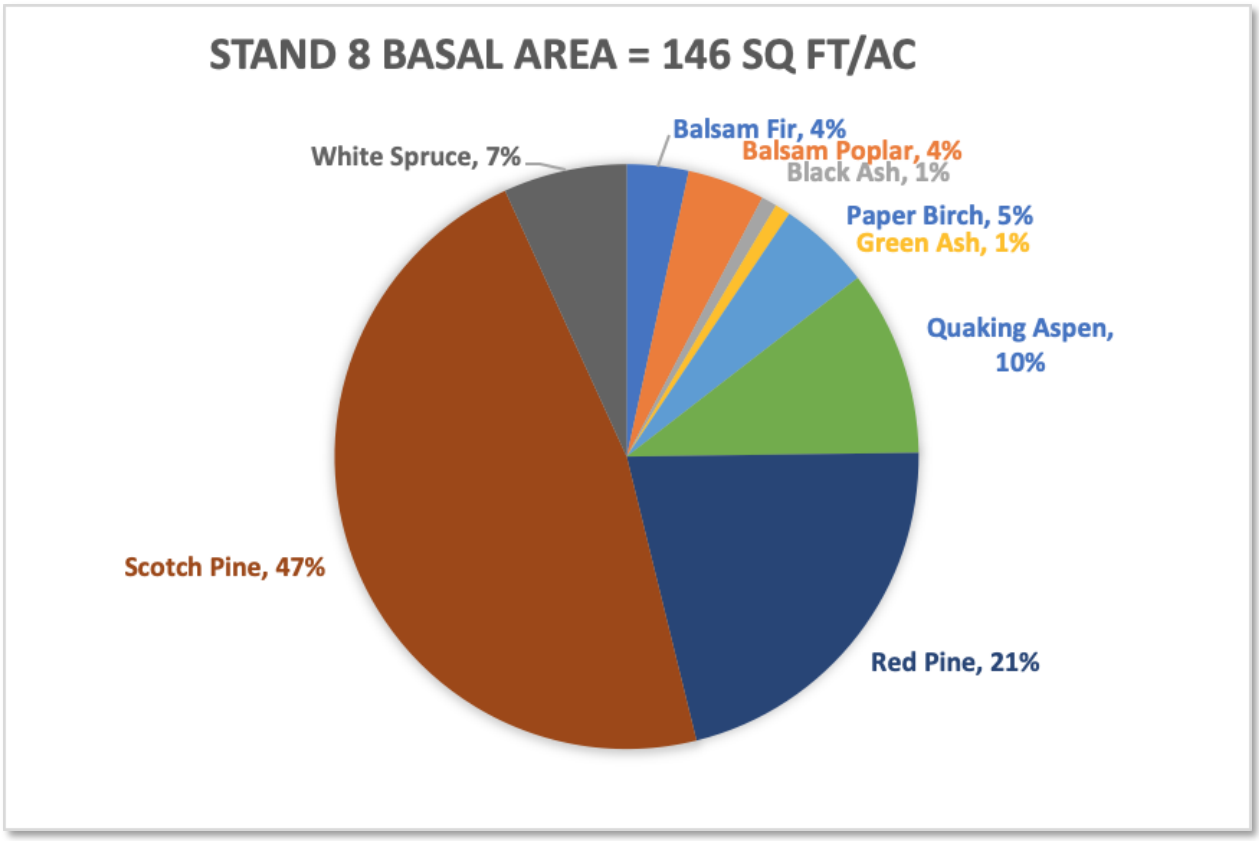
rotting. Some Scots pine have recently been girdled and the understory seeded with native species. This area has high recreational use, with easy access from Skyline Parkway and nearby trailhead.

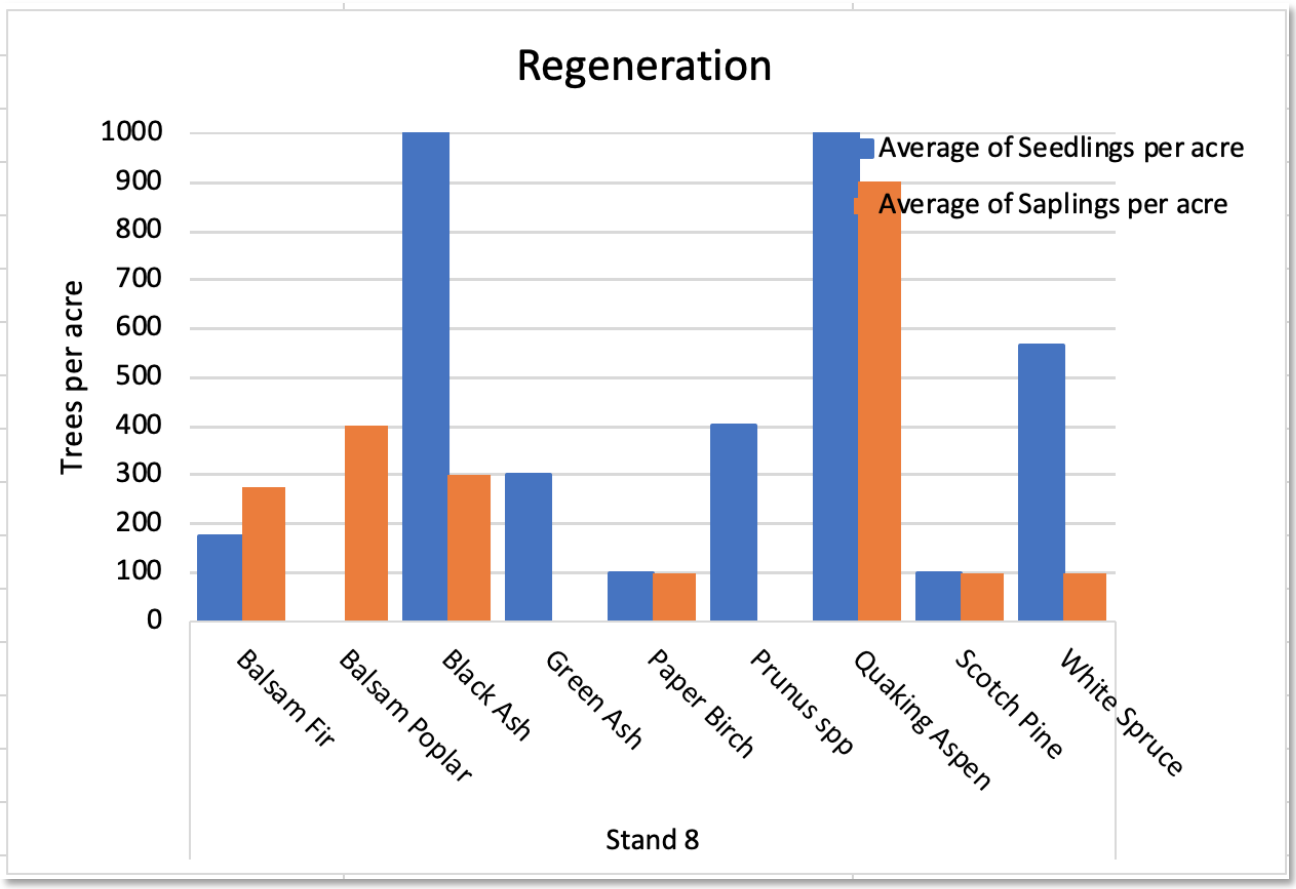
No action result (10-20 years): *Aspen* may recruit into gaps and openings, balsam fir likely to increase, fire risk likely to increase as pines age out and fall.

Management Goals, Strategies, and Actions

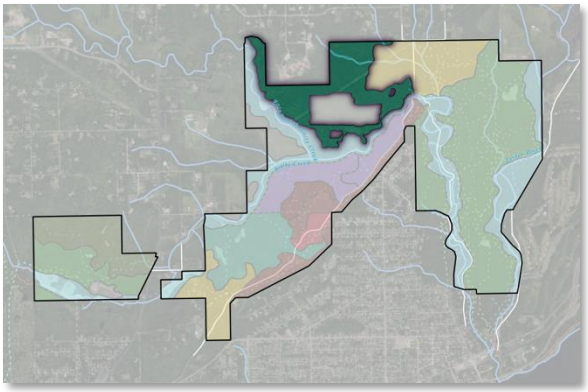
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Transition tree plantations to native forest composition	Thin overly stocked tree plantations, sell commercially when possible or remove offsite; Remove non-native tree species, sell commercially when possible or remove offsite; Interplant diverse native trees suitable to site conditions	Restore to natural red pine woodland ecosystem
Forest resilience	Reduce hazardous fuel load to reduce wildfire risk and severity	Thin and remove overcrowded balsam fir or white spruce; Thin and remove above ground dead/down woody debris (lacking soil contact) that creates a fuel ladder into tree canopies; Woody debris processing through biochar creation, pile burning, or off-site chipping	Slash and storm damage tree removal
Regeneration; Restore/enhance native plant communities	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning	
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Assisted migration - Introduce species native to adjacent regions with slightly warmer climates	
Regeneration	Artificial regeneration	Plant trees; Disperse tree seeds	


Stand 8: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
25
20
15
10
5
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 24
Diameter Class (1")
White Spruce
Scotch Pine
Red Pine
Quaking Aspen
Paper Birch
Green Ash
Black Ash
Balsam Poplar
Balsam Fir


STAND 8 BASAL AREA = 146 SQ FT/AC
Balsam Fir, 4%
Balsam Poplar, 4%
Black Ash, 1%
White Spruce, 7%
Paper Birch, 5%
Green Ash, 1%
Quaking Aspen, 10%
Scotch Pine, 47%
Red Pine, 21%


Regeneration
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Average of Seedlings per acre
Average of Saplings per acre
Balsam Fir
Balsam Poplar
Black Ash
Green Ash
Paper Birch
Prunus spp
Quaking Aspen
Scotch Pine
White Spruce
Stand 8

Stand 9 Aspen-Birch (Red Maple)





Stand Characteristics

Forest Type: Aspen-Birch (Red Maple)

Size: 135 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn44a	43.2	32.07%
MHn46b	36.4	27.03%
FDn43b	34.2	25.34%
Disturbed	10.3	7.65%
WFn55a	10.1	7.52%

Dominant Soil:

- E3A (65%): Cuttre complex, 0 to 3 percent slopes. Silt loam, silty clay loam, over clay at 5-8". Somewhat poorly drained to poorly drained.
- E8D (9%): Amnicon-Fluvaquents, frequently flooded, complex, 0 to 18 percent slopes.Silt loam, silty clay loam over clay at 13" or stratified silt loam to gravelly clay loam at 11". Well drained.
- E9E (8%): Miskoaki-Fluvaquents, frequently flooded, complex, 0 to 45 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.

Ecological Site (USDA): F092XY012WI - Moist Clayey Lowlands, F092XY007WI - Wet Loamy or Clayey Lowlands, F092XY015WI - Clayey Uplands

Successional Stage (MDNR): Young forest (0-35 years) to early transitional forest (35-95 years)

Average Stand Diameter (DBH): 8.8" (SE=0.5)

Average Stand Basal Area: 98 ft2/ac (SE=10.8)

Snags per acre: 74 medium, (6-11" DBH), 8 large (>12" DBH), mostly aspen

Coarse woody debris: High to medium

Wildfire risk: Moderate due to blowdown and possible ignition source from powerline

Invasive Species: Buckthorn is pervasive as large and small saplings, low amounts of honeysuckle present

Pests & Disease: EAB has resulted in near complete mortality of canopy trees >8" DBH

Current Condition: In this large, mixed-age yet homogenous stand, aspen is by far the dominant canopy tree at mixed size classes with about one third <5" DBH, one half between 6-14", and the remainder up to 20". Black ash is excessively abundant up to 5" DBH and regenerating seedlings and saplings, with some dead mature ash as well. Regeneration is also high for red maple and quaking aspen, with some balsam poplar, yellow birch, and balsam fir. There are occasional mature red maple, sugar maple, basswood, and

yellow birch. Buckthorn is well established as large understory trees and dense stands of young saplings, along with thick beaked hazel, speckled alder, mountain maple, and serviceberry. Dominant understory plants are bluejoint grass, lady fern, bracken fern, and strawberry. The stand exhibits fire-influenced characteristics though this may have been the aftermath of logging slash fires or other disturbance, whereas the moist soil conditions suggest species tolerant of saturated conditions may be better suited. Blowdown is evident throughout the stand, primarily of aspen. Deer activity is high in this area.

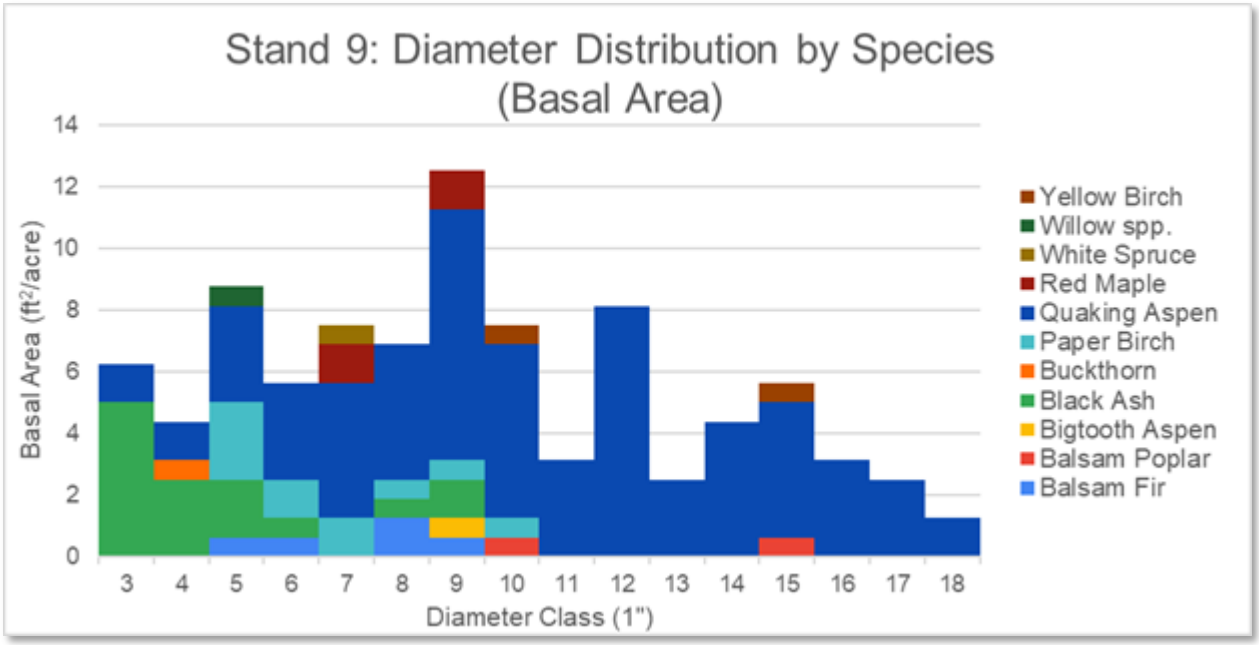
Current Recreational Uses or Management:
There are no trails through the stand, although there is access from a trailhead parking to the north on Maxwell Rd via the powerline corridor. There is evidence of hunting activity.

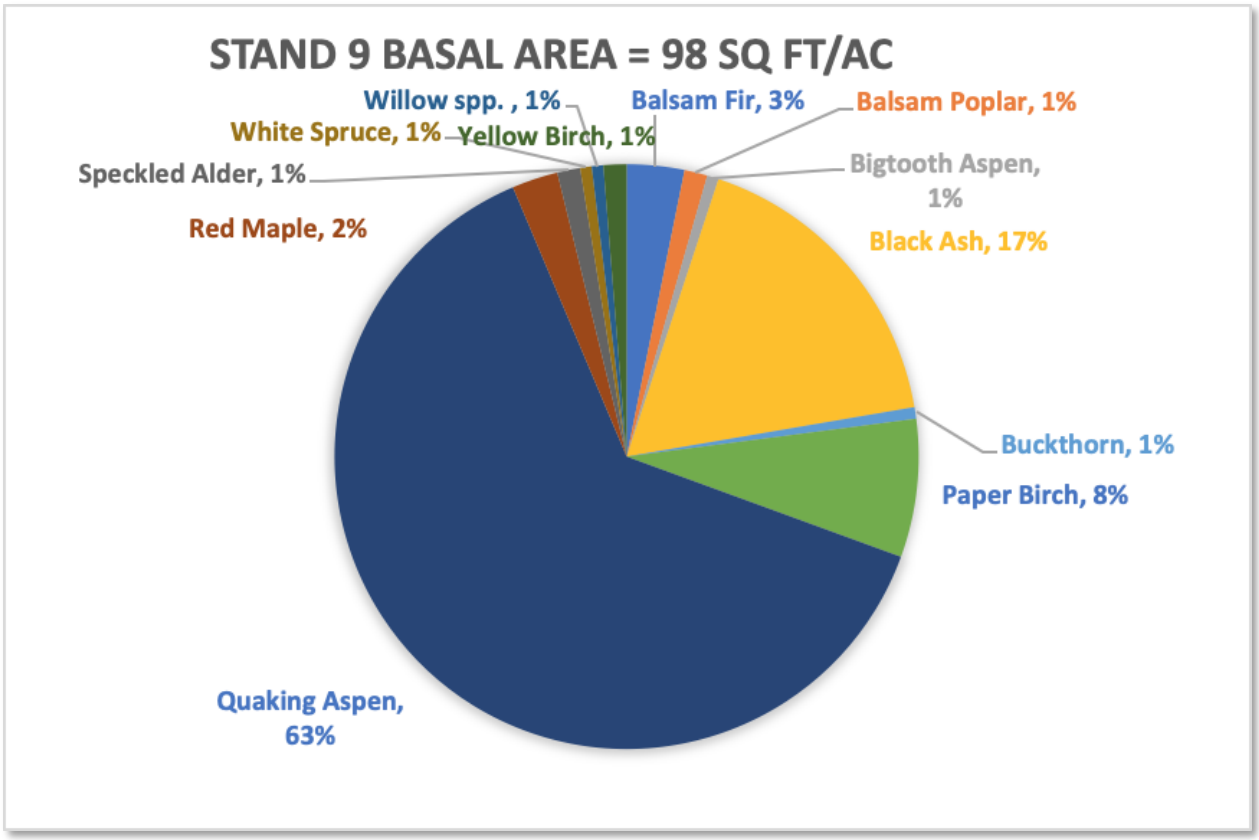
Adjacent land use concerns:
Private gravel pit to the north potentially impacting water quality/quantity feeding East branch Amity Creek. Large field in the center of the stand (stand 7) with many non-native species and edge effects.

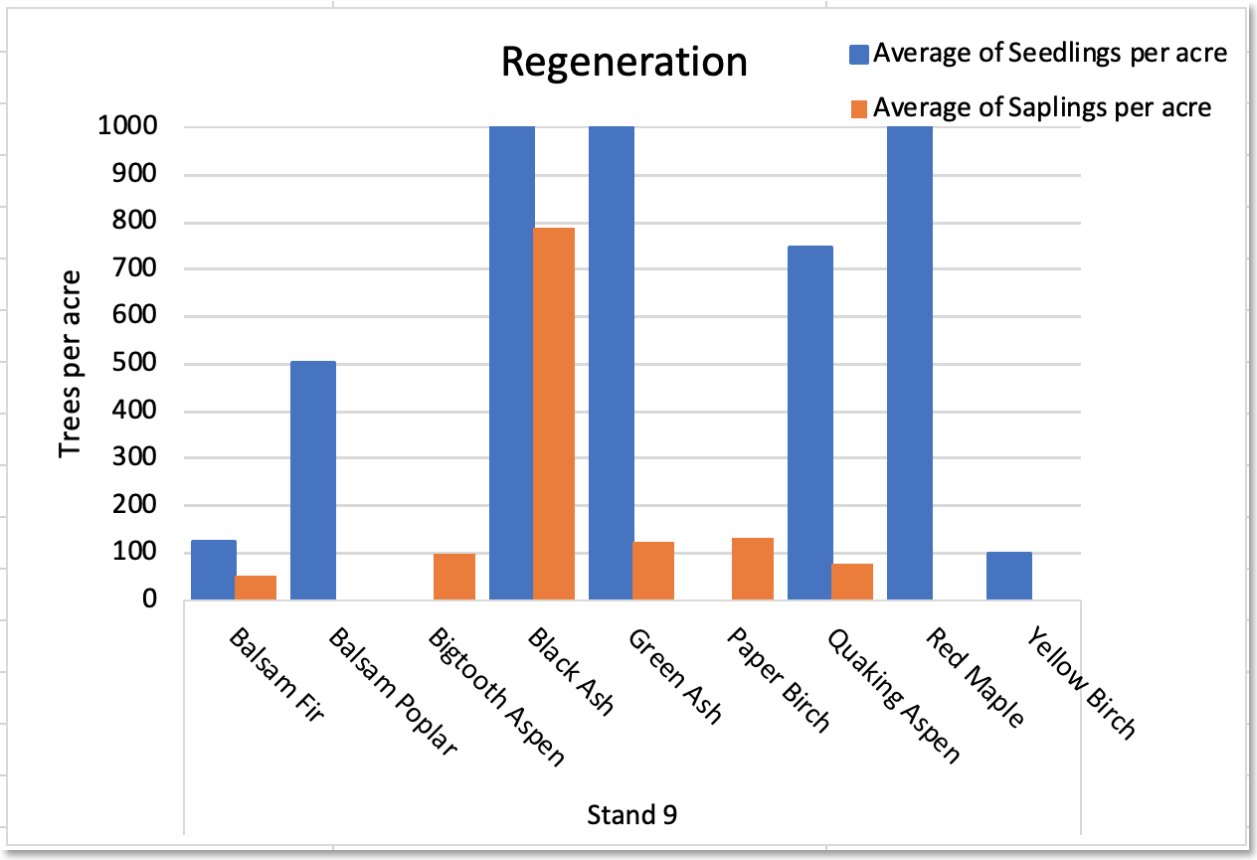
No action result (10-20 years): Mature aspen will continue to die, creating additional large snags; additional blowdown is likely to occur. Buckthorn may become increasingly problematic, especially in areas with ash and eventually aspen as these species die out due to EAB or age. The stand will continue as an aspen-red maple canopy.

Management Goals, Strategies, and Actions

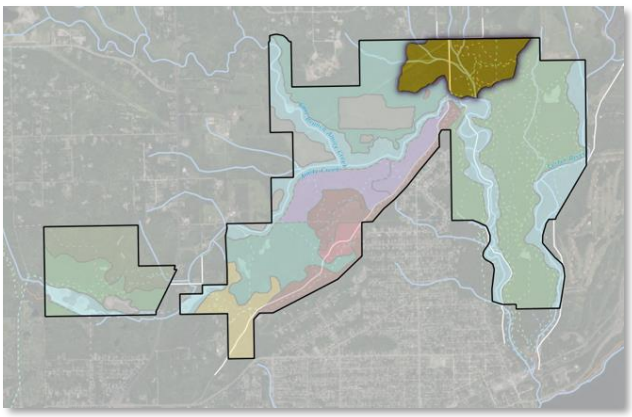
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Regeneration	Reduce competition in midstory	Mulch/masticate shrub layer	Mastication in strips of overabundant shrubs (up to 30% of stand at one time). Target alder, buckthorn
Regeneration	Artificial regeneration	Plant trees	Plant long-lived moisture tolerant hardwood species
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Assisted migration - Introduce species native to adjacent regions with slightly warmer climates	


Stand 9: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
14
12
10
8
6
4
2
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Diameter Class (1")
Yellow Birch
Willow spp.
White Spruce
Red Maple
Quaking Aspen
Paper Birch
Buckthorn
Black Ash
Bigtooth Aspen
Balsam Poplar
Balsam Fir


STAND 9 BASAL AREA = 98 SQ FT/AC
Willow spp. , 1%
Balsam Fir, 3%
Balsam Poplar, 1%
White Spruce, 1%
Yellow Birch, 1%
Speckled Alder, 1%
Bigtooth Aspen, 1%
Red Maple, 2%
Black Ash, 17%
Buckthorn, 1%
Paper Birch, 8%
Quaking Aspen, 63%



Stand 10 Aspen-Birch (Balsam Fir)





Stand Characteristics

Forest Type: Aspen-Birch (Balsam Fir)

Size: 110 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn43b	77.6	70.80%
MHn44a	10.2	9.30%
MHn46b	8.8	8.02%
WFn55a	7.5	6.85%

Dominant Soil:

- E3B (30%): Cuttre complex, 0 to 8 percent slopes. Silt loam, silty clay loam, over clay at 5-8". Somewhat poorly drained to poorly drained.
- E23F (30%): Miskoaki-Udifluvents, flooded, complex, 1 to 45 percent slopes. Silt loam, silty clay loam over clay at 6"; sandy loam, stratified very gravelly sandy loam. Well drained to somewhat poorly drained.
- E3A (22%): Cuttre complex, 0 to 3 percent slopes. Silt loam, silty clay loam, over clay at 5-8". Somewhat poorly drained to poorly drained.
- E16D (9%): Amnicon-Cuttre complex, 5 to 18 percent slopes. Silt loam, silty clay loam over clay at 8-13". Moderately well drained to somewhat poorly drained.

Ecological Site (USDA): F092XY012WI - Moist Clayey Lowlands, F092XY007WI - Wet Loamy or Clayey Lowlands, F092XY015WI - Clayey Uplands, F092XY004WI - Seasonally Dry Floodplains (35%) *Successional Stage (MDNR):* Young forest (0-35 years) to early transitional forest (35-95 years)

Average Stand Diameter (DBH): 8.9" (SE=1.0)

Average Stand Basal Area: 136 ft2/ac (SE=15.7)

Snags per acre: 60 medium, (6-11" DBH), 2 large (>12" DBH), mostly aspen, red pine, ash

Coarse woody debris: Medium

Wildfire risk: High due to fuel loading, dense balsam fir and road passage through unit

Invasive Species: Medium - Buckthorn is widespread

Pests & Disease: EAB - Mature ash is completely dead where present

Current Condition: This lowland aspen-dominant stand is similar to stand 9 with the addition of paper birch and a very thick emerging intermediate and regeneration layer of balsam fir. It includes a seasonal drainage feeding Amity Creek. Quaking aspen is by far the dominant canopy tree at mixed size classes with about one third <5" DBH, one half between 6-14", and the remainder up to 20". A robust intermediate layer is dominated by balsam fir with paper birch, red maple, and buckthorn. Regeneration is very thick with balsam fir as seedlings and saplings, as well as many black ash, green ash, paper birch, and quaking aspen. Red maple, white pine, and white spruce are emerging as seedlings. This is one of few stands with white pine regeneration - unclear if natural or planted and unprotected. Buckthorn is pervasive, but coincides with mountain maple, beaked hazel, dogwoods, and a variety of native fruiting shrubs at lower densities. Understory is strongly dominated by large-leaved aster with some bush honeysuckle, bracken fern, strawberry, sarsparilla, and sedges.

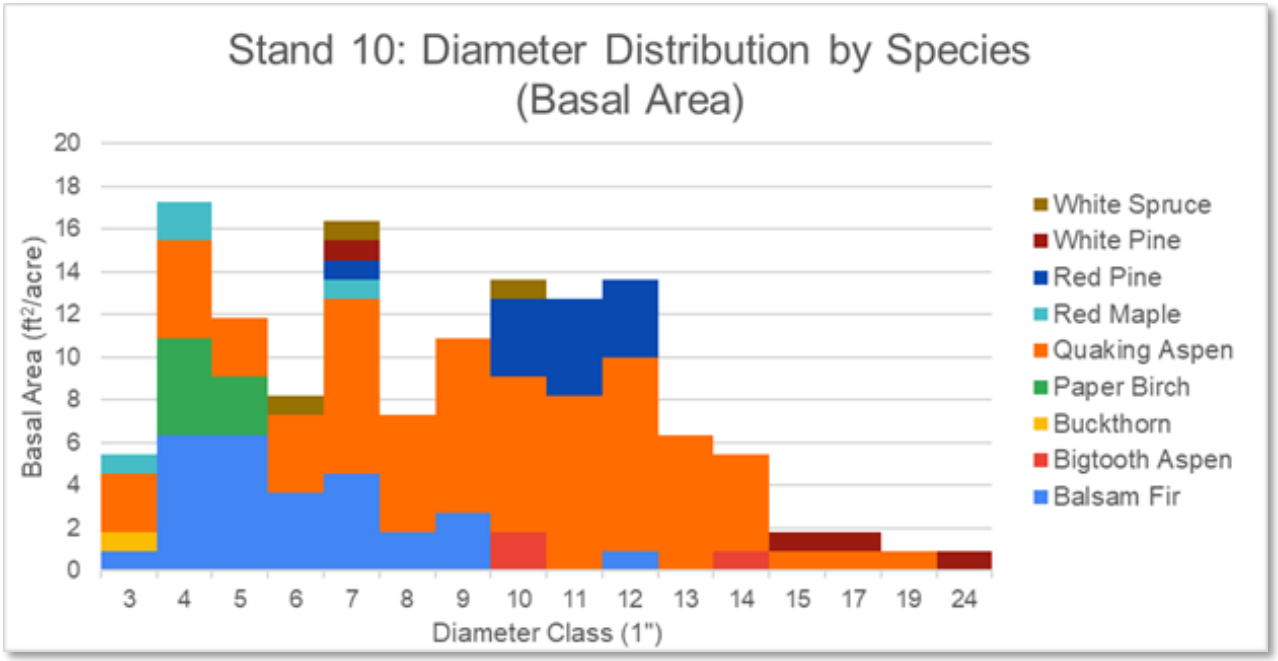
Current Recreational Uses or Management:
Several recreational trails including snowmobile, ski, hiking, and mountain biking east of Seven Bridges Road.

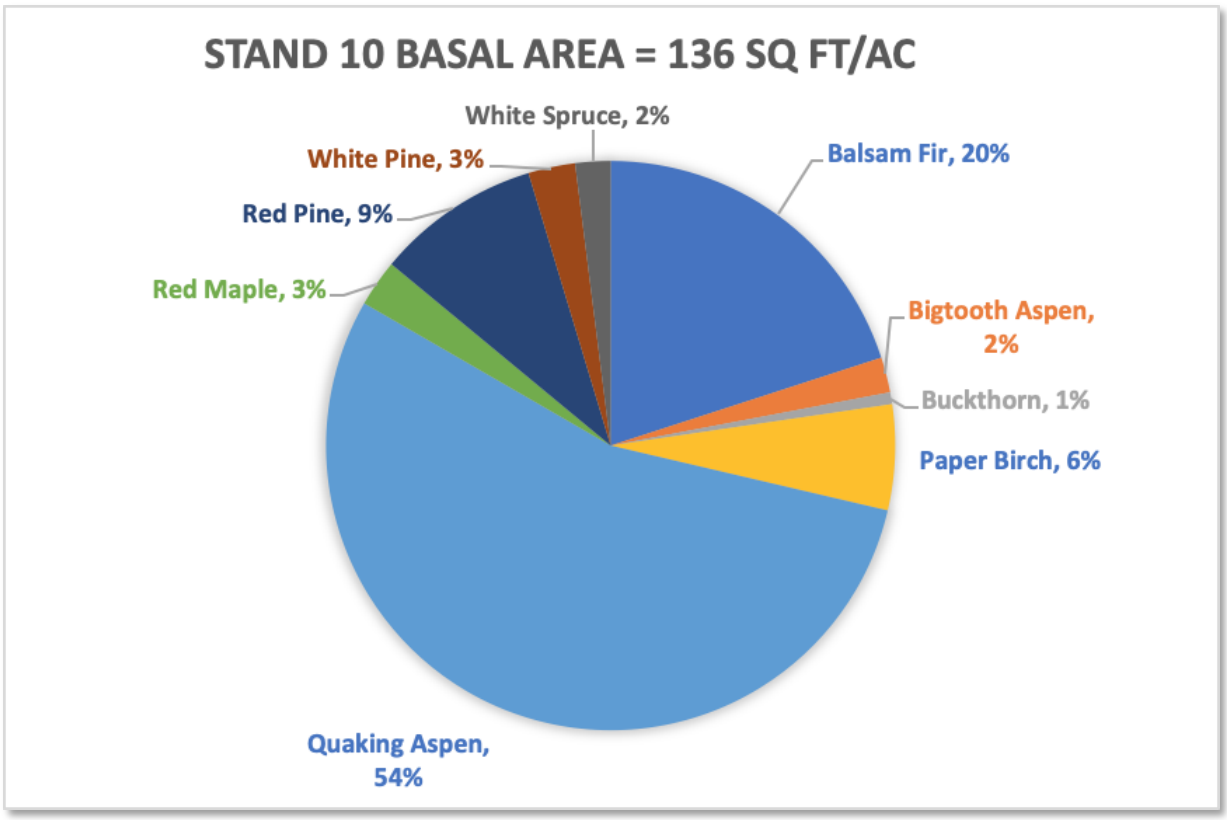
Adjacent land use concerns:
Some recreational trails and Seven Bridges Road may negatively impact wetland hydrology. Powerline corridor, residential area to the north.

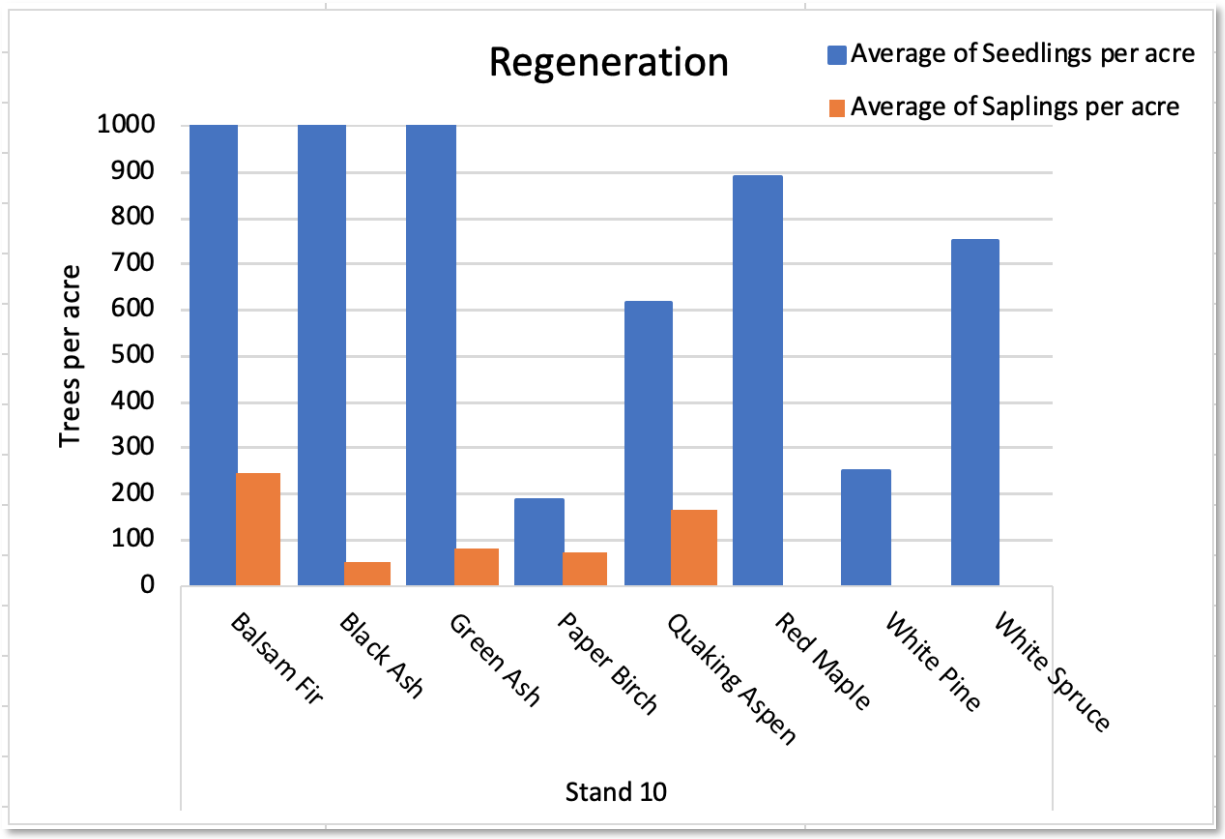
No action result (10-20 years): Increased prevalence and growth of balsam firs and red maple leading to elevated fire risk. Ash-dominant lowlands may convert to shrub-dominant wetland, especially where buckthorn is present.

Management Goals, Strategies, and Actions

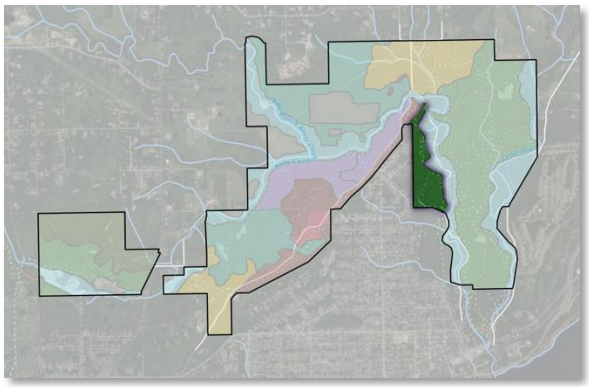
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	Initial mulching in tandem with fuels reduction, maintained through intermittent burning and grazing
Forest resilience	Reduce hazardous fuel load to reduce wildfire risk and severity	Thin and remove overcrowded balsam fir or white spruce; Thin and remove above ground dead/down woody debris (lacking soil contact) that creates a fuel ladder into tree canopies; Woody debris processing through biochar creation, pile burning, or off-site chipping	Retain low density of vigorous balsam fir, limb up 10'
Restore/enhance native plant communities; Regeneration; Recreation	Restore and maintain fire-dependent plant communities; Manage for open or partially open (“park-like”) understory conditions	Prescribed burning; prescribed grazing	Rotate between burning and grazing as conditions/capacity allows. Ladder fuels must be reduced before burning.
Regeneration	Artificial regeneration	Plant trees	Plant long-lived fire tolerant species
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Assisted migration - Introduce species native to adjacent regions with slightly warmer climates	


Stand 10: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
20
18
16
14
12
10
8
6
4
2
0
3 4 5 6 7 8 9 10 11 12 13 14 15 17 19 24
Diameter Class (1")
White Spruce
White Pine
Red Pine
Red Maple
Quaking Aspen
Paper Birch
Buckthorn
Bigtooth Aspen
Balsam Fir


STAND 10 BASAL AREA = 136 SQ FT/AC
White Spruce, 2%
White Pine, 3%
Red Pine, 9%
Red Maple, 3%
Balsam Fir, 20%
Bigtooth Aspen, 2%
Buckthorn, 1%
Paper Birch, 6%
Quaking Aspen, 54%



Stand 11 Aspen-Birch





Stand Characteristics

Forest Type: Aspen-Birch

Size: 43 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn43b	19.8	46.43%
MHn44a	17.9	41.80%
RVx54a	2.7	6.34%

Dominant Soil:

- E15A (66%): Badriver complex, 0 to 3 percent slopes. Silt loam and silty clay loam, clay at 4-5", silty clay and silty clay loam at 34-56"+. Somewhat poorly drained to poorly drained.
- F160F (16%): Rock outcrop-Mesaba-Barto complex, 18 to 60 percent slopes. Gravelly sand loam over bedrock between 0-28". Well drained.
- E23F (8%): Miskoaki-Udifluvents, flooded, complex, 1 to 45 percent slopes. Silt loam, silty clay loam over clay at 6"; sandy loam, stratified very gravelly sandy loam. Well drained to somewhat poorly drained.

Ecological Site (USDA): F092XY012WI - Moist Clayey Lowlands, F092XY007WI - Wet Loamy or Clayey Lowlands, F092XY015WI - Clayey Uplands, F092XY004WI - Seasonally Dry Floodplains (35%)

Successional Stage (MDNR): Young forest (0-35 years) to early transitional forest (35-95 years)

Average Stand Diameter (DBH): 9.1" (SE=0.7)

Average Stand Basal Area: 107 ft2/ac (SE=12.7)

Snags per acre: 50 medium (6-11" DBH)

Coarse woody debris: High to Medium

Wildfire risk: Moderate due to high fuel loading on the ground, tree density, and proximity to residential areas

Invasive Species: Buckthorn prevalent throughout the stand, well-established in some areas

Pests & Disease: EAB established, ash mortality widespread

Current Condition: This stand is the upper banks grading down into lower Amity Creek with moderate slopes and eastern aspect. This is a strongly dominant young quaking aspen stand, with about half the aspen 5" DBH or less and the other half 6-15" DBH. Paper birch is the next most common species, with very occasional black ash, balsam poplar, and red maple. Black ash is an abundant seedling but interestingly no saplings were counted. Aspen was the most common seedling that was also found at the sapling stage. Paper birch and balsam poplar are also present as saplings. White spruce and red maple are also found as seedlings. Understory trees and tall shrubs are abundant, notably speckled alder, serviceberry, buckthorn, mountain maple, and dogwoods. Herbaceous layer is dominated by bush honeysuckle, bracken fern, dewberry, and isolated patches of staghorn sumac.

Current Recreational Uses or Management:
There are two hiking trails through the stand, entering from Hawk Ridge and the neighboring residential area. Social trails are common.

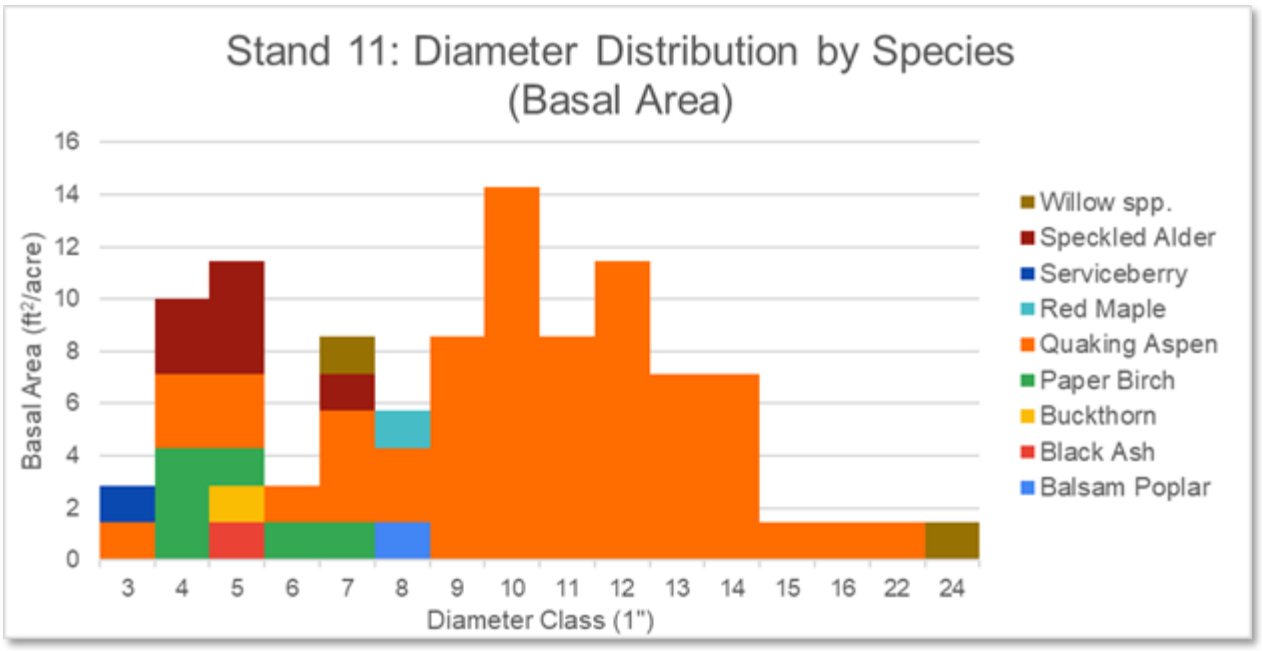
Adjacent land use concerns:
Residential area to the west of the stand

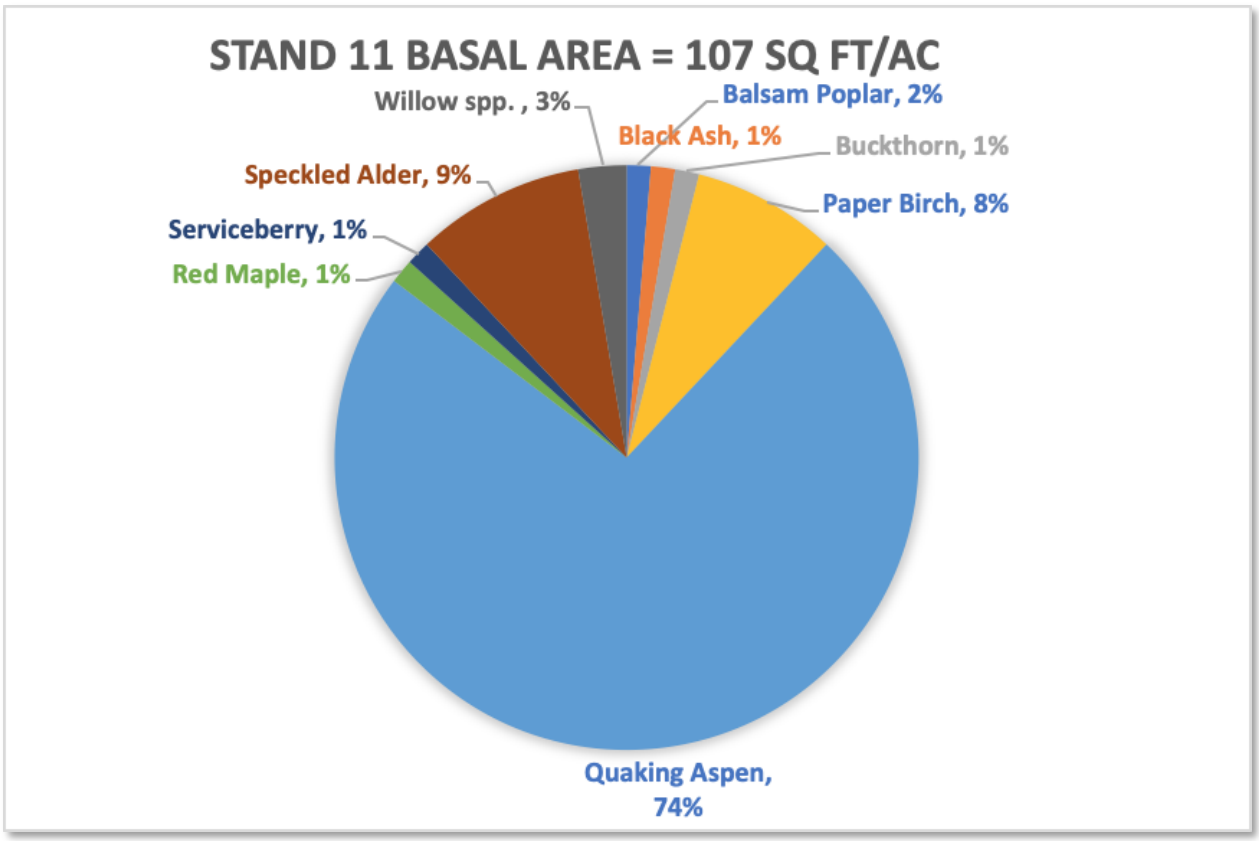
No action result (10-20 years): Buckthorn will increase and push out native understory shrub layer. Aspen and birch will continue to age and begin turning to snags, while red maple and white spruce may increase.

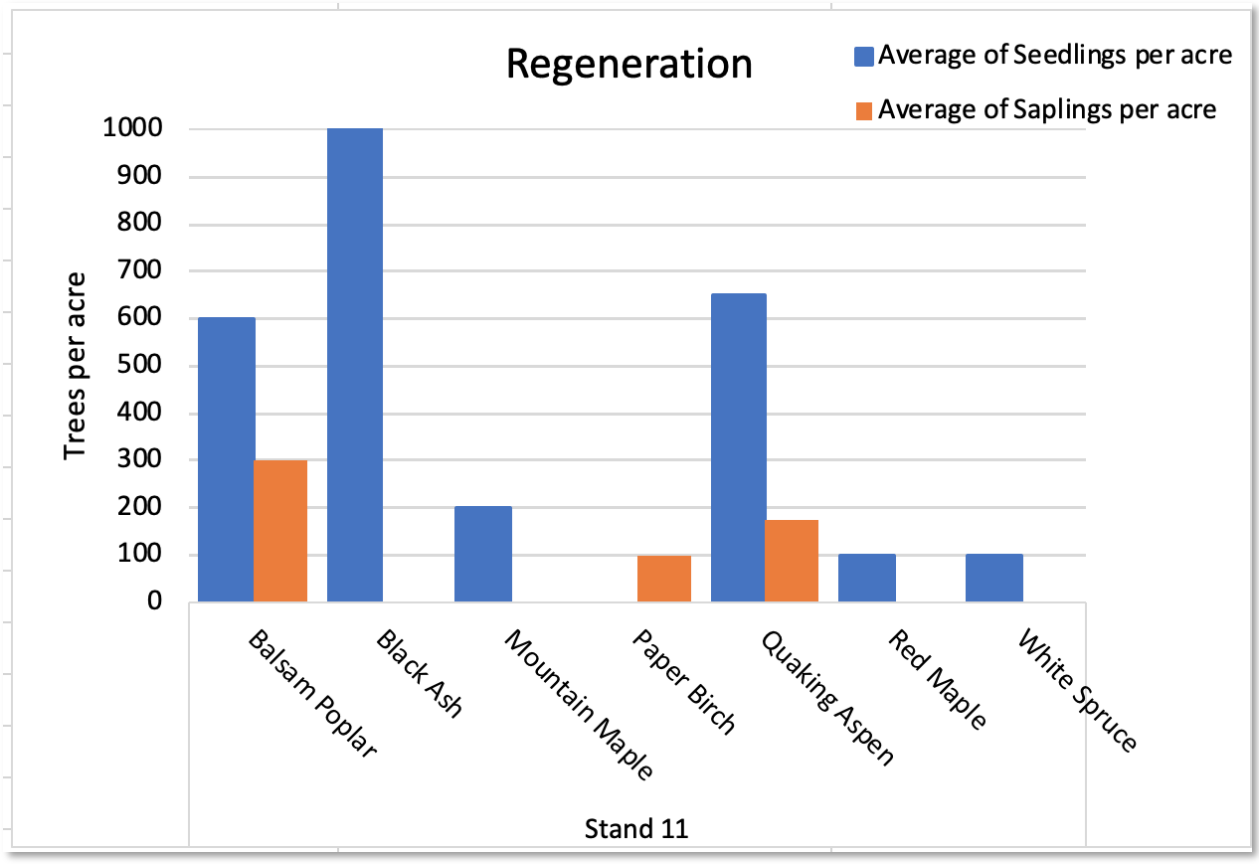
Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes

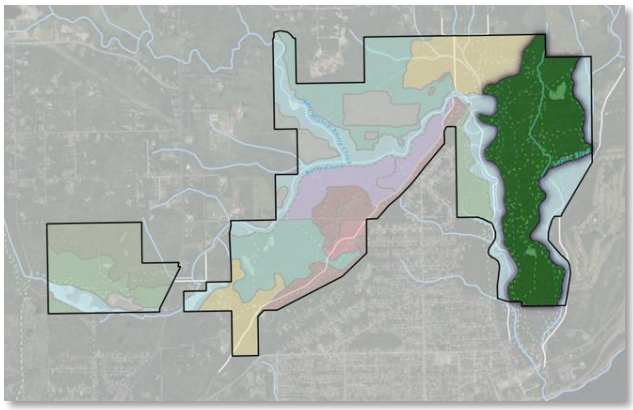
Restore/enhance native plant communities	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	Followup treatment of buckthorn, prescribed grazing or herbicide treatment
Regeneration	Reduce competition in midstory	Mulch/masticate shrub layer	Mastication in strips of overabundant shrubs (up to 30% of stand at one time). Target alder, buckthorn
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Gap selection	Gap widths 0.5-2x height of trees; cut during growing season
Regeneration	Artificial regeneration	Plant trees	Plant long-lived moisture tolerant hardwood species
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Assisted migration - Introduce species native to adjacent regions with slightly warmer climates	




STAND 11 BASAL AREA = 107 SQ FT/AC
Willow spp. , 3%
Balsam Poplar, 2%
Black Ash, 1%
Buckthorn, 1%
Speckled Alder, 9%
Paper Birch, 8%
Serviceberry, 1%
Red Maple, 1%
Quaking Aspen, 74%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Black Ash
Mountain Maple
Paper Birch
Quaking Aspen
Red Maple
White Spruce
Stand 11

Stand 12 Aspen-Birch





Stand Characteristics

Forest Type: Aspen-Birch

Size: 295 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn43b	235.0	79.80%
MHn46b	20.2	6.86%
RVx54a	17.4	5.91%

Dominant Soil:

- E3B (48%): Cuttre complex, 0 to 8 percent slopes. Silt loam, silty clay loam, over clay at 5-8". Somewhat poorly drained to poorly drained.
- E16D (18%): Amnicon-Cuttre complex, 5 to 18 percent slopes. Silt loam, silty clay loam over clay at 8-13". Moderately well drained to somewhat poorly drained.
- E9E (15%): Miskoaki-Fluvaquents, frequently flooded, complex, 0 to 45 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.
- E11E (7%): Miskoaki-Rock outcrop complex, 18 to 70 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.

Ecological Site (USDA): F092XY012WI - Moist Clayey Lowlands, F092XY007WI - Wet Loamy or Clayey Lowlands

Successional Stage (MDNR): Transitional forest (35-95 years)

Average Stand Diameter (DBH): 9.8" (SE=0.4)

Average Stand Basal Area: 116 ft2/ac (SE=6.1)

Snags per acre: 177 medium (6-11" DBH), 20 large (>12" DBH)

Coarse woody debris: Medium to high

Wildfire risk: Medium to high in isolated patches of dense young balsam fir, heavy fuel loading from dense trees, blowdown, and numerous snags

Invasive Species: Buckthorn throughout the stand, more well-established in southern half of stand

Pests & Disease: EAB established with dead and dying trees present; minimal fir mortality; localized aspen and birch mortality

Current Condition: This is the largest stand in the Lester-Amity recreation area, and has a fairly similar composition throughout. Quaking aspen and paper birch by far dominate the canopy, with a geometric distribution of size classes indicating the stand has some mature characteristics (aspen 15-22" DBH) but is still maturing with majority smaller trees at 3-11" DBH. Occasional remnant conifers (white spruce, white pine, jack pine) suggest fire-influenced characteristics that could be perpetuated through active fire management. Black ash, green ash, and willow are present in lower-lying drainages, high water overflows

from Amity Creek, and wetlands. Young balsam fir is dense in isolated pockets and there is some bigtooth aspen. Black ash and green ash are strongly regenerating primarily in lowerlying areas, with quaking aspen and red maple abundant as seedlings and saplings throughout. Blowdown is apparent in patches. Buckthorn is the most common midstory species, along with serviceberry, beaked hazel, and speckled alder, and lower quantities of other native shrubs (*Prunus* spp., red-osier dogwood, mountain maple, downy arrowwood [*Viburnum opulus*], hawthorns [*Crataegus* spp.). Dominant understory plants are large-leaved aster, bush honeysuckle, dewberry, bracken fern, currant, and goldenrod.

Current Recreational Uses or Management:
This stand has a high concentration of trails for multiple recreation types, including hiking, skiing, mountain biking, and snowmobiling. It is accessible from trailheads on all sides of the property and receives high visitor use. Lester-Amity is one of the most accessible recreation areas for Duluth residents.

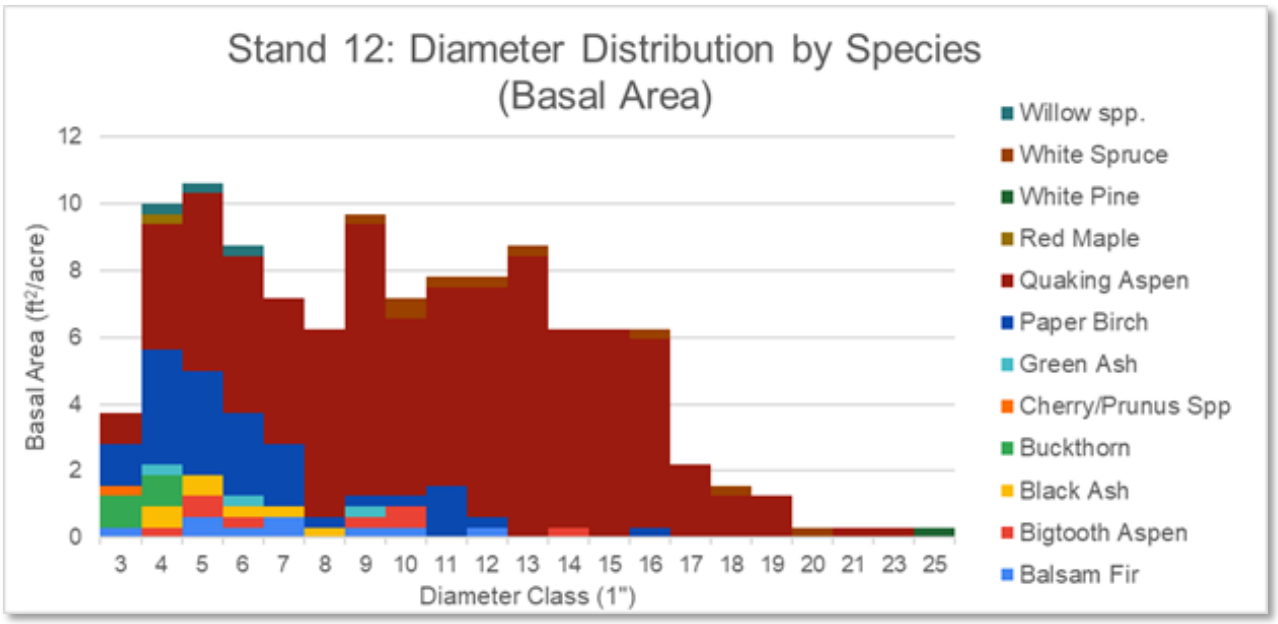
Adjacent land use concerns:
N/A

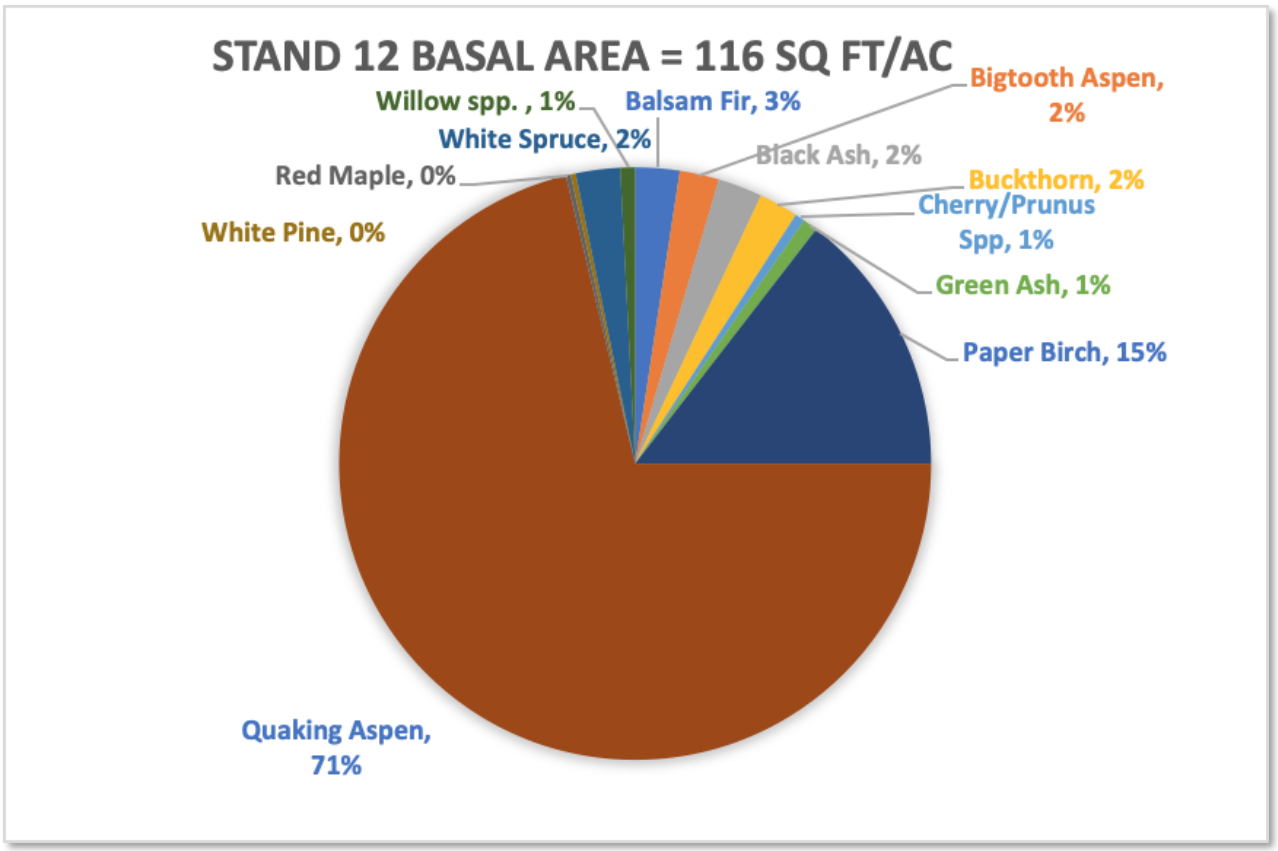
No action result (10-20 years): Fire-dependent characteristics may transition to more mesic hardwood characteristics with incursion of red maple, unless a wildfire occurs. Aspen will continue to die off as it matures. Dense aspen and birch may be vulnerable to future windthrow events and forest resilience may decline due to lack of diversity. Dense stands of balsam fir may fail from competition stress or spruce budworm increasing hazardous fuel load.

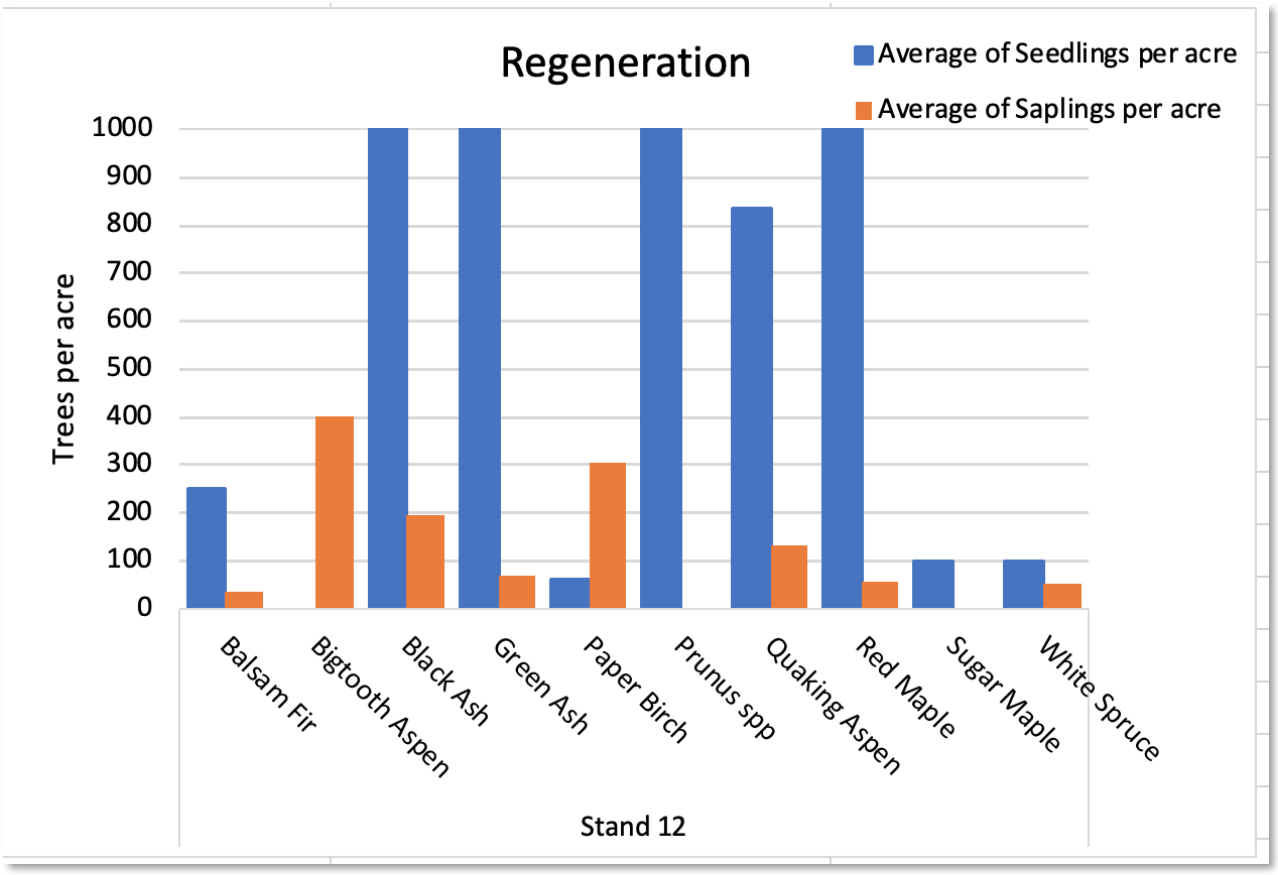
Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	Initial mulching, maintained through intermittent burning and grazing
Recreation	Maintain trail functionality	Cut and remove weakened or dead trees along trails	
Recreation; Forest resilience; Restore/enhance native plant communities	Manage for open or partially open ("park-like") understory conditions	Mulch/masticate dense shrubs	Target buckthorn and hazel
Restore/enhance native plant communities; Regeneration; Recreation	Restore and maintain fire-dependent plant communities; Manage for open or partially open ("park-like") understory conditions	Prescribed burning; prescribed grazing	Rotate between burning and grazing as conditions/capacity allows. Ladder fuels must be reduced before burning.

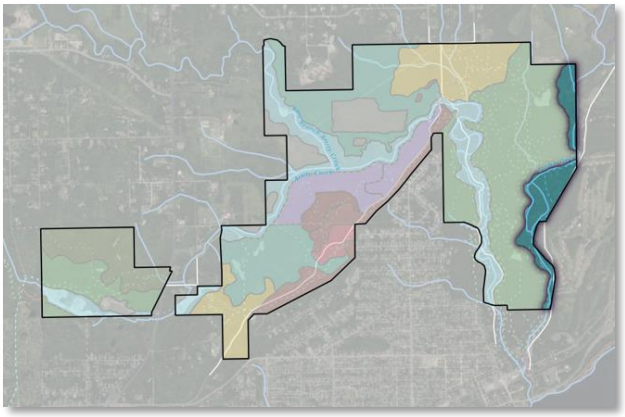
Regeneration; Forest resilience; Ecosystem function	Artificial regeneration	Plant trees	late successional, fire tolerant conifers (or direct seed), fruiting shrubs






Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Bigtooth Aspen
Black Ash
Green Ash
Paper Birch
Prunus spp
Quaking Aspen
Red Maple
Sugar Maple
White Spruce
Stand 12

Stand 13 Aspen-Birch (Riparian)





Stand Characteristics

Forest Type: Aspen-Birch (Riparian)

Size: 76 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn33b	27.3	36.07%
FFn57a	13.9	18.45%
RVx43a2	11.1	14.74%
FDn43b	6.3	8.31%
RVx54a	6.3	8.29%
MHn46b	5.9	7.82%

Dominant Soil:

- E11E (40%): Miskoaki-Rock outcrop complex, 18 to 70 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.
- E8D (25%): Amnicon-Fluvaquents, frequently flooded, complex, 0 to 18 percent slopes. Silt loam, silty clay loam over clay at 13" or stratified silt loam to gravelly clay loam at 11". Well drained.
- E13E (16%): Udifluvents, occasionally flooded-Rollins complex, 0 to 30 percent slopes. Extremely gravelly loam 0-80" or sandy loam over gravelly sandy loam at 5" at extremely gravelly sand 14-80". Moderately well drained to somewhat excessively drained.
- E24F (11%): Miskoaki-Cuttre complex, 5 to 45 percent slopes. Silt loam or silty clay loam over clay at 6-8". Well drained to somewhat poorly drained.

Ecological Site (USDA): F092XY015WI - Clayey Uplands, F092XY007WI - Wet Loamy or Clayey Lowlands, F092XY004WI - Seasonally Dry Floodplains, F092XY013WI - Sandy Uplands

Successional Stage (MDNR): Young forest (0-55 years)

Average Stand Diameter (DBH): 9.2" (SE=0.6)

Average Stand Basal Area: 110 ft^2/ac (SE=12.6)

Snags per acre: 9 large (>12" DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Moderate densities of buckthorn and occasional honeysuckle

Pests & Disease: Emerald ash borer has caused near or total mortality to ash trees

Current Condition: The Lester River floodplain includes lower lying black ash swamps with black ash up to 8" DBH highly impacted by emerald ash borer, and slopes and upper terraces featuring a mixed-age fire-dependent paper birch and quaking aspen forest with diameters ranging from 3 to 20". Canopy cover is variable with regeneration high likely due to regular canopy gaps. Black ash is the most abundant regenerating species by far, with green ash, quaking aspen next most common, and lower amounts of balsam poplar, paper birch, red maple, and balsam fir. The midstory is relatively thick with serviceberry,

beaked hazel, round-leaved dogwood, and a diversity of other native shrubs, along with buckthorn. Bluejoint is common in the floodplain forest, along with thimbleberry, large-leaved aster, currant, and raspberries and dewberries (*Rubus* spp.).

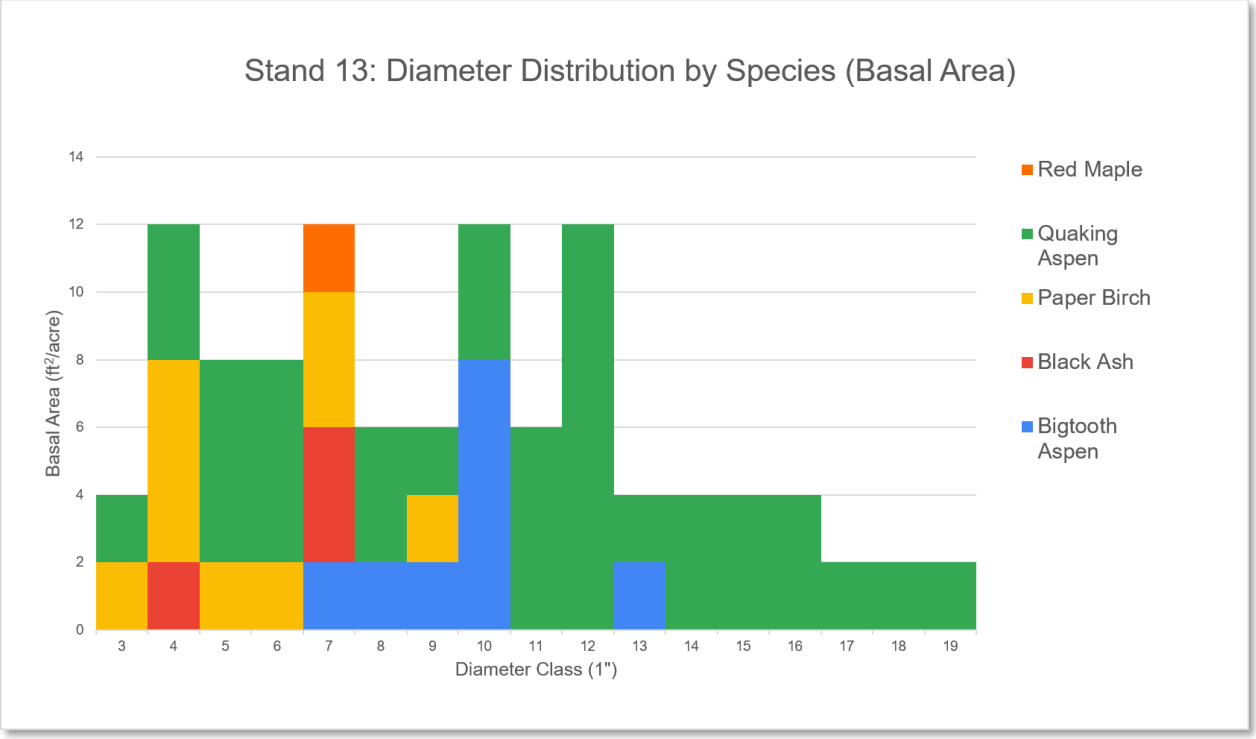
Current Recreational Uses or Management:
This stand is further from main trailheads and has only a single hiking trail through it, meaning lower recreational traffic. There were indications of high wildlife uses, including tracks, scat and browse.

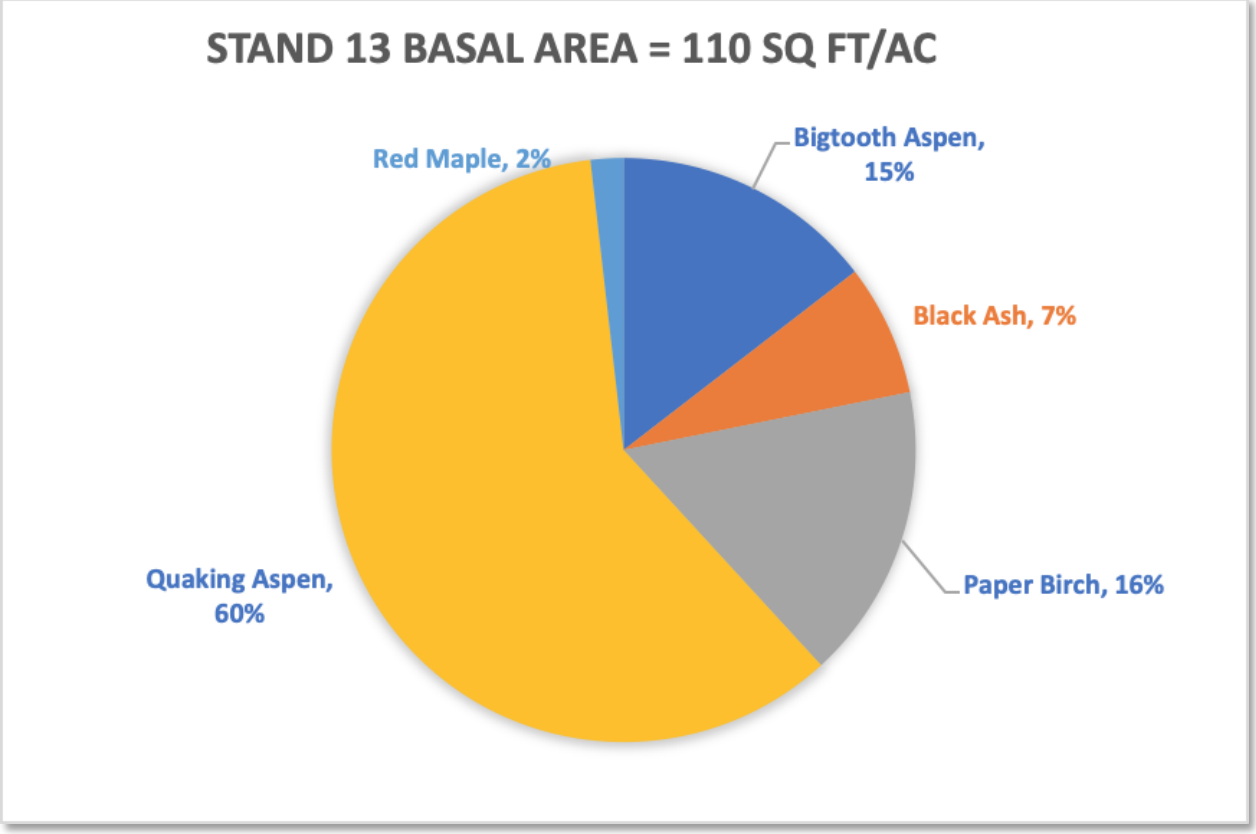
Adjacent land use concerns:
Lester River Road is uphill of the unit - concern for runoff and pollution. Residential areas upstream of this natural area may contribute runoff and pollution.

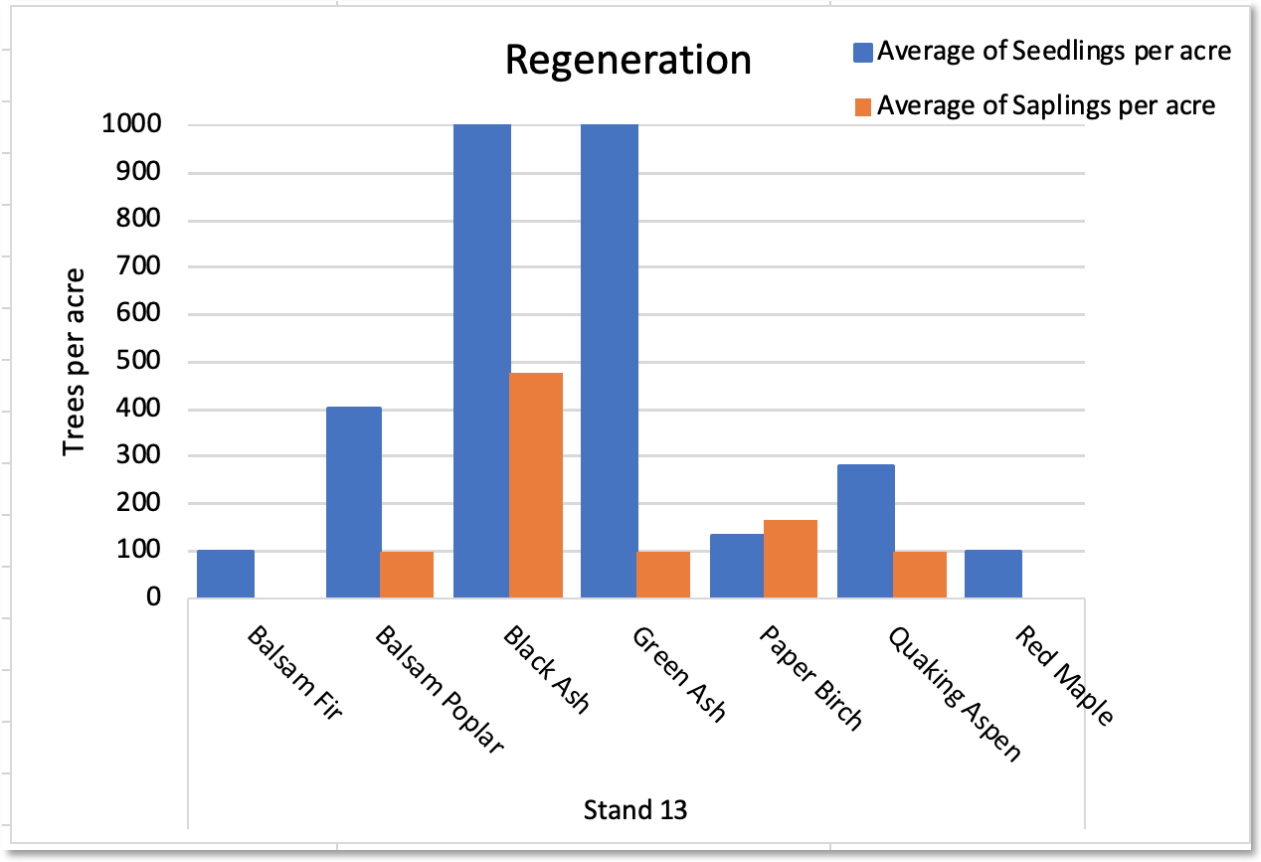
No action result (10-20 years): Birch and aspen are likely to persist. Later successional species may not establish on their own leaving a low diversity forest. A low diversity forest is less resilient to climate change-induced extreme rain, heat, drought, and storm events. Lester River aquatic habitat may be negatively impacted by loss of shade and organic matter deposition from ash trees in the wake of emerald ash borer

Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Underplanting - Plant trees other than ash where ash decline and mortality is advanced	
Restore/enhance native plant communities	Restore and maintain fire-dependent plant communities	Prescribed burning	On sandy outwash hill in south part of unit


Stand 13: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
Diameter Class (1")
Red Maple
Quaking Aspen
Paper Birch
Black Ash
Bigtooth Aspen


STAND 13 BASAL AREA = 110 SQ FT/AC
Red Maple, 2%
Bigtooth Aspen, 15%
Black Ash, 7%
Quaking Aspen, 60%
Paper Birch, 16%



Stand 14 Developed/Riparian



Stand Characteristics

Forest Type: Developed/Riparian

Size: 75 acres

NPC (MDNR)	*Acres*	*% of stand*
Developed	13.9	18.61%
Disturbed	13.1	17.59%
FDn33b	9.6	12.90%
MHn44a	6.3	8.45%
FDn43b	6.2	8.29%
MHn46b	6.2	8.24%
RVx43a2	6.0	8.08%
RVx54a	5.9	7.89%
FFn57a	5.4	7.20%

Dominant Soil:

- E23F (51%): Miskoaki-Udifluvents, flooded, complex, 1 to 45 percent slopes. Silt loam, silty clay loam over clay at 6"; sandy loam, stratified very gravelly sandy loam. Well drained to somewhat poorly drained.
- E11E (45%): Miskoaki-Rock outcrop complex, 18 to 70 percent slopes. Silt loam, silty clay loam, clay at 6". Well drained.

Ecological Site (USDA): F092XY015WI - Clayey Uplands, F092XY004WI - Seasonally Dry Floodplains (35%)

Successional Stage (MDNR): Young forest (0-55 years) to early transitional forest (55-95 years)

Average Stand Diameter (DBH): 8.9" (SE=1.0)

Average Stand Basal Area: 107 ^{2} (SE=19.0)

Snags per acre: 55 medium (6-11" DBH), 9 large (>12" DBH)

Coarse woody debris: Medium to high

Wildfire risk: High on upper embankments due to dead, dying, and fallen planted red pines and proximity to trailheads, Seven Bridges Road, and Lester-Amity Chalet

Invasive Species: Buckthorn saplings at a low density

Pests & Disease: Cause of red pine mortality is very likely overcrowding, but insects or disease may be a contributing or secondary factor

Current Condition: This unit is a mosaic of floodplain forest and bedrock channels of Amity Creek, steep embankments of overcrowded and failing red pine plantations, and upper slopes that are either highly eroded or composed of young to maturing birch-aspen stands. The floodplain forest includes quaking aspen, white spruce, balsam poplar, black ash, green ash, and occasional black willow spanning fairly evenly across the 3-14" size class. Regeneration is healthy, with a diversity of both seedlings and sapling including balsam poplar, black ash, green ash, quaking aspen, balsam fir, white spruce, and even red and white pine (most pines were likely planted). The upper banks include older floodplain terraces of aspen and birch, and steep slopes feature multiple monoculture stands of planted red pines over 80 years old. These were likely planted densely at approximately 8-ft-on-center to prevent erosion, which was successful, but they are now overcrowded and dead, dying, or struggling with <25% live crown. The shrub layer varies from sparse to moderately dense with dominant species being mountain maple, red osier dogwood, beaked hazel, and a higher diversity of native shrubs (*Prunus* spp., mountain ash, *Amelanchier* spp., willows, and the rare buffaloberry) compared to other stands. Thimbleberry is a dominant understory species, along with large-leaved aster, hawkweed, and raspberries and dewberries (*Rubus* spp.).

Current Recreational Uses or Management:

: This stand retains valuable native plant community but also has significant areas of development, recreational impacts, and managed vegetation. The Lester Amity Chalet, Seven Bridges Road, ski trails, hiking trails, mountain biking trails, snowmobile trails, parking pullouts, and numerous "social trails" and river sit spots are amongst such infrastructure. Numerous planting

Adjacent land use concerns:

Lower Amity Creek is one of the most accessible recreation areas for Duluth residents and is a highly valued site for numerous recreational users, providing opportunities for both good land stewardship and risks of negative impacts like trampling, pollution, trash/debris, and disruption of

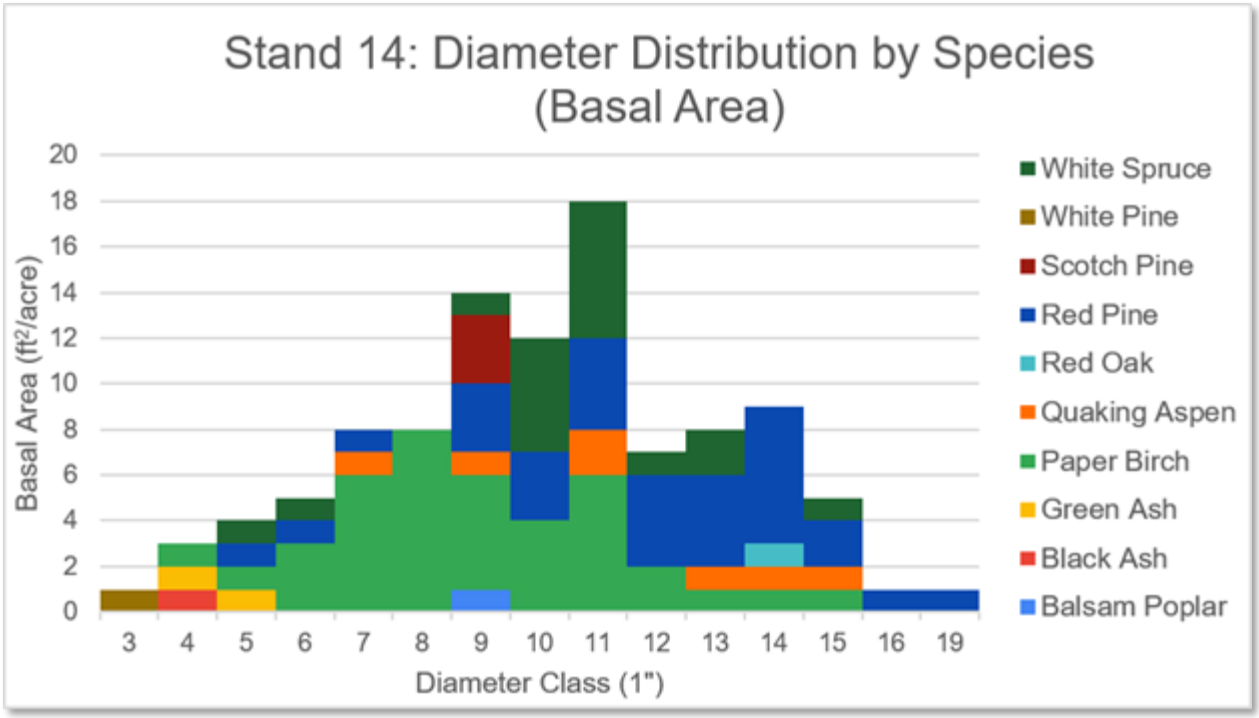
projects have been undertaken across multiple generations, as indicated by the >80 year old planted red pines along with planted and caged seedlings of white cedar, white pine, red pine, and white spruce in the floodplain terraces.

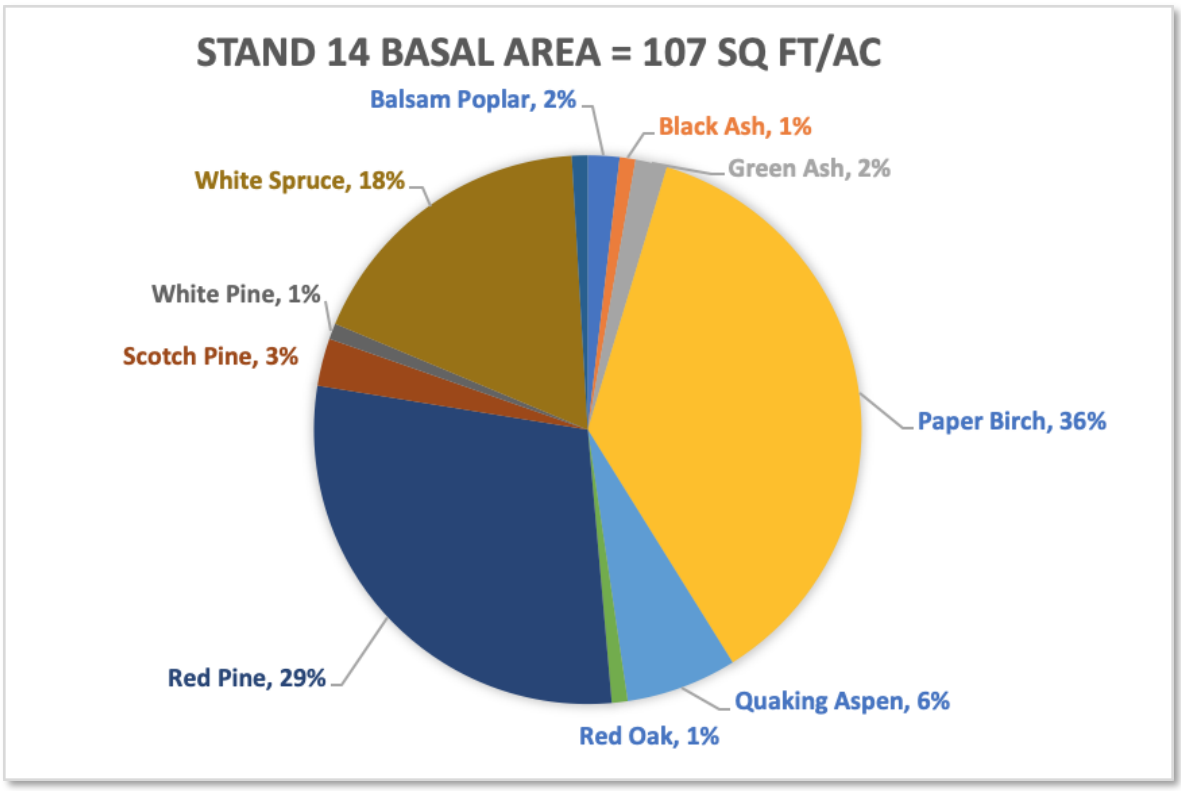
wildlife. Extremely dense stands of buckthorn occur to the south and west of the stand and are encroaching into the park.

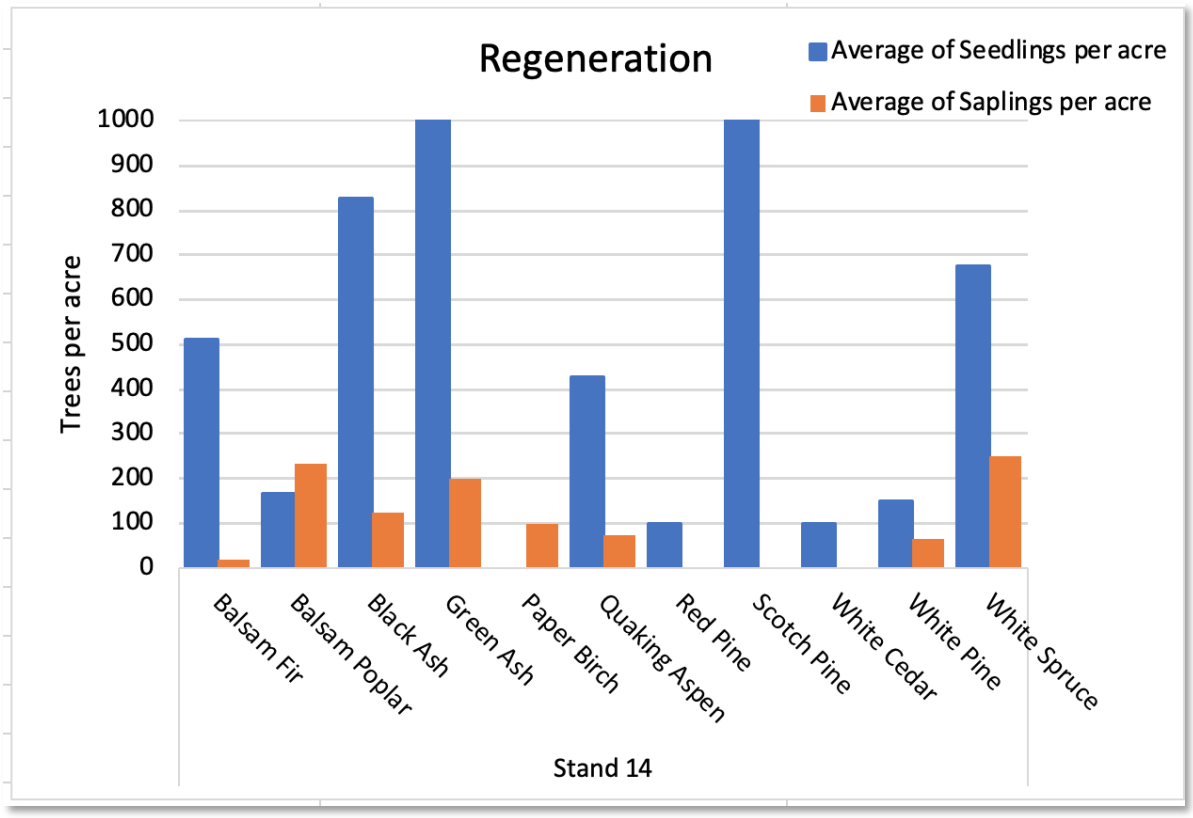
No action result (10-20 years): Red pines will continue to fail and fall over, resulting in hazards to the public, a maintenance burden, an unattractive viewshed, and increased wildfire risk. Natural tree regeneration may occur but buckthorn or native shrubs like hazel, dogwood, and mountain maple may become dominant. Floodplain forest will persist but longer-lived shade-tolerant species may not establish on their own leaving a lower diversity forest.

Management Goals, Strategies, and Actions

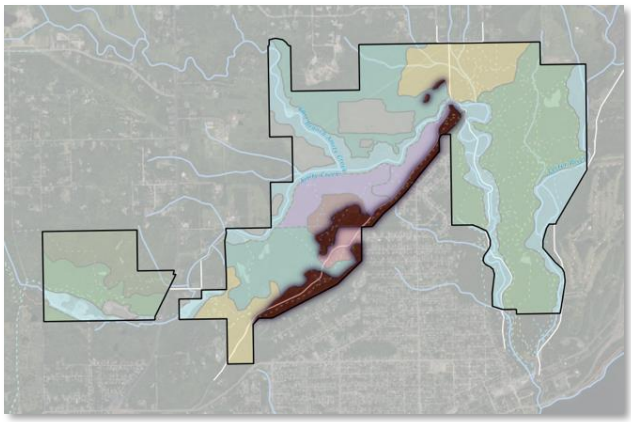
Goal	Strategy	Action	Notes
Restore/enhance native plant communities; Ecosystem function	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	Avoid soil disturbance on slopes; avoid herbicides near wetlands and waterways
Restore/enhance native plant communities	Transition tree plantations to native forest composition	Thin overly stocked tree plantations, sell commercially when possible or remove offsite; Interplant diverse native trees suitable to site conditions	Reduce red pine competition, create canopy openings for regeneration and understory growth
Regeneration; Ecosystem function	Artificial regeneration	Plant trees	Establish riparian conifers


Stand 14: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
20
18
16
14
12
10
8
6
4
2
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 19
Diameter Class (1")
White Spruce
White Pine
Scotch Pine
Red Pine
Red Oak
Quaking Aspen
Paper Birch
Green Ash
Black Ash
Balsam Poplar


STAND 14 BASAL AREA = 107 SQ FT/AC
Balsam Poplar, 2%
Black Ash, 1%
Green Ash, 2%
White Spruce, 18%
White Pine, 1%
Scotch Pine, 3%
Paper Birch, 36%
Red Pine, 29%
Quaking Aspen, 6%
Red Oak, 1%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Pine
Scotch Pine
White Cedar
White Pine
White Spruce
Stand 14

Stand 15 Rocky Outcrop (Aspen-Red Oak)





Stand Characteristics

Forest Type: Rocky Outcrop (Aspen-Red Oak)

Size: 68 acres

NPC (MDNR)	*Acres*	*% of stand*
ROn23a	40.6	60.01%
FDn33b	12.1	17.81%
MHn35b	7.6	11.20%

Dominant Soil:

- F160F (67%): Rock outcrop-Mesaba-Barto complex, 18 to 60 percent slopes. Gravelly sand loam over bedrock between 0-28". Well drained.
- F147D (24%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.
- F112D (7%): Forbay-Augustana complex, 3 to 18 percent slopes. Loam to 79". Well drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest, F093AY013MN Loamy uplands, F093AY006MN - Depressional Wet Hardwood Forest

Successional Stage (MDNR): N/A

Average Stand Diameter (DBH): 4.8" (SE=1.2)

Average Stand Basal Area: 46 ft2/ac (SE=13.1)

Snags per acre: 1.5 large (>12" DBH)

Coarse woody debris: Low to medium

Wildfire risk: Moderate due to dry exposed environment, some dead fir, and risk of ignition from recreational users and vehicles along Skyline Parkway

Invasive Species: Medium amount of buckthorn plants fairly well established in the tall shrub layer

Pests & Disease: Some dead fir was noted which may suggest spruce budworm, although cause of mortality was not confirmed

Current Condition: This stand makes up the highest peak of Hawk Ridge and the contiguous ridgeline extending to the northeast and southwest, a rocky outcrop of sparsely growing stunted tree growth characterized by a fire-dependent plant community. Quaking aspen is the dominant tree averaging 3-8" DBH, with fewer red oak in all size classes up to 14" DBH, red maple 3-5" DBH, and occasional paper birch. Regeneration is modest, with more saplings than seedlings, indicating healthy establishment of young trees though at a sparse density. Saplings are mostly aspen and a few red maple, with seedlings of balsam fir, paper birch, aspen, red maple, and red oak. Shrub layer is dense, composed of red-osier dogwood, serviceberry, buckthorn, beaked hazel, and chokecherry. Herbaceous layer is very dominantly bush honeysuckle with a greater diversity of plants compared to other stands.

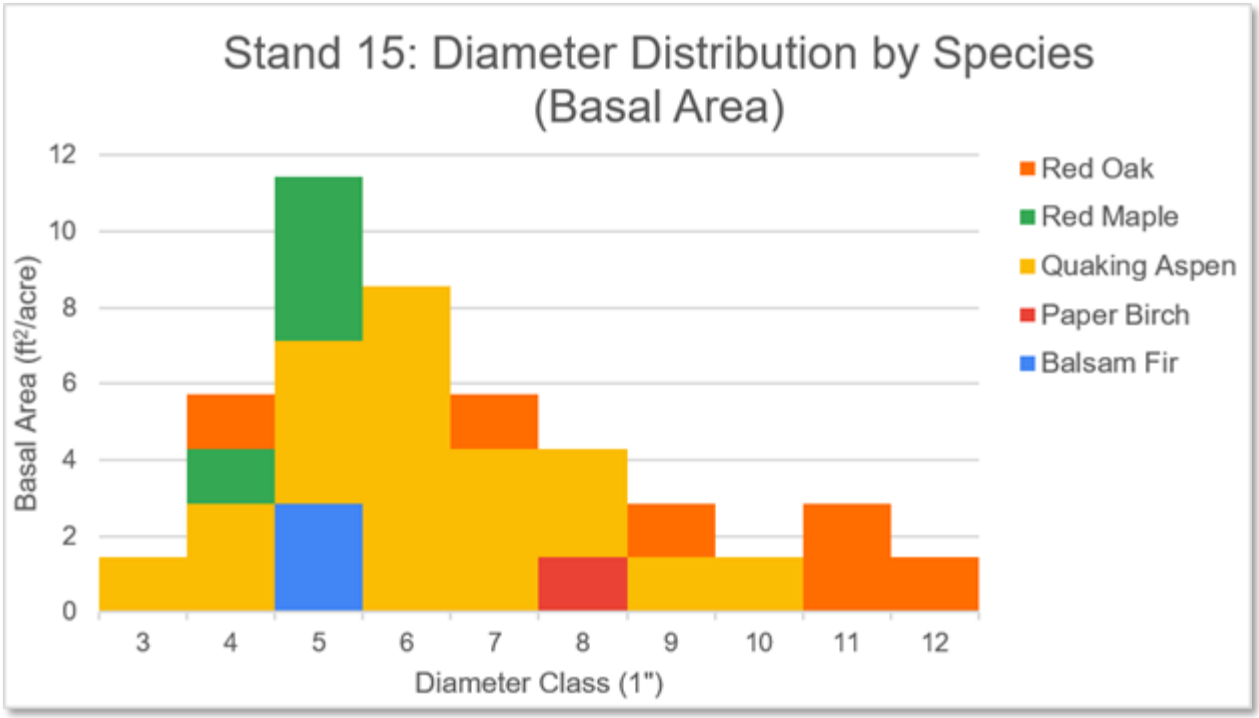
Current Recreational Uses or Management:
Several hiking trails intersect within this stand. A powerline corridor bisects the unit. Skyline Parkway follows the ridgeline through the entire length of the stand. The stand includes the central public viewing and educational activity during peak hawk migration in the spring and fall. The stand also boasts stunning views of Lake Superior that would be compromised if tree growth continues downslope.

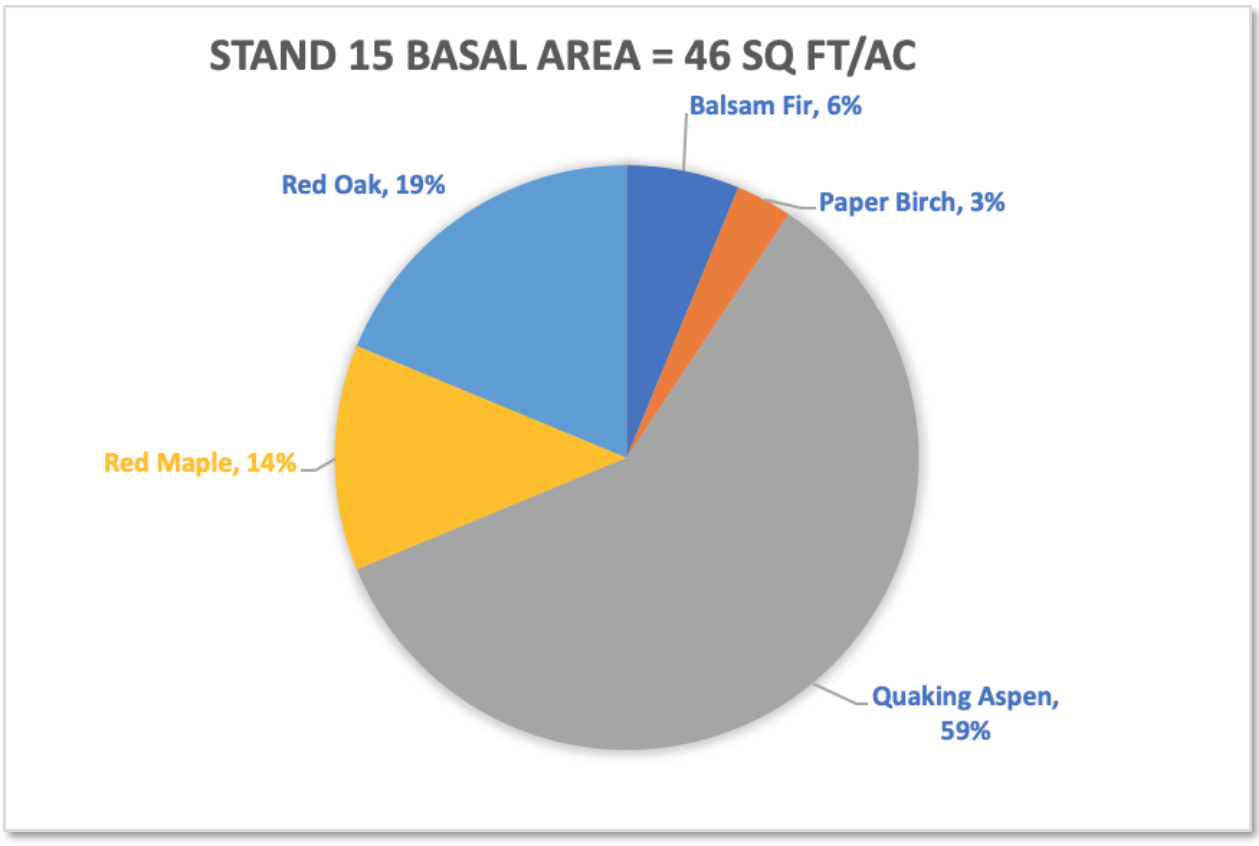
Adjacent land use concerns:
Ignition source from recreational users throughout Hawk Ridge or vehicles on Skyline Parkway. Potential for trampling and trash/debris from high visitor use.

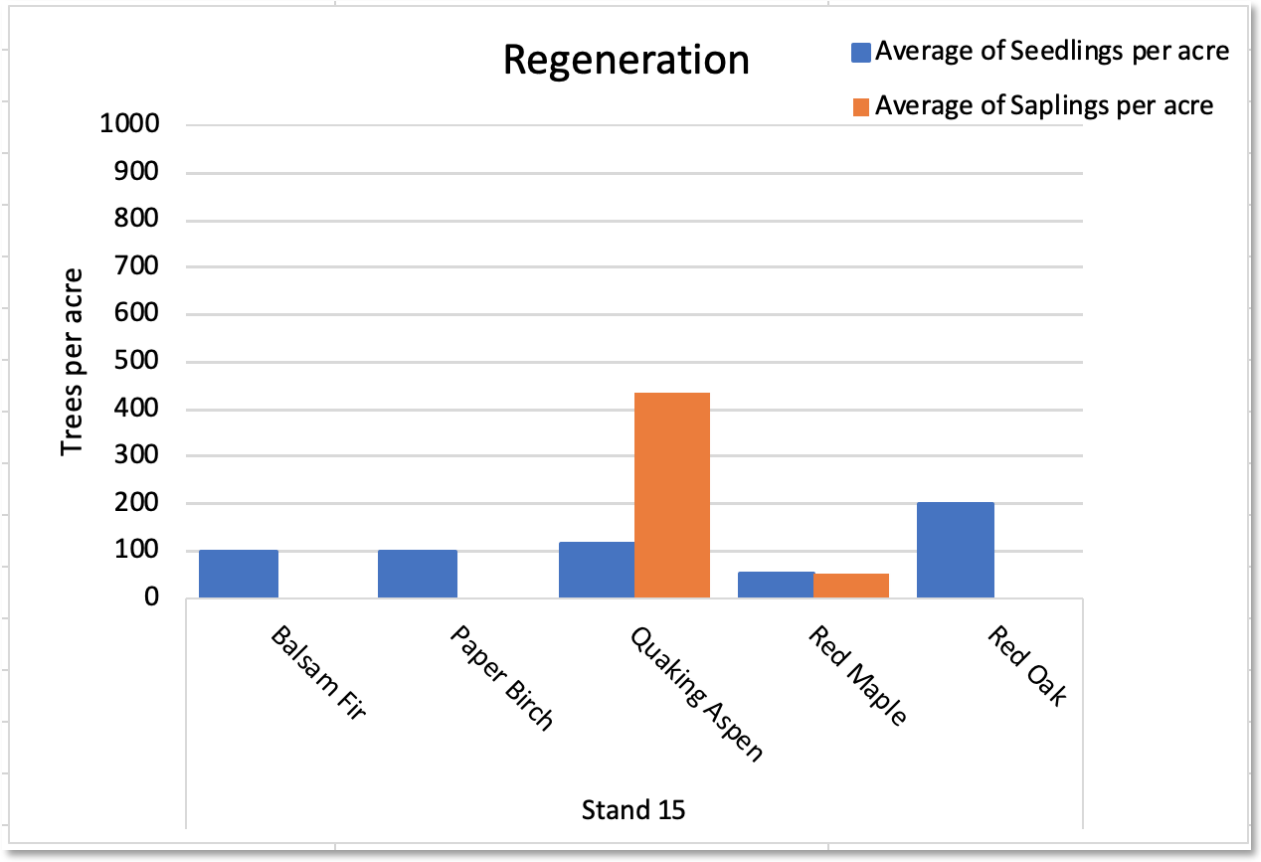
No action result (10-20 years): The stand is not likely to change much given the harsh conditions of the rocky outcrop environment and adaptation of existing plants to environmental extremes like drought, wind, and cold exposure. Greater tree mortality could occur in the event of an extreme drought or heat wave, or a wildfire.

Management Goals, Strategies, and Actions

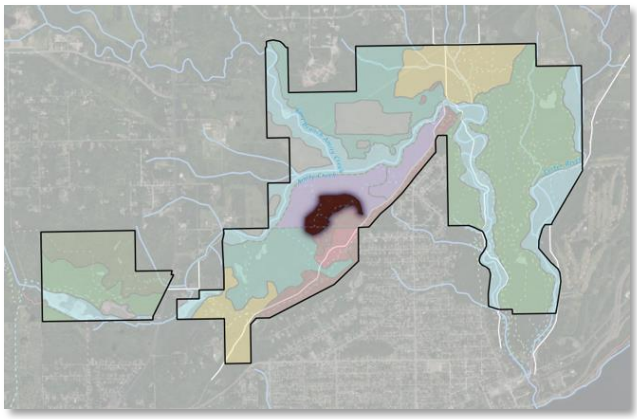
Goal	Strategy	Action	Notes
Restore/enhance native plant communities; Recreation	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	Additional invasive species present along road
Restore/enhance native plant communities; Recreation	Restore and maintain fire-dependent plant communities	Prescribed burning	Red maple establishing in younger age classes, Buckthorn present, follow up monitor
Recreation	Manage viewsheds at key viewpoints	Cut tall vegetation; Remove accumulated woody debris	hand cut vegetation


Stand 15: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
3
4
5
6
7
8
9
10
11
12
Diameter Class (1")
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Balsam Fir


STAND 15 BASAL AREA = 46 SQ FT/AC
Balsam Fir, 6%
Paper Birch, 3%
Red Oak, 19%
Red Maple, 14%
Quaking Aspen, 59%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Stand 15

Stand 16 Aspen-Birch (Balsam Fir)





Stand Characteristics

Forest Type: Aspen-Birch (Balsam Fir)

Size: 22 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn43b1	11.4	52.98%
FDn33a1	5.1	23.70%
FDn33b	2.4	11.32%
FDn43b	1.3	6.01%

Dominant Soil:

- F160F (68%): Rock outcrop-Mesaba-Barto complex, 18 to 60 percent slopes. Gravelly sand loam over bedrock between 0-28". Well drained.
- F147D (32%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest, F093AY013MN Loamy uplands

Successional Stage (MDNR): Young forest (0-35 years)

Average Stand Diameter (DBH): 6.0" (SE=0.4)

Average Stand Basal Area: 100 ft2/ac (SE=14.4)

Snags per acre: 49 medium (6-11" DBH)

Coarse woody debris: High

Wildfire risk: High due to quantity of dense living and dead balsam fir forming a fuel ladder, blowdown trees, steep slope, and high visitor traffic

Invasive Species: Buckthorn in low quantities

Pests & Disease: The presence of dead fir may suggest spruce budworm, although cause of mortality was not confirmed

Current Condition: This very rocky, steep stand is located on the northwestern-facing slope of the Hawk Ridge peak. Soil is minimal and stunted trees grow primarily out of crevices in the rock. Dominant trees are an equal mix of paper birch, quaking aspen, and balsam fir. Diameter distribution indicates a young stand with a geometric distribution of numerous <5" diameter trees, some 6-8" trees, and only occasional 9-11" trees. Regeneration is strong and of the same species composition as well as occasional red maple and black ash seedlings. Fuel loading is very high with blowdown trees, dense living balsam fir, and dead balsam fir forming a fuel ladder, posing a significant wildfire risk. Beaked hazel, mountain maple, serviceberry, and red-osier dogwood form a moderately dense shrub layer. Moss, lichens, large-leaved aster, and bush honeysuckle are the dominant herbaceous layer. Blueberry is present but not in abundance.

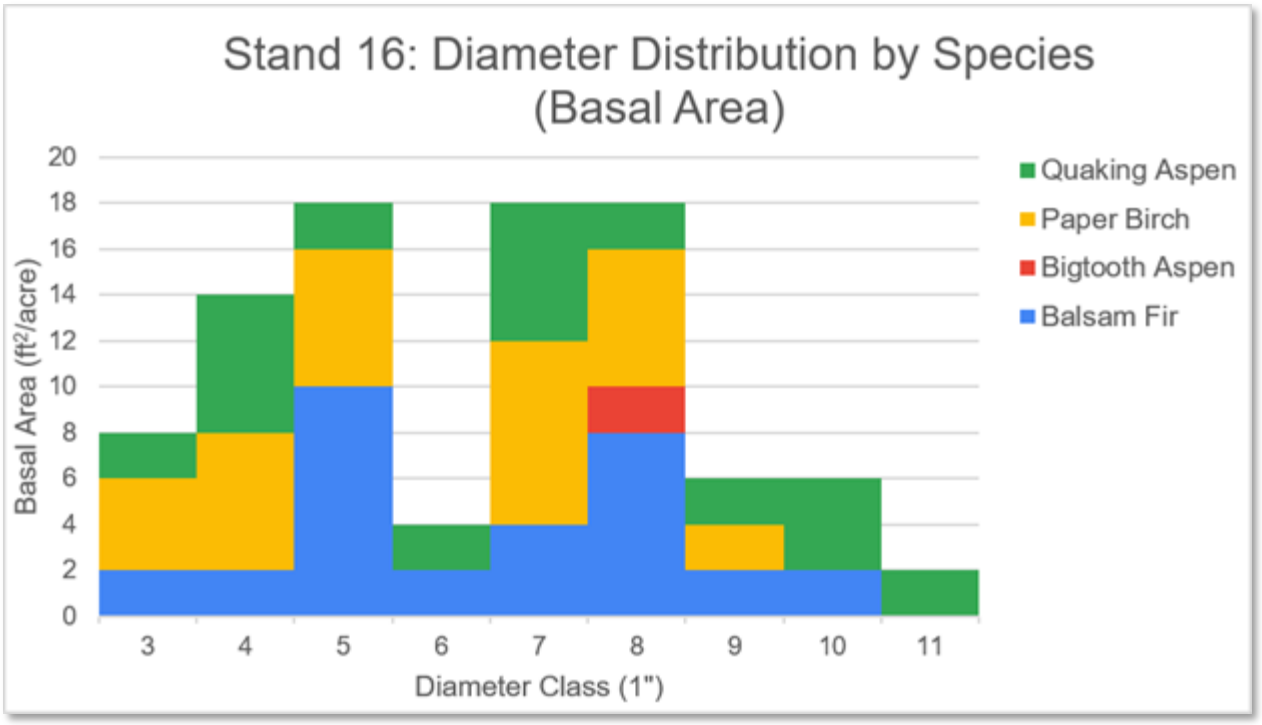
Current Recreational Uses or Management:
The Ridge Loop trail traverses down this slope. Dense buildup of downed trees and rocky steep terrain discourages off-trail use.

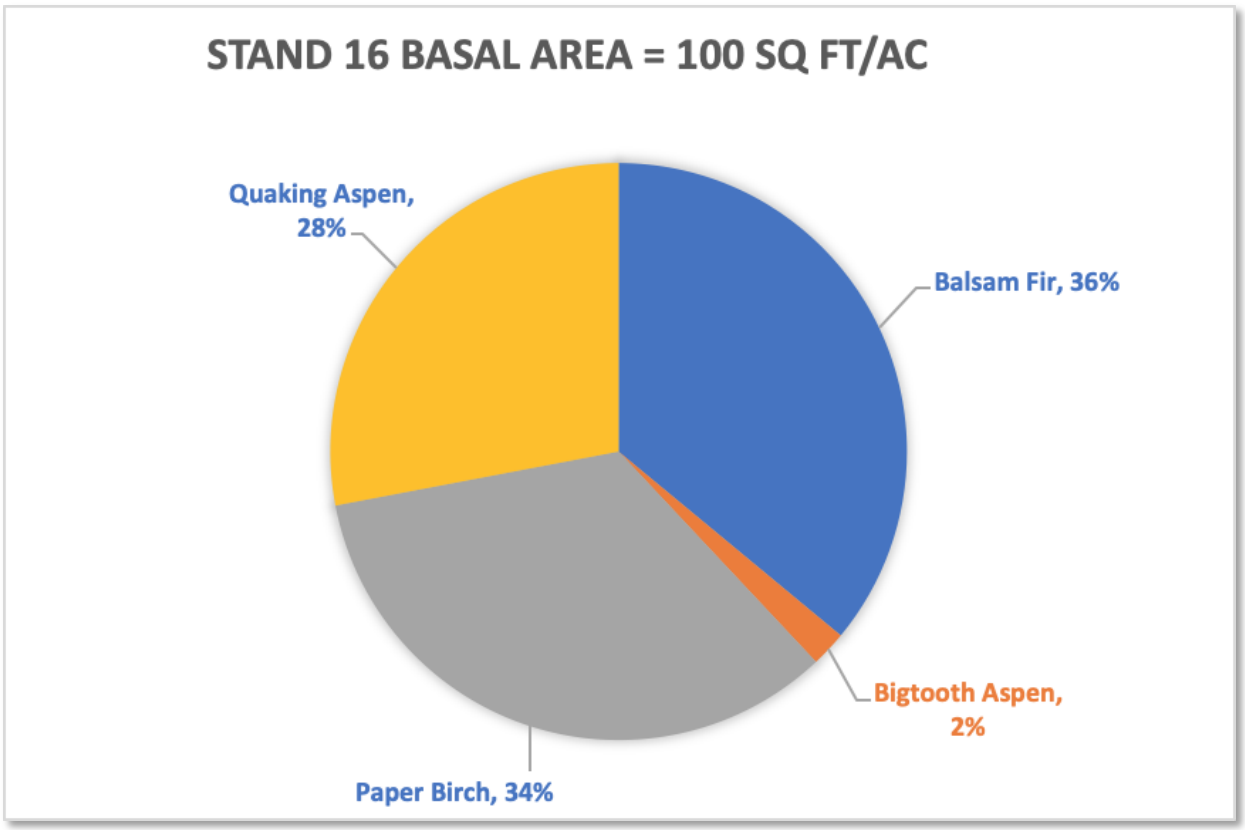
Adjacent land use concerns:
Ignition source from recreational users throughout Hawk Ridge or vehicles on Skyline Parkway.

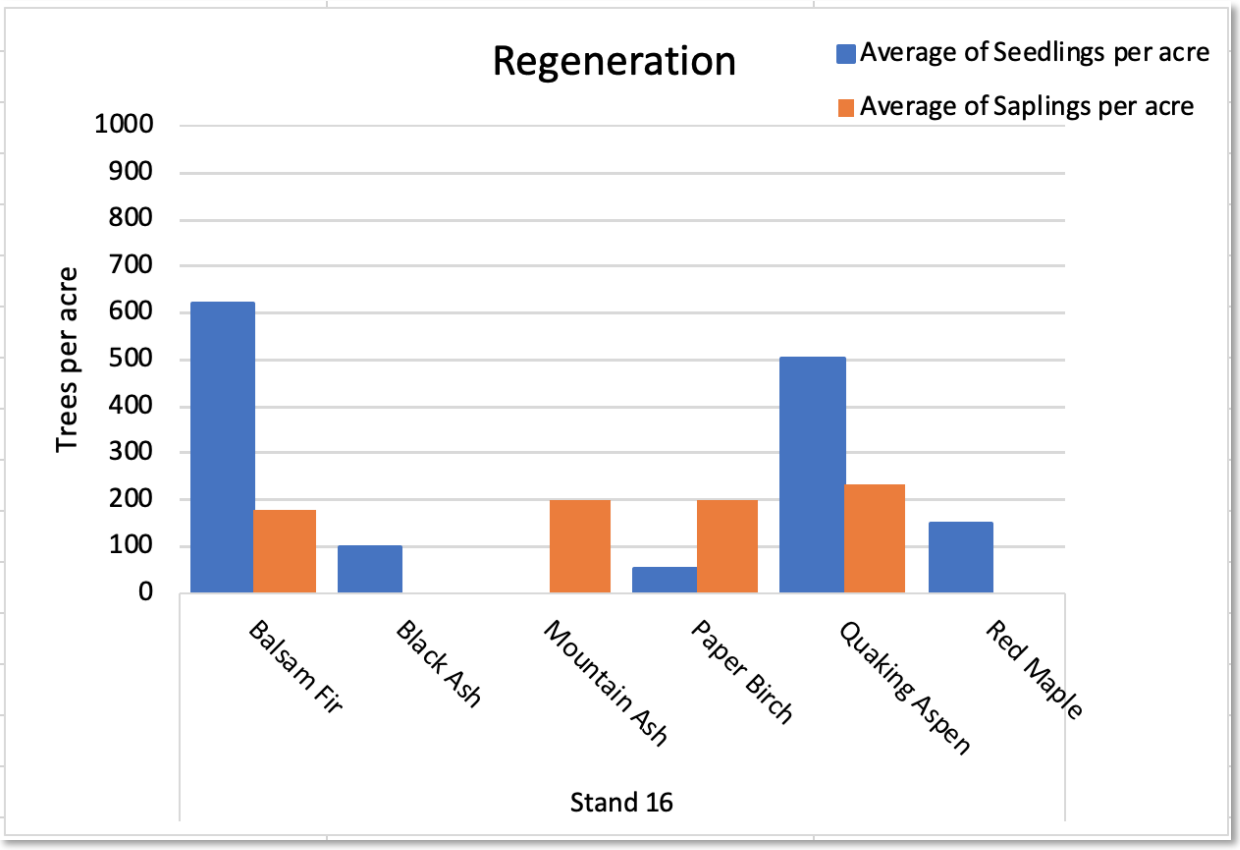
No action result (10-20 years): Balsam fir will continue to die from competition with each other and drought impacts. A fire in this stand is inevitable and would involve intense fire behavior and potentially severe fire effects setting back all vegetation for a long period. A controlled burn after mechanical removal of some fuels will reduce fire intensity and severity.

Management Goals, Strategies, and Actions

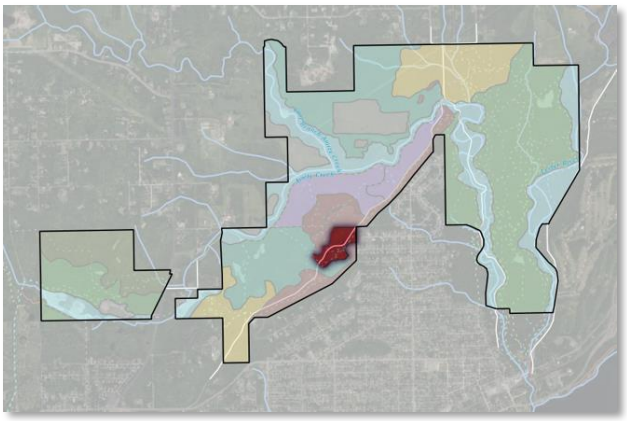
Goal	Strategy	Action	Notes
Forest resilience	Reduce hazardous fuel load to reduce wildfire risk and severity	Remove accumulated woody debris	
Forest resilience; Restore/enhance native plant communities	Restore and maintain fire-dependent plant communities	Prescribed burn	Red maple establishing in younger age classes, Buckthorn present, follow up monitor




STAND 16 BASAL AREA = 100 SQ FT/AC
Quaking Aspen, 28%
Balsam Fir, 36%
Bigtooth Aspen, 2%
Paper Birch, 34%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Black Ash
Mountain Ash
Paper Birch
Quaking Aspen
Red Maple
Stand 16

Stand 17 Northern Hardwoods (Red Oak)





Stand Characteristics

Forest Type: Northern Hardwoods (Red Oak)

Size: 19 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	13.1	69.63%
FDn33b	1.5	7.89%
FDn43b1	1.4	7.47%
Developed	1.4	7.36%

Dominant Soil:

- F160F (61%): Rock outcrop-Mesaba-Barto complex, 18 to 60 percent slopes. Gravelly sand loam over bedrock between 0-28". Well drained.
- F147D (39%): Ahmeek-Canosia-Rock outcrop complex, 0 to 25 percent slopes. Loam, silt-loam over gravelly sandy loam at 4-5". Well drained to poorly drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest, F093AY013MN Loamy uplands

Successional Stage (MDNR): Transitional forest (55-95 years)

Average Stand Diameter (DBH): 10.1”; SE 0.6”

Average Stand Basal Area: 134 ft2/ac; SE 14.3 ft2/ac

Snags per acre: 2 medium (6-11” DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Buckthorn is present throughout but in low amounts and mostly seedlings

Pests & Disease: Some dead spruce was noted which may suggest spruce budworm, although cause of mortality was not confirmed

Current Condition: This is the most hardwood-dominant forest stand at Hawk Ridge, located on the toe slope of the Hawk Ridge peak with a southeastern aspect. Red oak is by far the dominant canopy species, forming a partially-closed canopy of trees averaging 9-14” DBH. Quaking aspen, paper birch, and sugar maple are also common, averaging 6-11” DBH. Sugar maple and to a lesser extent red maple are the dominant subcanopy trees. Regeneration is generally low. Sugar maple is the primary sapling tree, and quaking aspen seedlings are abundant but there were no aspen saplings. Red oak, basswood, balsam fir, paper birch, and green ash are also present in lower amounts. Shrub layer is sparse with buckthorn and dogwood as the most common species. Thimbleberry and large-leaved aster are the dominant understory plants. The stand exhibits characteristics of both fire-dependent and mesic hardwood forest, indicating a possible transition from fire-dependent to mesic hardwood type in the absence of fire.

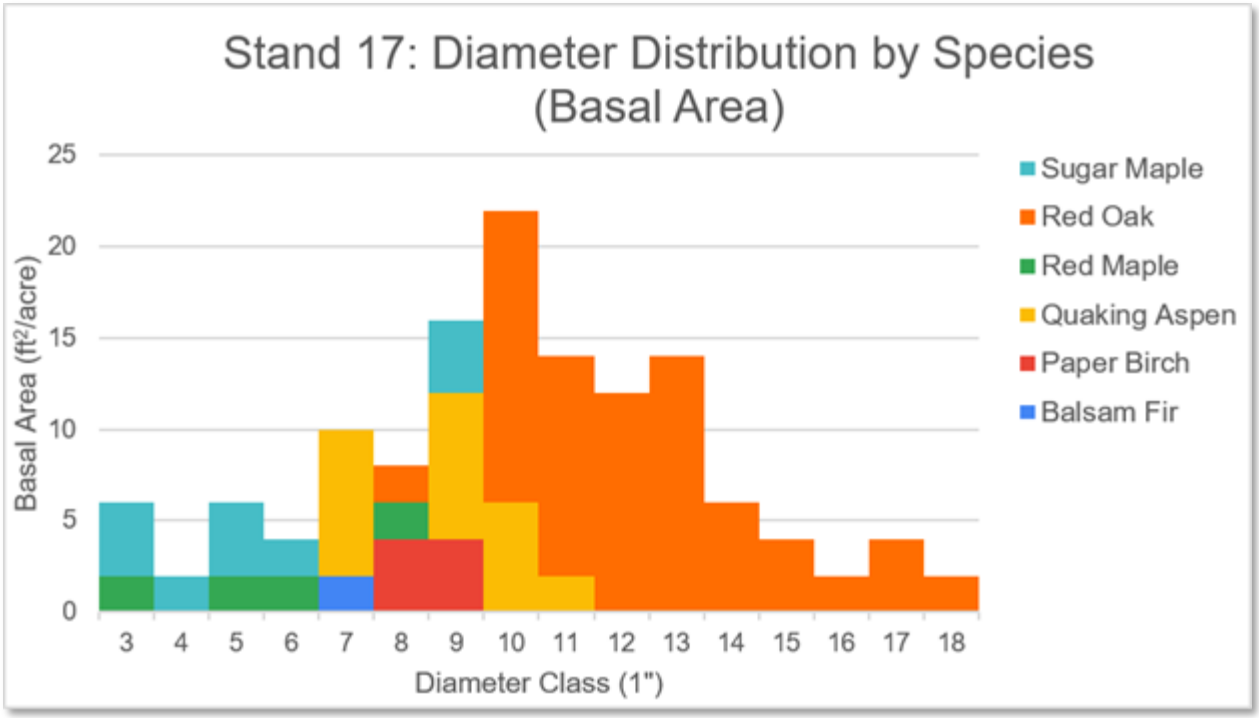
Current Recreational Uses or Management:
There are many hiking trails within the stand and some evidence of vegetation trampling in the understory. Skyline parkway bisects the unit - a source of visitors and invasive species.

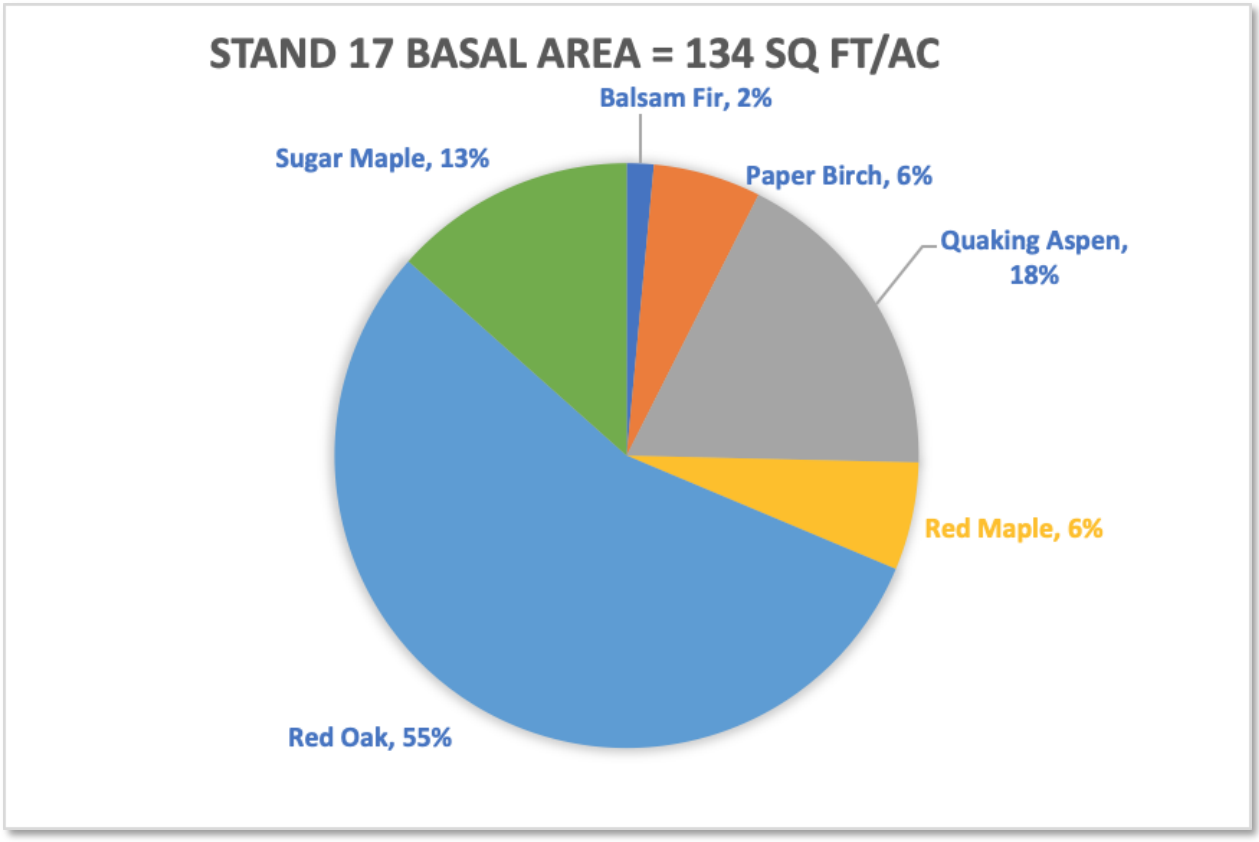
Adjacent land use concerns:
Residential area just downhill from the unit - possible source of extra foot traffic, invasive species, and trash/debris.

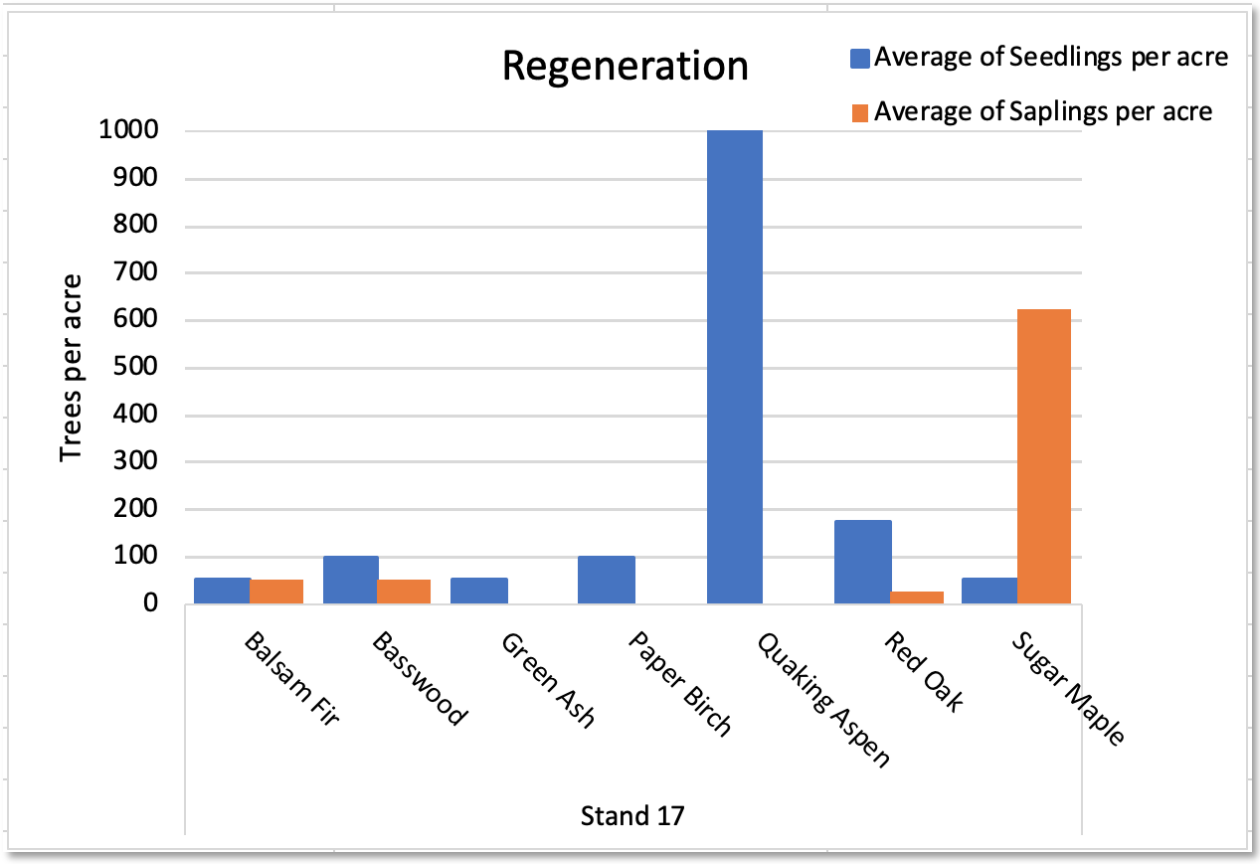
No action result (10-20 years): The stand may transition more completely to a mesic hardwood forest type, unless a severe drought limits establishment of hardwoods in favor of drought-hardy species present in the stand such as red oak.

Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Restore/enhance native plant communities; Regeneration	Restore and maintain fire-dependent plant communities	Prescribed burning	Understory is quite bare, use fire under oak stand to stimulate tree and fire-dependent herbaceous plant germination. Avoid areas of sugar maple dominance
Regeneration	Artificial regeneration	Plant trees	Supplemental if needed
Regeneration	Protect seedlings and saplings (natural or artificial regeneration)	Large area deer exclosure - natural materials or fence	Understory is quite bare, use deer exclosure to protect naturally regenerating trees


Stand 17: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
25
20
15
10
5
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Diameter Class (1")
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Balsam Fir


STAND 17 BASAL AREA = 134 SQ FT/AC
Balsam Fir, 2%
Sugar Maple, 13%
Paper Birch, 6%
Quaking Aspen, 18%
Red Maple, 6%
Red Oak, 55%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Basswood
Green Ash
Paper Birch
Quaking Aspen
Red Oak
Sugar Maple
Stand 17

Section 4: Mission Creek Forest Mission)

Figure 3: Mission Stands Map

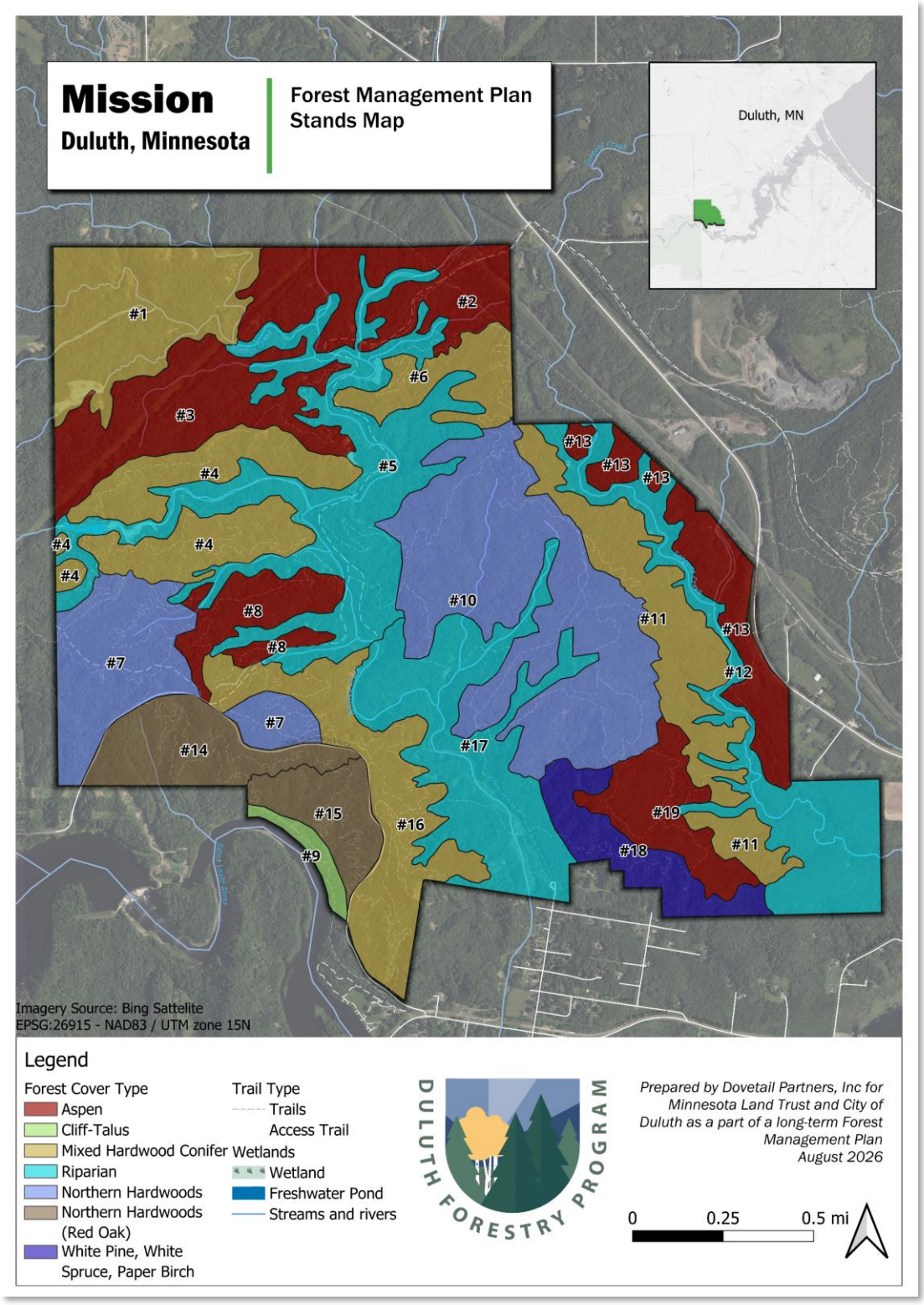
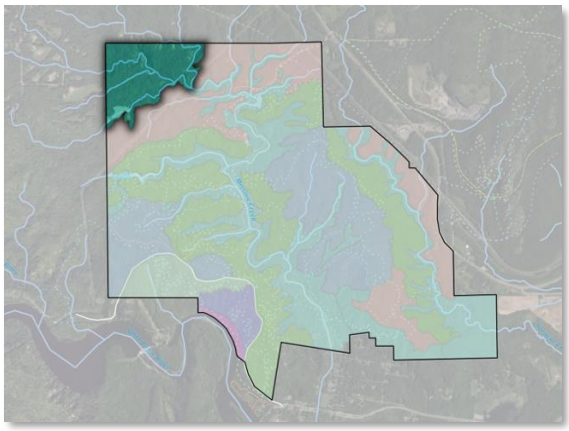


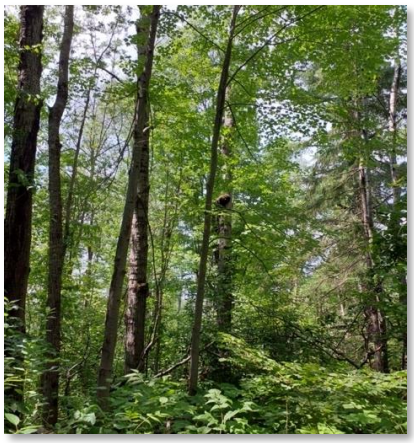
Table 7: Mission Creek Stand Attributes

Stand #	Forest Typ	Acres	Soil Prima	NPC Primary	Avg DBH (in)	SE DBH (in)	Avg Basal Area (ft2/ac)	SE Basal Area (ft2/ac)	SiteIndex1	SiteIndex1_species	SiteIndex2	SiteIndex2_species	Total Plots
1	Mixed Hardwood Conifer	120.3	F155G	MHn35b	9.1	0.9	105	10.4	73.7	Quaking Aspen			11
2	Aspen	100.2	F155G	MHn35b	10.4	0.5	137	12.2	73.7	Quaking Aspen			12
3	Aspen	108.7	F155B	MHn35b	8.3	0.6	128	10.7	73.7	Quaking Aspen			13
4	Mixed Hardwood Conifer	115	F155G	MHn35b	9.6	0.4	119	13	68.3	Quaking Aspen	40	White Spruce	9
5	Riparian	222.9	F155G	MHn44c	8.8	0.4	113.3	8.1	85.0	Quaking Aspen	57	White Spruce	15
6	Mixed Hardwood Conifer	44.7	F155G	MHn35b	11.7	0.9	138	9.8	73.7	Quaking Aspen			6
7	Northern Hardwoods	111.1	F155G	MHn35b	10.1	0.7	109	10	68.3	Quaking Aspen	40	White Spruce	12
8	Aspen	48.9	F155G	MHn35b	8.6	0.5	118	13.1	68.3	Quaking Aspen	46	Red Oak	5
9	Cliff/Talus	12	F155G	MHn44b / CTn11e					n/a	n/a	n/a	n/a	1
10	Northern Hardwoods (White Pine, Red Pine)	254.3	F155G	MHn35b	10.4	0.3	119.6	7.2	74.3	Quaking Aspen	40	Sugar Maple	23
11	Mixed Hardwood Conifer	116.6	F155B	MHn35b	10.6	0.5	155	13.4	74.3	Quaking Aspen	40	Sugar Maple	10

12	Riparian	128.3	F155G	MHn44b / MHn35b	9.8	0.7	115	14.6	85.0	Quaking Aspen	57	White Spruce	15
13	Aspen	72.2	F155G	MHn35b	9.3	0.5	127	13.7	73.7	Quaking Aspen			6
14	Northern Hardwoods (Red Oak)	69.5	F155G	MHn35b	10.6	0.6	118	11.1	76.0	Quaking Aspen	48	Red Oak	8
15	Northern Hardwoods (Red Oak, White Pine, Red Pine)	44.7	F155G	MHn35b	11.3	1.2	118	13.9	76.0	Quaking Aspen	48	Red Oak	5
16	Mixed Hardwood Conifer	119.8	F155G	MHn35b	9.4	0.5	128	17.6	50.0	Red Oak	63	White Spruce	12
17	Riparian	160.4	F155G	MHn44b / MHn44c	11.2	0.8	123.1	9.7	85.0	Quaking Aspen	57	White Spruce	16
18	White Pine, White Spruce, Paper Birch	52.8	F155G	MHn44b	11.8	1.8	125	21.9	52.0	White Spruce	60	Red Oak	4
19	Mixed Hardwood Conifer	56.4	F155B	MHn35b	9.2	0.5	142	15.8	67.0	Quaking Aspen	53	White Spruce	5

Stand 1 Mixed Hardwood Conifer





Stand Characteristics

Forest Type: Mixed Hardwood Conifer

Size: 120 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	35.1	29%
MHn44c	22.7	19%
FDn43b	18.4	15%
MHn46b	17.2	14%
RVx54a	14.1	12%

Ecological Site (USDA): F092XY014WI - Loamy Uplands F092XY015WI - Clayey Uplands

Dominant Soils: F155G, F155B. Udalfs-Eutrudepts complex, slopes ranging from 0-8% on ridgetops (F155B) to 25-70% slopes (F155G) on tributary drainages

Successional Stage: Transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 9.1" (SE=0.89)

Average Stand Basal Area: 105 ft2/ac (SE=10.4)

Snags per acre: 12 medium (6-11" DBH), 3 Large (>12"DBH)

Coarse woody debris: Medium to High

Wildfire risk: Low

Invasive Species: Low - Buckthorn was observed rarely, and at low amounts

Pests & Disease: Emerald ash borer is present in the mature ash trees with partial mortality and top-kill.

Current Condition: This maturing mesic hardwood-conifer forest is located at the northwest corner of the Mission Creek property and consists of numerous steep slopes and headwater drainages that converge to form the Mission Creek tributaries. Wildlife activity and in particular beaver activity is high in the lowlands with frequent beaver-felled trees and ponding behind dams with speckled alder and herbaceous wetlands. Canopy is moderately filled in with a dense midstory of hazel and thimbleberry. The oldest age class of trees are the occasional remnant white pine (23-38" DBH), uncommon sugar maple and yellow birch (not documented in inventory), and white spruce (11-16" DBH). A maturing cohort of 5-10" DBH paper birch, aspen, and occasional red maple occur on the upper slopes with balsam poplar, black ash, and occasional basswood in lower lying areas. Red oak and balsam fir of the 5-7" size class are present in low density in drier portions of the stand. Black ash vastly dominates the regeneration layer (<5" DBH), with green ash, balsam poplar, paper birch, quaking aspen, and basswood also present in reasonable abundance. Tall shrubs include occasional speckled alder in the lowlands, and hazel on upper slopes. Dominant understory plants include dewberry, gooseberry, lady fern, large-leaved aster, raspberry, thimbleberry, bush honeysuckle, and fly honeysuckle.

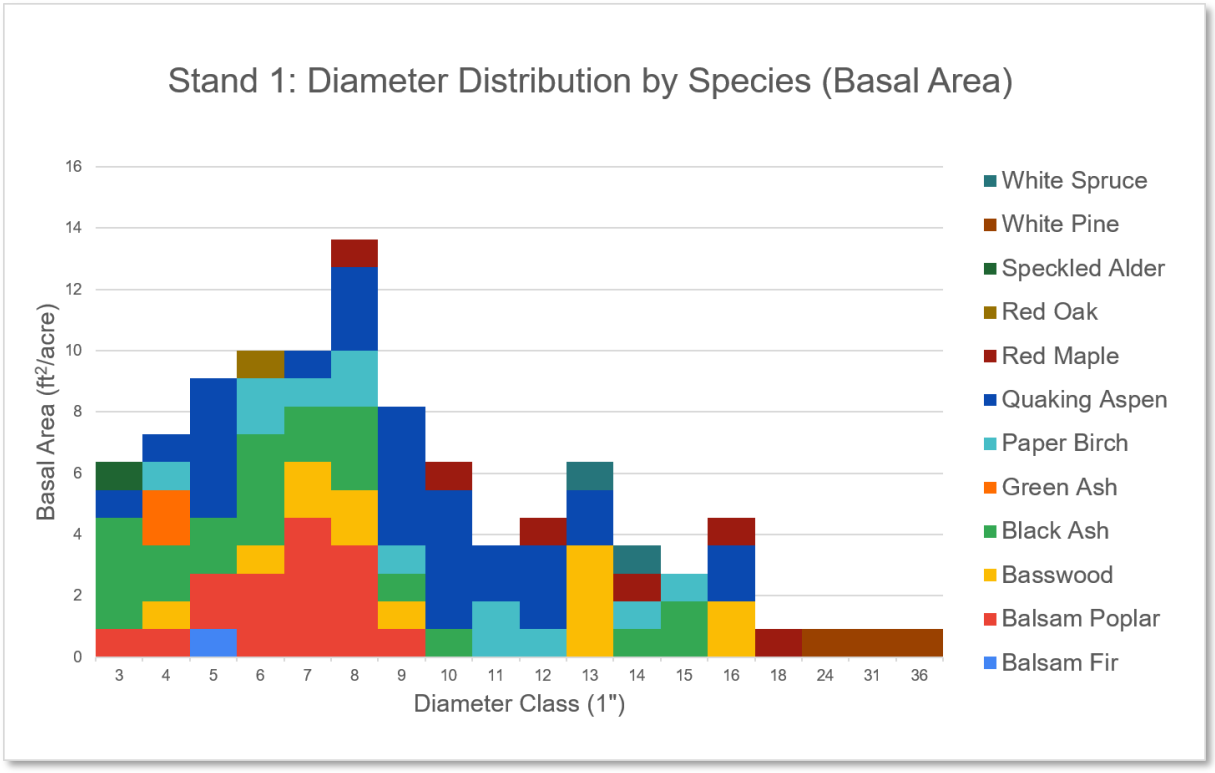
Current Recreational Uses or Management:
Recreational use of this stand is limited due to the lack of trails and difficult access.

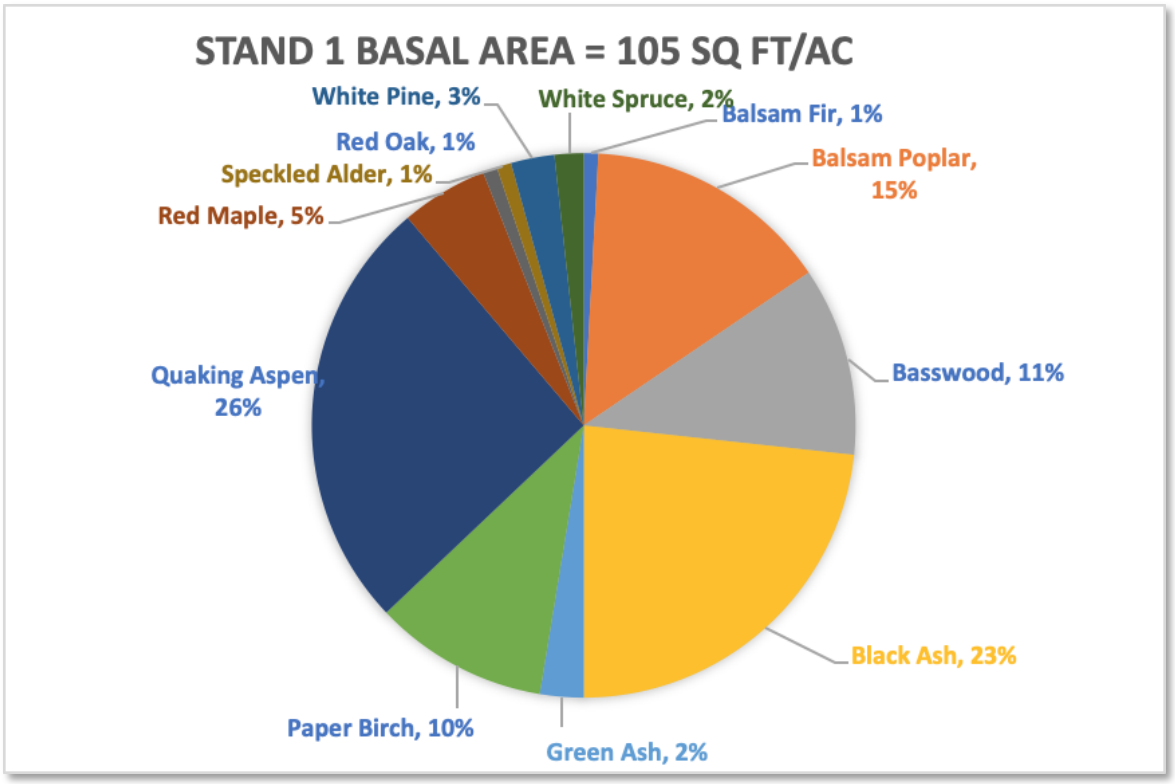
Adjacent land use concerns:
Private property borders the north and west sides of the stand and may cause impacts from runoff into the Mission Creek headwaters, invasive species incursion, or social trails.

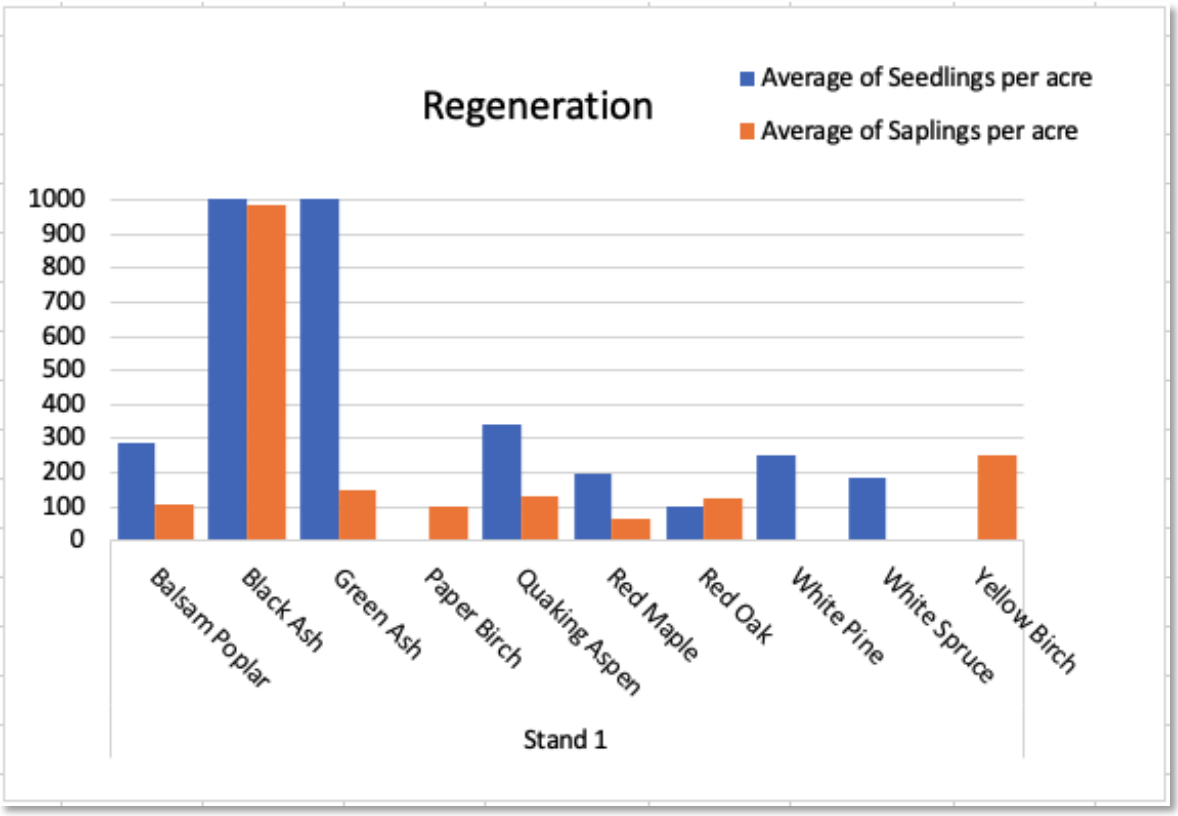
No action result (10-20 years): The ash mortality from EAB will continue and Mission Creek headwater floodplains may become more herbaceous or shrub dominant.

Management Goals, Strategies, and Actions

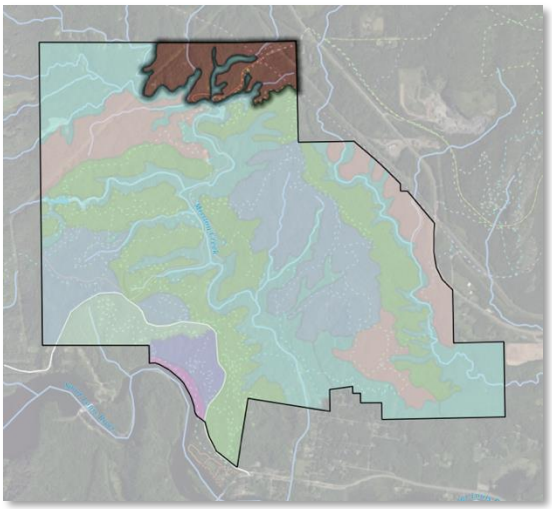
Goal	Strategy	Action	Notes
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Systemic herbicide injection annually into mature female trees during early-stage invasion to serve as seed crops for future ash regeneration; Girdle ash trees to attract EAB in combination with systemic herbicide injection to adjacent trees; Underplanting - Plant trees other than ash where ash decline and mortality is advanced	Access limited

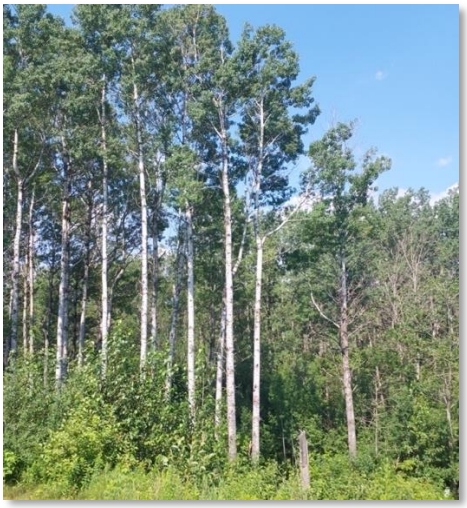



STAND 1 BASAL AREA = 105 SQ FT/AC
White Pine, 3%
White Spruce, 2%
Balsam Fir, 1%
Red Oak, 1%
Balsam Poplar, 15%
Speckled Alder, 1%
Red Maple, 5%
Quaking Aspen, 26%
Basswood, 11%
Black Ash, 23%
Paper Birch, 10%
Green Ash, 2%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
White Pine
White Spruce
Yellow Birch
Stand 1

Stand 2 Aspen





Stand Characteristics

Forest Type: Aspen

Size: 100 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	55.9	72%
Disturbed	8.7	11%
MHn44c	5.5	7%

Ecological Site (USDA):

Dominant Soils: F155G (83%), F155B (17%) Udalfs-Eutrudepts complex, slopes ranging from 0-8% on ridgetops (F155B) to 25-70% slopes (F155G) on tributary drainages. Very fine sandy loam and silt loam. Moderately well to well drained.

Successional Stage: Transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 10.4" (SE=0.89)

Average Stand Basal Area: 137ft2/ac (SE=12.2ft2/ac)

Snags per acre: 31 medium (6-11" DBH), 2 Large (>12"DBH)

Coarse woody debris: Medium/High to High

Wildfire risk: Low. A portion of this unit is adjacent to railroad tracks, which can be a source of wildfire ignitions

Invasive Species: Low, with some buckthorn saplings dispersed throughout the stand

Pests & Disease: Minimal aspen mortality and some evidence of EAB

Current Condition: This mature aspen stand is located at the northeast portion of the property with trailhead frontage on Becks Rd/Highway 3. The overstory is well-stocked and dominated by quaking aspen throughout most size classes. There is some paper birch in the 5-12" size classes. Quaking aspen, red maple, paper birch, and white spruce compose the majority of the 2-7" size class. Black ash is present in the overstory and overrepresented (along with green ash) in the seedling size classes. A few remnant white pine (up to 31" DBH) and occasional red pine are scattered along the slopes. There is some recruitment of paper birch into sapling size classes, while quaking aspen is recruiting but not establishing well into the sapling stage, possibly due to canopy closure. The midstory is dense and dominated by beaked hazel, roundleaf dogwood, serviceberry, native *Prunus* species, and downy arrowwood. The understory is dominated by bush honeysuckle, goldenrod, large-leaved aster, oak fern, and thimbleberry.

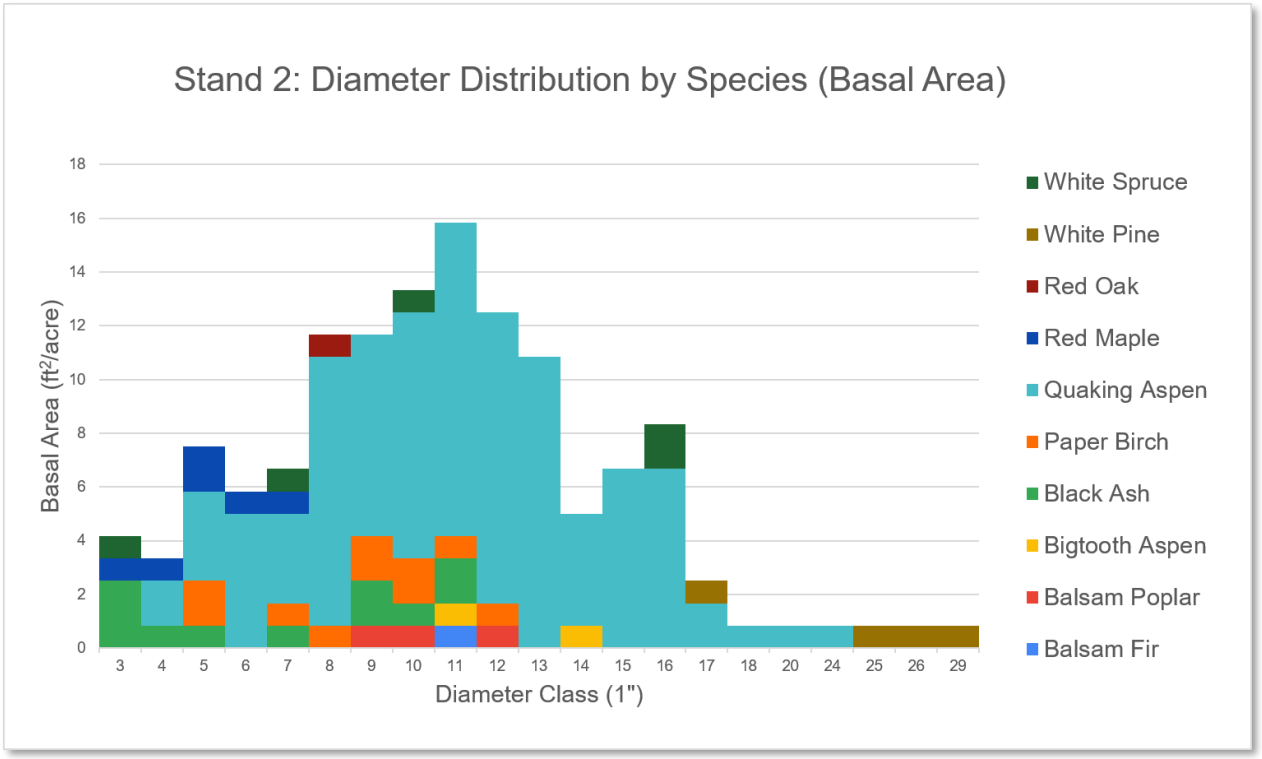
Current Recreational Uses or Management:
The Mission Creek Parkway, Willard Munger State Trail and additional trails are located through a portion of this stand as well as the Becks Rd Trailhead.

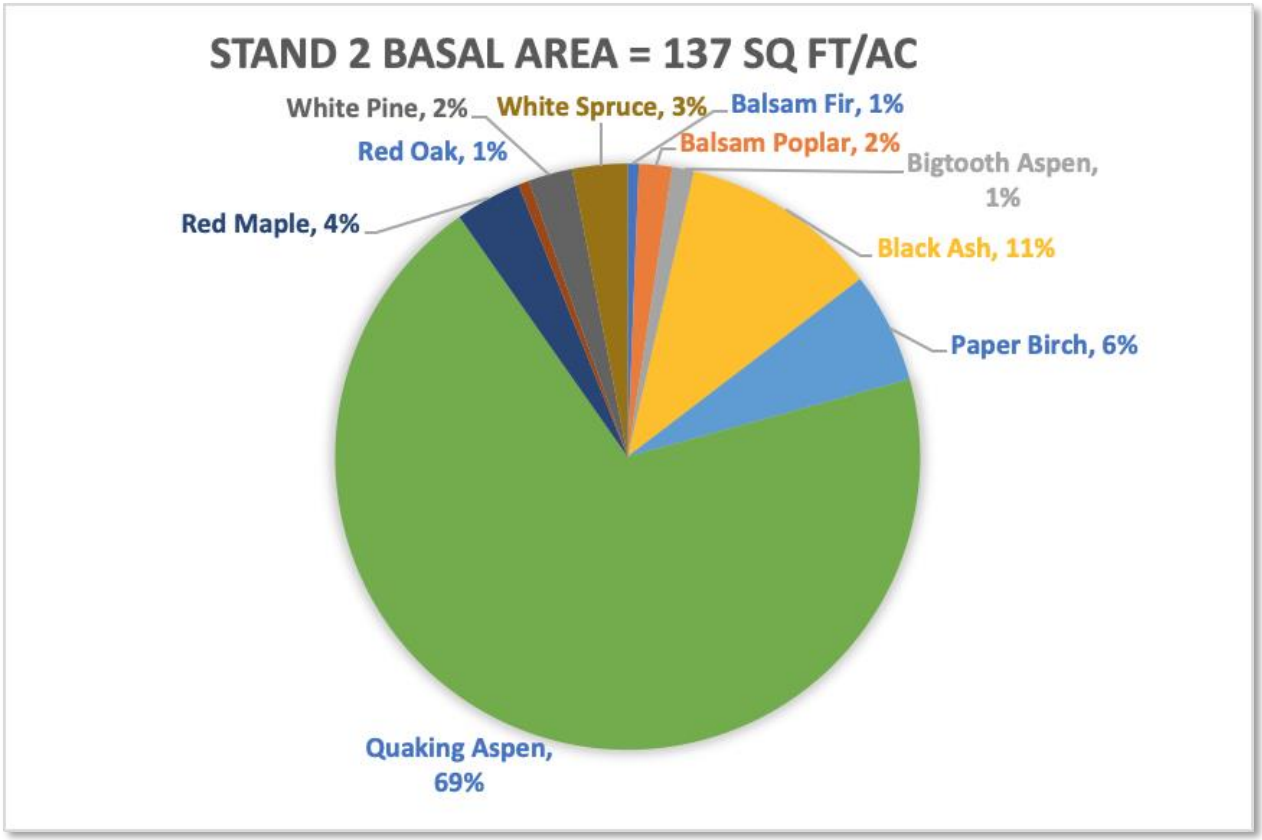
Adjacent land use concerns:
Trailhead parking lot, numerous multi-use trails, active railroad, and powerline corridor present in this stand pose risks of ongoing impacts such as soil compaction, vegetation trampling, pollution runoff into Mission Creek tributaries, and introduction of invasive species from recreational users, train traffic, and trail/railway maintenance operations.

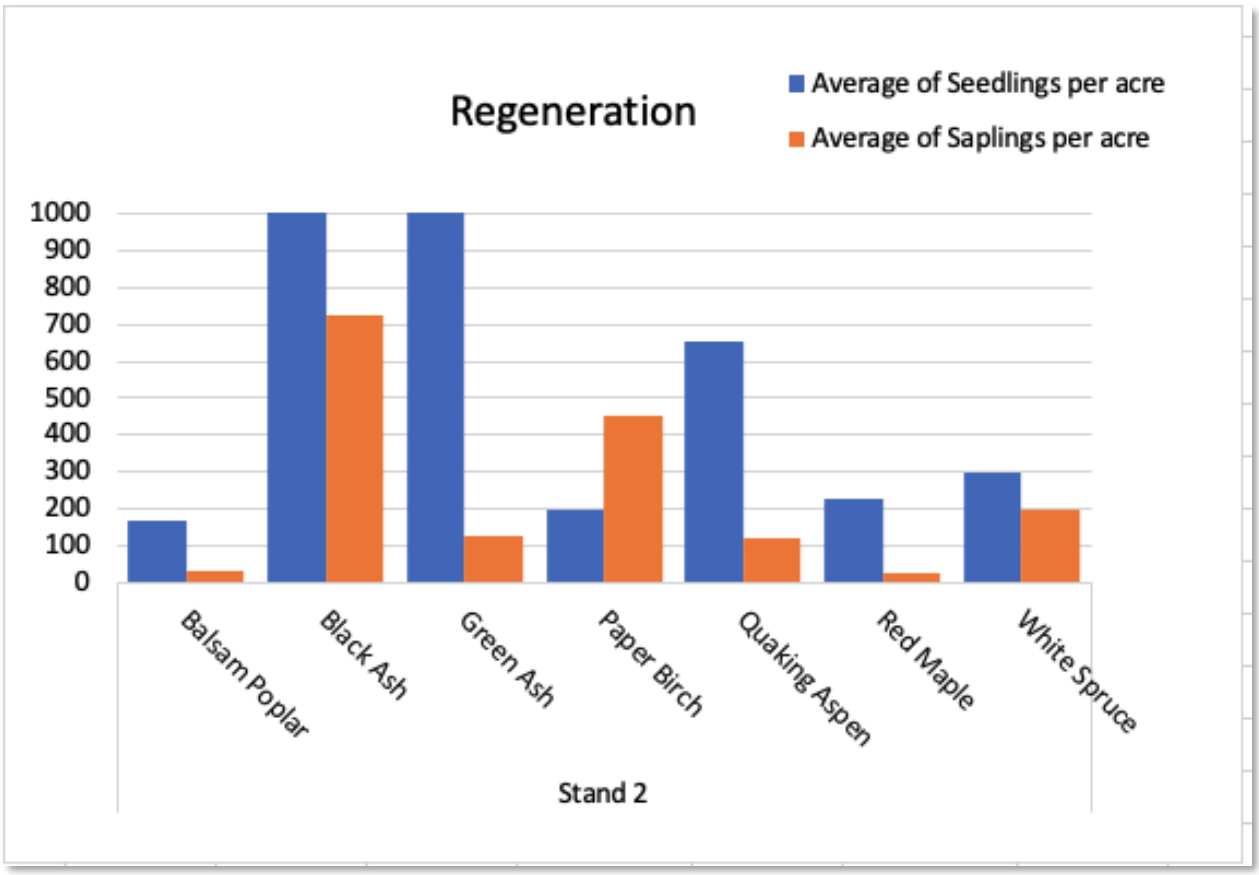
No action result (10-20 years): This stand is dominated by quaking aspen, a relatively short-lived early successional species that is generally unable to regenerate under its own canopy in the absence of disturbance. Over the next 10-20 years, these trees would become increasingly mature, with individual tree mortality creating small gaps. Black and green ash regeneration is abundant and likely to recruit in these gaps. This stand has a limited non-ash hardwood seed source. Sugar maple, white spruce, and basswood would be expected to emerge as the next successional species in this forest type, but few saplings of these species were observed.

Management Goals, Strategies, and Actions

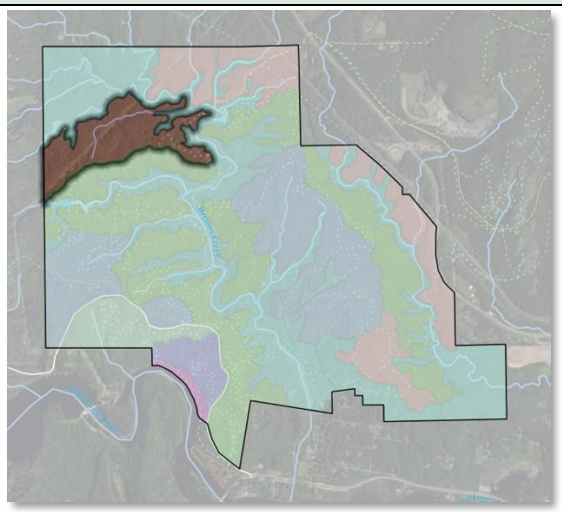
Goal	Strategy	Action	Notes
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine, red pine
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	site prep before cones drop
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort. Target red maple, aspen.

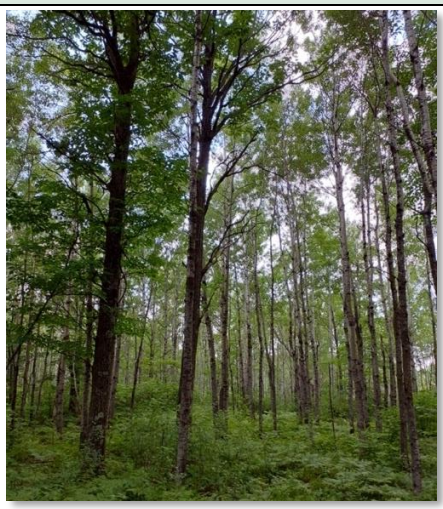

Stand 2: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
16
18
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 20 24 25 26 29
Diameter Class (1")
White Spruce
White Pine
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Black Ash
Bigtooth Aspen
Balsam Poplar
Balsam Fir


STAND 2 BASAL AREA = 137 SQ FT/AC
White Pine, 2%
White Spruce, 3%
Balsam Fir, 1%
Red Oak, 1%
Balsam Poplar, 2%
Bigtooth Aspen, 1%
Red Maple, 4%
Black Ash, 11%
Paper Birch, 6%
Quaking Aspen, 69%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
White Spruce
Stand 2

Stand 3 Aspen





Stand Characteristics

Forest Type: Aspen

Size: 109 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	77.6	71%
Disturbed	20.1	18%
MHn44c	10.2	9%

Ecological Site (USDA):
F092XY014WI - Loamy Uplands
F092XY015WI - Clayey Uplands

Dominant Soils: F155B (51%), F155G (49%) Udalfs-Eutrudepts complex, slopes ranging from 0-8% on ridgetops (F155B) to 25-70% slopes (F155G) on tributary drainages. Very fine sandy loam and silt loam. Somewhat poorly drained to well drained.

Successional Stage: Transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 8.3" (SE=0.64)

Average Stand Basal Area: 128 ft^2/ac (SE=10.7)

Snags per acre: 16 medium (6-11" DBH), 2 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low - Occasional large buckthorn saplings throughout unit

Pests & Disease: Deer browse present, limiting seedling recruitment

Current Condition: This stand consists of uplands dominated by aspen with birch and a mix of white spruce and northern hardwood species. A high-voltage powerline splits the stand. The average tree diameter is smaller compared to other stands on the property. Balsam poplar and paper birch are the second and third, most common tree species, respectively, in this unit. Overall, this unit is dominated by early-successional species, with few longer-lived hardwood species such as red oak, red maple, and sugar maple present. Ash regeneration is the most abundant compared to other species in this stand, but less abundant overall compared to similar stands. Aside from ash regeneration, balsam poplar had the most recruitment into the sapling size classes, with quaking aspen and red oak most abundant in the seedling size classes. The midstory is composed of a mix of beaked hazel, mountain maple, roundleaved dogwood, speckled alder, native *Prunus* species, and serviceberry. Mature, established beaked hazel is prevalent in the understory. Dominant understory plants are bracken fern, bush honeysuckle, goldenrod, lady fern, large-leaved aster, pyrola, raspberry, and thimbleberry.

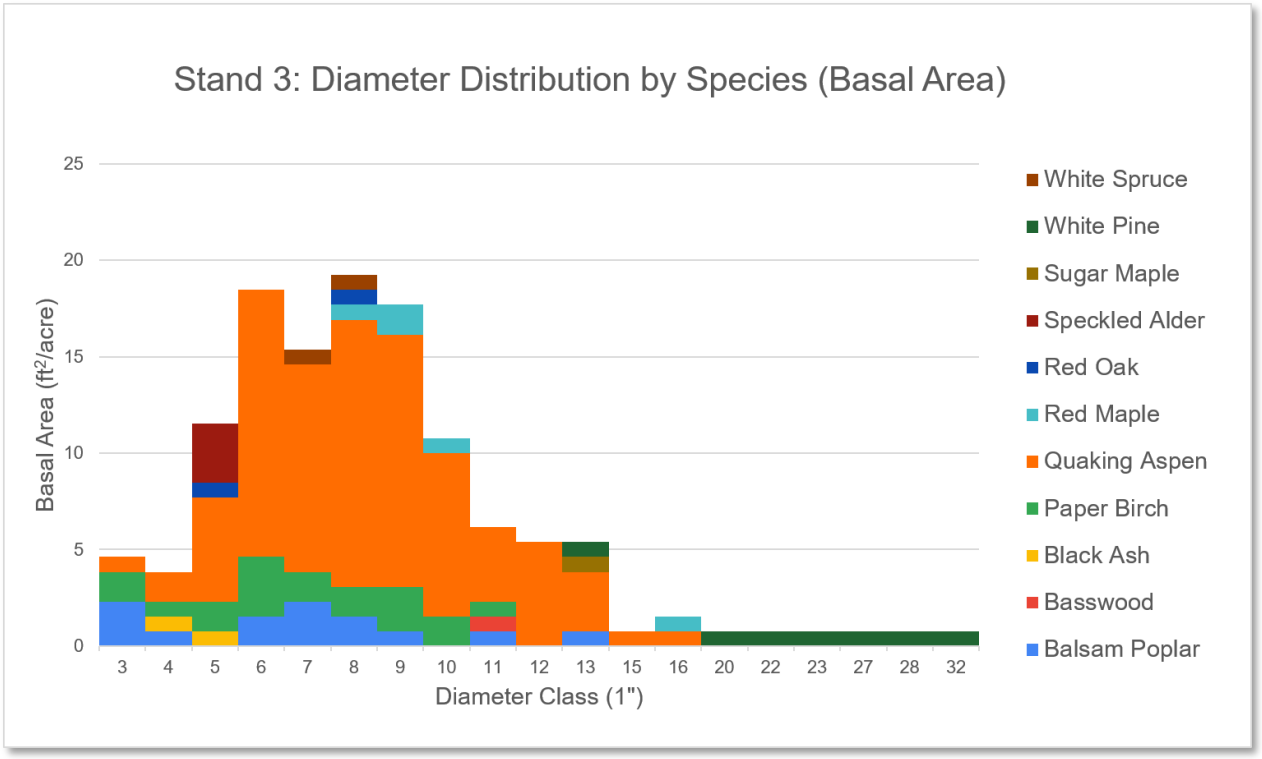
Current Recreational Uses or Management:
Limited trails are present in this unit, though the powerline corridor provides some foot or potentially all-terrain vehicle access through herbaceous vegetation.

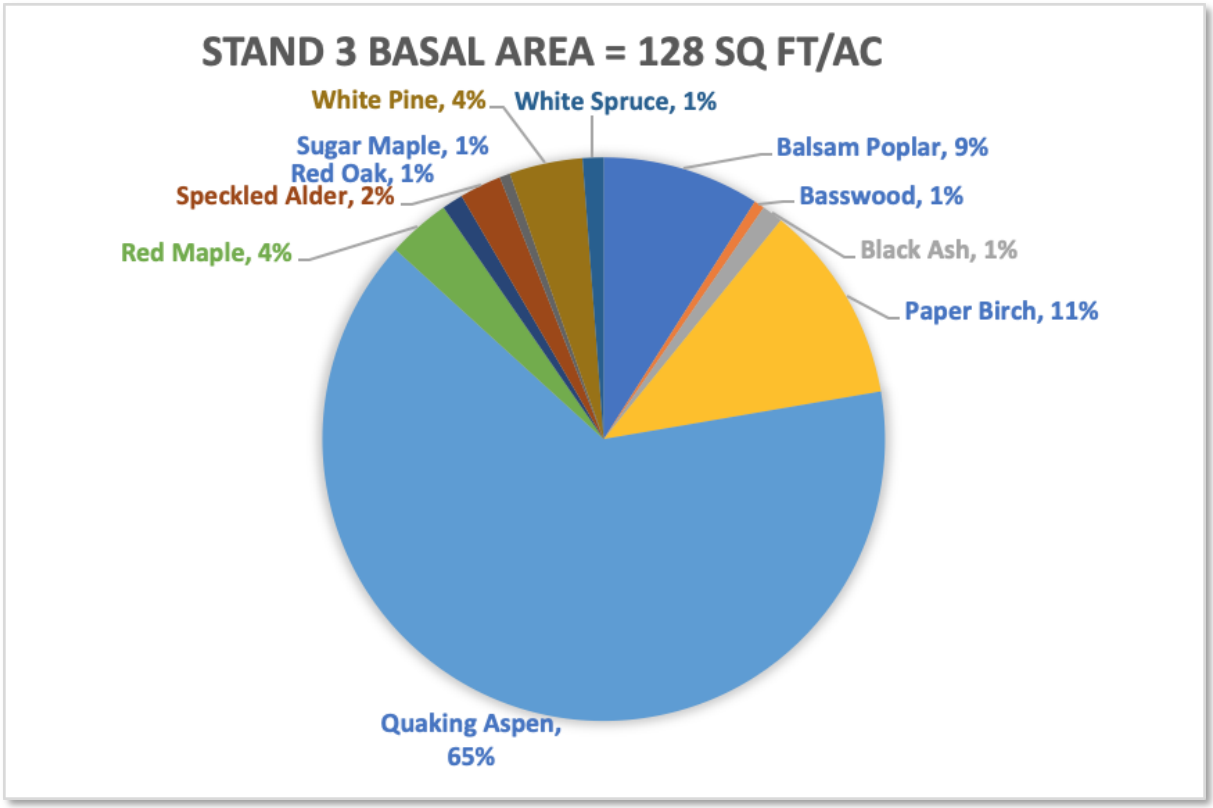
Adjacent land use concerns:
Private property borders the west side of the stand and may cause impacts from runoff into the Mission Creek headwaters, invasive species incursion, or social trails.

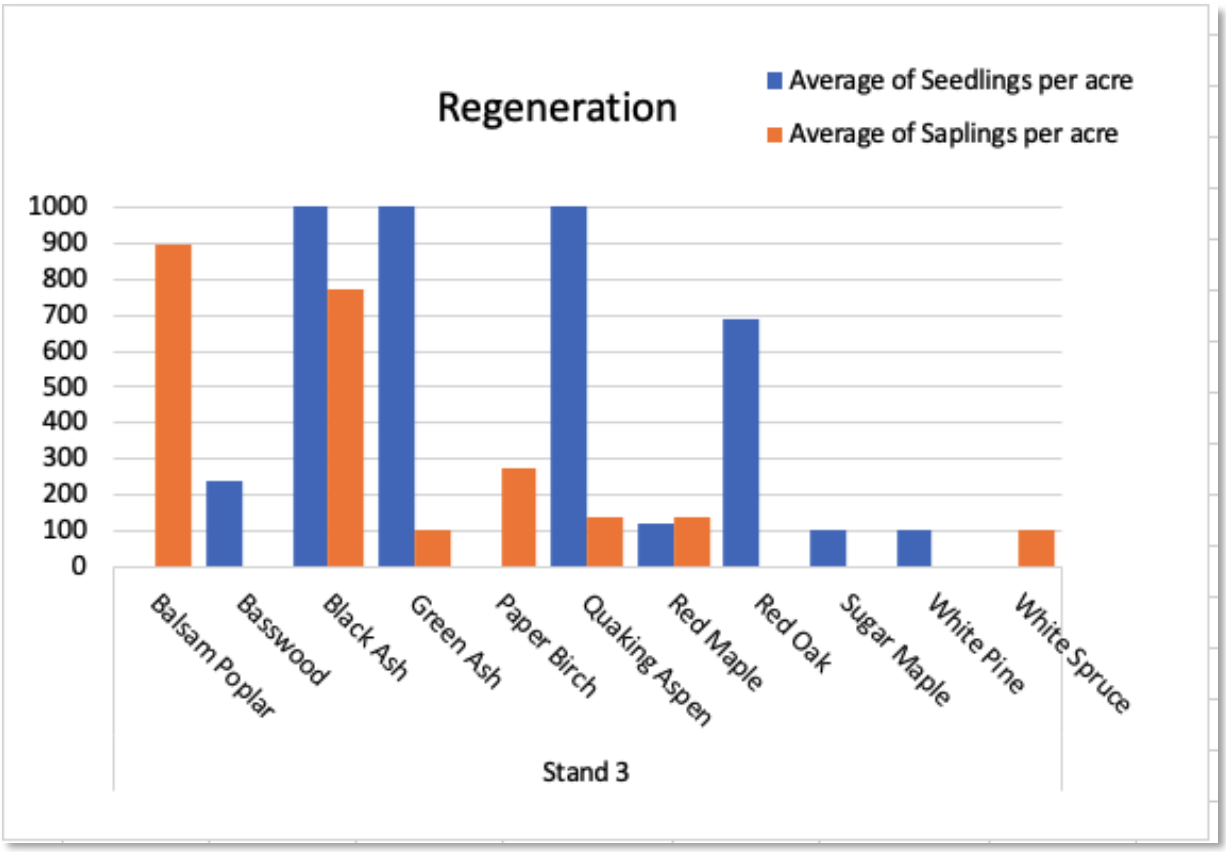
No action result (10-20 years): This stand is dominated by quaking aspen, a relatively short-lived early successional species that is generally unable to regenerate under its own canopy in the absence of disturbance. Over the next 10-20 years, these trees would become increasingly mature, with individual tree mortality creating small gaps. Hazel shrubs are highly abundant in this stand, and are likely to further establish in gaps and compete with tree seedlings. This stand has a limited non-ash hardwood seed source, but some balsam poplar, red maple and paper birch are recruiting to saplings.

Management Goals, Strategies, and Actions

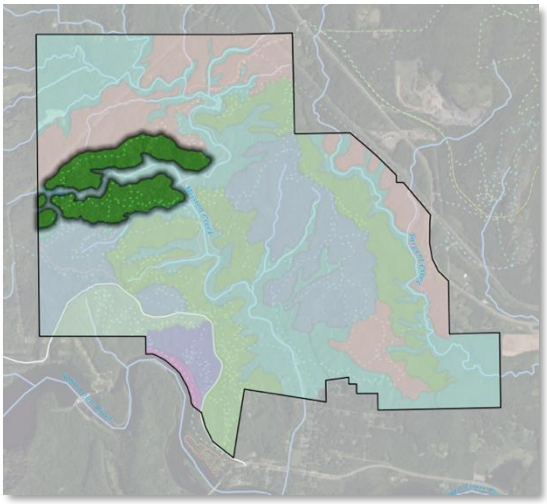
Goal	Strategy	Action	Notes
Regeneration; Restore/enhance native plant communities	Reduce competition in midstory	Mulch/masticate shrub layer	Target hazel




STAND 3 BASAL AREA = 128 SQ FT/AC
White Pine, 4%
White Spruce, 1%
Sugar Maple, 1%
Red Oak, 1%
Speckled Alder, 2%
Balsam Poplar, 9%
Basswood, 1%
Black Ash, 1%
Red Maple, 4%
Paper Birch, 11%
Quaking Aspen, 65%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Stand 3

Stand 4 Mixed Hardwood Conifer





Stand Characteristics
Forest Type: Mixed Hardwood Conifer
Size: 115 acres
NPC

MHn35b	103.2	90%
MHn44c	10.8	9%
(MDNR)	*Acres*	*% of stand*

Ecological Site (USDA):
F092XY014WI - Loamy Uplands
F092XY015WI - Clayey Uplands
Dominant Soils: F155G (69%), F155B (31%)
Udalfs-Eutrudepts complex, slopes ranging from 0-8% on ridgetops (F155B) to 25-70% slopes (F155G) on tributary drainages. Very fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitional between young and mature (55-95 years)
Average Stand Diameter (DBH): 9.6" (SE=0.42)
Average Stand Basal Area: 119 ft^2/ac (SE=13)
Snags per acre: 21 medium (6-11" DBH), primarily aspen
Coarse woody debris: Medium
Wildfire risk: Low
Invasive Species: Low amounts of scattered buckthorn
Pests & Disease: None noted

Current Condition: This transitional aspen-hardwood stand follows along a south-facing slope in the upper portion of Mission Creek. Quaking aspen is the most abundant overstory tree species present (ranging mostly from 5-16" DBH). Sugar maple, paper birch, basswood, and to a lesser extent red maple and white spruce are abundant in the 4-10" DBH range, indicating the stand is transitioning naturally into the mature form of this mesic hardwood forest type. Ironwood (primarily of the 2" size class) is also prevalent in the understory. Despite the diverse seedling regeneration, few trees (aside from some ash) are currently recruiting into the sapling age classes. Canopy is dense in places but with sizeable openings, in which beaked hazel is quite dense. The midstory also includes ironwood, native *Prunus* species, round-leafed dogwood, and serviceberry. Dominant understory plants include bush honeysuckle, Pennsylvania sedge, lady fern, large-leaved aster, and a diversity of other ferns.

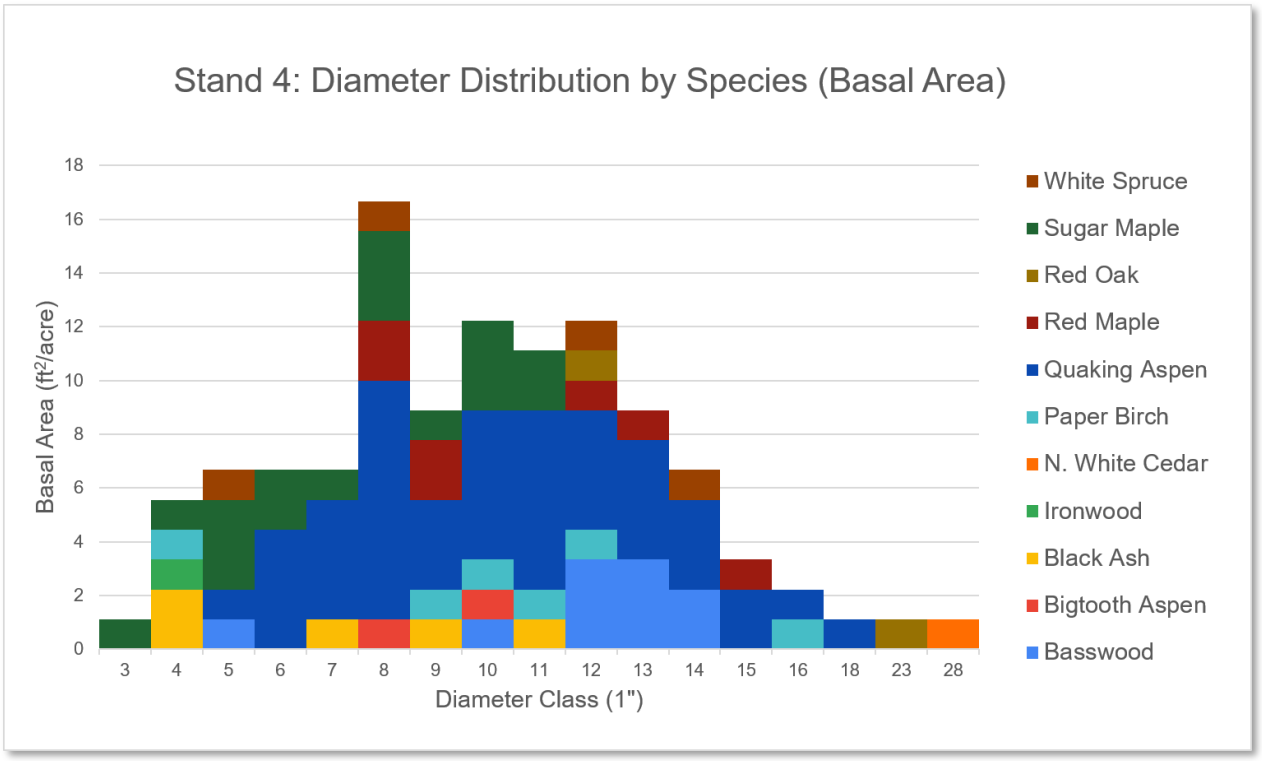
Current Recreational Uses or Management:
The Duluth Traverse hiking/mountain biking trail runs cross-slope through this unit.

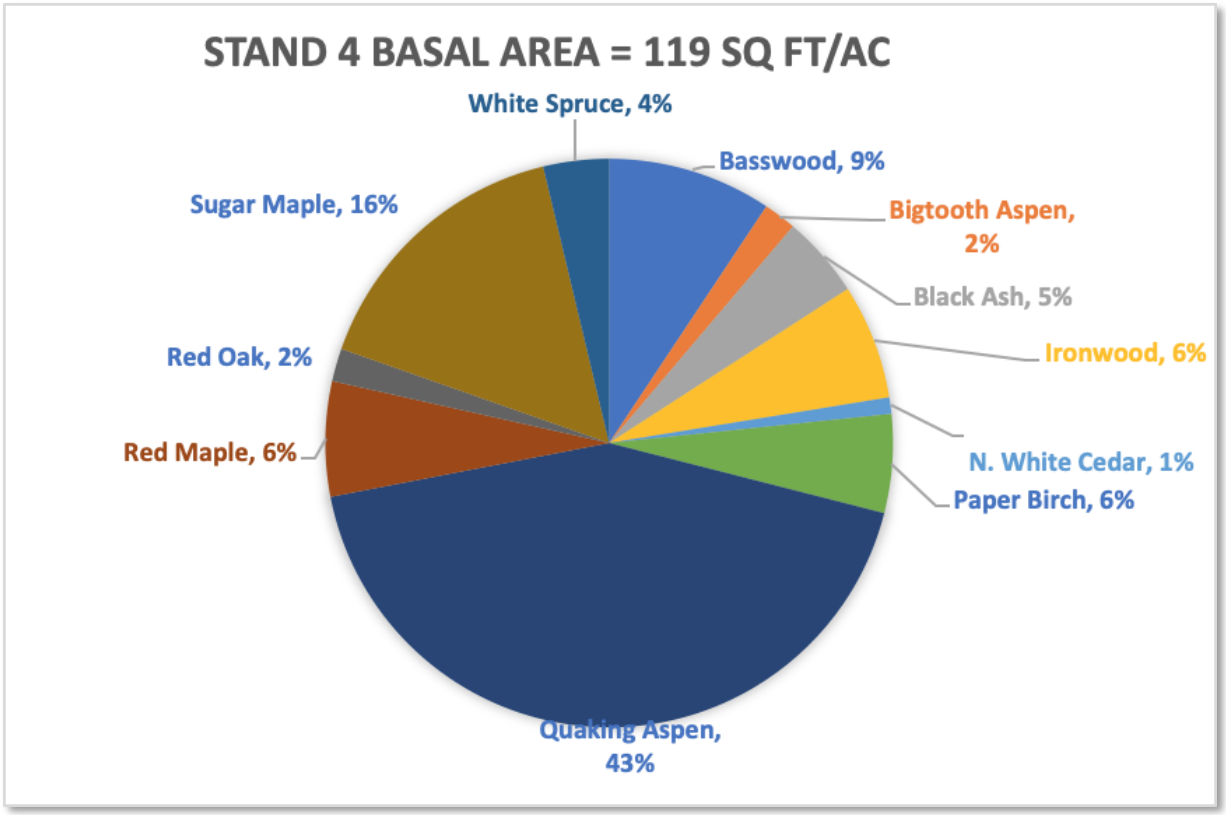
Adjacent land use concerns:
To the west of this unit is Jay Cooke State Park, potentially bringing higher numbers of visitors via connected hiking trails.

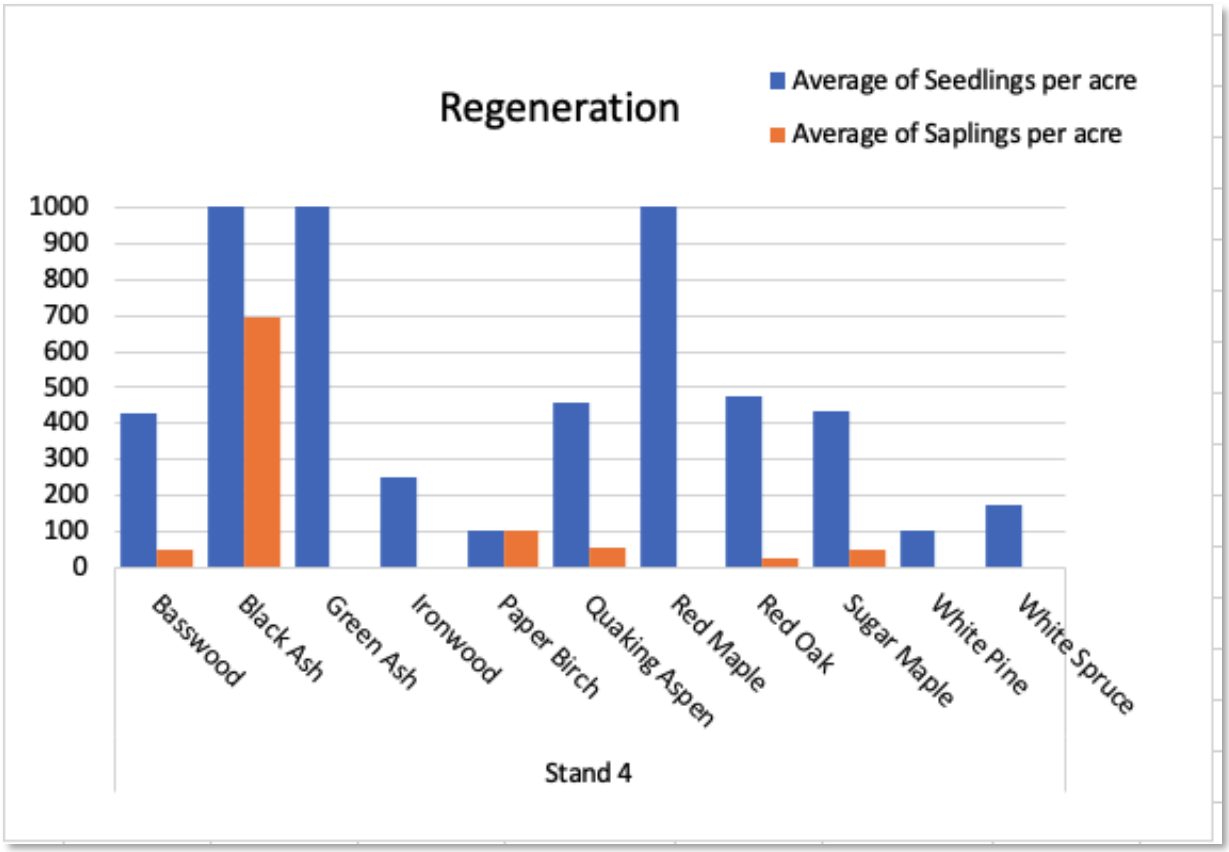
No action result (10-20 years): Due to the closed canopy conditions, this stand would be expected to transition to shade tolerant tree species such as maples, basswood, and ironwood. Mature aspen will continue to age out and naturally turn to snags or fall over, contributing to coarse woody debris and forest complexity. Hardwoods may continue to successfully establish into maturity; however, if deer browse continues at high pressure, stand density may decline in favor of dense hazel thickets.

Management Goals, Strategies, and Actions

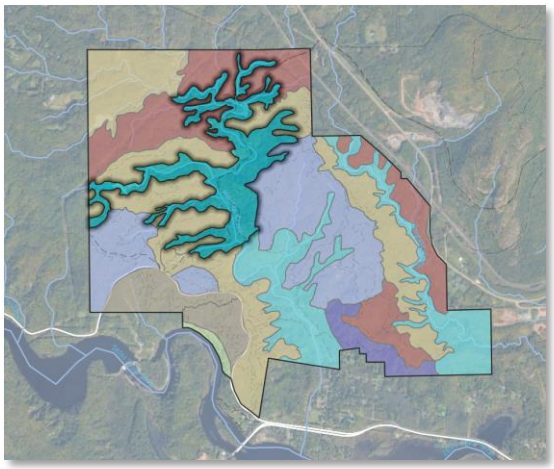
Goal	Strategy	Action	Notes
Regeneration	Protect seedlings and saplings (natural or artificial regeneration)	Large area deer exclosure - natural materials or fence	




STAND 4 BASAL AREA = 119 SQ FT/AC
White Spruce, 4%
Basswood, 9%
Bigtooth Aspen, 2%
Black Ash, 5%
Ironwood, 6%
N. White Cedar, 1%
Paper Birch, 6%
Quaking Aspen, 43%
Red Maple, 6%
Red Oak, 2%
Sugar Maple, 16%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Basswood
Black Ash
Green Ash
Ironwood
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Stand 4

Stand 5 Riparian





Stand Characteristics
Forest Type: Riparian
Size: 223 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn44c	78.3	35%
MHn44	33.9	15%
MHn46b	31.0	14%
MHn35b	26.8	12%
MHn44a	17.3	8%

Ecological Site (USDA):
F092XY014WI - Loamy Uplands
Dominant Soils: F155G (93%), F155B (7%)
Udalfs-Eutrudepts complex, 25-70% slopes (F155G) on tributary drainages. Very fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitional between young and mature (35-95 years)
Average Stand Diameter (DBH): 8.8" (SE=0.4)
Average Stand Basal Area: 113.3ft^2/ac (SE=8.1)
Snags per acre: 13 medium (6-11" DBH), 2 large (>12"DBH)
Coarse woody debris: Medium to High
Wildfire risk: Low
Invasive Species: Low - Occasional buckthorn
Pests & Disease: EAB is present in this stand but does not appear to have caused widespread mortality. Symptoms of early-stage infestation associated decline are present such as slight canopy decline and epicormic sprouting

Current Condition: This unit encompasses the riparian areas and adjacent slopes between the Mission Creek headwaters and lower portion of Mission Creek. The variable aspects, elevations, and slopes provide many terrestrial microhabitats in addition to the aquatic habitat in the streams themselves. North-facing slopes feature mature white cedar, yellow birch, and white spruce. Many slopes are actively eroding, exposing bare mineral soil and supporting white pine and white cedar regeneration. Exposed slopes also provide uncommon early seral habitat in an otherwise mature forest and support higher concentrations of balsam poplar and serviceberry. Overall, the overstory tree species distribution in this stand is young and relatively even. While black ash, quaking aspen, and balsam poplar are the most common species in this unit, they are not overrepresented in most size classes, especially the larger size classes of trees. White spruce is the primary conifer component of this stand, with the majority of white spruce in the 2-10" size classes and less frequent legacy sizes (28"+). The midstory supports beaked hazel, mountain maple, native *Prunus* species, roundleafed dogwood, and serviceberry. Dominant understory plants include ostrich fern, horsetail, lady fern, thimbleberry, and gooseberry.

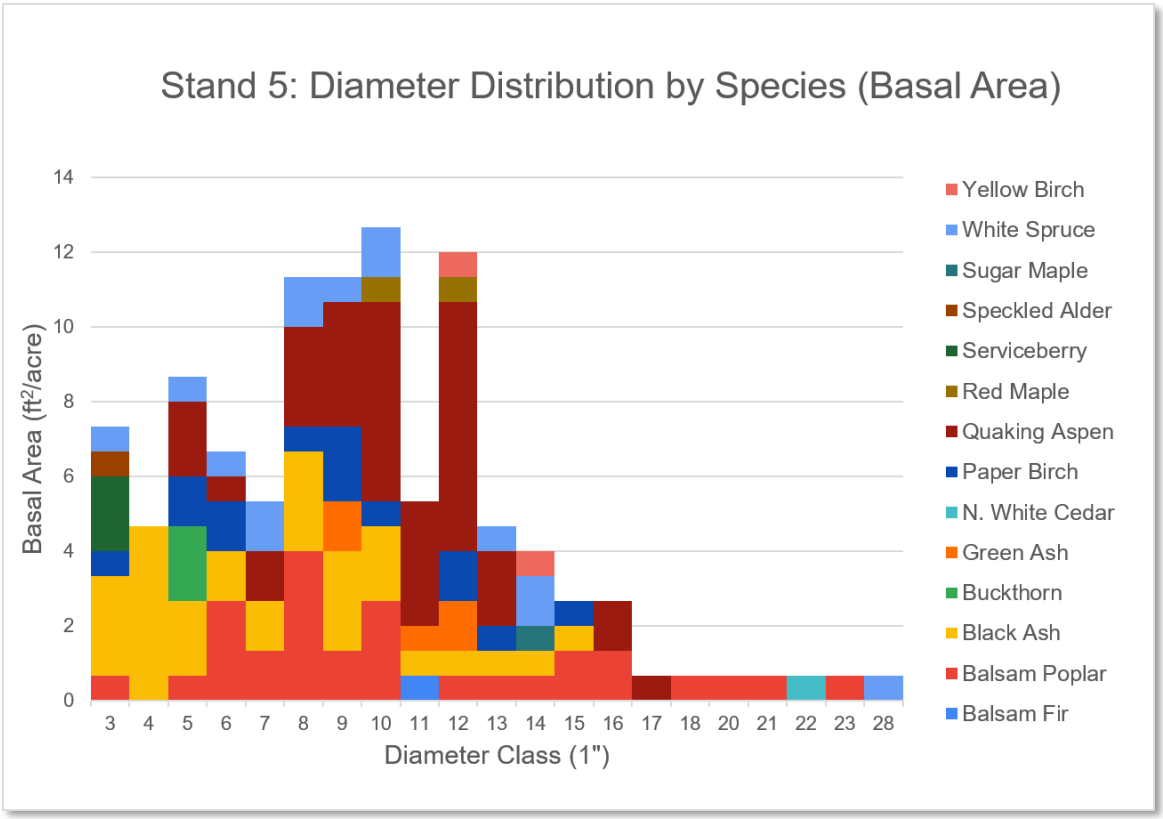
Current Recreational Uses or Management:
Multiple trails are present within this unit, including the Mission Creek Parkway and its associated stone bridges.

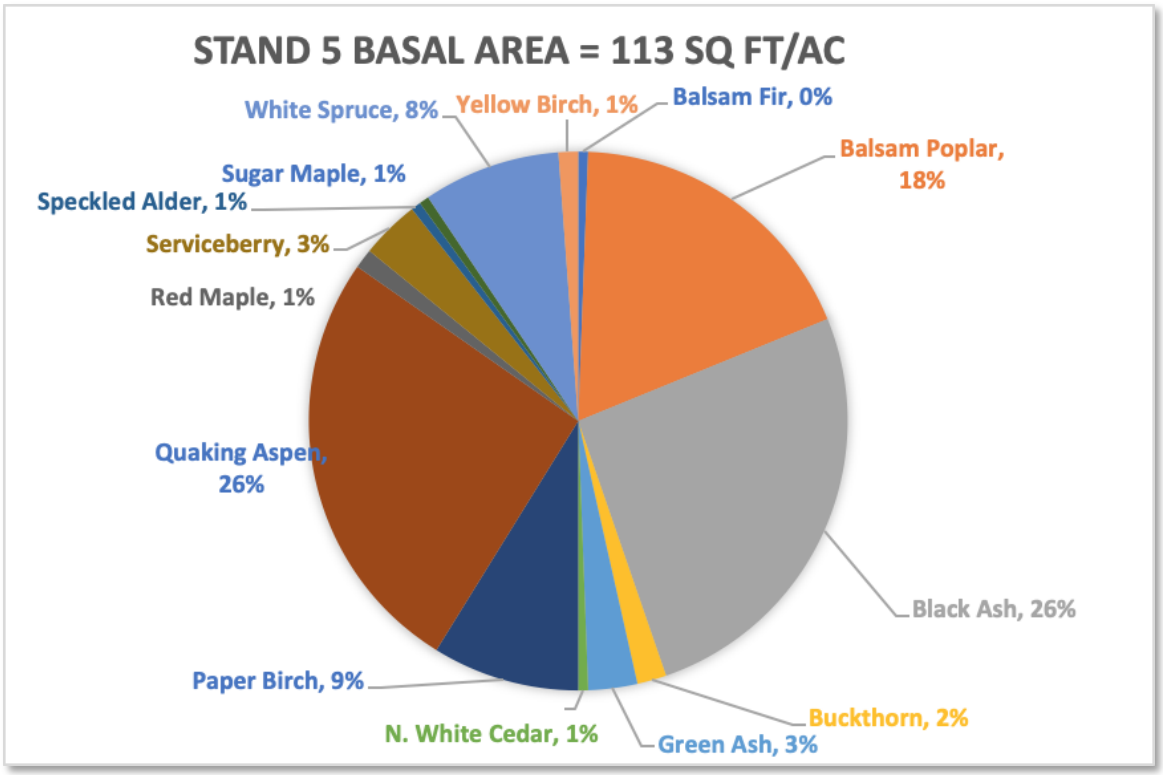
Adjacent land use concerns:
Possible pollution from adjacent private properties entering the Mission Creek watershed

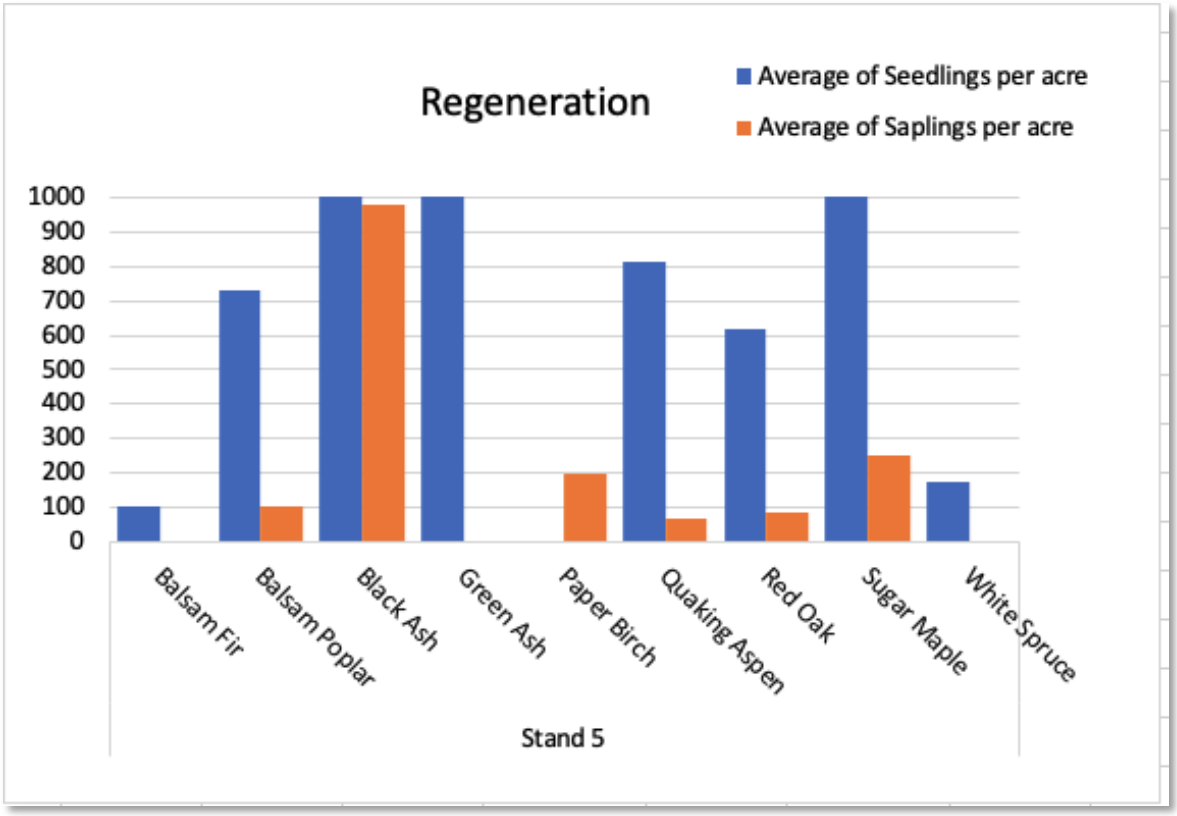
No action result (10-20 years): Slopes will likely continue to erode especially during high rainfall or snowmelt conditions, perhaps hindering regeneration. Where stable periods of time pass, naturally regenerating trees, particularly characteristic of the mature form of this forest type may establish, particularly white spruce if other species succumb to deer browse. Black ash regeneration is abundant, but its longevity and ability to become established as an overstory tree is limited by EAB. Alternatively, shrubs may become dominant where trees are unsuccessful in their establishment.

Management Goals, Strategies, and Actions

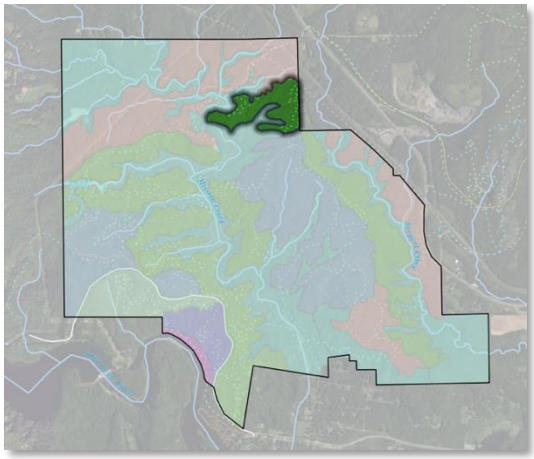
Goal	Strategy	Action	Notes
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Systemic herbicide injection annually into mature female trees during early-stage invasion to serve as seed crops for future ash regeneration; Girdle ash trees to attract EAB in combination with systemic herbicide injection to adjacent trees; Underplanting - Plant trees other than ash where ash decline and mortality is advanced	


Stand 5: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 20 21 22 23 28
Diameter Class (1")
Yellow Birch
White Spruce
Sugar Maple
Speckled Alder
Serviceberry
Red Maple
Quaking Aspen
Paper Birch
N. White Cedar
Green Ash
Buckthorn
Black Ash
Balsam Poplar
Balsam Fir


STAND 5 BASAL AREA = 113 SQ FT/AC
White Spruce, 8%
Yellow Birch, 1%
Balsam Fir, 0%
Balsam Poplar, 18%
Sugar Maple, 1%
Speckled Alder, 1%
Serviceberry, 3%
Red Maple, 1%
Quaking Aspen, 26%
Black Ash, 26%
Paper Birch, 9%
N. White Cedar, 1%
Green Ash, 3%
Buckthorn, 2%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Oak
Sugar Maple
White Spruce
Stand 5

Stand 6 Mixed Hardwood Conifer





Stand Characteristics

Forest Type: Mixed Hardwood Conifer

Size: 45 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	32.6	76%
MHn44	4.9	11%
MHn46b	4.7	11%

Ecological Site (USDA):
F092XY014WI - Loamy Uplands

Dominant Soils: F115G (84%), F155B (16%)
Udalfs-Eutrudepts complex, 25-70% slopes (F155G) on tributary drainages. Very fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 11.7" (SE 0.9)

Average Stand Basal Area: 138 ft^2/ac (SE 9.8)

Snags per acre: 25 medium (6-11" DBH), 3 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low - buckthorn and honeysuckle present but occasional, with existing buckthorn large and established

Pests & Disease: Ash trees in this stand show signs of initial infestation by EAB such as slight canopy decline and damage to foliage caused by adult feeding

Current Condition: This mature stand is located on the slopes and uplands above upper Mission Creek in the northeast portion of the property. A dense stand of remnant white pines in the 22" to 34" size range occurs on the south-facing slope. Quaking aspen is most dominant in the 8" to 13" size classes, but not as overly abundant outside of these size classes. In the smaller, pulp and poletimber size classes, paper birch and black ash were most common, with aspen also present but less prevalent. In addition, the 4" to 7" size classes had fewer trees per acre than the immediately larger size classes, indicating the stand is in a later successional stage or an occurrence of a regeneration bottleneck. Mesic hardwood species (sugar maple, red oak) are present as mature trees in low quantity but with a notable lack of regeneration. Black and green ash dominate the seedling and sapling age classes, with quaking aspen and red maple are the next most prevalent seedling species. Other than ash, seedling recruitment into the sapling layer is limited, likely due to lack of light (closed canopy forest condition) and deer browse. The midstory is well-developed and is composed of beaked hazel, mountain maple, pagoda dogwood, round-leaved dogwood, and serviceberry. Dominant understory plants are thimbleberry, bush honeysuckle, largeleaved aster, and bracken fern.

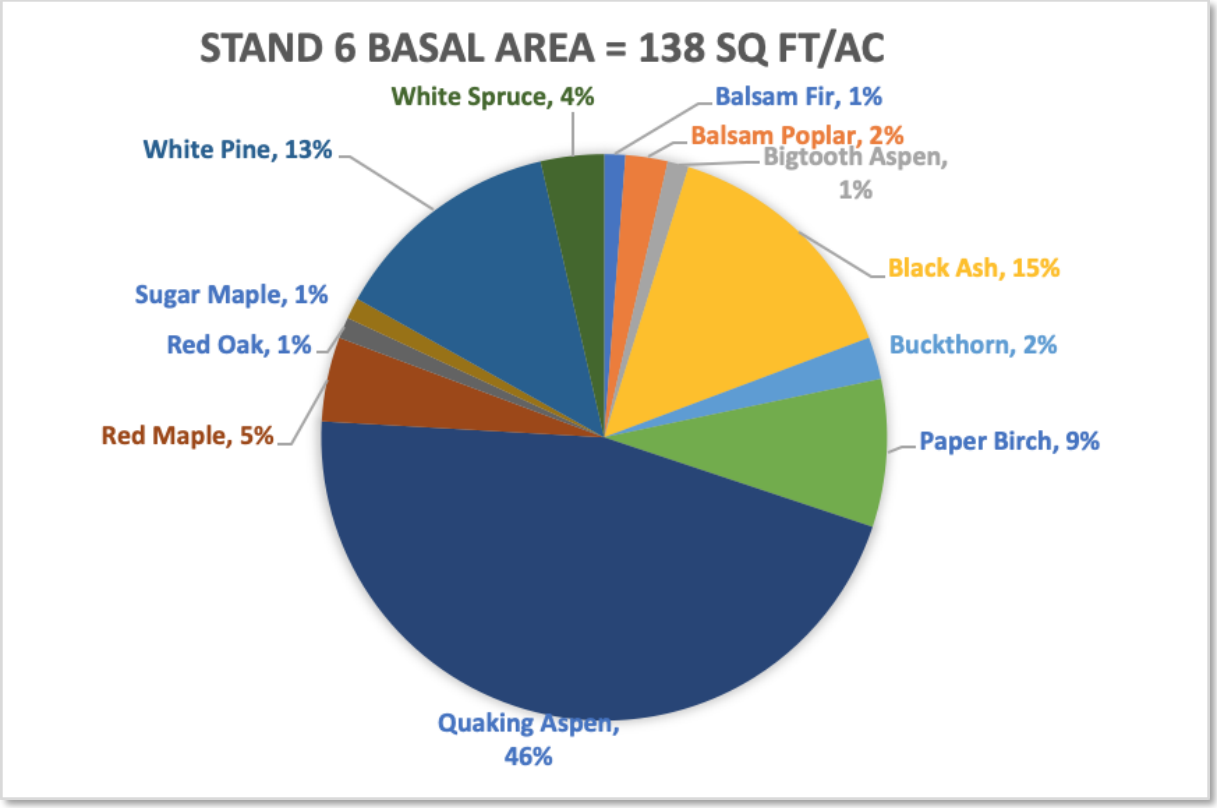
Current Recreational Uses or Management:
A very windy hiking trail meanders along contour through this unit.

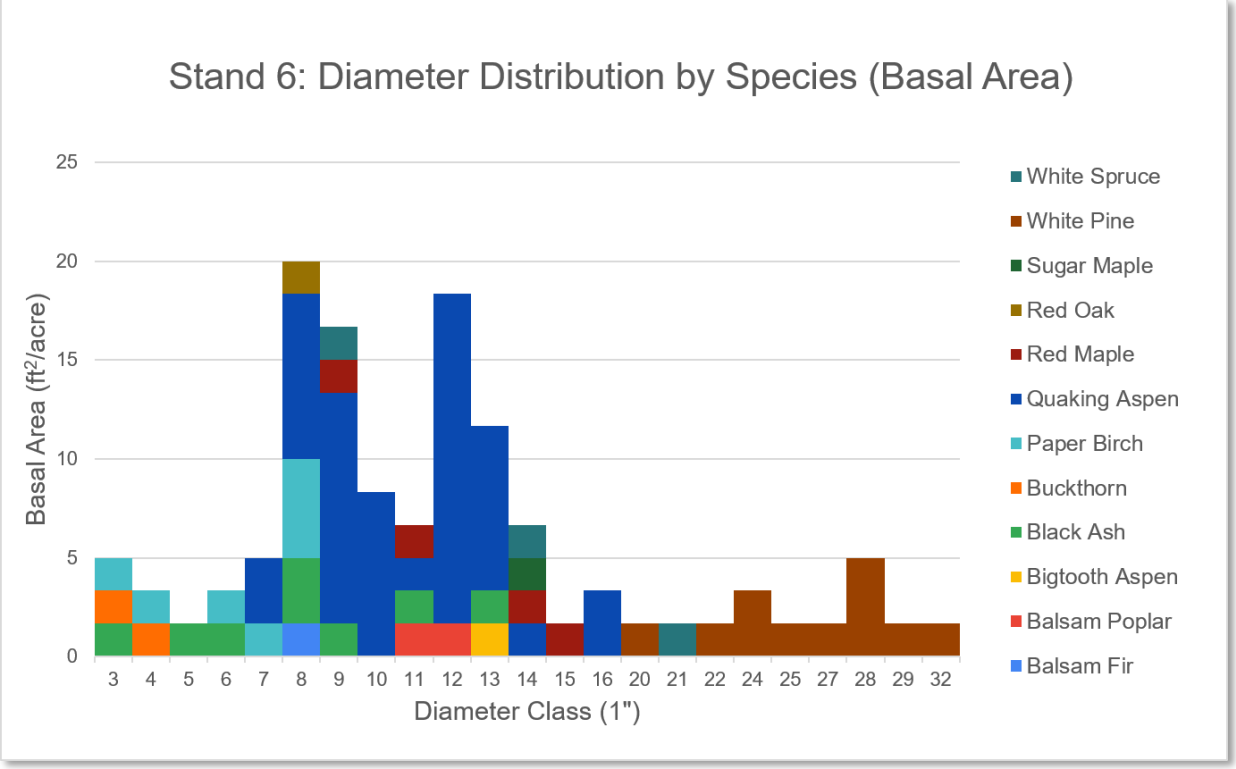
Adjacent land use concerns:
Private property abuts the east side of the unit.

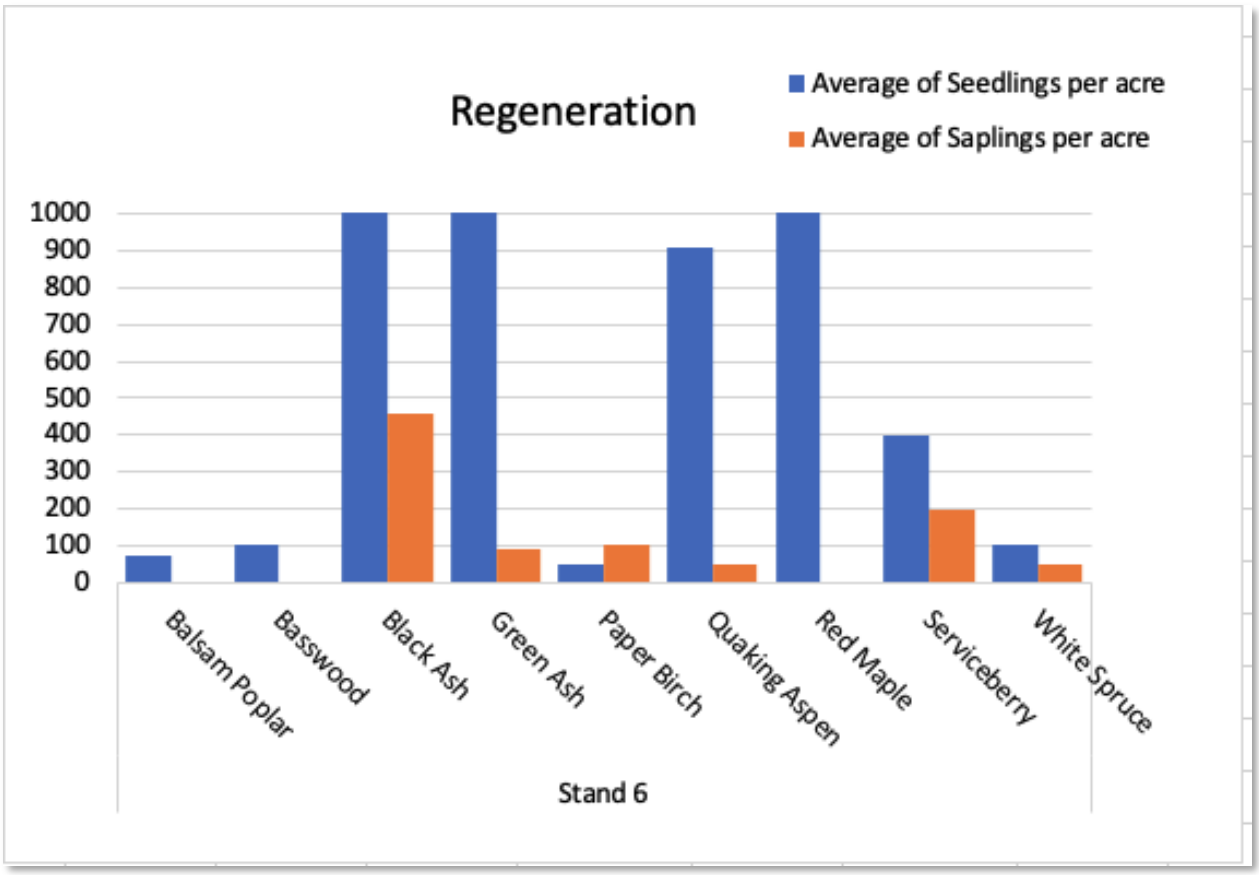
No action result (10-20 years): Old white pines will eventually age out and become snags. Aspen and birch are likely to become dominant in areas with little competition from shrubs or buckthorn.

Management Goals, Strategies, and Actions

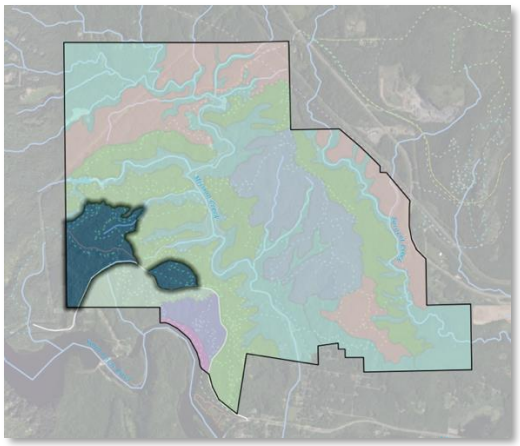
Goal	Strategy	Action	Notes
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	site prep before cones drop
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort. Target red maple, aspen.


STAND 6 BASAL AREA = 138 SQ FT/AC
White Spruce, 4%
Balsam Fir, 1%
Balsam Poplar, 2%
Bigtooth Aspen, 1%
White Pine, 13%
Black Ash, 15%
Sugar Maple, 1%
Red Oak, 1%
Buckthorn, 2%
Red Maple, 5%
Paper Birch, 9%
Quaking Aspen, 46%


Stand 6: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
25
20
15
10
5
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 20 21 22 24 25 27 28 29 32
Diameter Class (1")
White Spruce
White Pine
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Buckthorn
Black Ash
Bigtooth Aspen
Balsam Poplar
Balsam Fir


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Serviceberry
White Spruce
Stand 6

Stand 7 Northern Hardwoods





Stand Characteristics

Forest Type: Northern Hardwoods

Size: 111 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	92.4	83%
MHn46b	12.4	11%

Ecological Site (USDA):
F092XY014WI - Loamy Uplands
F092XY015WI - Clayey Uplands

Dominant Soils: Dominant Soil: F155G (55%), F155B (45%)
Udalfs-Eutrudepts complex, 25-70% slopes (F155G) on tributary drainages. Very fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 10.1" (SE=0.7)

Average Stand Basal Area: 109 ft^2/ac (SE=10)

Snags per acre: 19 medium (6-11" DBH), 3 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low, minimal buckthorn observed

Pests & Disease: Signs of early EAB are present, including slight canopy decline of ash trees

Current Condition: This diverse hardwood stand is located on the west-southwest portion of the property adjacent to highway 210. It contains some slopes and hills characteristic of the rest of the property but is comparatively flat. Unlike adjacent stands, aspen is a minor component of a mixed forest composition. Aside from remnant (23"-31") white, the largest trees are red oak, quaking aspen, basswood, red maple, and paper birch, with red oak being the most abundant (14"-25" DBH). The majority of seedlings and saplings are green and black ash. Quaking aspen, red oak, sugar maple, and red maple are the most numerous non-ash seedling species present. While there is some non-ash recruitment into the sapling size classes, no red oak or red maple saplings were observed despite their relative abundance as seedlings, whereas aspen, basswood, sugar maple, and ironwood have greater sapling abundance. There are more than typical number of white pine seedlings present, but they are not surviving to sapling size. The midstory is relatively open and is composed of mostly beaked hazel with some roundleafed dogwood. Dominant understory plants include Pennsylvania sedge, largeleaved aster, bracken fern, lady fern, and Canada mayflower.

Current Recreational Uses or Management:
Several hiking trails including the North Country/Duluth Traverse and Superior Hiking Trail, and mountain bike

Adjacent land use concerns:
Several pullouts and trailhead parking areas are present along highway 210, which are

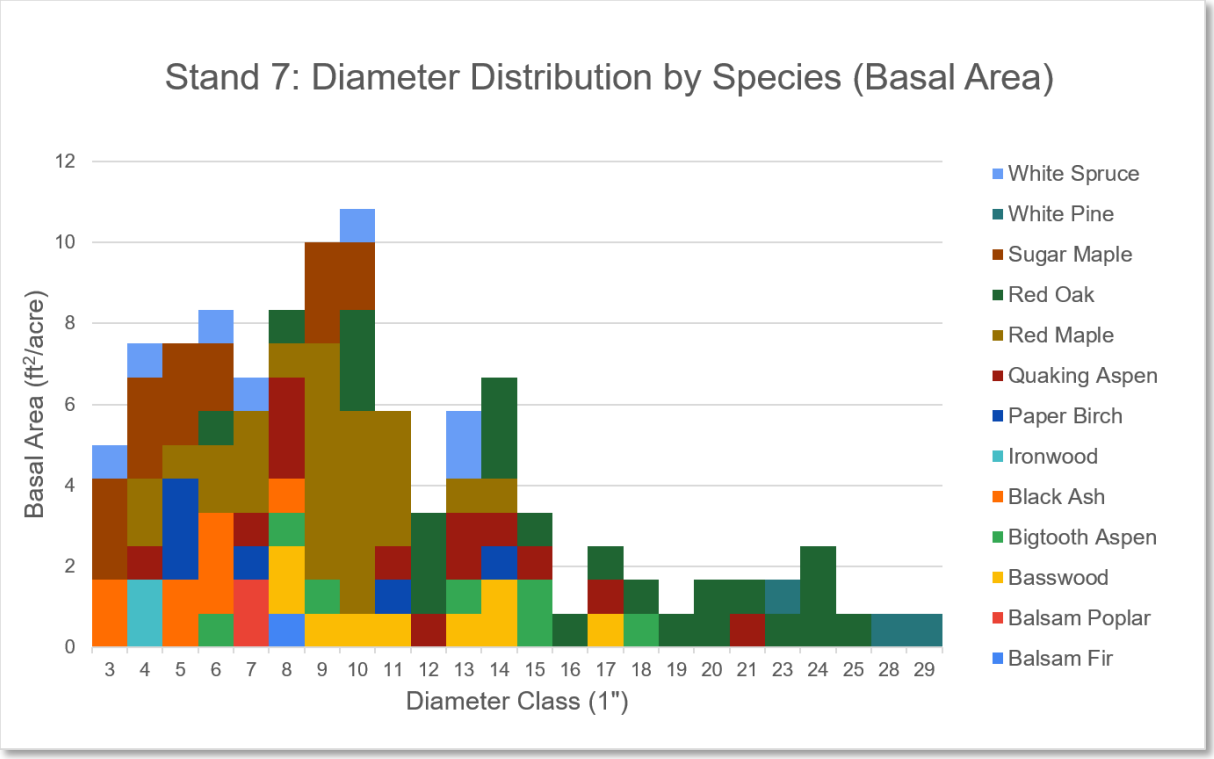
trails criss-cross the unit. A couple recently overgrown road grades and an access gate suggest recent management activity. A two-track road allowing motorized access from Highway 210 is present in the southwest portion of the stand, near the property line.

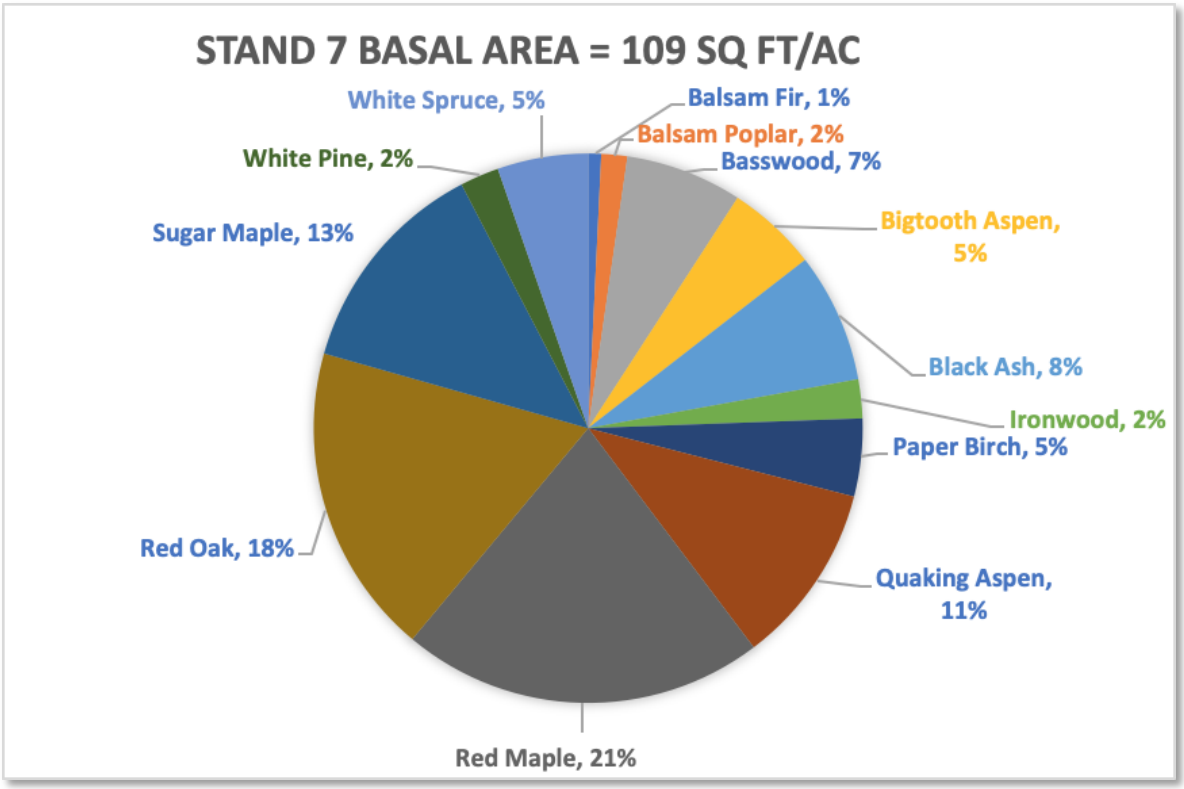
sources of higher concentration of trail uses. To the west of this unit is Jay Cooke State Park, potentially bringing higher numbers of visitors via connected hiking trails.

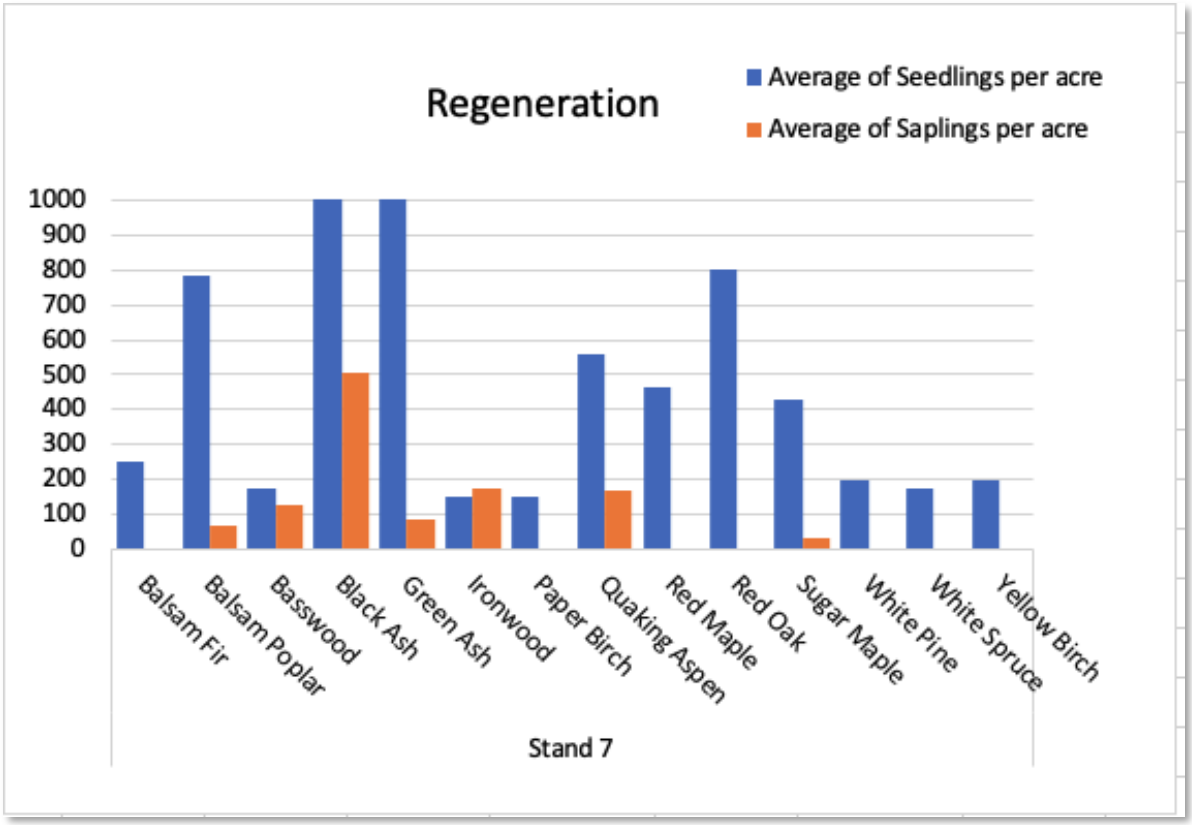
No action result (10-20 years): The stand has diverse and moderate regeneration, but closed canopy conditions and high deer abundance will favor shade tolerant species, such as red maple and ironwood, or species less palatable to deer such as white spruce. Ash regeneration is abundant, but its longevity and ability to become established as an overstory tree is limited by EAB. Alternatively, shrubs may become dominant where trees are unsuccessful in their establishment. Red maple in the 5-11" age classes will continue to grow and become more dominant in the overstory.

Management Goals, Strategies, and Actions

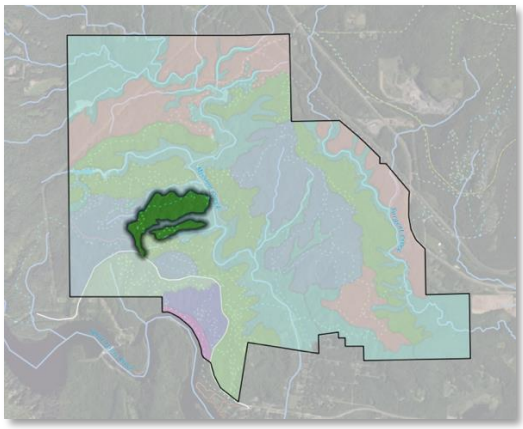
Goal	Strategy	Action	Notes
Regeneration	Protect seedlings and saplings (natural or artificial regeneration)	Large area deer exclosure - natural materials or fence	




STAND 7 BASAL AREA = 109 SQ FT/AC
White Spruce, 5%
Balsam Fir, 1%
Balsam Poplar, 2%
White Pine, 2%
Basswood, 7%
Sugar Maple, 13%
Bigtooth Aspen, 5%
Black Ash, 8%
Ironwood, 2%
Paper Birch, 5%
Red Oak, 18%
Quaking Aspen, 11%
Red Maple, 21%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Basswood
Black Ash
Green Ash
Ironwood
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Yellow Birch
Stand 7

Stand 8 Aspen





Stand Characteristics

Forest Type: Aspen

Size: 49 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	40.5	83%
MHn44c	6.6	13%

Ecological Site (USDA):
F092XY014WI - Loamy Uplands
F092XY015WI - Clayey Uplands

Dominant Soils: F155G (59%), F155B (42%)
Udalfs-Eutrudepts complex, 0-8% and 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Young forest (0-55 years)

Average Stand Diameter (DBH): 8.6" (SE=0.4)

Average Stand Basal Area: 118 ft^2/ac (SE=13)

Snags per acre: 29 medium (6-11" DBH), Paper birch

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low, occasional buckthorn present in stand

Pests & Disease: None observed

Current Condition: This mid-aged aspen-dominant stand is located on the flat ridgetops and east-facing slopes that lead down to Mission Creek. Canopy is primarily composed of trees under 10" DBH, majority quaking aspen with components of sugar maple, red oak, paper birch, red oak, and white spruce. Regeneration is strongly black ash, likely to fail due to EAB, with healthy amounts of quaking aspen and some white spruce, paper birch, and red maple. The midstory is a mix of open and dense and is composed mostly of beaked hazel with some serviceberry and buckthorn. Dominant understory plants include bracken fern, bush honeysuckle, bunchberry, and largeleafed aster.

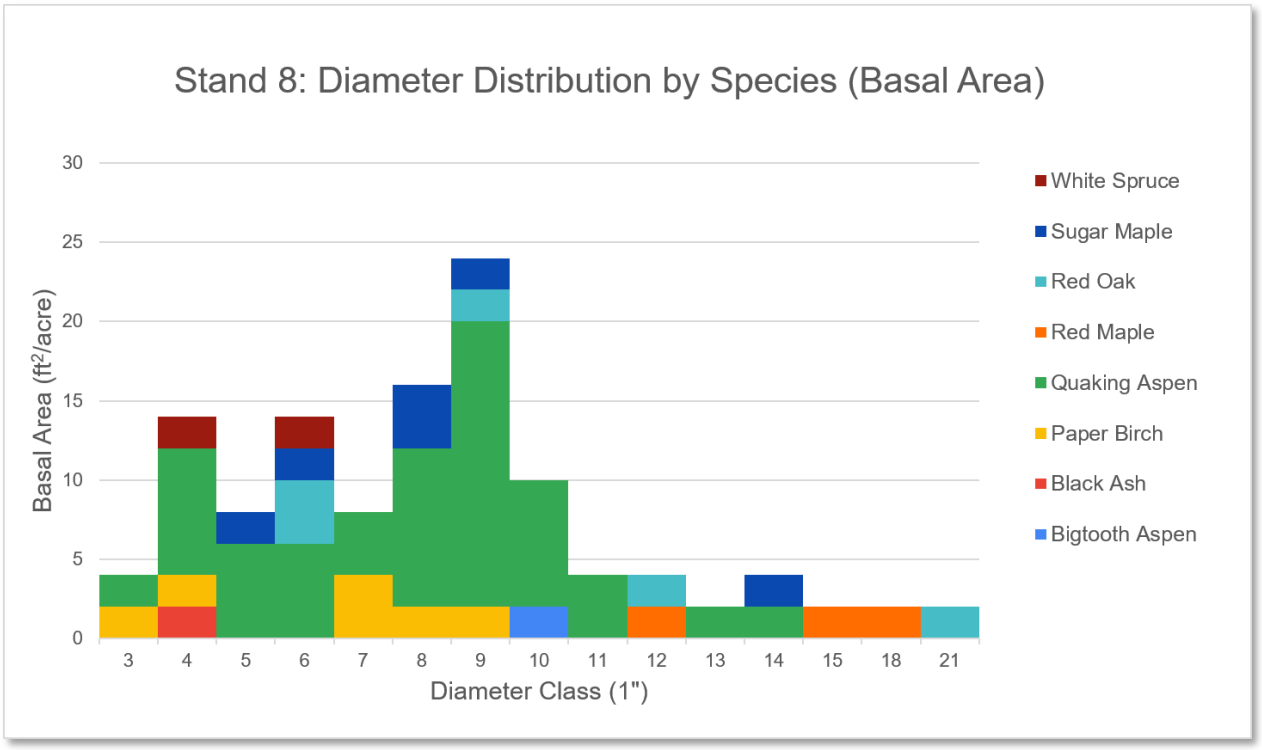
Current Recreational Uses or Management:
The Superior Hiking Trail stretches across the flatter uplands in the northern portion of this stand before routing downslope to cross Mission Creek. The southern portion of the stand hosts several crisscrossing mountain bike trails, which have a trailhead along Highway 210.

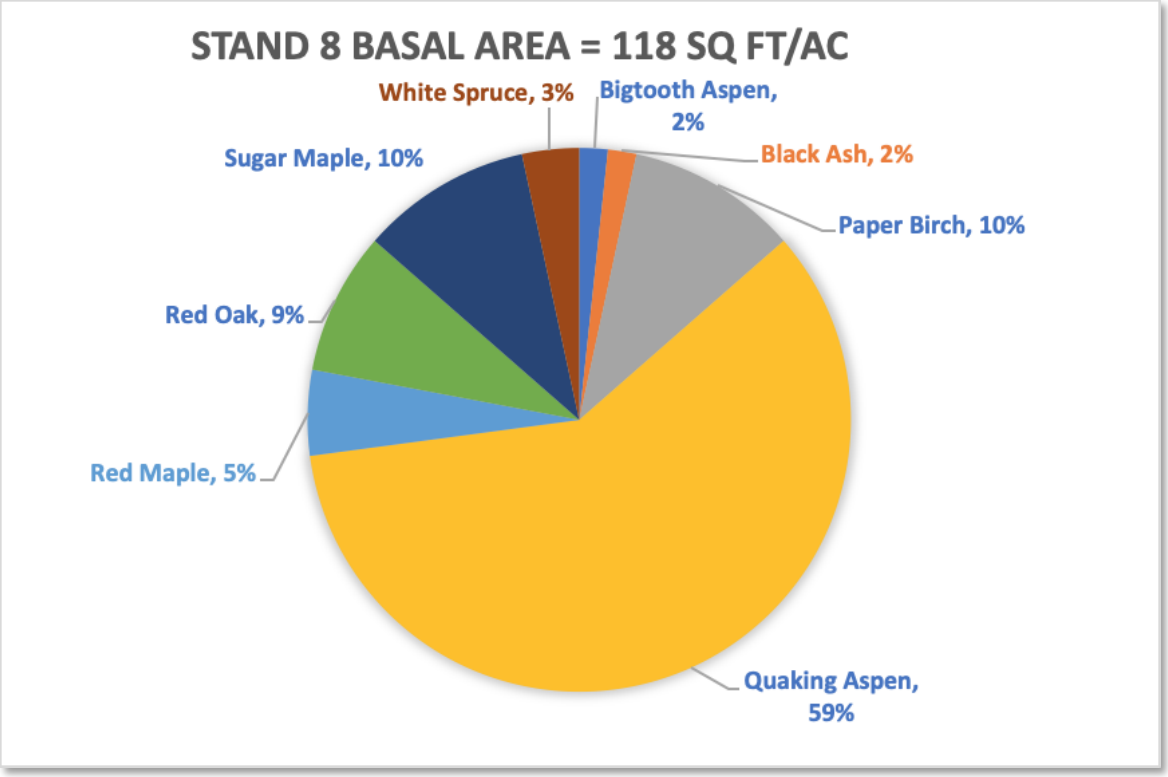
Adjacent land use concerns:
The trailhead along highway 210 is a source of higher concentration of trail users.

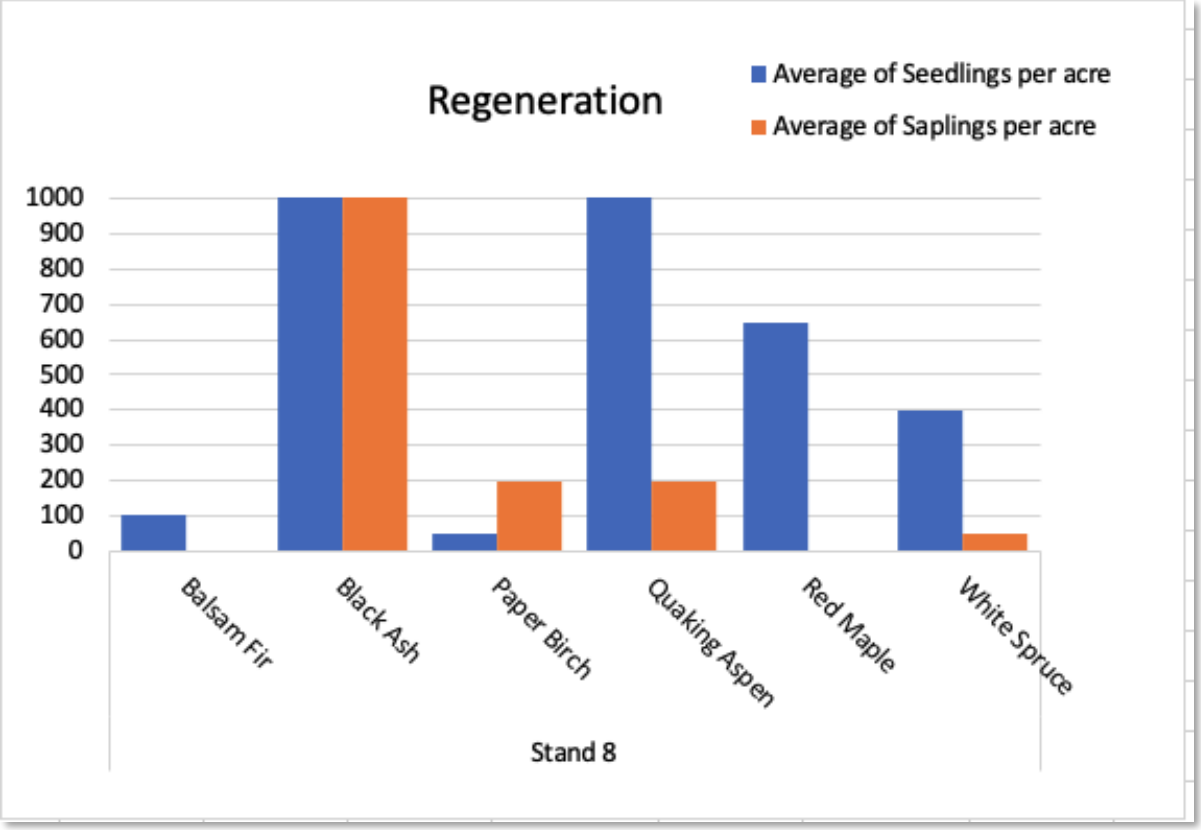
No action result (10-20 years): Quaking aspen will continue to grow and move into the larger size classes. Buckthorn may begin to become an midstory competitor.

Management Goals, Strategies, and Actions

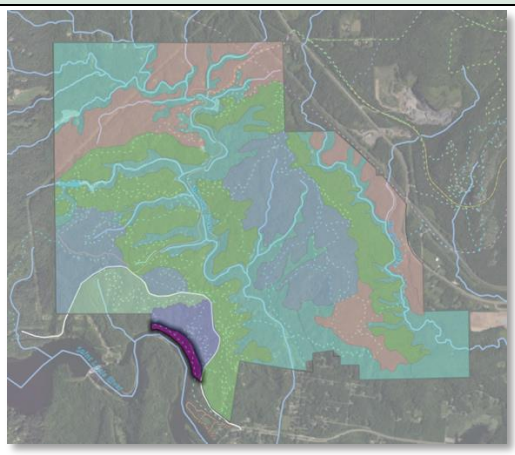
Goal	Strategy	Action	Notes
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Gap selection	Gap widths 0.5-2x height of trees; cut during growing season




STAND 8 BASAL AREA = 118 SQ FT/AC
White Spruce, 3%
Bigtooth Aspen, 2%
Black Ash, 2%
Paper Birch, 10%
Quaking Aspen, 59%
Red Maple, 5%
Red Oak, 9%
Sugar Maple, 10%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Black Ash
Paper Birch
Quaking Aspen
Red Maple
White Spruce
Stand 8

Stand 9 Cliff/Talus





Stand Characteristics

Forest Type: Cliff/Talus

Size: 12 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn44b	4.6	38%
CTn11e	4.2	35%
MHn35b	1.8	15%
CTn42d	0.8	7%

Ecological Site (USDA):
F092XY014WI - Loamy Uplands

Dominant Soils: Dominant Soil: F155G (96%)
Udalfs-Eutrudepts complex, 0-8% and 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Young forest/non-forested

Average Stand Diameter (DBH): N/A

Average Stand Basal Area: N/A

Coarse woody debris: Low

Wildfire risk: Low due to extensive mineral soil on sloughing banks and proximity to river

Invasive Species: None noted

Pests & Disease: None noted

Current Condition: This small, southwest-facing unit consists of the steep slopes along the St Louis river. Portions of it are non-forested and a full forest inventory was not possible due to lack of tree cover and inaccessibility. Due to erosion and the sloughing of slopes, the forest here overall is young, brushy, and dominated by early successional species such as balsam poplar. Young white spruce, green ash, red oak, and bigtooth aspen are also present. Shrubs are abundant and robust, especially roundleaved dogwood and speckled alder. Understory plants are diverse and dominated by wild grape, poison ivy, and a variety of grasses, as well as numerous early-successional forbs.

Current Recreational Uses or Management:
A trail runs along the length of the upper contour of this unit. The lowest contour of this unit grades into the banks of the St. Louis river.

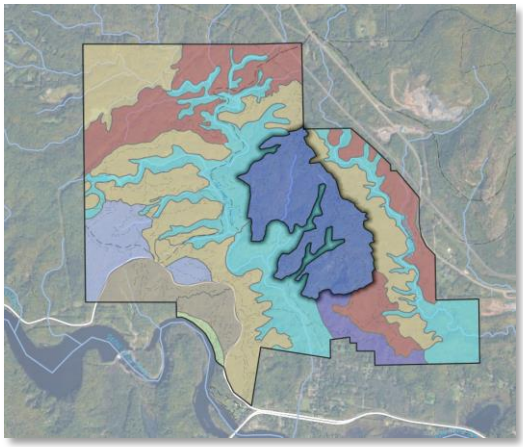
Adjacent land use concerns:
A dam restricts water flow just upstream of this unit, likely impacting the native plant community and ecological function of the lowest elevation portion of this unit.

No action result (10-20 years): Continued sloughing of these extremely steep slopes is expected to occur especially during extreme rain events. Natural recruitment and replacement of early successional forest is likely to happen across much of the unit where seedlings have enough time to establish themselves between extreme weather events.

Management Goals, Strategies, and Actions

Manage in alignment with St. Louis River Estuary restoration plans in support of cliff-talus plant communities.

Stand 10 Northern Hardwoods (White Pine, Red Pine)





Stand Characteristics

Forest Type: Northern Hardwoods (White Pine, Red Pine)

Size: 254 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	217.9	86%

Ecological Site (USDA): F092XY014WI - Loamy Uplands F092XY015WI - Clayey Uplands

Dominant Soils: F155G, F155B Udalfs-Eutrudepts complex, 0-8% and 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 10.4" (SE=0.3)

Average Stand Basal Area: 120 ft^2/ac (SE=7.2)

Snags per acre: 17 medium (6-11" DBH), 2 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low - Buckthorn and honeysuckle are occasionally present

Pests & Disease: EAB is present in the stand with healthy trees or minimal dieback noted in some areas while mortality is occurring in others. Deer browse was noted on aspen and ash.

Current Condition: This mixed-age stand is located on the higher terrain between Mission Creek and Sargent Creek, draining into Mission Creek. The stand contains a series of ridges providing varying microclimates and ephemeral streams which support diverse overstory trees and herbaceous plant species. With an average stand basal area of 120 ft^2 per acre, the overstory is well-stocked. The oldest age class of trees are remnant white pines in the 23-31" size classes, with paper birch, sugar maple, and quaking aspen as co-dominants. A diverse suite of hardwood species are present in the seedling layer, with around as many sugar maple, red maple, and red oak seedlings present as quaking aspen seedlings. Similar to most stands, ash is the most numerous seedling and sapling species. The midstory is variable with some areas completely open under closed birch canopy and other areas dense with hazel in canopy gaps, or very crowded sapling white spruce. Roundleaf dogwood, buckthorn, serviceberry, and mountain maple are also common shrub components. Dominant understory plants are thimbleberry, Pennsylvania sedge, bracken fern, largeleaved aster, and bunchberry, with a high diversity of other herbaceous species.

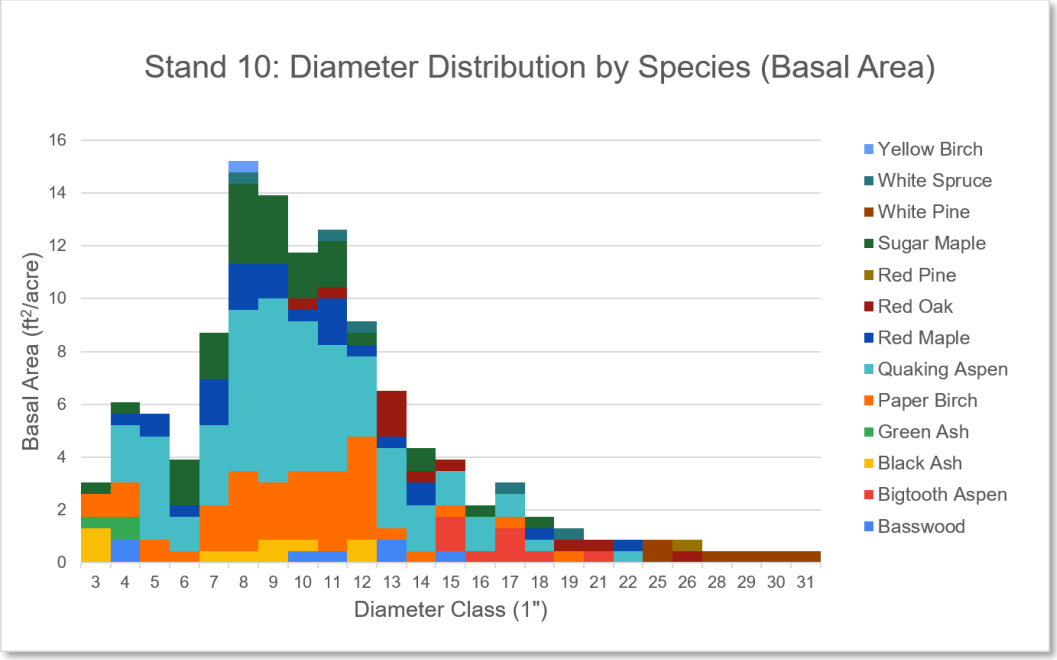
Current Recreational Uses or Management:
Several hiking and mountain bike trails cross through the stand.

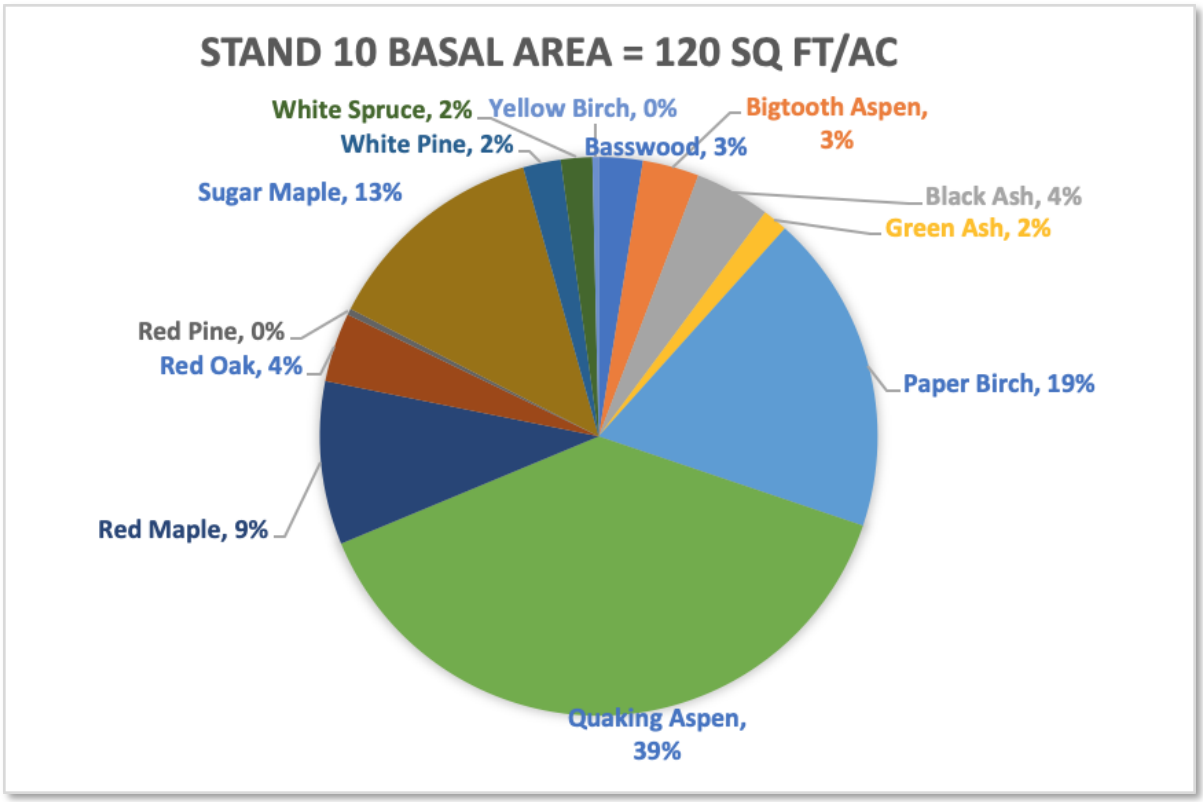
Adjacent land use concerns:
None.

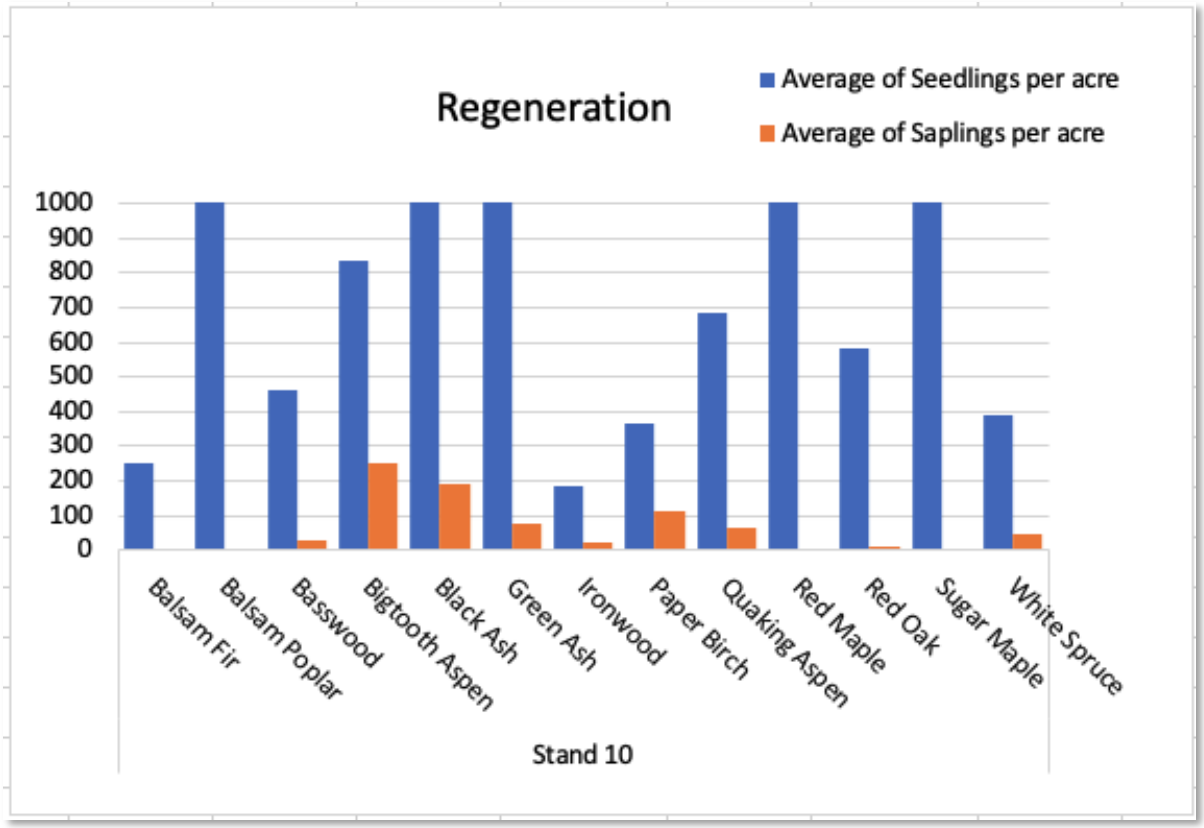
No action result (10-20 years): Sugar maple may become more dominant if canopy openings occur from individual falling trees and seedlings are able to persist through sapling stage without deer herbivory. If sugar maple is not able to recruit and grow into the canopy, white spruce may become more dominant as a deer-resistant species. White pine would typically establish in this forest type but may not due to lack of regeneration or establishment.

Management Goals, Strategies, and Actions

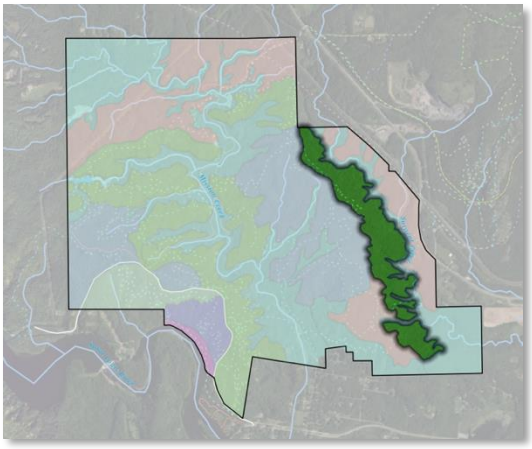
Goal	Strategy	Action	Notes
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine, red pine
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	site prep before cones drop
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort. Target red maple, aspen.




STAND 10 BASAL AREA = 120 SQ FT/AC
White Spruce, 2%
Yellow Birch, 0%
Bigtooth Aspen, 3%
White Pine, 2%
Basswood, 3%
Sugar Maple, 13%
Black Ash, 4%
Green Ash, 2%
Red Pine, 0%
Red Oak, 4%
Paper Birch, 19%
Red Maple, 9%
Quaking Aspen, 39%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Basswood
Bigtooth Aspen
Black Ash
Green Ash
Ironwood
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Spruce
Stand 10

Stand 11 Mixed Hardwood Conifer





Stand Characteristics

Forest Type: Mixed Hardwood Conifer

Size: 117 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	96.0	82%
MHn44a	8.8	8%

Ecological Site (USDA): F092XY014WI - Loamy Uplands F092XY015WI - Clayey Uplands

Dominant Soils: F155G (50%), F155B (50%) Udalfs-Eutrudepts complex, 0-8% and 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Young forest (0-55 years) and transitional between young and mature (55-95 years)

Average Stand Diameter (DBH): 10.6" (SE=0.5)

Average Stand Basal Area: 155 ft^2/ac (SE=13)

Snags per acre: 30 medium (6-11" DBH), 3 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low to medium amounts of buckthorn scattered throughout stand

Pests & Disease: Aspen shoot blight (Shepards crook) observed on aspen seedlings

Current Condition: This stand spans the ridgetops and east-facing slopes of Sargent creek. It contains a broad spectrum of age classes of aspen-birch forest. In some sections, larger paper birch (10-16" diameter) exhibit broad canopies with very open understories and limited regeneration. In other places, younger birch and aspen (diameters 5-10") grow more densely or have more prevalent sugar maple-basswood-ironwood-red oak components. Shade-tolerant red maple, sugar maple, ironwood and white spruce are most common under closed canopies. Compared to the adjacent stand 10, stand 11 has fewer sugar maples but more trees per acre overall (especially in 5-7" size classes). Conifer regeneration is overall poor with more hardwood dominance. Aspen regeneration was present but noted to be growing poorly due to aspen shoot blight (Shepards crook). The midstory is variably dense and is composed of beaked hazel, roundleafed dogwood, serviceberry, downy arrowwood, speckled alder, buckthorn, and mountain maple. Dominant understory plants are thimbleberry, Pennsylvania sedge, bracken fern, and largeleaved aster.

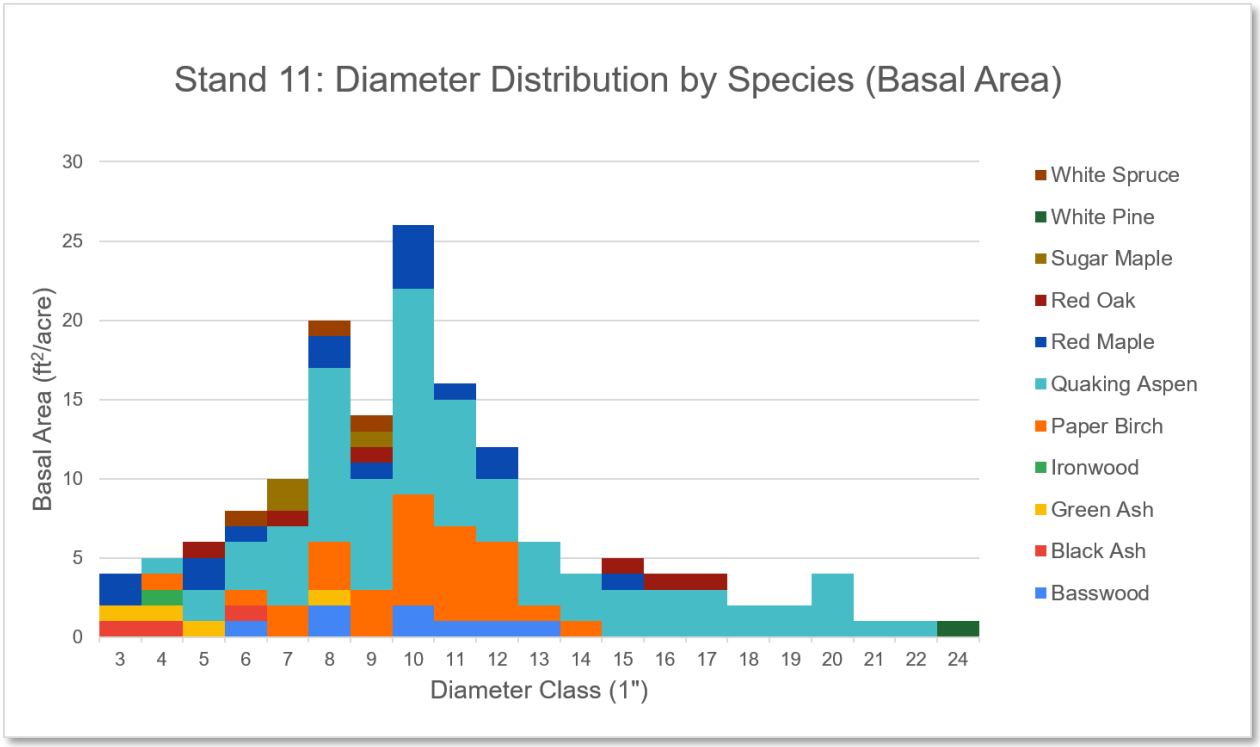
Current Recreational Uses or Management:
This unit has only occasional hiking or mountain biking trails with user-generated trails suggesting evidence of hunters. Browse height and flattened vegetation indicate large animal presence such as moose.

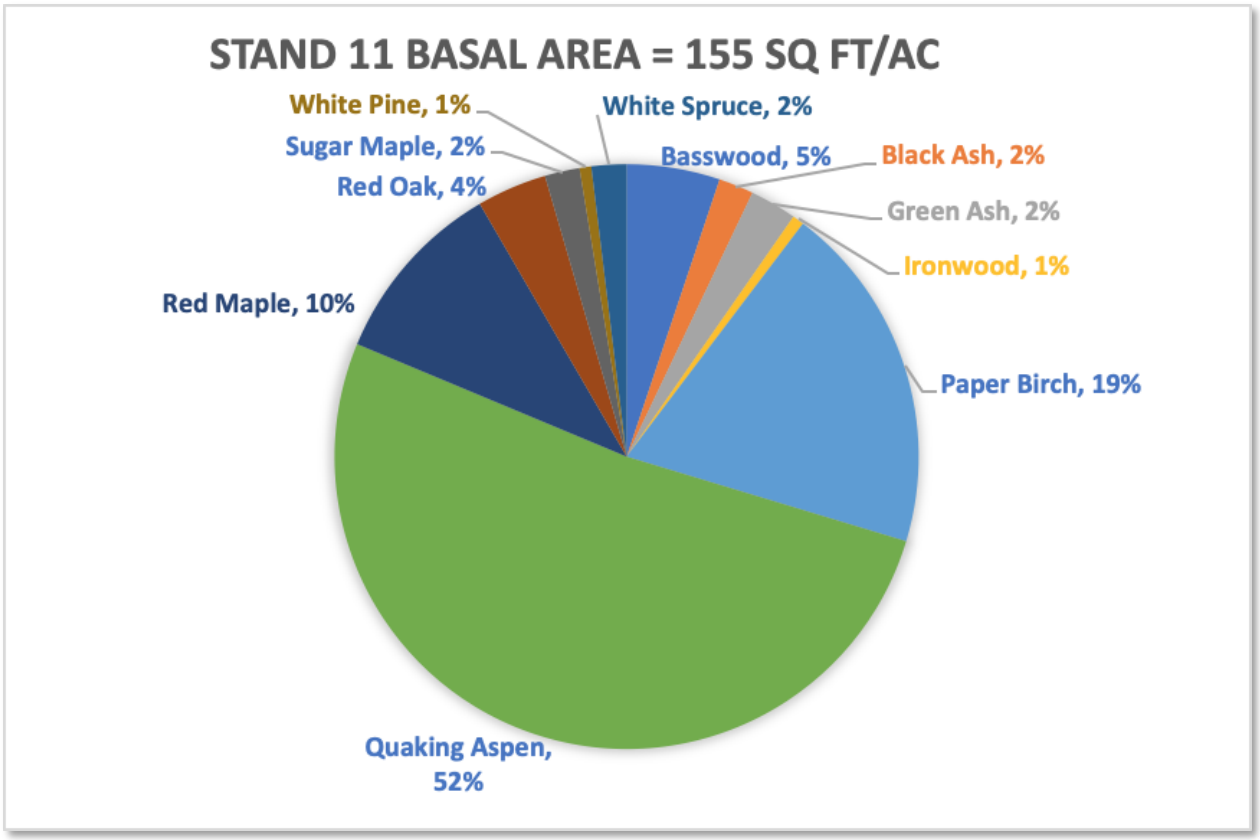
Adjacent land use concerns:
None.

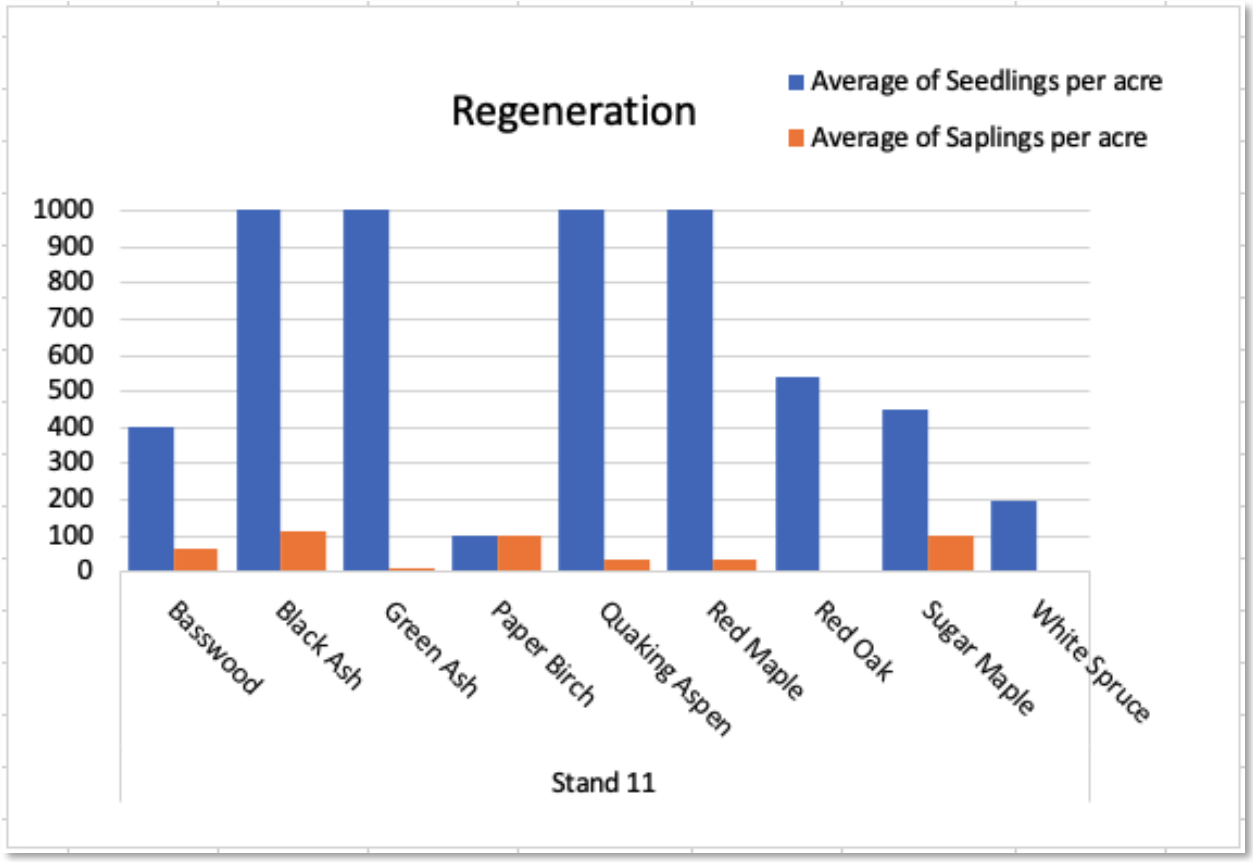
No action result (10-20 years): Aspen and birch will age out, creating large cavity trees for wildlife. Black ash regeneration will eventually fail due to EAB. If hardwoods such as red maple, sugar maple, and red oak are able to become established the stand may turn into a mature hardwood dominant stand. However, if herbivory pressure continues to be heavy, the stand may revert to a more open-canopy stand with shrub-dominance or possibly early-successional aspen clones. White pines will eventually die out and not be replaced.

Management Goals, Strategies, and Actions

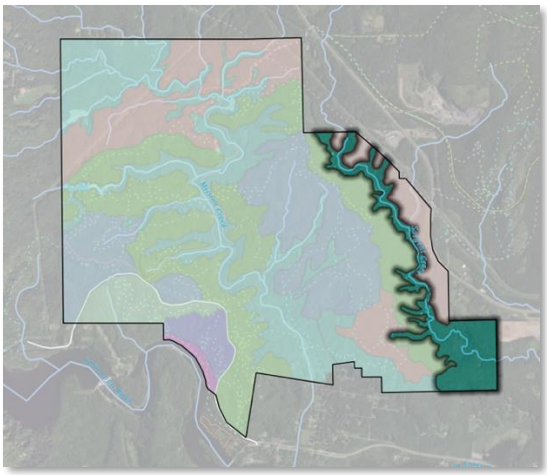
Goal	Strategy	Action	Notes
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine, red pine
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	site prep before cones drop
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort. Target red maple, aspen.


Stand 11: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
30
25
20
15
10
5
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 24
Diameter Class (1")
White Spruce
White Pine
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Ironwood
Green Ash
Black Ash
Basswood


STAND 11 BASAL AREA = 155 SQ FT/AC
White Pine, 1%
White Spruce, 2%
Sugar Maple, 2%
Basswood, 5%
Black Ash, 2%
Red Oak, 4%
Green Ash, 2%
Ironwood, 1%
Red Maple, 10%
Paper Birch, 19%
Quaking Aspen, 52%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Basswood
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Spruce
Stand 11

Stand 12 Riparian





Stand Characteristics

Forest Type: Riparian

Size: 128 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn44b	40.7	32%
MHn35b	38.1	30%
MHn46b	25.1	20%
FFn57a	14.3	11%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (71%), F155B (13%), E3B (7%), E24F (6%), E2B (2%), F111B (1%) Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitional between young and mature forest (35-95 years)

Average Stand Diameter (DBH): 9.8" (SE=0.7)

Average Stand Basal Area: 115 ft^2/ac (SE=14.6)

Snags per acre: 18 medium (6-11" DBH), 4 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low to medium presence of buckthorn, occasional invasive honeysuckle

Pests & Disease: EAB was present and well established throughout this stand with dead, dying, declining and minimally affected trees present. Blash ash is a significant component of this stand.

Current Condition: This is a maturing riparian corridor and lowland forest in the farthest southeast part of the property is bisected by Sargent Creek. The overstory is composed of 17-25" DBH white spruce, quaking aspen, and paper birch with occasional balsam poplar, white cedar, and yellow birch on low slopes, and black ash in the floodplain. A mixture of other conifer and hardwood species are also present. Regeneration is dominantly black ash, with aspen, white spruce, and balsam fir, and small numbers of other hardwood species, most of which are not recruiting to the sapling stage. The midstory is moderately dense, especially along stream edges, and is composed of beaked hazel, mountain maple, roundleafed dogwood, speckled alder, and to a lesser extent serviceberry. Thimbleberry is the dominant understory plant, along with large-leaved aster, lady fern, horsetails, bush honeysuckle, bunchberry, and bracken fern. The abundance of these (especially thimbleberry) limits the establishment of tree seedlings. Wildlife use is high in this remote stand including signs of moose.

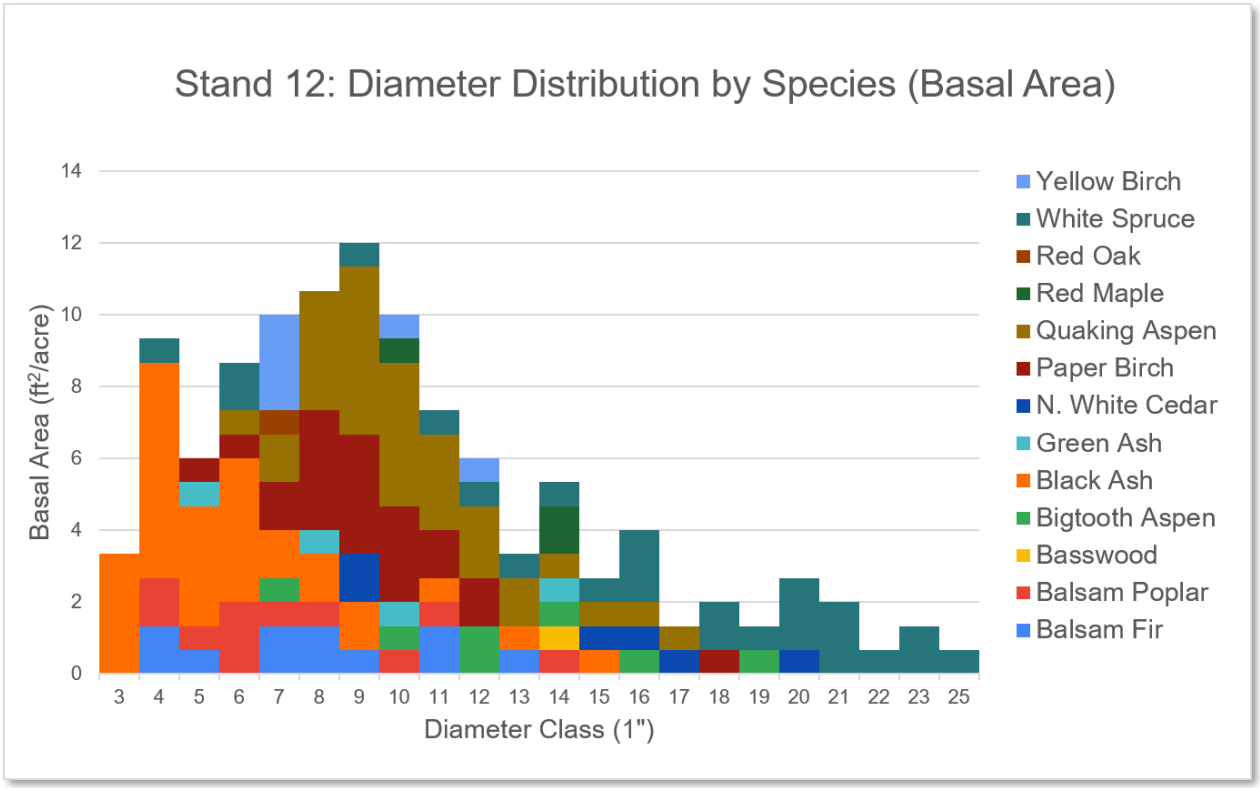
Current Recreational Uses or Management:
This stand is challenging to access due to very steep terrain and remoteness from trailheads, with only one trail crossing the Sargent creek valley. There is some evidence of social trails from adjacent residential areas in this stand. Log and rock sediment traps have previously been installed in the creek presumably to improve aquatic habitat.

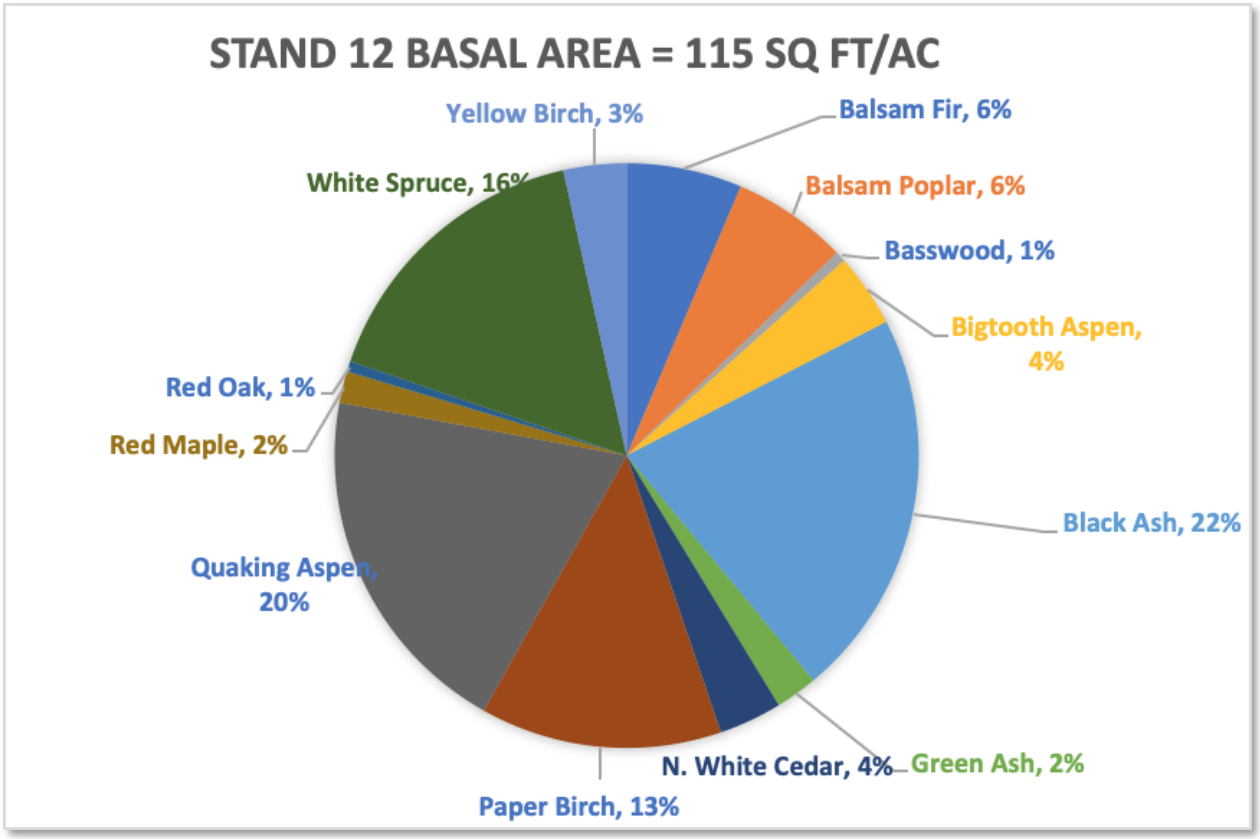
Adjacent land use concerns:
Private property, a railroad, and Becks Road to the north.

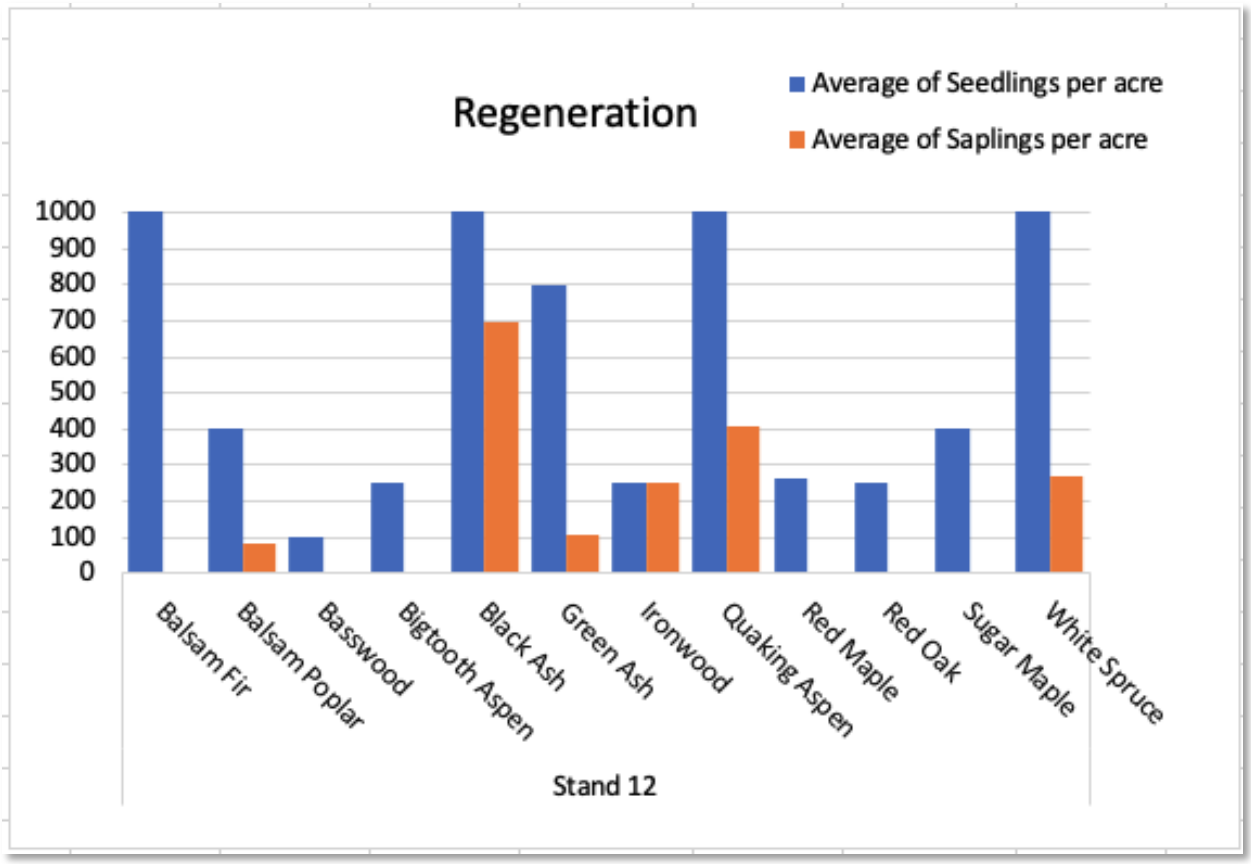
No action result (10-20 years): Complete ash mortality and resulting degradation of lowland forest habitat quality and possible buckthorn and other shrub takeover. White spruce, balsam fir, and balsam poplar is likely to become dominant in place of ash where sunlight is sufficient and competing vegetation is lower.

Management Goals, Strategies, and Actions

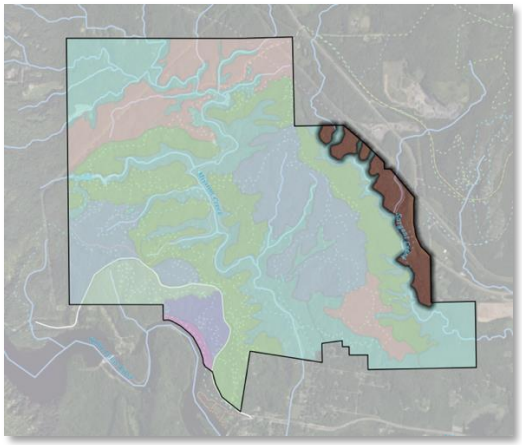
Goal	Strategy	Action	Notes
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Systemic herbicide injection annually into mature female trees during early-stage invasion to serve as seed crops for future ash regeneration; Girdle ash trees to attract EAB in combination with systemic herbicide injection to adjacent trees; Underplanting - Plant trees other than ash where ash decline and mortality is advanced	Prioritize trunk injections for seed trees with less than 30% canopy loss


Stand 12: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 25
Diameter Class (1")
Yellow Birch
White Spruce
Red Oak
Red Maple
Quaking Aspen
Paper Birch
N. White Cedar
Green Ash
Black Ash
Bigtooth Aspen
Basswood
Balsam Poplar
Balsam Fir


STAND 12 BASAL AREA = 115 SQ FT/AC
Yellow Birch, 3%
Balsam Fir, 6%
White Spruce, 16%
Balsam Poplar, 6%
Basswood, 1%
Bigtooth Aspen, 4%
Red Oak, 1%
Red Maple, 2%
Black Ash, 22%
Quaking Aspen, 20%
N. White Cedar, 4%
Green Ash, 2%
Paper Birch, 13%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Basswood
Bigtooth Aspen
Black Ash
Green Ash
Ironwood
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Spruce
Stand 12

Stand 13 Aspen





Stand Characteristics

Forest Type: Aspen

Size: 72 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	47.1	84%
MHn46b	4.6	8%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (82%), F111B (13%), E3A (3%), F155B (2%)
Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Young (0 to 55 years) and transitioning between young and mature forest (55 to 95 years)

Average Stand Diameter (DBH): 9.3" (SE=0.5)

Average Stand Basal Area: 127 ft^2/ac (SE=14)

Snags per acre: 40 medium (6-11" DBH), aspen

Coarse woody debris: Low/Medium

Wildfire risk: Low. However, a portion of this unit is adjacent to Becks Rd and railroad tracks, which can be wildfire ignition sources

Invasive Species: Medium - buckthorn was present throughout the stand, heavy in a few areas, including the aspen plantation

Pests & Disease: Initial stages of EAB infestation is present, with trees showing some decline but without widespread mortality

Current Condition: This maturing aspen-dominant stand is located at the eastern edge of the property, adjacent to railroad tracks and Becks Rd. The stand is relatively flat next to the road and drops off steeply with a western aspect down to Sargent Creek. The southeastern part of the unit is a distinct patch of plantation aspen (possibly a hybrid variety). Aspen is by far the dominant tree in both the natural and plantation sections of this stand, with the majority of trees in the 5-10" size class and some larger trees. The regeneration in this stand, primarily aspen and ash, is limited, but where there are canopy openings or edge habitat it is more prevalent. The midstory is moderately to very dense with notable semi-managed meadow openings and is composed of beaked hazel, buckthorn, mountain maple, roundleafed dogwood, serviceberry, and downy arrowwood. Dominant understory plants include largeleafed aster and thimbleberry.

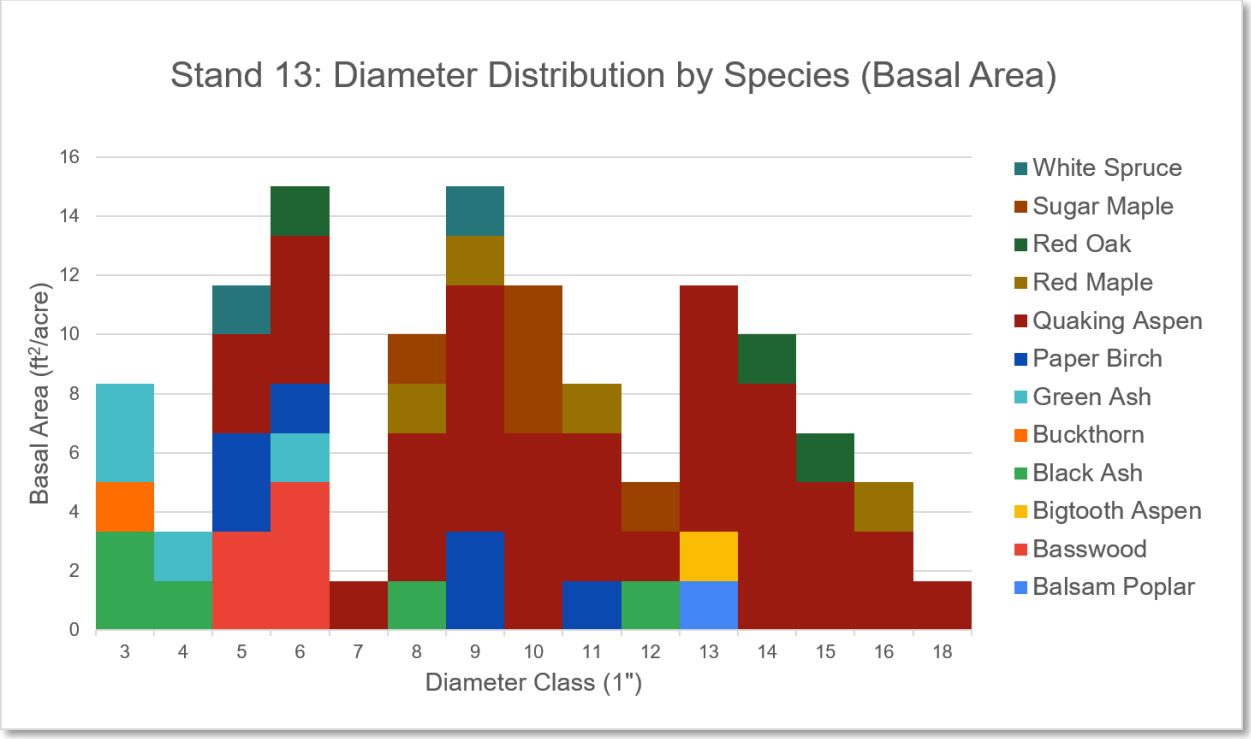
Current Recreational Uses or Management:
This stand is on the far (east) side of Sargent Creek and accessible only through the Munger Trail Trailhead on the other side of Becks Road. A <5 acre section of this stand is an actively managed quaking aspen plantation with mowed two-track roads and dense buckthorn understory.

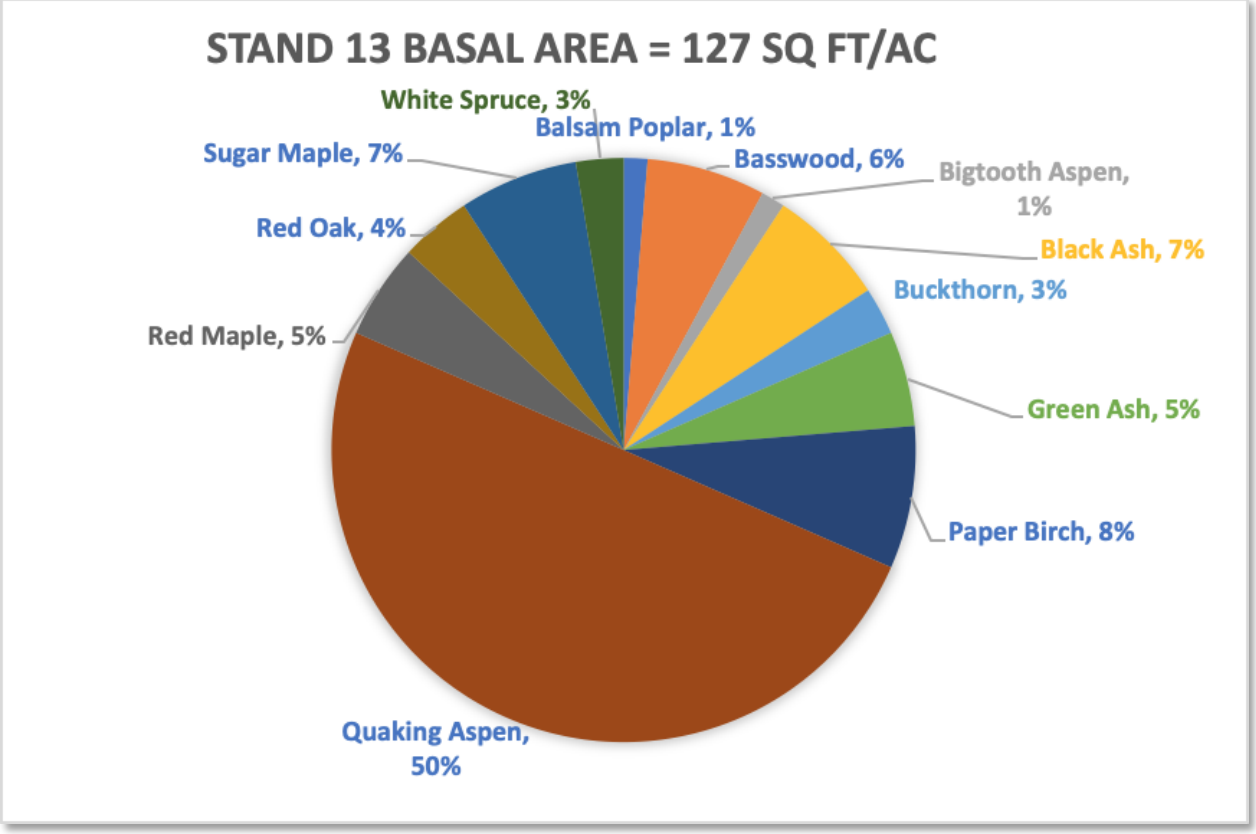
Adjacent land use concerns:
The actively managed plantation has roads that lead to an abutting private residence. Railroad contribute noise, pollution runoff into Sargent Creek tributaries, and possible source of non-native introductions.

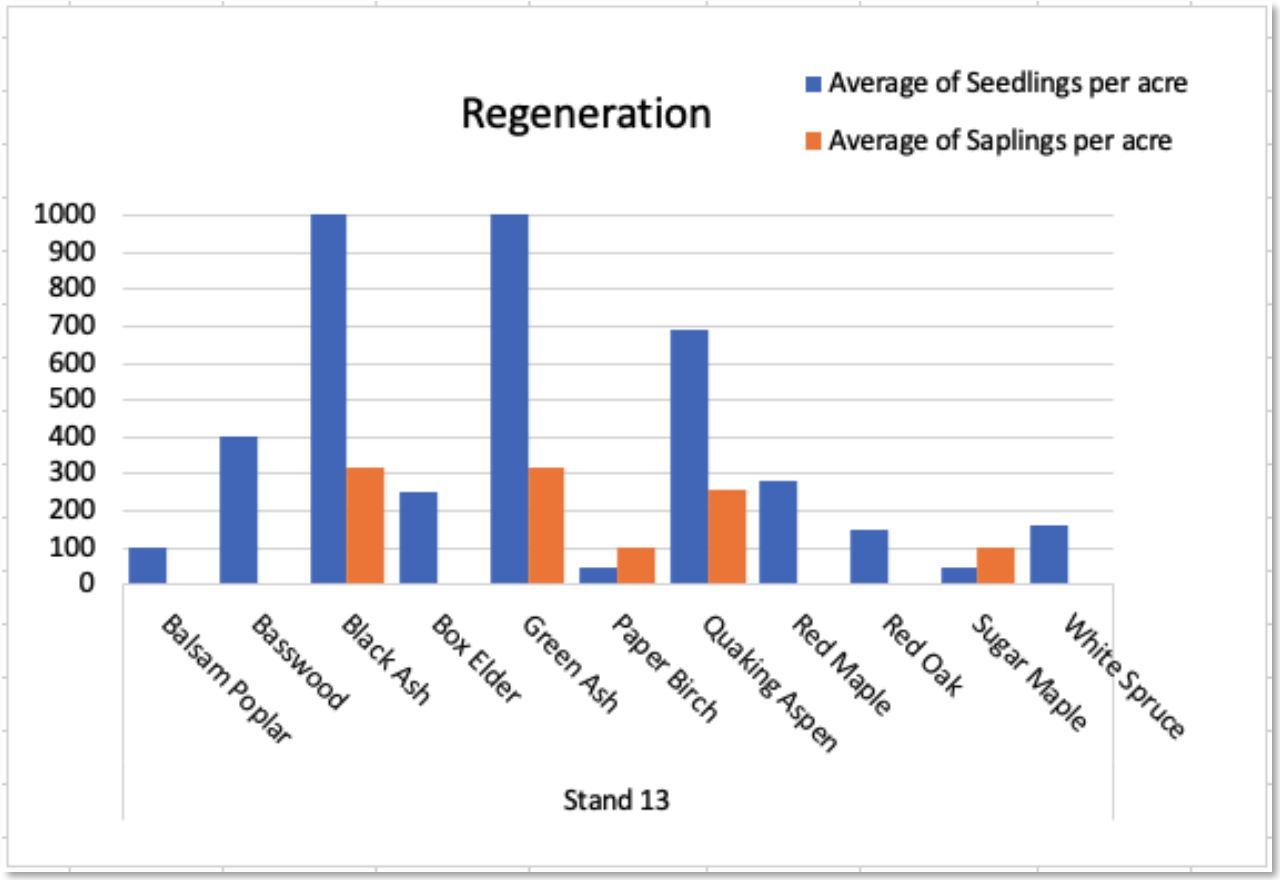
No action result (10-20 years): Aspen will mature and the stand will be subject to small gap dynamics from single tree mortality or possibly a larger stand-replacing windthrow event. Snags and coarse woody debris will increase as aspen trees decline and die of old age. Aspen or sugar maple will remain dominant depending on level of disturbance. Buckthorn will continue to spread and fill in a dense midstory, choking out native shrubs, understory trees, and herbaceous plants. Natural regeneration of other tree species will be challenging due to aspen dominance and midstory density.

Management Goals, Strategies, and Actions

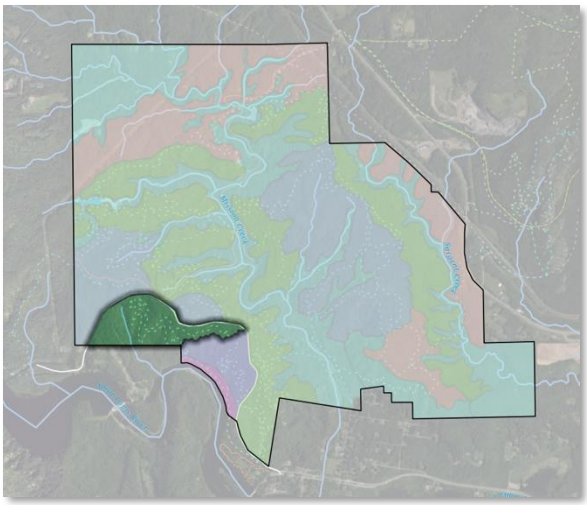
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter	
Restore/enhance native plant communities	Transition tree plantations to native forest composition	Thin overly stocked tree plantations, sell commercially when possible or remove offsite; Remove non-native tree species, sell commercially when possible or remove offsite; Interplant diverse native trees suitable to site conditions	Aspen plantation may not be a native variety - consider clearcutting and full replacement
Regeneration; Restore/enhance native plant communities	Reduce competition in midstory	Mulch/masticate shrub layer	

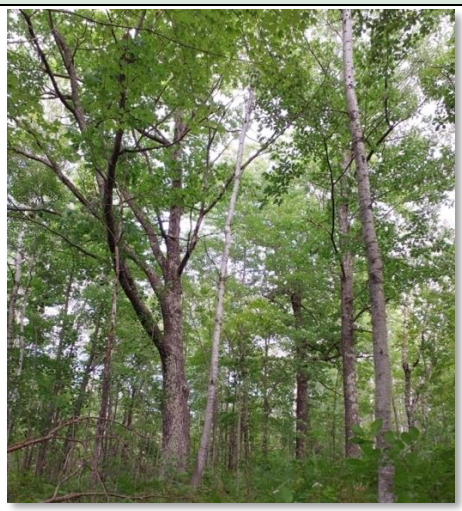

Stand 13: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
16
3
4
5
6
7
8
9
10
11
12
13
14
15
16
18
Diameter Class (1")
White Spruce
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Green Ash
Buckthorn
Black Ash
Bigtooth Aspen
Basswood
Balsam Poplar


STAND 13 BASAL AREA = 127 SQ FT/AC
White Spruce, 3%
Balsam Poplar, 1%
Sugar Maple, 7%
Basswood, 6%
Bigtooth Aspen, 1%
Red Oak, 4%
Black Ash, 7%
Buckthorn, 3%
Red Maple, 5%
Green Ash, 5%
Paper Birch, 8%
Quaking Aspen, 50%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Black Ash
Box Elder
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Spruce
Stand 13

Stand 14 Northern Hardwoods (Red Oak)





Stand Characteristics

Forest Type: Northern Hardwoods (Red Oak)

Size: 69 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	54.2	78%
MHn44c	6.4	9%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (90%), F155B (10%) Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitioning from young to mature forest (55 to 95 years)

Average Stand Diameter (DBH): 10.6" (SE=0.6)

Average Stand Basal Area: 118 ft^2/ac (SE=11)

Snags per acre: 26 medium (6-11" DBH), 1 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Moderate due to ignition risk from highway 210 and dam service road, and presence of fire-prone plant community.

Invasive Species: Buckthorn is very abundant in this stand, some of the highest on the property.

Pests & Disease: Ash is not abundant in this stand but EAB evidence was observed on mature ash where it occurs

Current Condition: This mid-successional stand is in the southwest corner of the property. The area slopes down towards the St. Louis river with some flat areas atop ridges near Highway 210 and along a service drive to the Fond du Lac dam. This is the most oak-dominant stand on the property. Sugar maple and red maple are common in the 5-7" DBH range. Due to the generally closed canopy conditions, few tree seedlings are recruiting into the sapling size classes. After ash, red oak seedlings were the most numerous seedling species. The midstory is fairly open with occasional patches of beaked hazel, roundleafed dogwood, and serviceberry. Dominant understory plants include Pennsylvania sedge, lady fern, thimbleberry, bunchberry, and bracken fern.

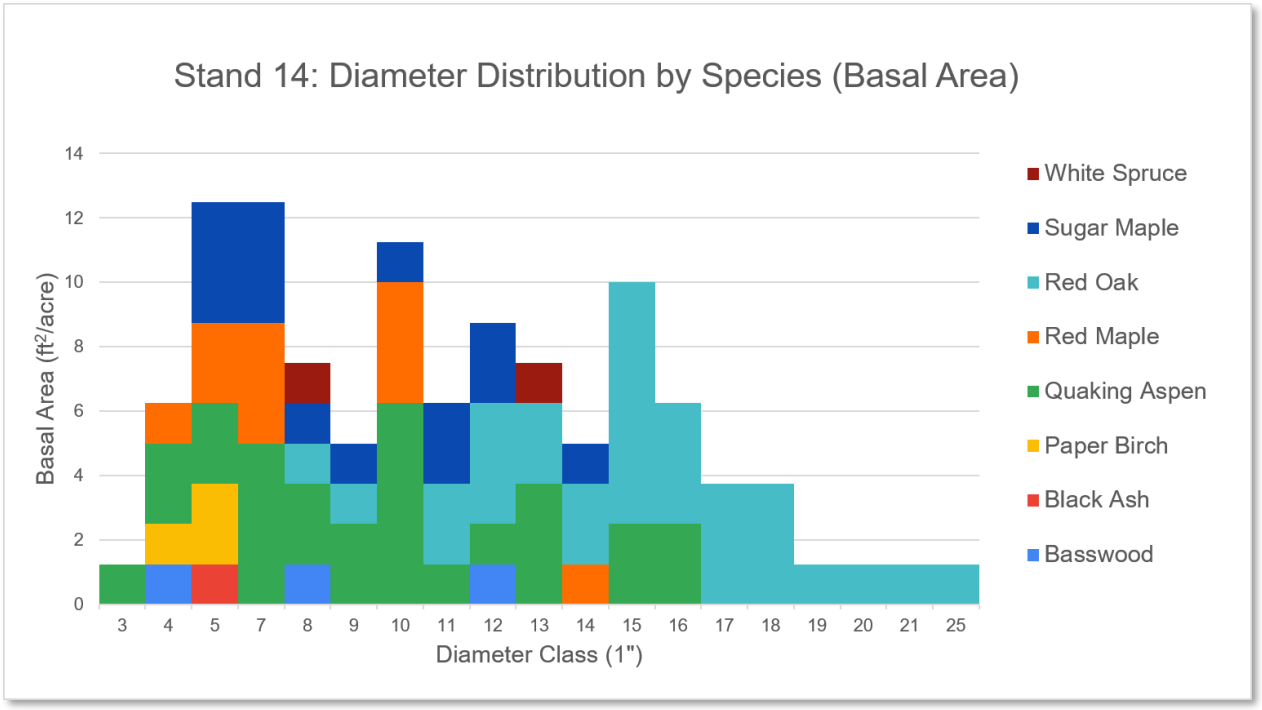
Current Recreational Uses or Management:
This is an accessible stand. Evidence of hunting, fishing or other off-trail recreation. Some trash was found on the hill below the service drive.

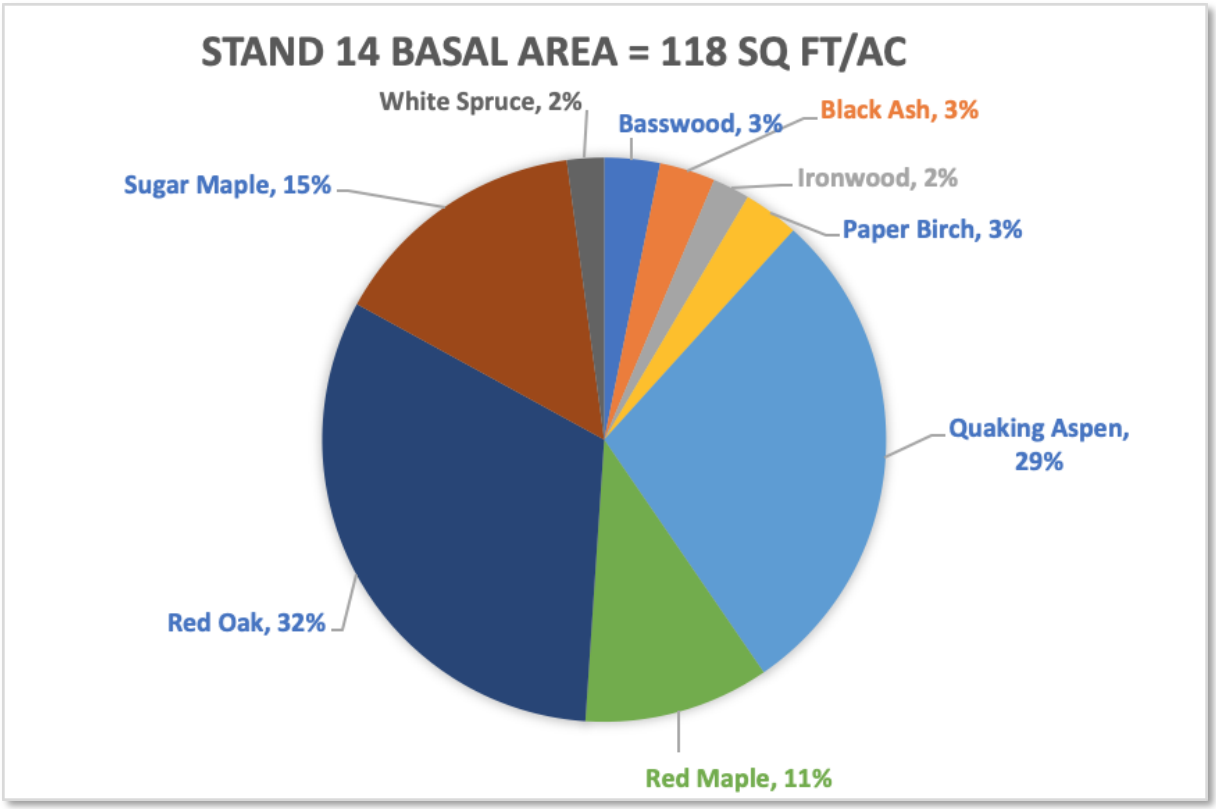
Adjacent land use concerns:
The nearby Fond du Lac Dam is considered critical infrastructure. Highway 210 may be a source of pollution, trash/debris, and invasive species.

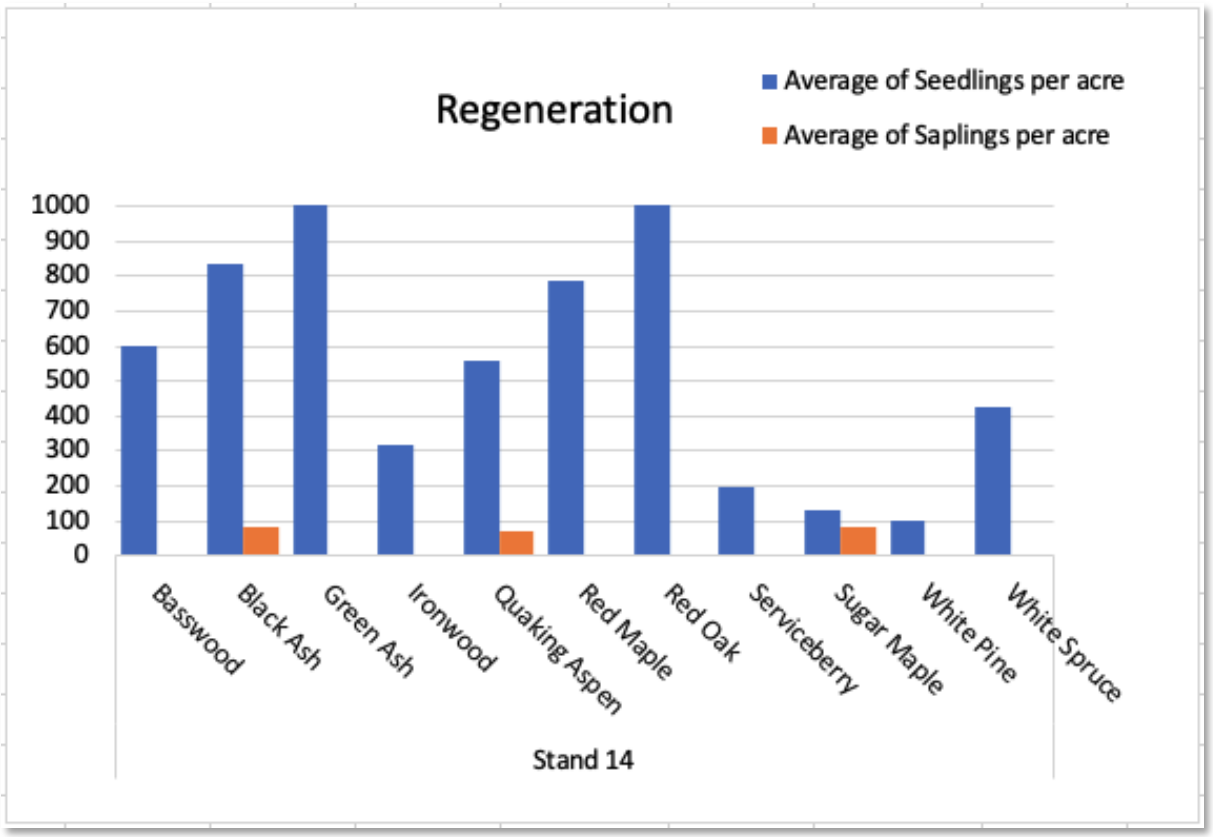
No action result (10-20 years): Conversion to shade tolerant species, closed canopy conditions will favor maples and white spruce if seeds where seed sources are present. Buckthorn abundance is likely to increase, especially in canopy gaps. Red oak regeneration is unlikely to recruit without moderately scaled disturbance, and mesophication and lack of fire may gradually shift the stand towards a more fire-intolerant hardwood plant community type.

Management Goals, Strategies, and Actions

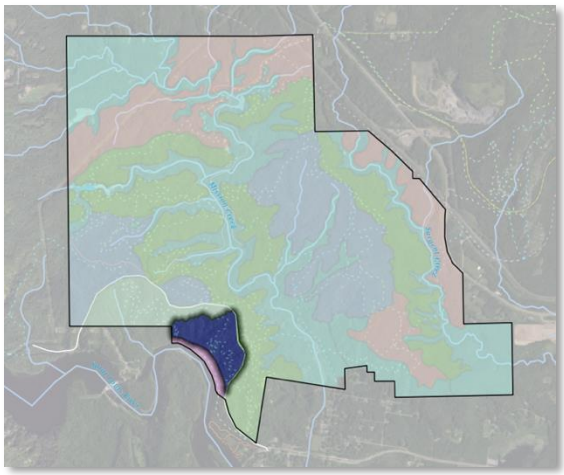
Goal	Strategy	Action	Notes
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest	establish oak cohort




STAND 14 BASAL AREA = 118 SQ FT/AC
White Spruce, 2%
Basswood, 3%
Black Ash, 3%
Ironwood, 2%
Paper Birch, 3%
Sugar Maple, 15%
Quaking Aspen, 29%
Red Oak, 32%
Red Maple, 11%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Basswood
Black Ash
Green Ash
Ironwood
Quaking Aspen
Red Maple
Red Oak
Serviceberry
Sugar Maple
White Pine
White Spruce
Stand 14

Stand 15 Northern Hardwoods (Red Oak, White Pine, Red Pine)





Stand Characteristics

Forest Type: Northern Hardwoods (Red Oak, White Pine, Red Pine)

Size: 45 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	34.2	77%
MHn44b	8.5	19%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (99%), F155B (1%) Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitioning from young to mature forest (55 to 95 years)

Average Stand Diameter (DBH): 11.3" (SE=1.2)

Average Stand Basal Area: 118 ft^2/ac (SE=14)

Snags per acre: 13 medium (6-11" DBH), 4 large (>12"DBH)

Coarse woody debris: Medium

Wildfire risk: Medium

Invasive Species: Low, Buckthorn observed occasionally and not established.

Pests & Disease: Some decline was noted on the ash trees in this stand, indicating presence of EAB

Current Condition: This closed-canopy white pine, red pine, red oak stand is located east of Stand 14 in the southwest to south-central portion of the property. It occupies the slopes and flatter ridgetops that drop down below Highway 210 and feed directly into the St. Louis river downstream of the Fond du Lac dam. The oldest and largest age class of trees are red and white pines with the largest white pine inventoried being 35" DBH. Presence of large conifer snags further indicates former pine dominance. The overstory in the rest of this stand is dominated by red oak (14-22" DBH) with paper birch, white spruce, and black ash codominant. Numerous surrounding seed sources allow for abundant regeneration of aspen, ash, and mixed hardwood species, but almost no saplings have been able to establish due to closed canopy conditions. The addition of hardwoods in the understory but lack of hardwoods in the canopy suggest this stand may have been a fire-dependent forest type that is transitioning to fire-intolerant species if fire continues to be excluded. The midstory is quite open with occasional beaked hazel and roundleaf dogwood patches. Pennsylvania sedge dominates the understory layer, along with bracken fern and thimbleberry.

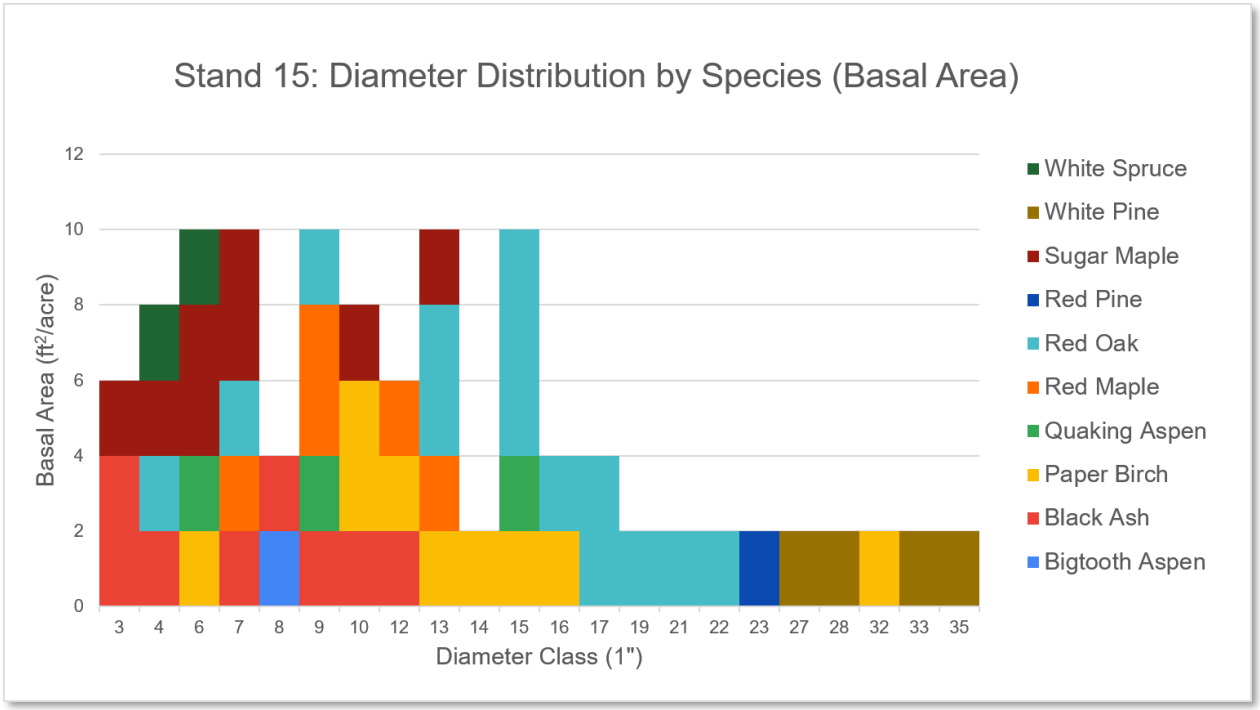
Current Recreational Uses or Management:
A mountain bike trail switchbacks throughout the stand. A trail enters the stand from Chambers Grove Park.

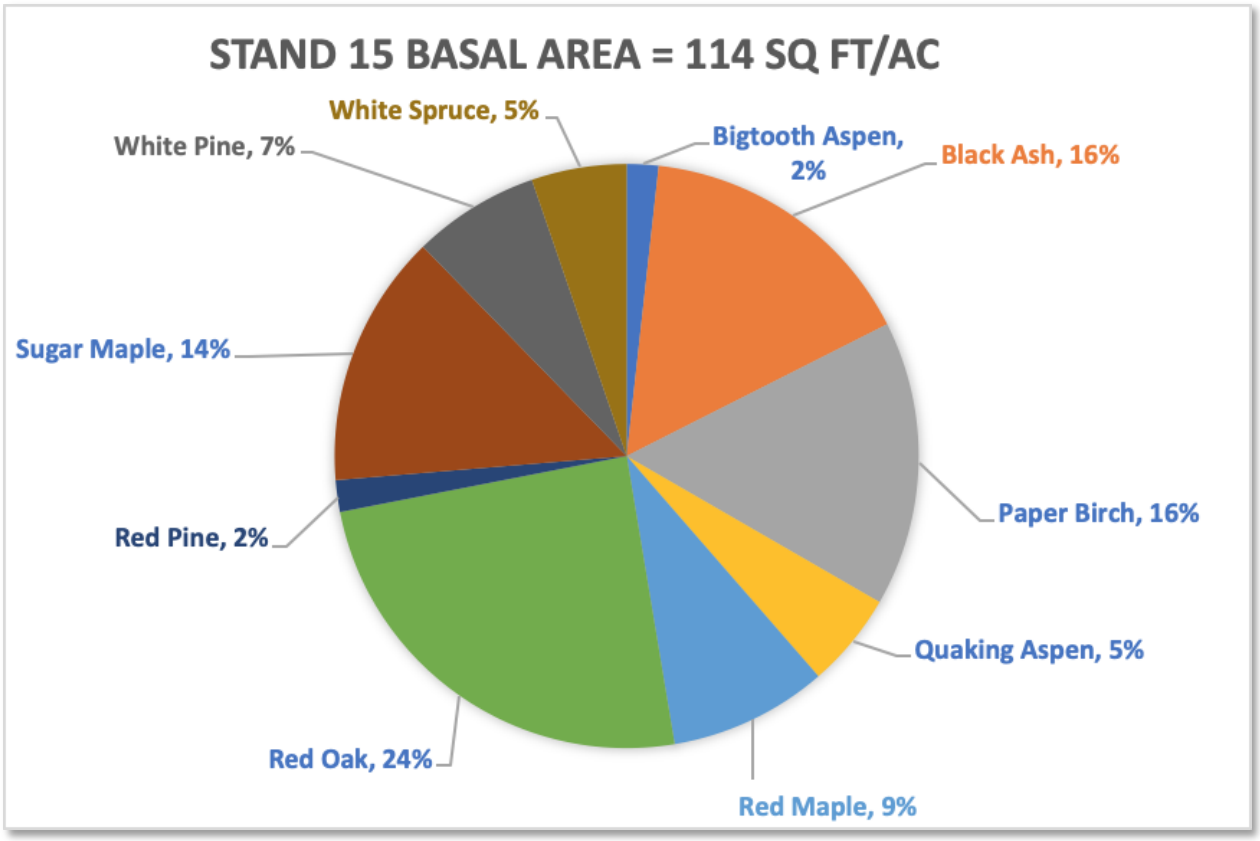
Adjacent land use concerns:
Highway 210 forms the eastern border of the stand and may be a source of pollution, trash/debris, and invasive species. Visitor density may be high due to proximity to Chambers Grove Park.

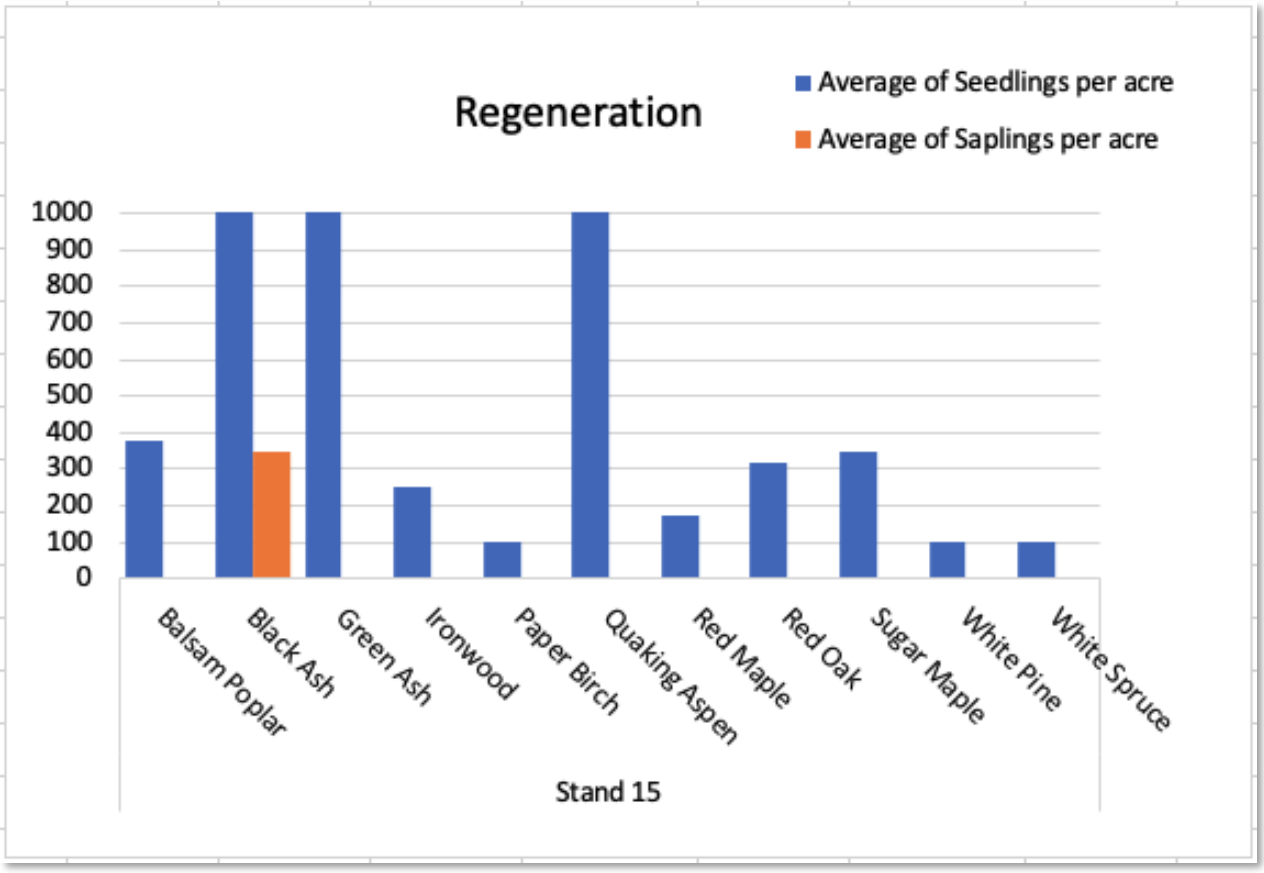
No action result (10-20 years): Over time, white and red pines will die out and be replaced by aspen and birch with some hardwood component - composition influenced by level of herbivory pressure. Mesophication and lack of fire may gradually shift the stand towards a more fire-intolerant hardwood plant community type. If herbivory pressure continues to prevent survival and establishment of saplings, the stand may shift to a more shrub-dominant community.

Management Goals, Strategies, and Actions

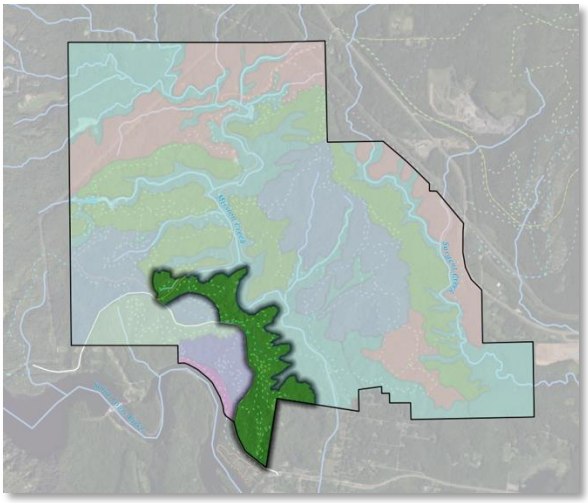
Goal	Strategy	Action	Notes
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine, red pine
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	site prep before cones drop
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort. Target red maple, aspen.

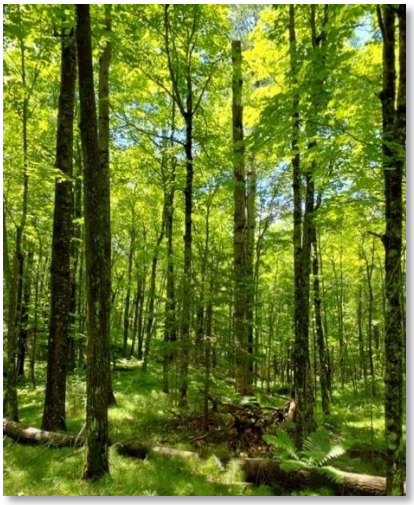

Stand 15: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
3 4 6 7 8 9 10 12 13 14 15 16 17 19 21 22 23 27 28 32 33 35
Diameter Class (1")
White Spruce
White Pine
Sugar Maple
Red Pine
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Black Ash
Bigtooth Aspen


STAND 15 BASAL AREA = 114 SQ FT/AC
White Spruce, 5%
White Pine, 7%
Bigtooth Aspen, 2%
Black Ash, 16%
Sugar Maple, 14%
Paper Birch, 16%
Red Pine, 2%
Quaking Aspen, 5%
Red Oak, 24%
Red Maple, 9%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Black Ash
Green Ash
Ironwood
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Stand 15

Stand 16 Mixed Hardwood Conifer





Stand Characteristics

Forest Type: Mixed Hardwood Conifer

Size: 120 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	85.1	71%
MHn47a	13.7	11%
MHn44c	8.1	7%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (68%), F155B (32%) Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitioning from young to mature forest (55 to 95 years)

Average Stand Diameter (DBH): 9.4" (SE=0.5)

Average Stand Basal Area: 128 ft^2/ac (SE=17)

Snags per acre: 17 medium (6-11" DBH)

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low - Buckthorn was present but not noted in abundance

Pests & Disease: EAB is likely present, but ash is a minor component of this stand

Current Condition: This mid-successional mixed conifer-hardwood stand is located at the southern recreational access point adjacent to Chambers Grove Park. It spans the east side of Highway 210 north to the Mission Creek Parkway, hosting the western upper banks of lower Mission Creek. It is primarily sloped or rolling terrain, with some flatter areas along Highway 210. The overstory is dominated by red oak and quaking aspen with white spruce, red maple and sugar maple prevalent in the smaller size classes (2-4" and 5-7"). The oldest age class of trees are white pine (32-34" DBH) and the aspen in this stand are mostly in the 5-10" DBH range. Ash seedlings are prolific with quaking aspen the next most common seedling species. However, there is little sapling recruitment, and what is present is limited to a select species, including ash, quaking aspen, and white spruce. The shrub midstory is relatively open and is composed of serviceberry, round-leaved dogwood, speckled alder and some beaked hazel. The most dominant understory plants include sedge (Pennsylvania Sedge), lady fern, horsetail, bush honeysuckle, Canada mayflower, and bunchberry, with Pennsylvania sedge becoming dominant in some areas.

Current Recreational Uses or Management:
This stand borders Chambers Grove Park and is a recreational access point with several trails.

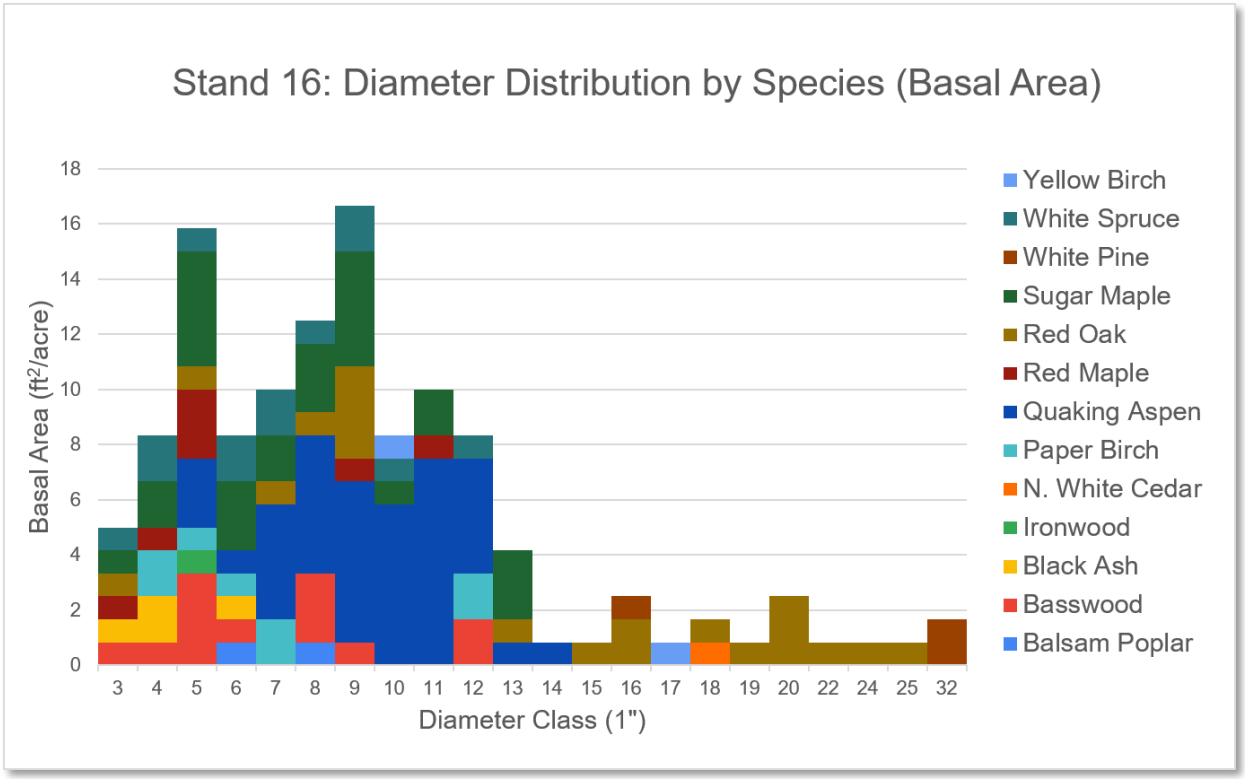
Adjacent land use concerns:
Highway 210 forms the western border of the stand and may be a source of pollution, trash/debris, and invasive species. Visitor density

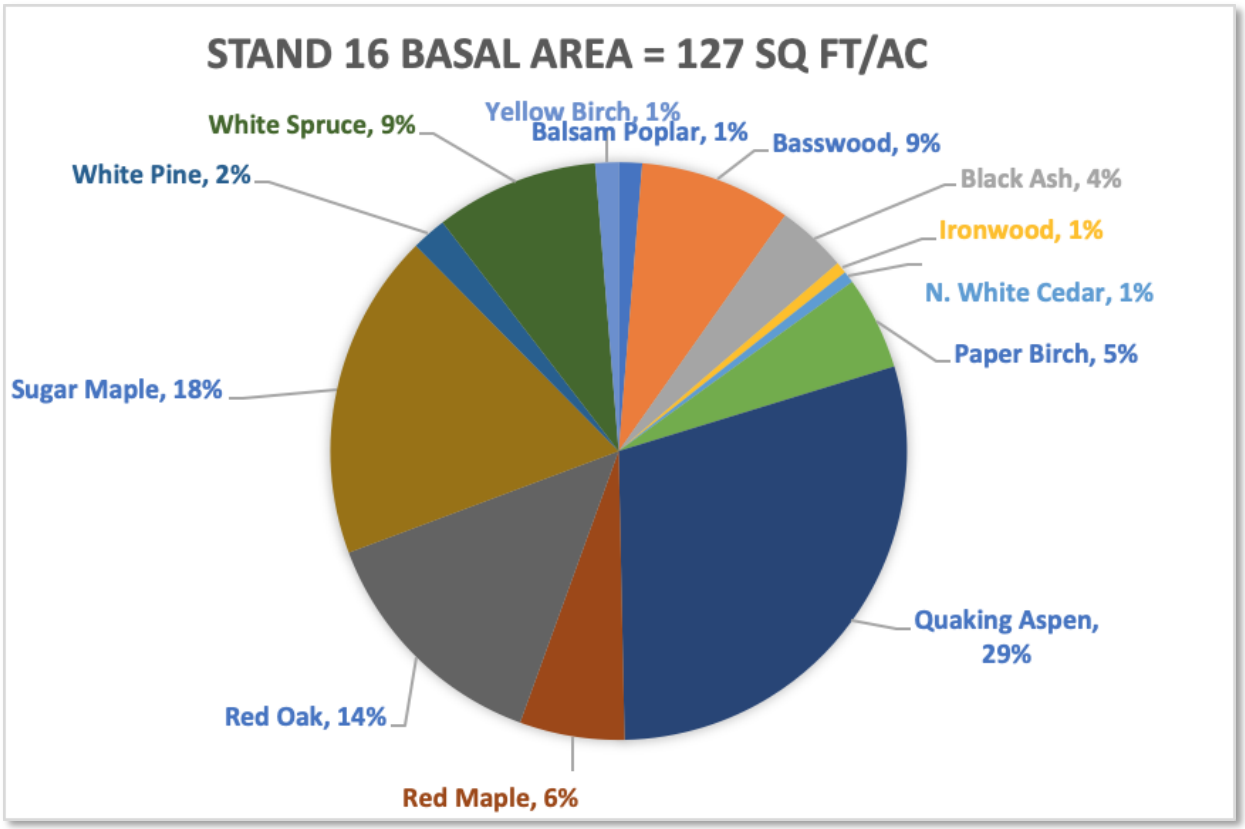
may be high due to proximity to Chambers Grove Park.

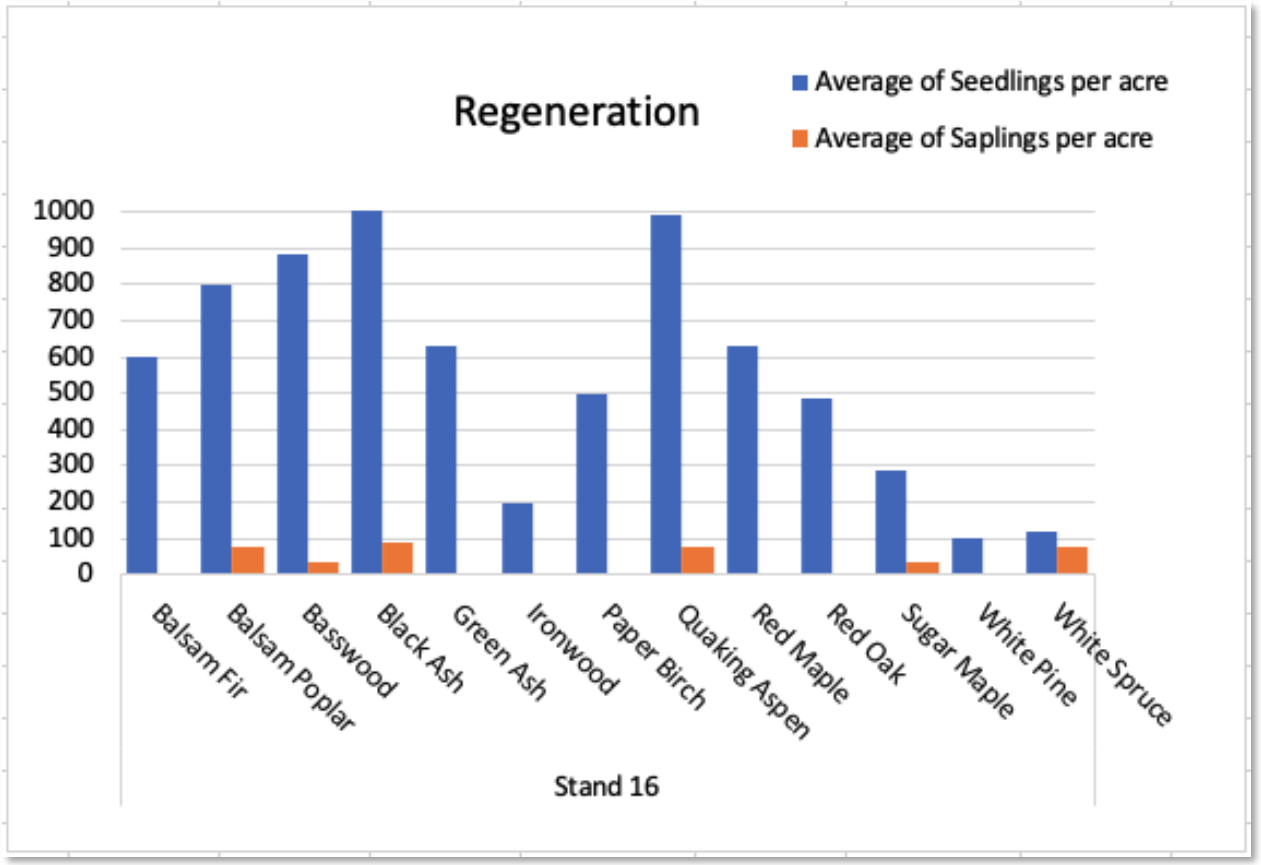
No action result (10-20 years): Mature aspen will continue to age out and naturally turn to snags or fall over, contributing to coarse woody debris and forest complexity. Hardwoods may continue to successfully establish into maturity; however, if deer browse continues at high pressure, stand density may decline in favor of dense shrub thickets or tree diversity will reduce to favor white spruce. Ash regeneration is abundant and well-positioned to take advantage of gaps, but its longevity is questionable due to EAB. Flood events may wash out patches of establishing riparian forest or introduce seeds of novel species from upstream runoff.

Management Goals, Strategies, and Actions

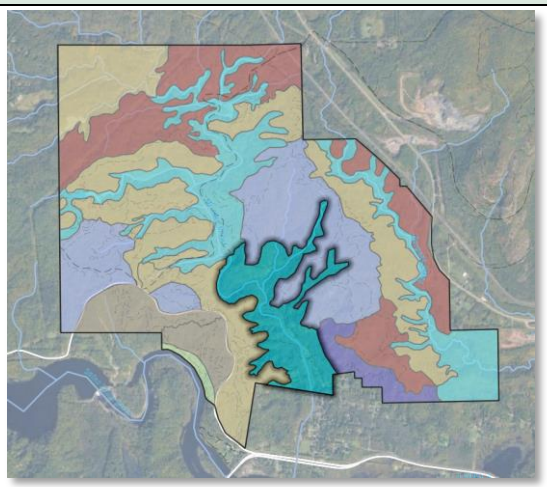
Goal	Strategy	Action	Notes
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine, red pine
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	site prep before cones drop
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort. Target red maple, aspen.
Regeneration	Protect seedlings and saplings (natural or artificial regeneration)	Large area deer exclosure - natural materials or fence	

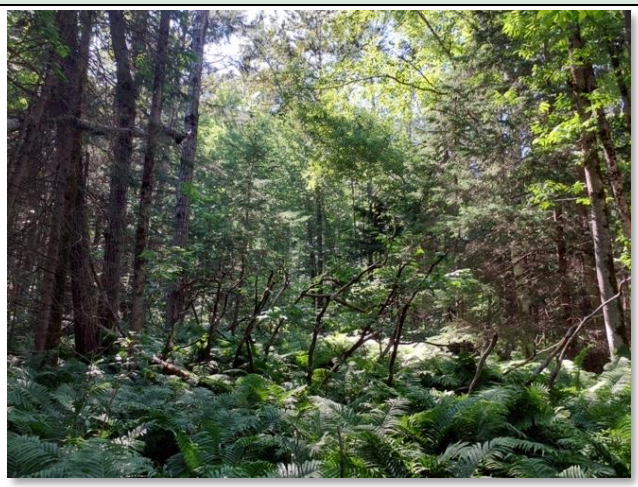

Stand 16: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
16
18
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 22 24 25 32
Diameter Class (1")
Yellow Birch
White Spruce
White Pine
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
N. White Cedar
Ironwood
Black Ash
Basswood
Balsam Poplar


STAND 16 BASAL AREA = 127 SQ FT/AC
White Spruce, 9%
Yellow Birch, 1%
Balsam Poplar, 1%
Basswood, 9%
White Pine, 2%
Black Ash, 4%
Ironwood, 1%
N. White Cedar, 1%
Paper Birch, 5%
Sugar Maple, 18%
Quaking Aspen, 29%
Red Oak, 14%
Red Maple, 6%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Basswood
Black Ash
Green Ash
Ironwood
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Stand 16

Stand 17 Riparian





Stand Characteristics

Forest Type: Riparian

Size: 160 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn44b	32.1	23%
MHn44c	29.5	21%
MHn46b	20.3	15%
MHn35b	18.2	13%
FFn57a	13.5	10%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (65%), E12A (21%), F155B (3%)
Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Transitioning from young to mature forest (35 to 95 years)

Average Stand Diameter (DBH): 11.2" (SE=0.8)

Average Stand Basal Area: 123 ft^2/ac (SE=9.7)

Snags per acre: 22 medium (6-11" DBH), 4 large (>12"DBH)

Coarse woody debris: Medium-High

Wildfire risk: Low

Invasive Species: Low - Buckthorn was observed at low levels in a few places, with tansy, and reed canary grass observed infrequently at medium levels

Pests & Disease: EAB is present and appears to be somewhat established, with some areas exhibiting mortality in mature trees, but only canopy decline in other areas.

Current Condition: This riparian forest is the riverine bottomlands, floodplains, and adjacent slopes of the lower reaches of Mission Creek and its tributary streams. The tree species composition is overall diverse and includes a distinct pocket on the lowest-lying floodplain of mature black ash, white cedar, yellow birch, white spruce, and balsam poplar swamp. A patch of planted red pines is located near the trailhead, along with a disturbed and very open field with evidence of past development and non-native trees. Large remnant white pine, white cedar, and occasional red pine occur on steep primarily north-facing slopes. White spruce was present throughout the stand, as it is mid-tolerant of shade and less impacted by deer browse. As in other stands, early successional species such as quaking aspen, paper birch, and balsam poplar were most numerous by total trees per acre. Shade tolerant red and sugar maple were mostly present in the smaller (2-4" DBH size classes), with some larger red maple present. There was a wide array of regeneration present in the seedling class, but minimal diversity in the sapling age class as quaking aspen and black ash made up approximately 70% of saplings tallies. Seedlings of species that are highly palatable to deer, such as white cedar and white pine, were observed, but primarily in areas that were harder for deer to access, such as steep slopes. The midstory is open to dense, and is composed of

mountain maple, beaked hazel, and speckled alder. Ostrich fern and Pennsylvania sedge tended to dominate the groundlayer where it was found. Other dominant understory plants include thimbleberry, lady fern, sedges, and horsetail.

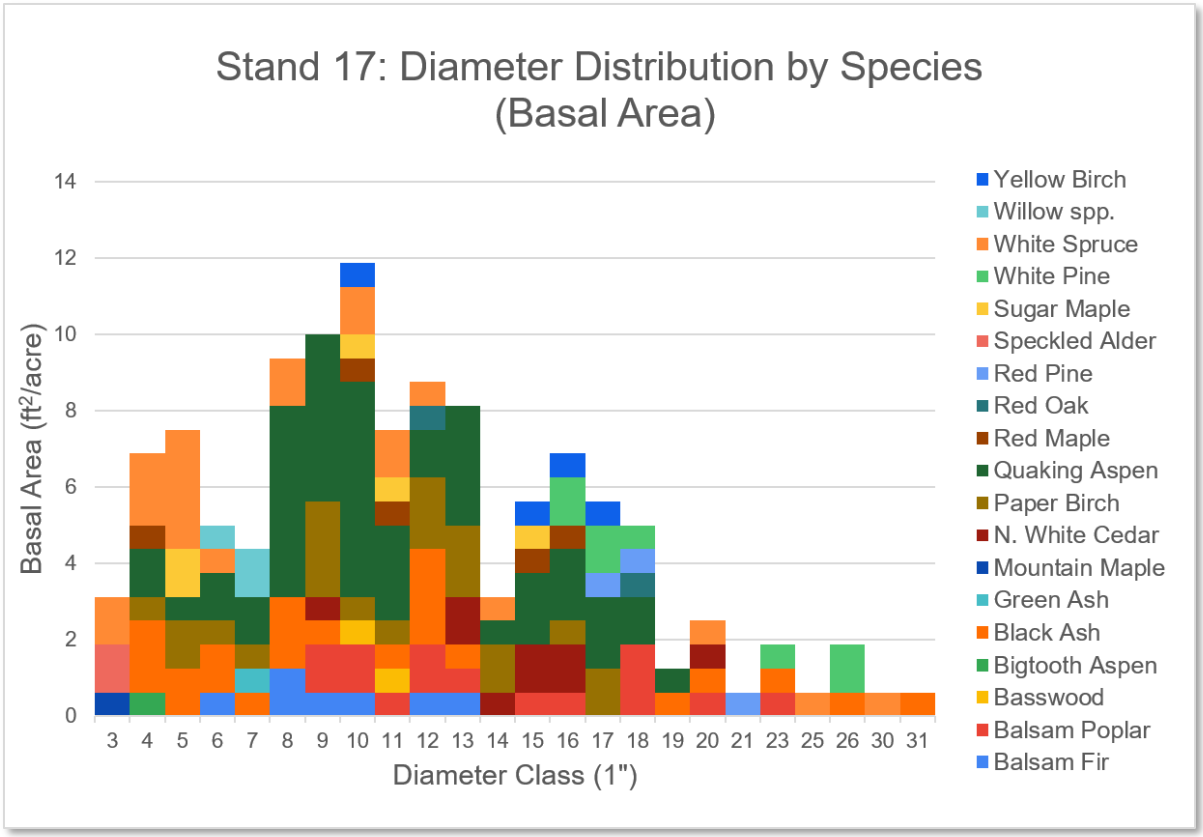
Current Recreational Uses or Management:
Past stream restoration and tree planting has been conducted in this unit. There are some recreational trails in this unit, including recreational access and parking through a residential area off 131st Ave W.

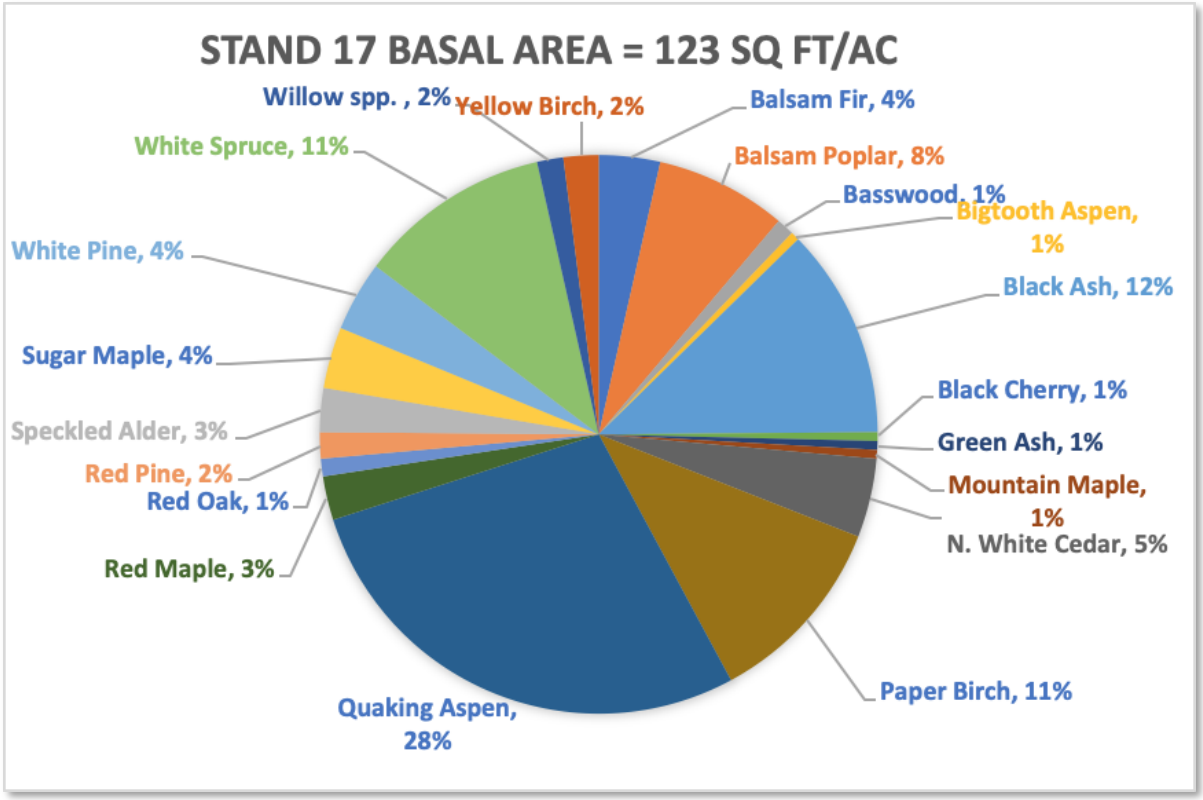
Adjacent land use concerns:
A low-lying residential area is located south of this stand adjacent to Mission Creek.

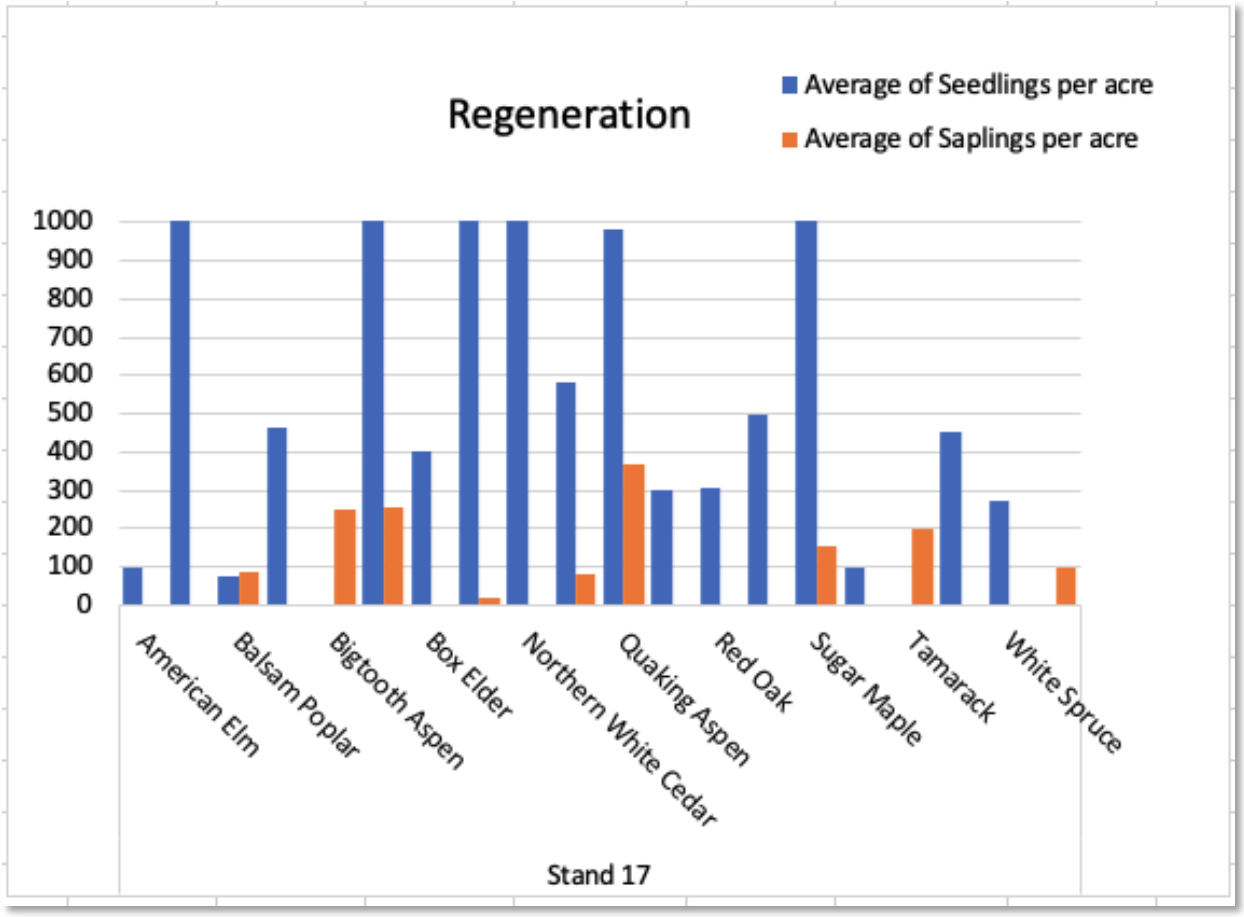
No action result (10-20 years): White spruce is present throughout all age classes and appears to be regenerating with current forest conditions. It is likely to remain the dominant conifer species. Black ash mortality will continue, with shrubs or ostrich fern likely to fill in the midstory and ground level vegetation, especially in black ash dominated areas.

Management Goals, Strategies, and Actions

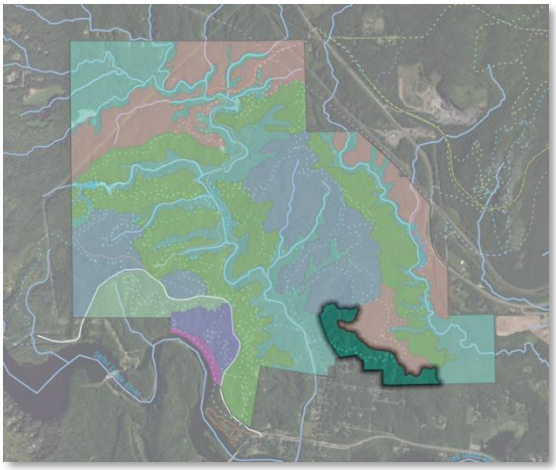
Goal	Strategy	Action	Notes
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Systemic herbicide injection annually into mature female trees during early-stage invasion to serve as seed crops for future ash regeneration; Girdle ash trees to attract EAB in combination with systemic herbicide injection to adjacent trees; Underplanting - Plant trees other than ash where ash decline and mortality is advanced	Easy Access, high visibility; Prioritize trunk injections for seed trees with less than 30% canopy loss
Ecosystem function	Stabilize soil along erodible stream and river banks	Seed fast-growing native grasses and forbs on eroded banks where tree cover is not deemed critical	


Stand 17: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 23 25 26 30 31
Diameter Class (1")
Yellow Birch
Willow spp.
White Spruce
White Pine
Sugar Maple
Speckled Alder
Red Pine
Red Oak
Red Maple
Quaking Aspen
Paper Birch
N. White Cedar
Mountain Maple
Green Ash
Black Ash
Bigtooth Aspen
Basswood
Balsam Poplar
Balsam Fir


STAND 17 BASAL AREA = 123 SQ FT/AC
Willow spp. , 2%
Yellow Birch, 2%
Balsam Fir, 4%
White Spruce, 11%
Balsam Poplar, 8%
Basswood, 1%
Bigtooth Aspen, 1%
White Pine, 4%
Black Ash, 12%
Sugar Maple, 4%
Black Cherry, 1%
Speckled Alder, 3%
Green Ash, 1%
Red Pine, 2%
Mountain Maple, 1%
Red Oak, 1%
N. White Cedar, 5%
Red Maple, 3%
Paper Birch, 11%
Quaking Aspen, 28%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
American Elm
Balsam Poplar
Bigtooth Aspen
Box Elder
Northern White Cedar
Quaking Aspen
Red Oak
Sugar Maple
Tamarack
White Spruce
Stand 17

Stand 18 White Pine, White Spruce, Paper Birch





Stand Characteristics

Forest Type: White Pine, White Spruce, Paper Birch

Size: 53 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn44b	26.4	50%
MHn35b	23.3	44%

Ecological Site (USDA): F092XY014WI - Loamy Uplands

Dominant Soils: F155G (95%), F155B (4%) Udalfs-Eutrudepts complex, 25-70% slopes. Fine sandy loam and silt loam. Moderately well drained to well drained.

Successional Stage: Mature forest (95-195 years)

Average Stand Diameter (DBH): 11.8" (SE=1.8)

Average Stand Basal Area: 125 ft^2/ac (SE=22)

Snags per acre: 24 medium (6-11" DBH), 1 large (>12"DBH)

Coarse woody debris: Medium to high

Wildfire risk: High due to fuel loading and proximity to residential area

Invasive Species: Moderate - buckthorn was noted throughout the stand, mostly at low levels but very dense in localized patches

Pests & Disease: None

Current Condition: This mature to old-growth forest is located on steep, south-facing steep slopes north of the residential area off Veterans Evergreen Memorial Drive in the south-central portion of the property. Large, remnant white pines are present throughout the stand, with paper birch, quaking aspen, red oak and white spruce the primary codominant species. A diverse array of other seedling species are present, but ash and sugar maple make up approximately 75% of seedlings tallied. Sapling recruitment is limited, due to the closed canopy conditions and limited sunlight. This may have been a fire-dependent forest type that is trending towards fire-intolerant species like maples due to lack of fire. Buckthorn and roundleaved dogwood are the primary midstory components. Pennsylvania sedge dominates the understory.

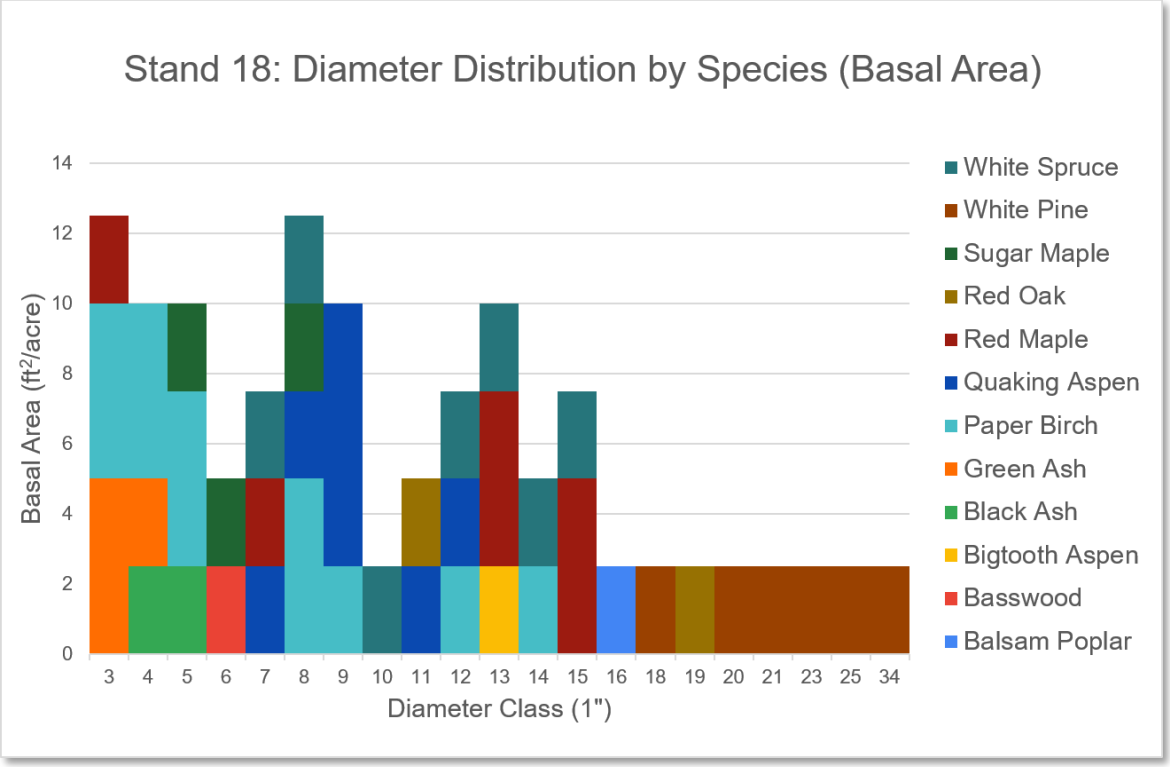
Current Recreational Uses or Management:
One trail is present through a portion of the stand. Very steep slopes deter off-trail uses.

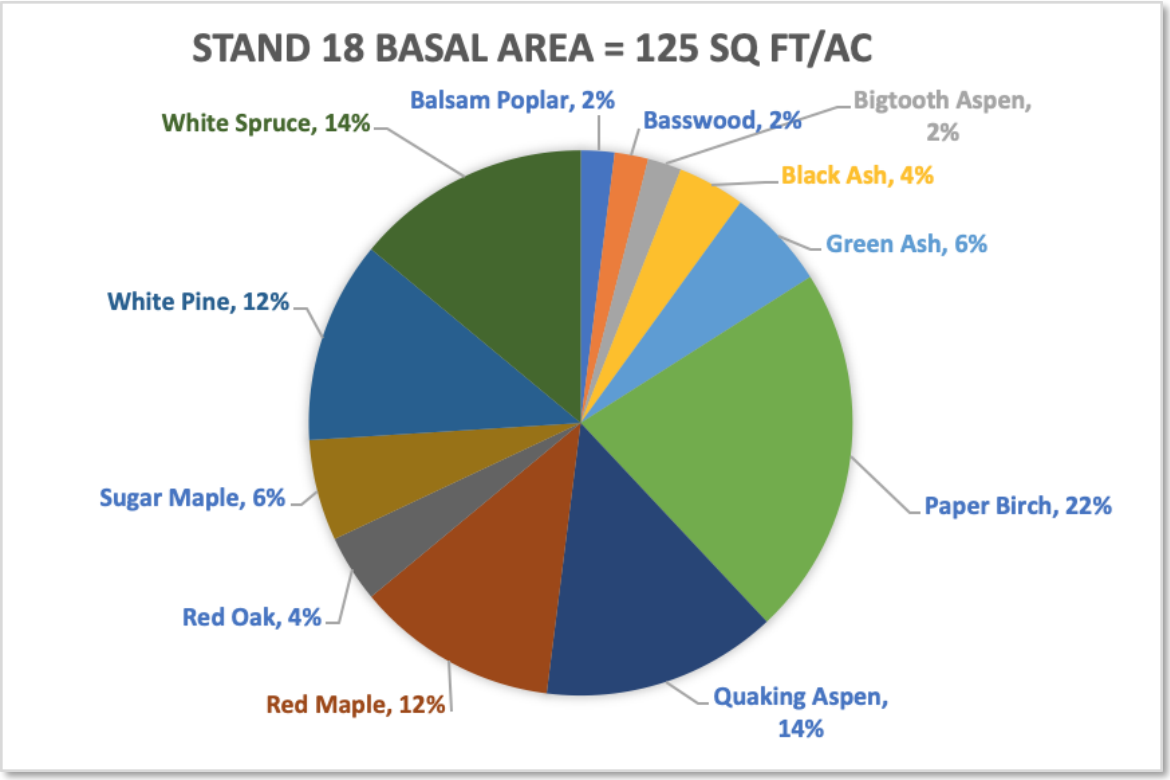
Adjacent land use concerns:
A residential area is adjacent to this unit. Potential wildfire ignition source or public safety concern in the event of a wildfire.

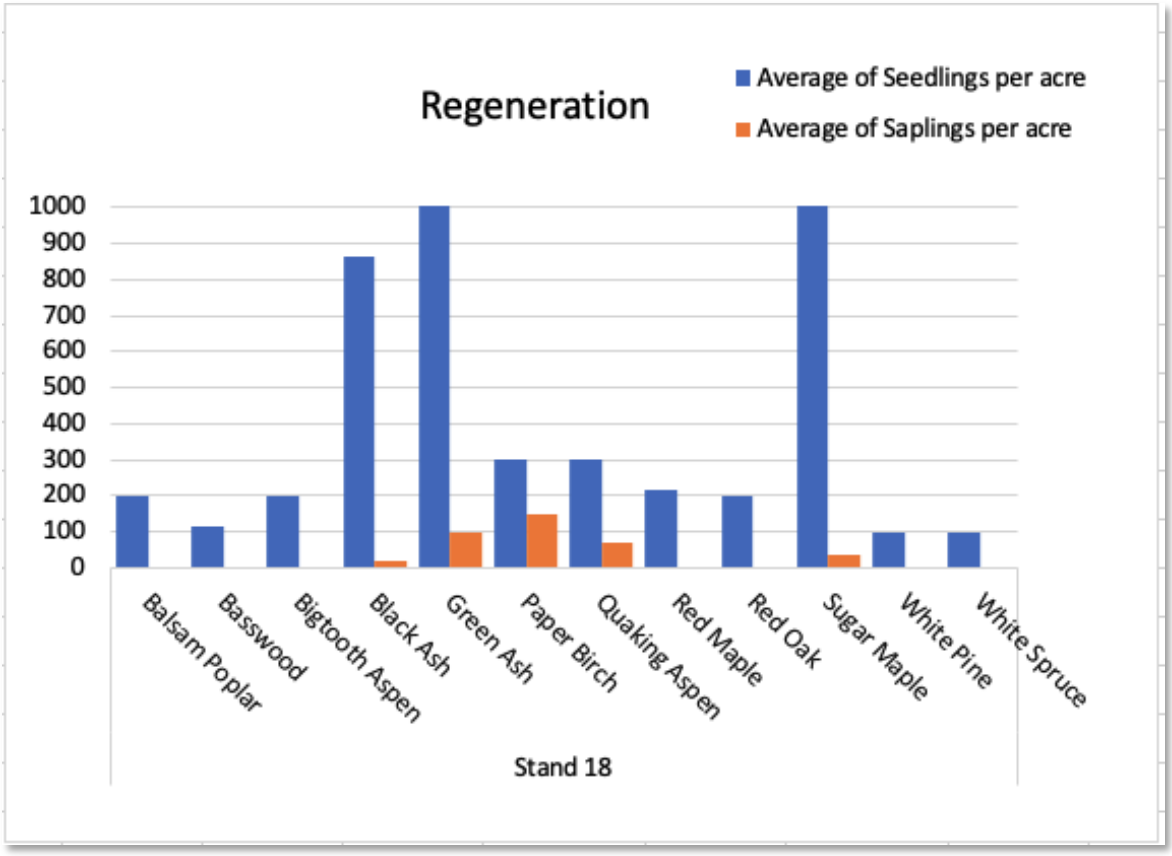
No action result (10-20 years): The white pine in this stand is mature and this species component will be reduced if a new cohort is not established. Mesophication, the transition from fire-dependent to fire-intolerant plant community is likely to occur. Black ash in the mid canopy will die, favoring shade tolerant trees (especially sugar maple) and shrubs.

Management Goals, Strategies, and Actions

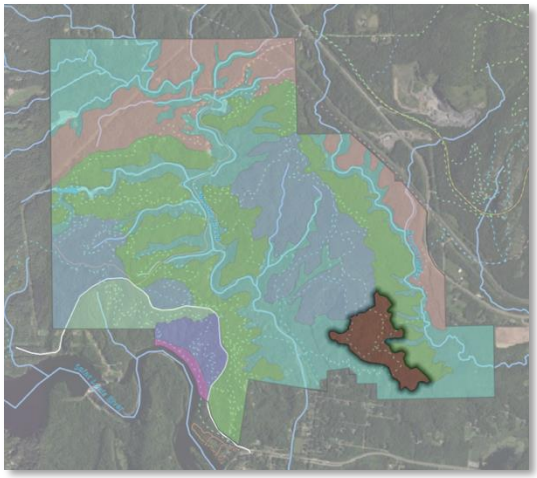
Goal	Strategy	Action	Notes
Forest resilience	Reduce hazardous fuel load to reduce wildfire risk and severity	Thin and remove overcrowded balsam fir or white spruce; Thin and remove above ground dead/down woody debris (lacking soil contact) that creates a fuel ladder into tree canopies; Woody debris processing through biochar creation, pile burning, or off-site chipping	
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Monitor for seed producing trees of interest	White pine, red pine, white cedar, white spruce
Regeneration	Promote natural regeneration in vicinity of seed-bearing trees	Site preparation - Prescribed burning OR Site preparation - Mechanical soil scarification	Site prep through surface burning or scarification before cones drop.
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Shelterwood harvest OR Girdle trees surrounding seed producing trees of interest	Thin canopy to 40-60% cover 1-5 years in advance of conifer regen effort.


Stand 18: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 23 25 34
Diameter Class (1")
White Spruce
White Pine
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Green Ash
Black Ash
Bigtooth Aspen
Basswood
Balsam Poplar


STAND 18 BASAL AREA = 125 SQ FT/AC
Balsam Poplar, 2%
Basswood, 2%
Bigtooth Aspen, 2%
White Spruce, 14%
Black Ash, 4%
Green Ash, 6%
White Pine, 12%
Paper Birch, 22%
Sugar Maple, 6%
Red Oak, 4%
Red Maple, 12%
Quaking Aspen, 14%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Bigtooth Aspen
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Stand 18

Stand 19 Mixed Hardwood Conifer





Stand Characteristics

Forest Type: Mixed Hardwood Conifer

Size: 56 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	35.7	63%
MHn46b	20.6	36%

Ecological Site (USDA): F092XY014WI - Loamy Uplands F092XY015WI - Clayey Uplands

Dominant Soils: F155B (76%), F155G (24%) Udalfs-Eutrudepts complex, 0-8% slopes. Fine sandy loam and silt loam. Somewhat poorly drained to well drained.

Successional Stage: Transitioning from young to mature forest (55-95 years)

Dominant Soil: F155B (76%), F155G (24%)

Average Stand Diameter (DBH): 9.2" (SE=0.5)

Average Stand Basal Area: 142 ft2/ac (SE=16)

Snags per acre: 77 medium (6-11" DBH), majority aspen

Coarse woody debris: Medium

Wildfire risk: Moderate in localized areas (spruce)

Invasive Species: Low, buckthorn was noted throughout, but as seedlings in low quantities

Pests & Disease: Dead quaking aspen regeneration was indicated due to the shady conditions

Current Condition: This mid-successional hardwood forest is located in the southeast portion of the property, on the gently rolling to relatively flat areas north of Stand 18 and the adjacent residential neighborhood. Canopy is overall dense, creating shady conditions that limit the regeneration and development of the understory. The oldest size class of trees are red oak (17-25" DBH). Quaking aspen is dominant in the 5-16" size class. Smaller trees under 7" are a mix of hardwoods and conifers including green ash, basswood, white spruce, and sugar maple, indicating the stand is moving from aspen dominance towards a mixed hardwood-white spruce stage. Tree seedlings are abundant, with green and black ash being the most abundant seedling species, and basswood and white spruce also prevalent. The midstory is very open, with tree and shrub recruitment limited. The dominant shrubs in this stand are beaked hazel, speckled alder, serviceberry, and downy arrowwood, with only speckled alder reaching the 6-ft size class. Buckthorn was also recorded in the shrub layer, but only in the under 6ft size class. Dominant understory plants include lady fern, hawkweed, dewberry, pyrola, and sedges, including Pennsylvania sedge.

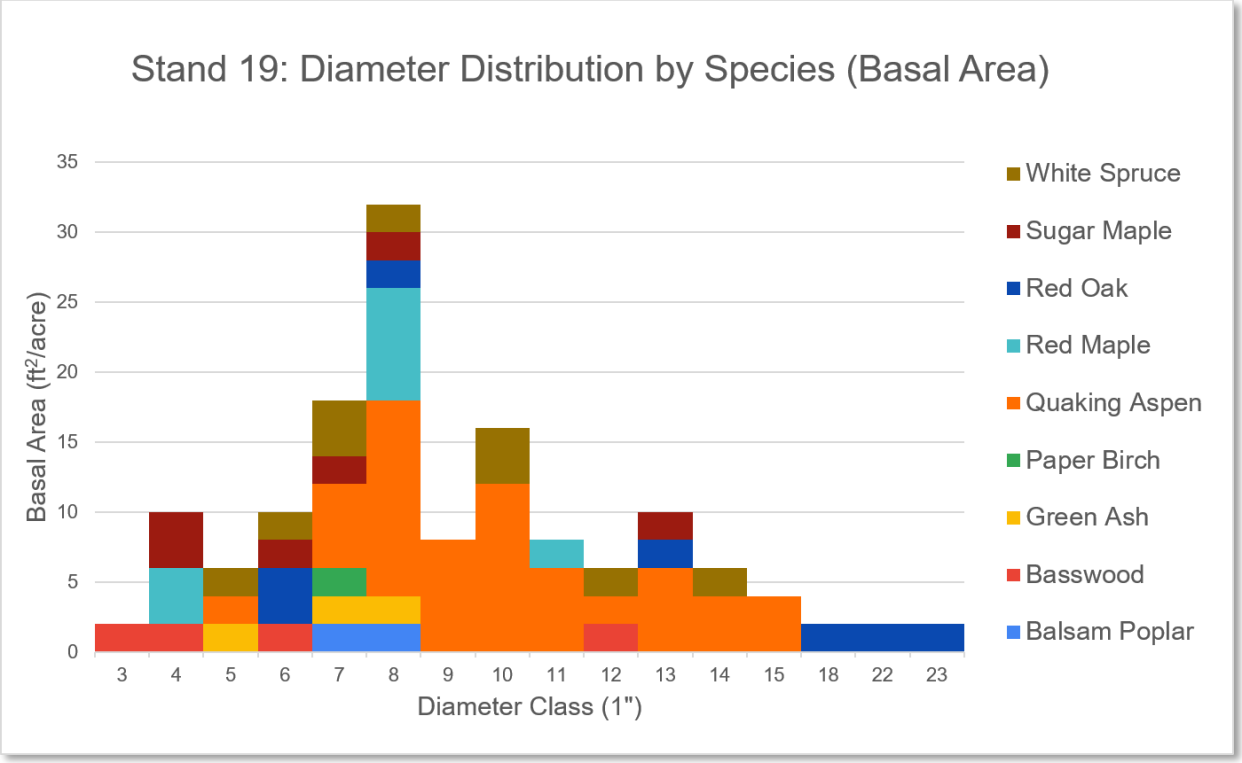
Current Recreational Uses or Management:
This stand receives moderate recreational use with two trails looping throughout the stand, though is relatively far away from trailheads.

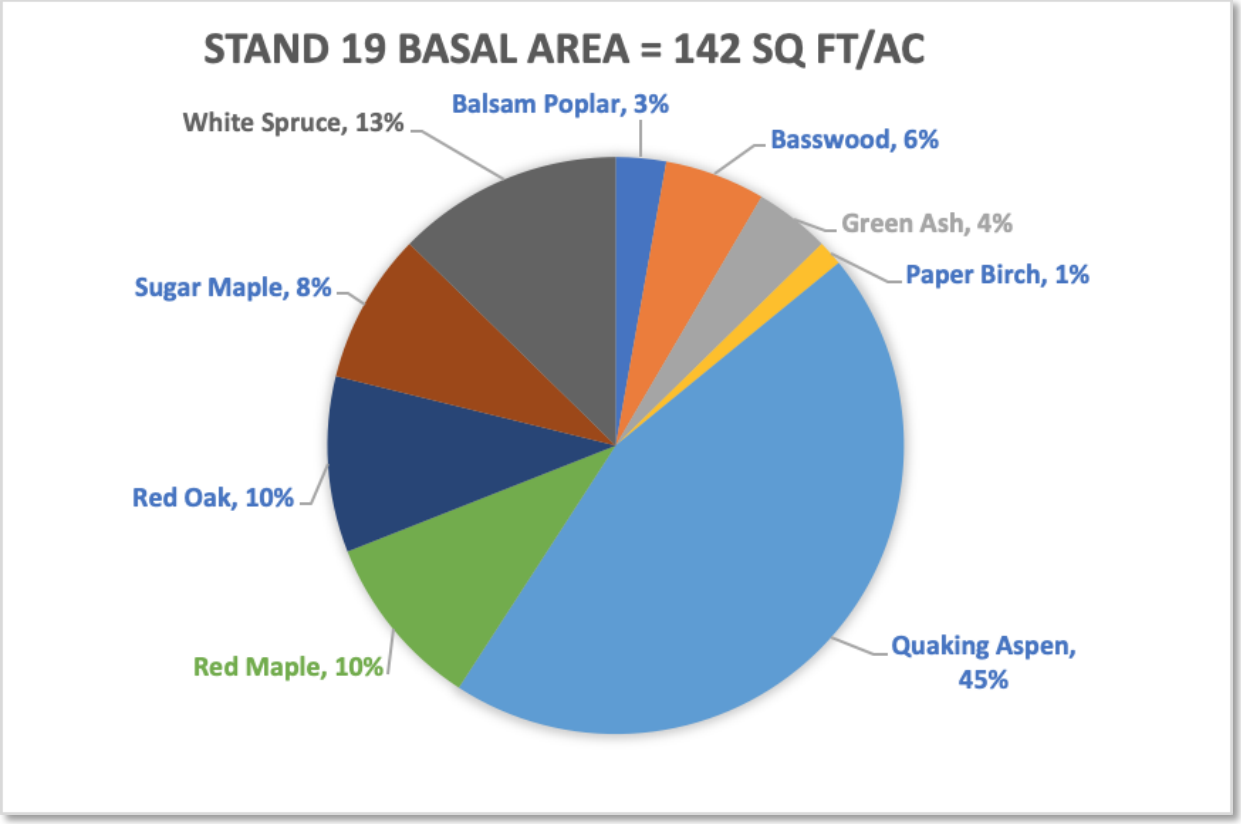
Adjacent land use concerns:
None noted.

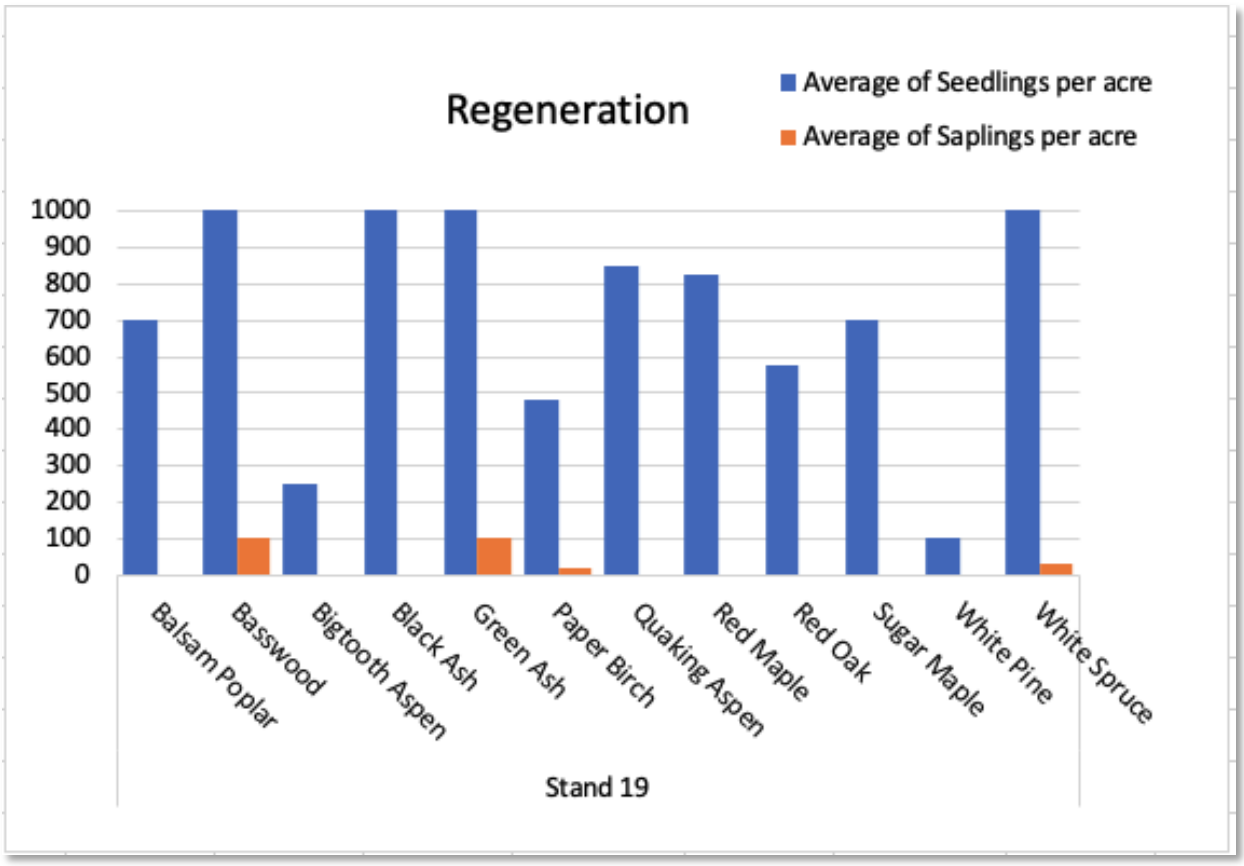
No action result (10-20 years): Aspen mortality due to age will continue, which will favor conversion to shade tolerant mixed hardwood condition and create wildlife-desired larger snags. If herbivory is too high, plant species composition will favor less palatable species.

Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Regeneration	Create canopy openings to allow sunlight to reach forest floor	Single tree selection	Cut aspen to release sugar maple saplings
Forest resilience	Reduce hazardous fuel load to reduce wildfire risk and severity	Thin and remove overcrowded balsam fir or white spruce; Thin and remove above ground dead/down woody debris (lacking soil contact) that creates a fuel ladder into tree canopies; Woody debris processing through biochar creation, pile burning, or off-site chipping	


Stand 19: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
35
30
25
20
15
10
5
0
3
4
5
6
7
8
9
10
11
12
13
14
15
18
22
23
Diameter Class (1")
White Spruce
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Green Ash
Basswood
Balsam Poplar


STAND 19 BASAL AREA = 142 SQ FT/AC
White Spruce, 13%
Balsam Poplar, 3%
Basswood, 6%
Green Ash, 4%
Paper Birch, 1%
Sugar Maple, 8%
Red Oak, 10%
Red Maple, 10%
Quaking Aspen, 45%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Bigtooth Aspen
Black Ash
Green Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
White Pine
White Spruce
Stand 19

Section 5: Piedmont-Brewer Forest (Piedmont)

Figure 4: Piedmont Stands Map

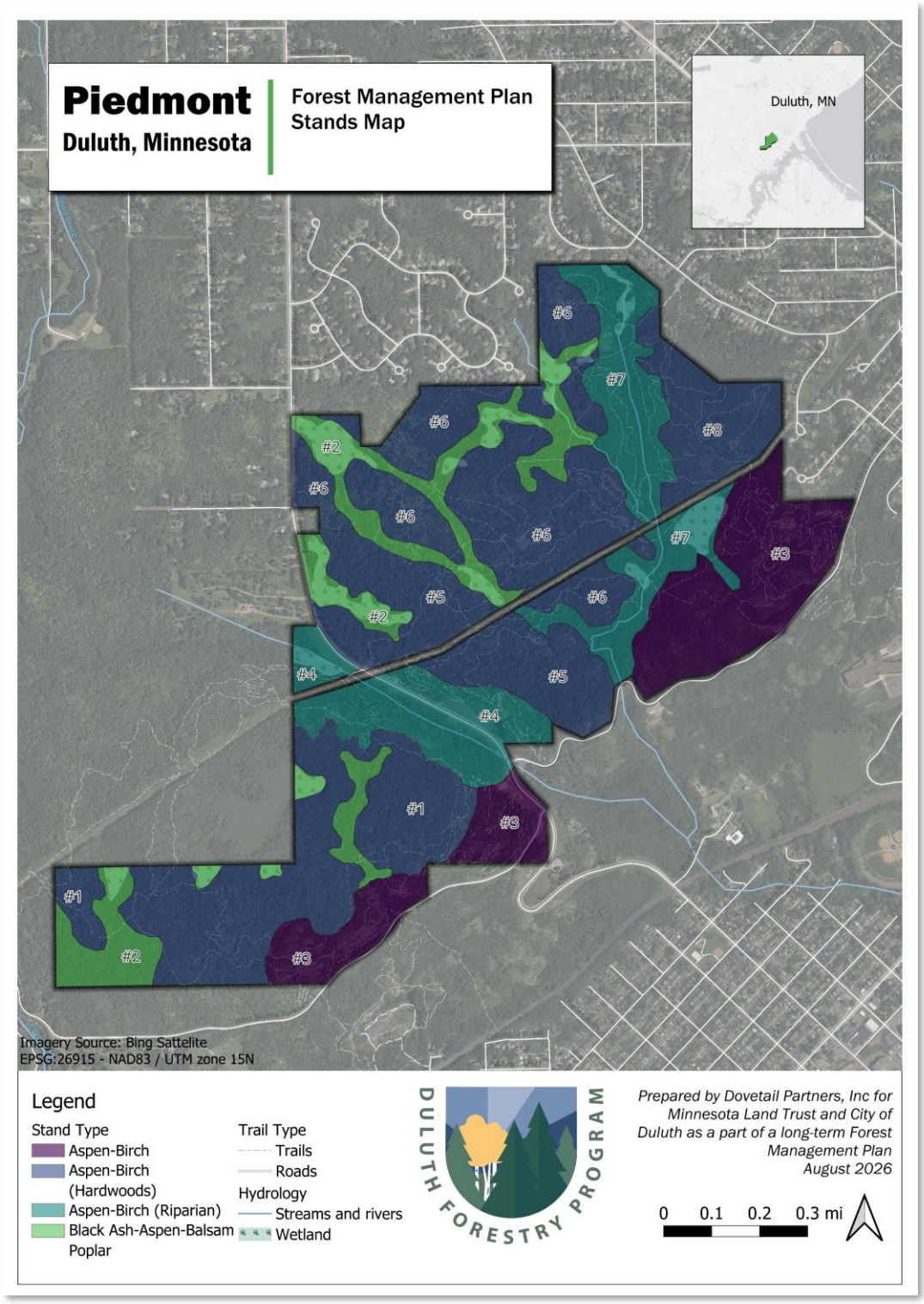
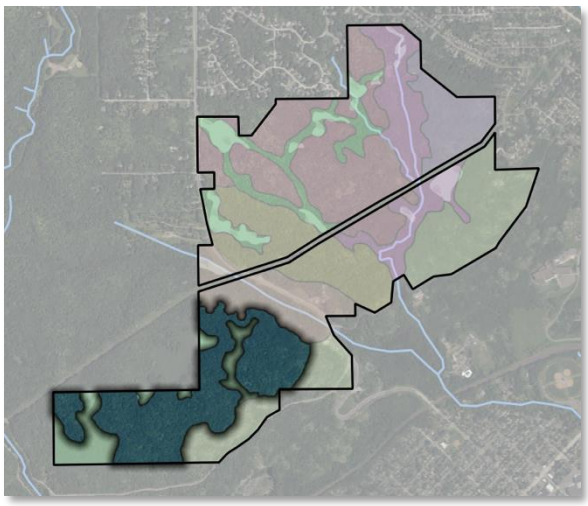


Table 8: Piedmont Stand Attributes Table

Stand #	Forest Typ	Acres	Soil Prima	NPC Primary	Avg DBH (in)	SE DBH (in)	Avg Basal Area (ft2/ac)	SE Basal Area (ft2/ac)	SiteIndex1	SiteIndex1_species	SiteIndex2	SiteIndex2_species	Total Plots
1	Aspen-Birch (Hardwoods)	113.2	F156D	MHn35b	8.5	0.5	87.3	9.1	68.0	Quaking Aspen	55	Yellow Birch	11
2	Black Ash-Aspen-Balsam Poplar	86.7	F134A	WFn55a	8.3	1.2	66.7	12.5	68.0	Quaking Aspen	55	Yellow Birch	9
3	Aspen-Birch	109.3	F160F	FDn43b2 / ROn23b	6.8	0.7	78.2	9.1	67.0	Quaking Aspen	64	Red Oak	11
4	Aspen-Birch (Riparian)	53	F148F	ROn23b / MHn46b	7.6	1.2	50	10.3	77.0	Quaking Aspen	42	Paper Birch	6
5	Aspen-Birch (Hardwoods)	71.8	F156D	MHn35b	10	1.4	65	15.1	82.5	Quaking Aspen	53	Sugar Maple	8
6	Aspen-Birch (Hardwoods)	126.6	F156D	MHn47a	8.7	0.4	102	12.5	82.0	Quaking Aspen	42	Sugar Maple	10
7	Aspen-Birch (Riparian)	69.4	F148F	MHn35b	8	1.3	50	15.5	55.0	Quaking Aspen			7
8	Aspen-Birch (Hardwoods)	36.8	F156D	MHn35b	7.5	0.7	71.4	14.9	56.5	Aspen	55	Sugar Maple	7

Stand 1 Aspen-Birch (Hardwoods)





Stand Characteristics

Forest Type: Aspen-Birch (Hardwoods)

Size: 113 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	105.4	93%

Dominant Soils:

- F156D (83%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.
- F160F (14%): Rock outcrop-Mesaba-Barto complex, 18 to 60% slopes. 0-40" to lithic bedrock; gravelly sandy loam. Well drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest, F093AY013MN - Loamy Upland

Successional Stage (MDNR): Mix of young forest (0-55 years) and transitional maturing forest (55-95 years)

Average Stand Diameter (DBH): 8.5" (SE=0.5)

Average Stand Basal Area: 87 ft^2/acre (SE=9.1)

Snags per acre: 48 medium (6-11" DBH), aspen

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Low to medium amounts of buckthorn were noted throughout the stand, some saplings well established

Pests & Disease: Emerald ash borer ubiquitous where ash is present

Current Condition: This forested stand is dominated by quaking aspen with a component of paper birch, lesser amount of basswood, and less frequent hardwoods like yellow birch, sugar maple, red maple, and red oak. Shallow, well-drained soil over bedrock makes growing conditions difficult, resulting in low basal area and low tree diversity with an overabundance of disturbance-tolerant species (aspen and birch). A moderate abundance of aspen snags indicates the stand has received recent disturbances (likely windstorms) that largely prevent it from maturing beyond the aspen-birch dominant stage. White pine and yellow birch are the longer-lived species that would be expected in this forest type - white pine is not currently present. Bur oak may also be successful if introduced. Beaked hazel forms a dense understory in some places in this stand, where other areas exhibited more open understory. Overall there was a low diversity of native midstory trees and shrubs. Bracken fern, bush honeysuckle, large-leaved aster, and lady fern are the most common understory plants.

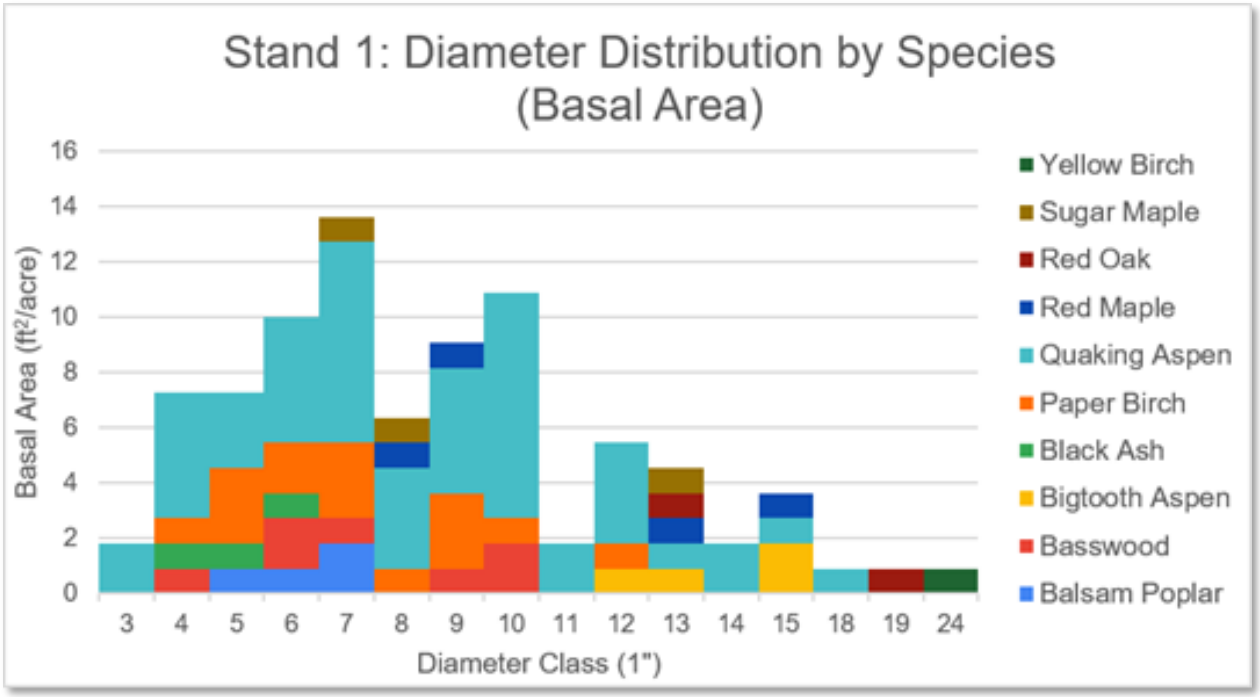
Current Recreational Uses or Management:
Brewer Park is accessed via a trailhead on Skyline Parkway near the intersection of St. Louis River Rd. The Superior Hiking Trail and a mountain bike trail traverse through this stand.

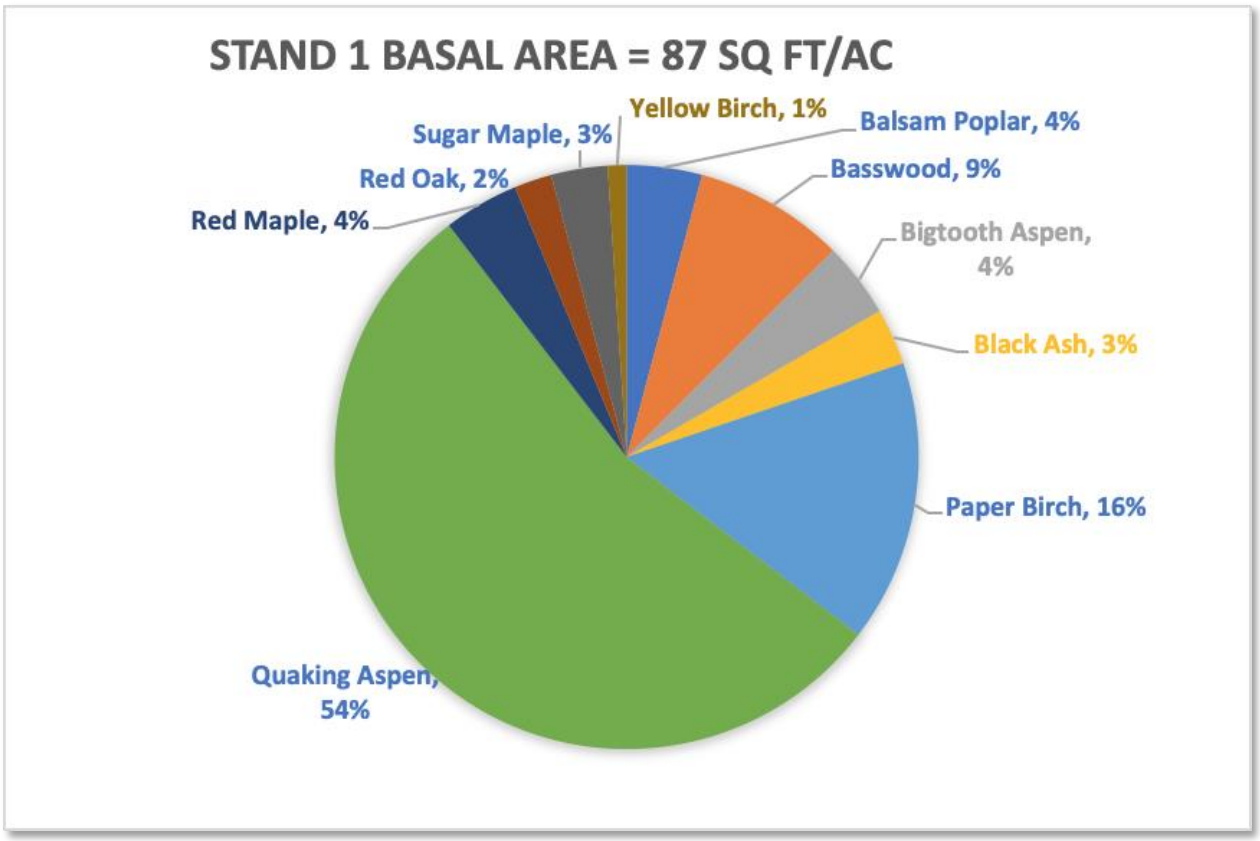
Adjacent land use concerns:
There is a cemetery to the south. The remainder of the stand is bordered by state lands also utilized for recreation.

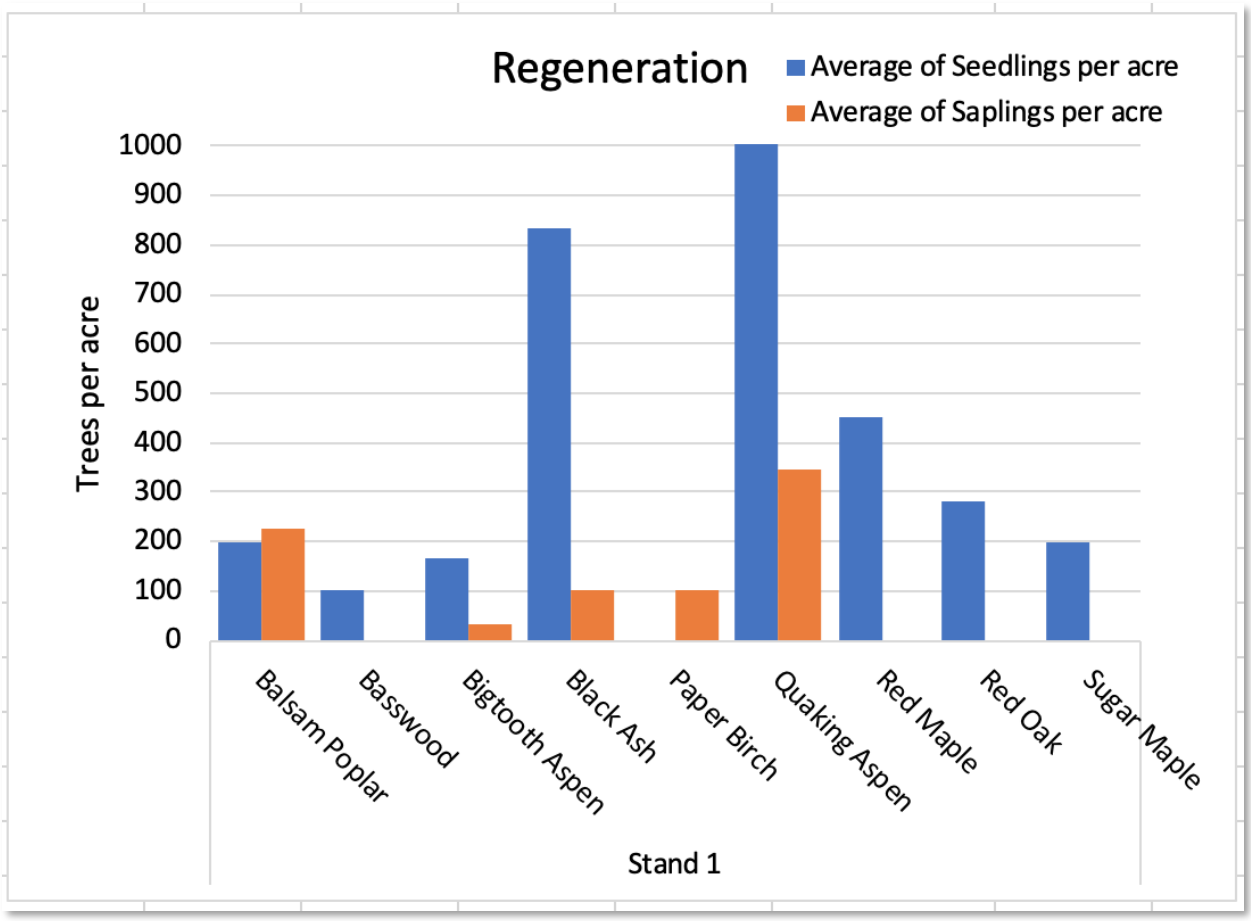
No action result (10-20 years): The stand will continue to fill with buckthorn in the midstory and crowd out the native shrub and herbaceous layer. Aspen is likely to replace itself with occasional other hardwood species. Conifers are likely to remain absent from the forest due to lack of seed source and tendency of this poor-quality ecological site type to remain in early- to mid-successional stages.

Management Goals, Strategies, and Actions

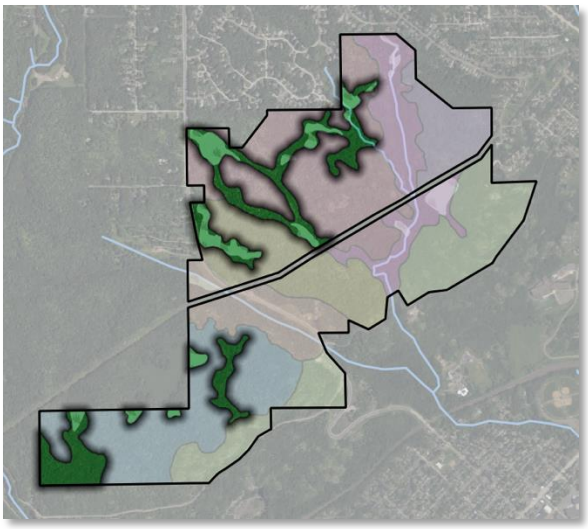
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	
Regeneration; Restore/enhance native plant communities	Reduce competition in midstory	Mulch/masticate shrub layer	Mastication in strips of overabundant shrubs (up to 30% of stand at one time). Target alder, buckthorn
Regeneration	Artificial regeneration	Plant trees	Hardwoods
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Select seeds of currently occurring species from slightly more southern stock	


Stand 1: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
16
14
12
10
8
6
4
2
0
3 4 5 6 7 8 9 10 11 12 13 14 15 18 19 24
Diameter Class (1")
Yellow Birch
Sugar Maple
Red Oak
Red Maple
Quaking Aspen
Paper Birch
Black Ash
Bigtooth Aspen
Basswood
Balsam Poplar


STAND 1 BASAL AREA = 87 SQ FT/AC
Yellow Birch, 1%
Balsam Poplar, 4%
Sugar Maple, 3%
Basswood, 9%
Red Oak, 2%
Red Maple, 4%
Bigtooth Aspen, 4%
Black Ash, 3%
Paper Birch, 16%
Quaking Aspen, 54%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Bigtooth Aspen
Black Ash
Paper Birch
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
Stand 1

Stand 2 Black Ash-Aspen-Balsam Poplar





Stand Characteristics

Forest Type: Black Ash-Aspen-Balsam Poplar

Size: 87 acres

NPC (MDNR)	*Acres*	*% of stand*
WFn55a	46.6	54%
MHn35b	16.5	19%
MHn47a	11.6	13%
MHn46b	6.8	8%

Dominant Soils:

- F134A (40%): Giese muck, depressional, 0 to 1 percent slopes. Muck to 1", silt loam to 11" over gravelly sandy loam. Very poorly drained.
- F156D (22%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.

Ecological Site (USDA): F093AY006MN - Depressional Wet Hardwood Forest, F093AY004MN - Peatland (35%)

Successional Stage (MDNR): Young forest (0-75 years)

Average Stand Diameter (DBH): 8.2" (SE=1.2)

Average Stand Basal Area: 67 ft^2/ac (SE=12.5)

Snags per acre: 31 medium (6-11"), 7 large (12"+), black ash and aspen

Coarse woody debris: Medium to high

Wildfire risk: Low

Invasive Species: Buckthorn and honeysuckle are common at moderate to high density in this stand

Pests & Disease: Emerald ash borer has caused canopy decline and epicormic sprouting, but not complete mortality of ash trees in this stand

Current Condition: This stand encompasses the wet forests and wetlands meandering throughout the flatter areas of aspen-hardwood forests across the northern and western portions of the property. Soils contain patches of peat characteristics, and are otherwise poorly drained. Black ash would have been the dominant tree but due to EAB mortality, basal area of mature trees is low with a balance of declining black ash, quaking aspen, balsam poplar, yellow birch, and occasional sugar maple. Regeneration is moderate for seedlings and poor for saplings, with black ash being by far the dominant establishing sapling. Other

regenerating species are balsam poplar, quaking aspen, red oak, and red maple. Speckled alder and buckthorn have become very thick under the canopy of some dead or dying ash trees. Red-osier dogwood is also common in the midstory. The understory exhibits wetland characteristics with a mix of grasses, brambles (*Rubus* spp.), lady fern, ostrich fern, bracken fern, sedges, and occasional sphagnum moss (peat).

Current Recreational Uses or Management:
These wetlands span multiple areas throughout the property with numerous intersecting trails.

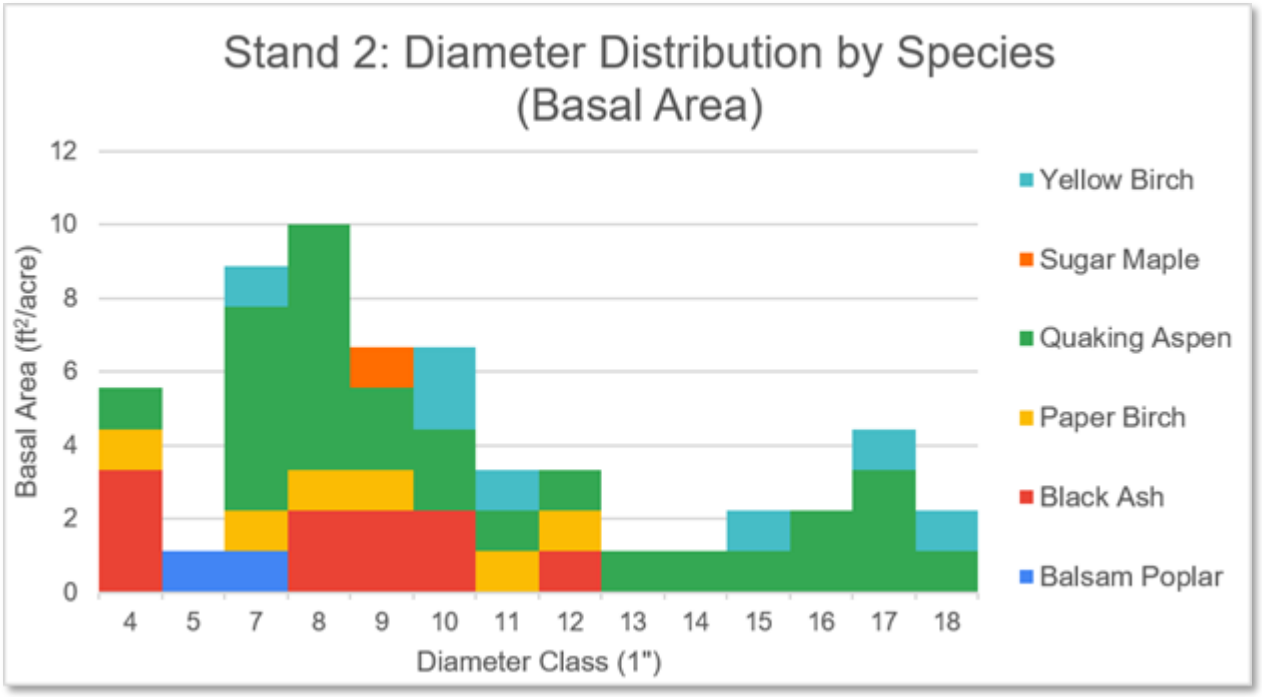
Adjacent land use concerns:
Residential areas and roads to the north and east of the property may contribute pollution, runoff, trash/debris, and invasive species to the wetlands. Natural wetland hydrology may be adversely modified from roadways and residential development. The powerline corridor in the northern half of the property may be impacting wetland hydrology.

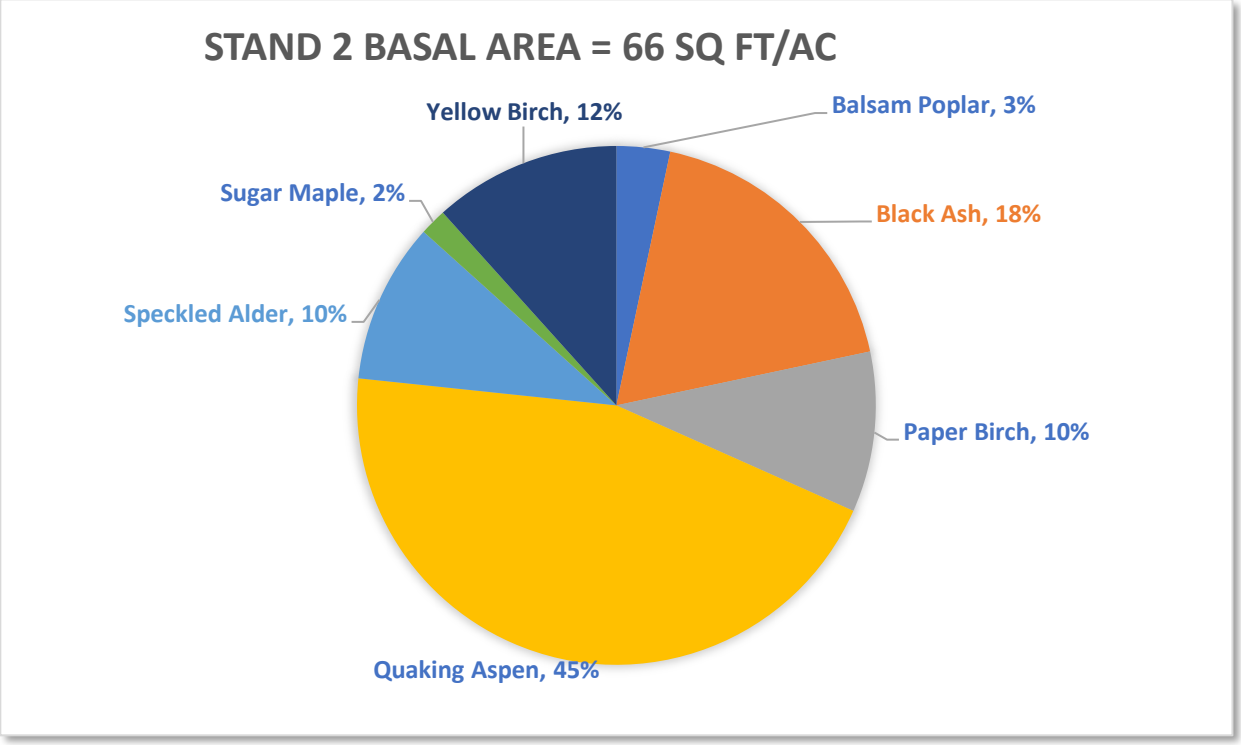
No action result (10-20 years): Black ash swamps may convert to speckled alder-dominant shrubby swamp. Buckthorn will expand. Tree species diversity may remain low and dominated by quaking aspen, balsam poplar, and occasional hardwoods.

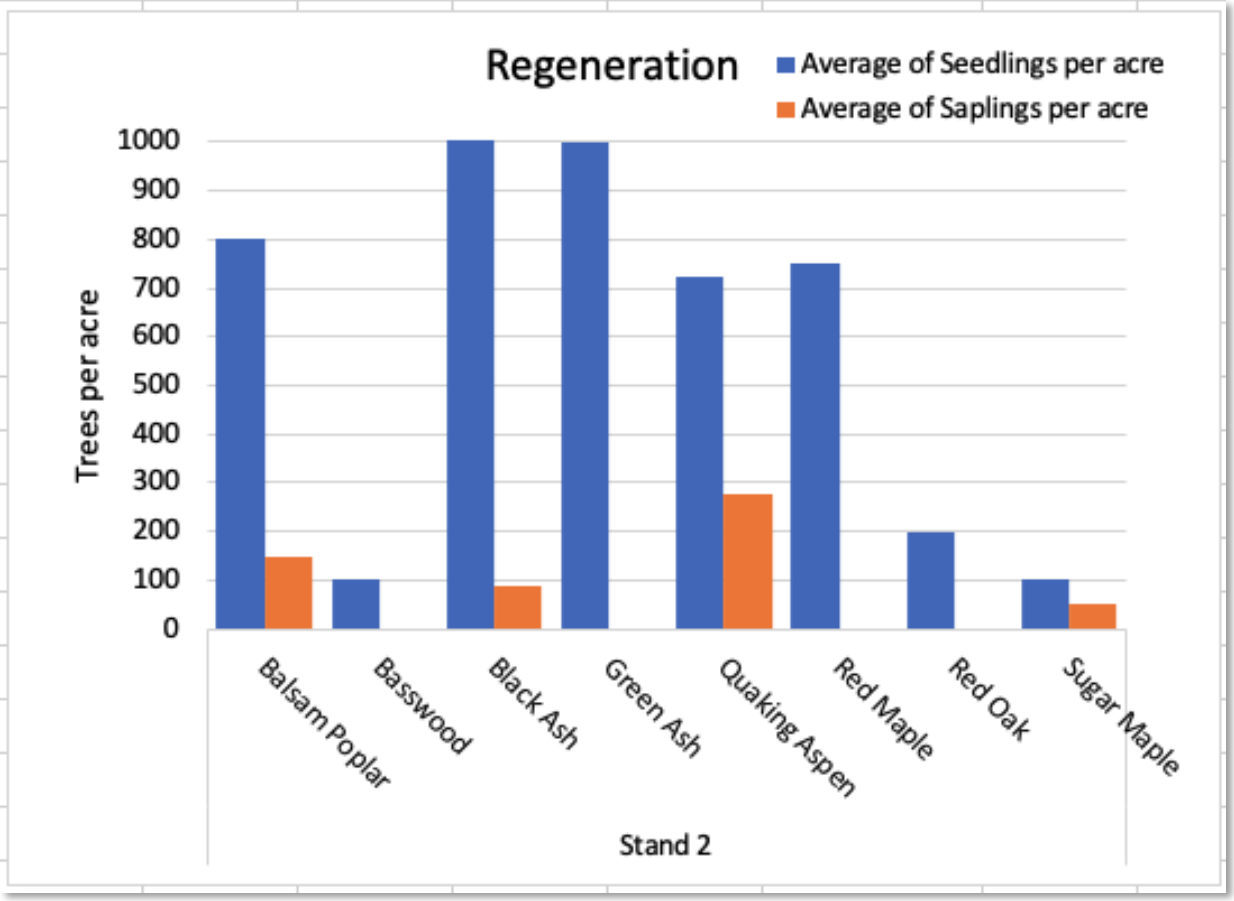
Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Masticate or mulch dense stands of buckthorn; Follow-up foliar herbicide treatment after initial removal OR Prescribed grazing on resprouts after initial removal	worst infestation in southwest corner of property
Ecosystem function	Retain or replace forested cover in the wake of emerald ash borer tree decline and mortality	Systemic herbicide injection annually into mature female trees during early-stage invasion to serve as seed crops for future ash regeneration; Girdle ash trees to attract EAB in combination with systemic herbicide injection to adjacent trees; Underplanting - Plant trees other than ash where ash decline and mortality is advanced	Prioritize trunk injections for seed trees with less than 30% canopy loss
Regeneration; Restore/enhance native plant communities	Reduce competition in midstory	Mulch/masticate shrub layer	Mastication in strips of overabundant shrubs (up to 30% of stand at one time)

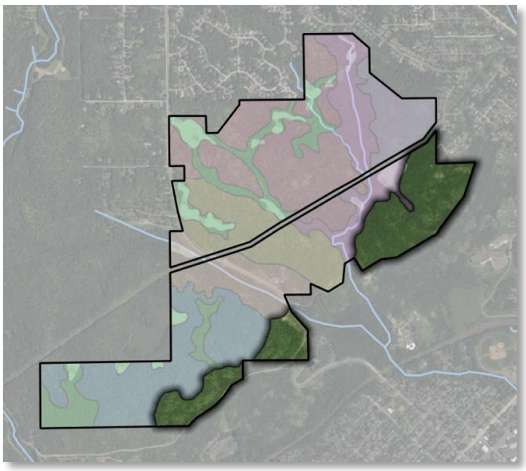
Regeneration	Artificial regeneration	Plant trees	Plant moisture tolerant trees, mix of hardwood and conifer (white pine, white cedar, yellow birch, eastern hemlock, tamarack, bur oak)
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Select seeds of currently occurring species from slightly more southern stock	




STAND 2 BASAL AREA = 66 SQ FT/AC
Yellow Birch, 12%
Balsam Poplar, 3%
Sugar Maple, 2%
Black Ash, 18%
Speckled Alder, 10%
Paper Birch, 10%
Quaking Aspen, 45%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Basswood
Black Ash
Green Ash
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
Stand 2

Stand 3 Aspen-Birch





Stand Characteristics

Forest Type: Aspen-Birch

Size: 109 acres

NPC (MDNR)	*Acres*	*% of stand*
FDn43b2	38.8	36%
ROn23b	33.1	30%
MHn35b	25.7	24%

Dominant Soil:

- F160F (80%): Rock outcrop-Mesaba-Barto complex, 18 to 60% slopes. 0-40" to lithic bedrock; gravelly sandy loam. Well drained.
- F156D (17%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest

Successional Stage (MDNR): N/A for rocky outcrop

Average Stand Diameter (DBH): 6.8" DBH (SE=0.7)

Average Stand Basal Area: 78 ft2/ac (SE=9.1)

Snags per acre: 23 medium (6-11" DBH), aspen

Coarse woody debris: Low to medium

Wildfire risk: Moderate due to dry exposed environment and risk of ignition from recreational users and vehicles along Skyline Parkway

Invasive Species: Buckthorn and honeysuckle are abundant throughout the stand

Pests & Disease: None observed

Current Condition: This young stand features expanses of exposed bedrock openings with forest and shrubs occurring in cracks or in patches of deeper well-drained soil. This bedrock-controlled, fire-prone, drought-prone forest type is poor quality (short trees characterized by rot and deformities) due to the southeastern exposure and variable moisture availability in the shallow soils. Bigtooth aspen up to 10" DBH is notably dominant here more than any other stand on the property. Quaking aspen and paper birch of the same size are also common. Mountain ash and serviceberry up to 5" DBH hold space as canopy species in bedrock-dominated openings where other trees are absent. There are occasional 10-17" sugar maple and red oak growing in very open conditions. Because of the open canopy of the stand, the midstory layer is robust in some places with buckthorn, red-osier dogwood, round-leaved dogwood, serviceberry, and a diversity of other native shrubs/midstory trees. In other places, there are notable extents of limited plant growth due to exposed bedrock and lack of soil. Bush honeysuckle, large-leaved aster, and bracken fern as the most common understory plants. The stand is unique in hosting sun/disturbance-loving plants like velvet-leaf blueberry, yarrow, valerian, and St. John's wort.

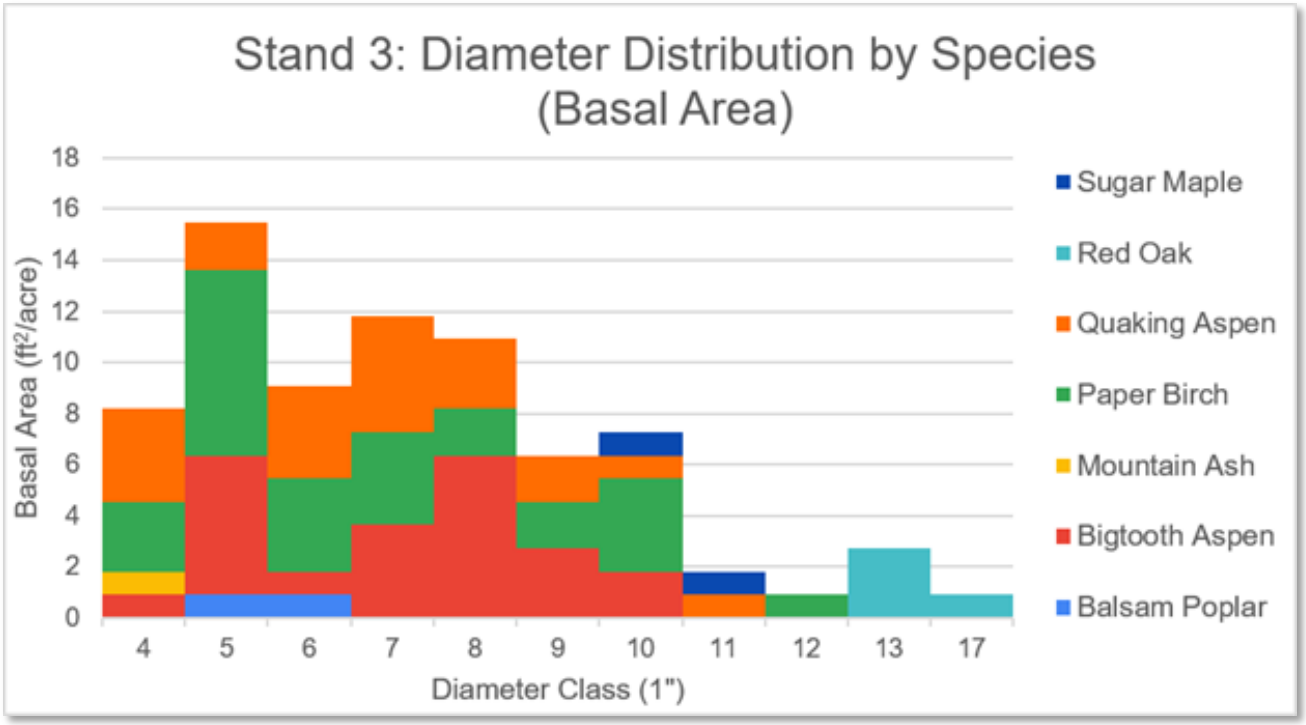
Current Recreational Uses or Management:
The stand features a high concentration of recreation trails including scenic overlooks that are somewhat trampled from foot traffic.

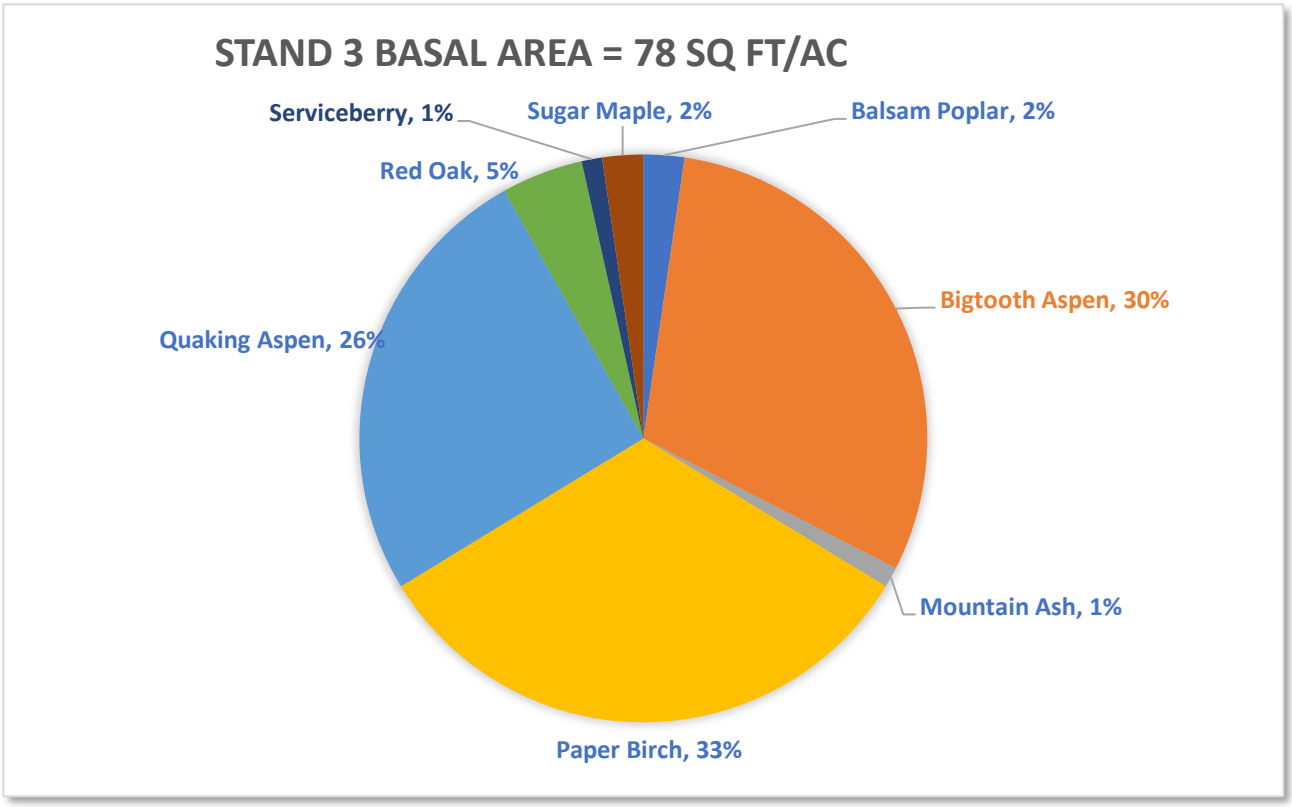
Adjacent land use concerns:
Skyline Parkway forms the southeastern boundary of this unit - access into the unit is limited due to steep and rocky slopes. Potential ignition from trail users or Skyline Parkway.

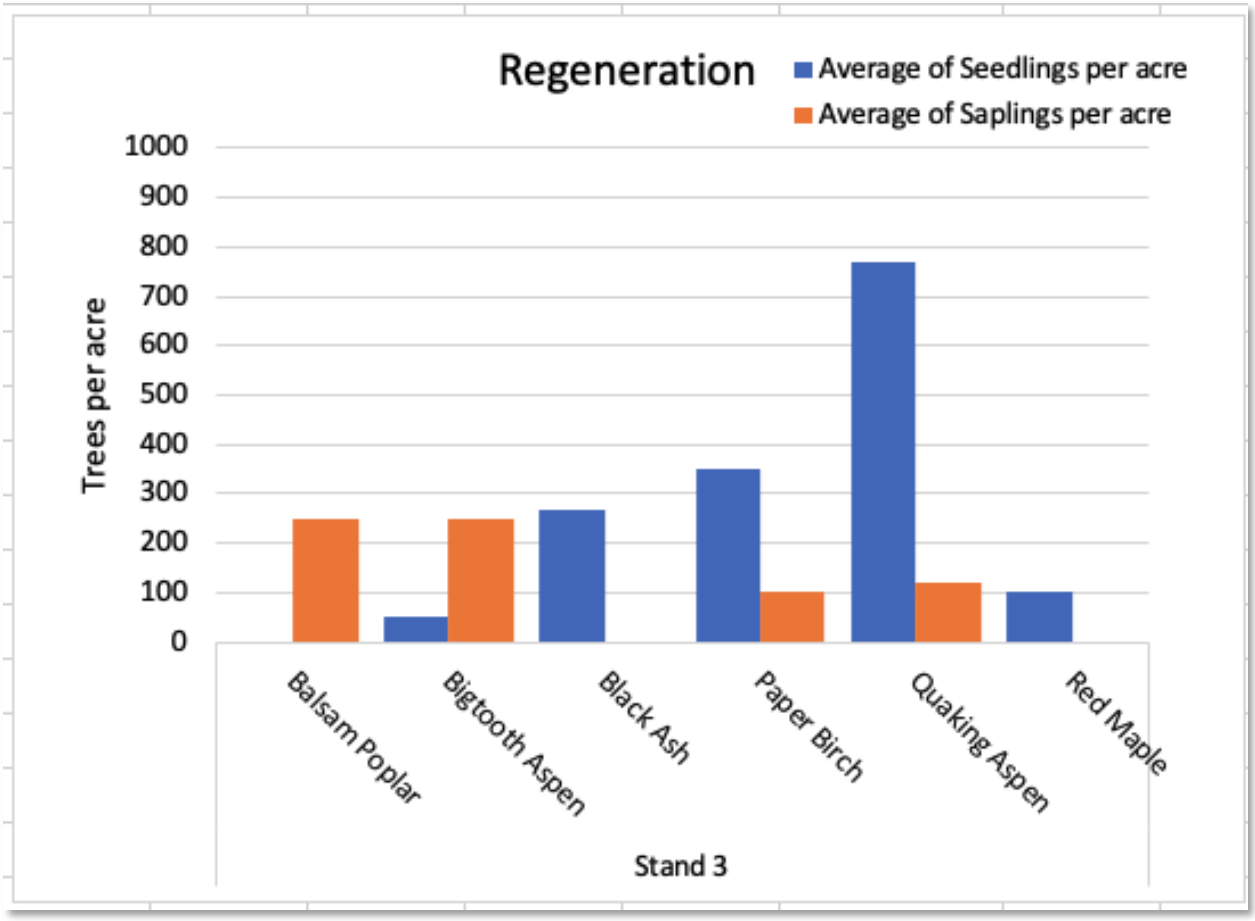
No action result (10-20 years): The stand is not likely to change much given the harsh conditions of the rocky outcrop environment and adaptation of existing plants to environmental extremes like drought, wind, and cold exposure. Greater tree mortality could occur in the event of an extreme drought or heat wave, or a wildfire with quaking aspen as the primary regenerating species. Hardwoods (sugar maple, red oak) may regenerate if temperature and precipitation patterns are mild with low occurrence of disturbances. Invasive species could be introduced from trail users.

Management Goals, Strategies, and Actions

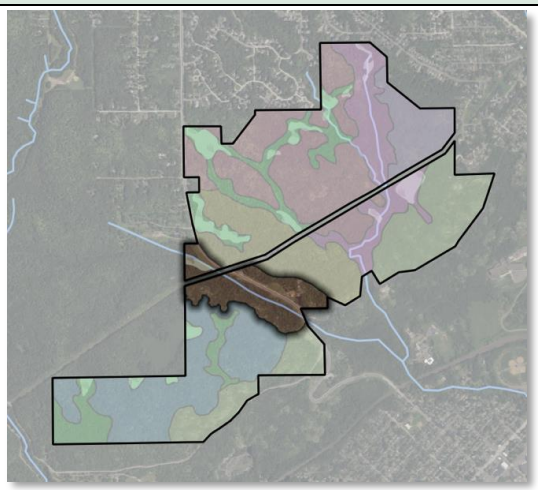
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter	Supplemental to burning
Recreation	Manage viewsheds at key viewpoints	Cut tall vegetation; Remove accumulated woody debris	Supplemental to burning; Hand cut tall vegetation in viewpoint areas
Restore/enhance native plant communities; Recreation	Restore and maintain fire-dependent plant communities	Prescribed burning	Rocky outcrops only, patch burns


Stand 3: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
18
16
14
12
10
8
6
4
2
0
4
5
6
7
8
9
10
11
12
13
17
Diameter Class (1")
Sugar Maple
Red Oak
Quaking Aspen
Paper Birch
Mountain Ash
Bigtooth Aspen
Balsam Poplar


STAND 3 BASAL AREA = 78 SQ FT/AC
Serviceberry, 1%
Sugar Maple, 2%
Balsam Poplar, 2%
Red Oak, 5%
Bigtooth Aspen, 30%
Quaking Aspen, 26%
Mountain Ash, 1%
Paper Birch, 33%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
1000
900
800
700
600
500
400
300
200
100
0
Trees per acre
Balsam Poplar
Bigtooth Aspen
Black Ash
Paper Birch
Quaking Aspen
Red Maple
Stand 3

Stand 4 Aspen-Birch (Riparian)





Stand Characteristics

Forest Type: Aspen-Birch (Riparian)

Size: 53 acres

NPC (MDNR)	*Acres*	*% of stand*
ROn23b	14.1	27%
MHn46b	11.3	21%
Disturbed	6.8	13%
CTn24	6.7	13%
MHn35b	5.6	11%

Dominant Soil:

- F148F (77%): Ahmeek-Rock outcrop-Fluvaquents, frequently flooded, complex, 0 to 50 percent slopes. Silt loam or mucky silt loam to 4-6" over gravelly sandy loam or stratified silt loam to gravelly loamy coarse sand. Well drained to poorly drained.
- F156D (22%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.

Ecological Site (USDA): F093AY013MN - Loamy Upland, F093AY009MN - Bedrock Controlled Upland Forest, F093AY005MN - Wet Floodplain

Successional Stage (MDNR): N/A for rocky outcrop; transitional (35-95 years) in creek floodplain

Average Stand Diameter (DBH): 7.6" DBH (SE=1.2)

Average Stand Basal Area: 50 ft2/ac (SE=10.3)

Snags per acre: 8 medium (6-11" DBH), 2 large (12"+), some black ash

Coarse woody debris: Low to medium

Wildfire risk: Medium due to vulnerability to drought and ignition risk from proximity to road

Invasive Species: Low quantities of buckthorn and honeysuckle

Pests & Disease: Emerald ash borer has caused canopy decline and some mortality where ash is present

Current Condition: This is one of the steepest and sparsest stands at Piedmont-Brewer, forming a ravine that includes the narrow floodplain of the west branch of Merritt Creek and its dramatic north- and south-facing embankments. This is a rare stand on the property in hosting a supercanopy of occasional large white pines (22-26" DBH). Quaking aspen and paper birch are the dominant canopy species, with balsam poplar abundant along the creek. On the harsh rocky embankments, mountain ash achieves canopy status in the absence of other mature trees with diameters up to 7". The only conifer saplings detected on the

property are found here - white pine, white spruce, occasional balsam fir, and even white cedar. Aspen is the most common regenerating tree, with balsam poplar and black ash common in the creekbed. Beaked hazel, mountain maple, mountain ash, buckthorn, and red-osier dogwood form a sparse shrub layer. Thimbleberry, goldenrod, bush honeysuckle, grasses, rock polypody, and rock-dwelling lichens characterize the herbaceous layer.

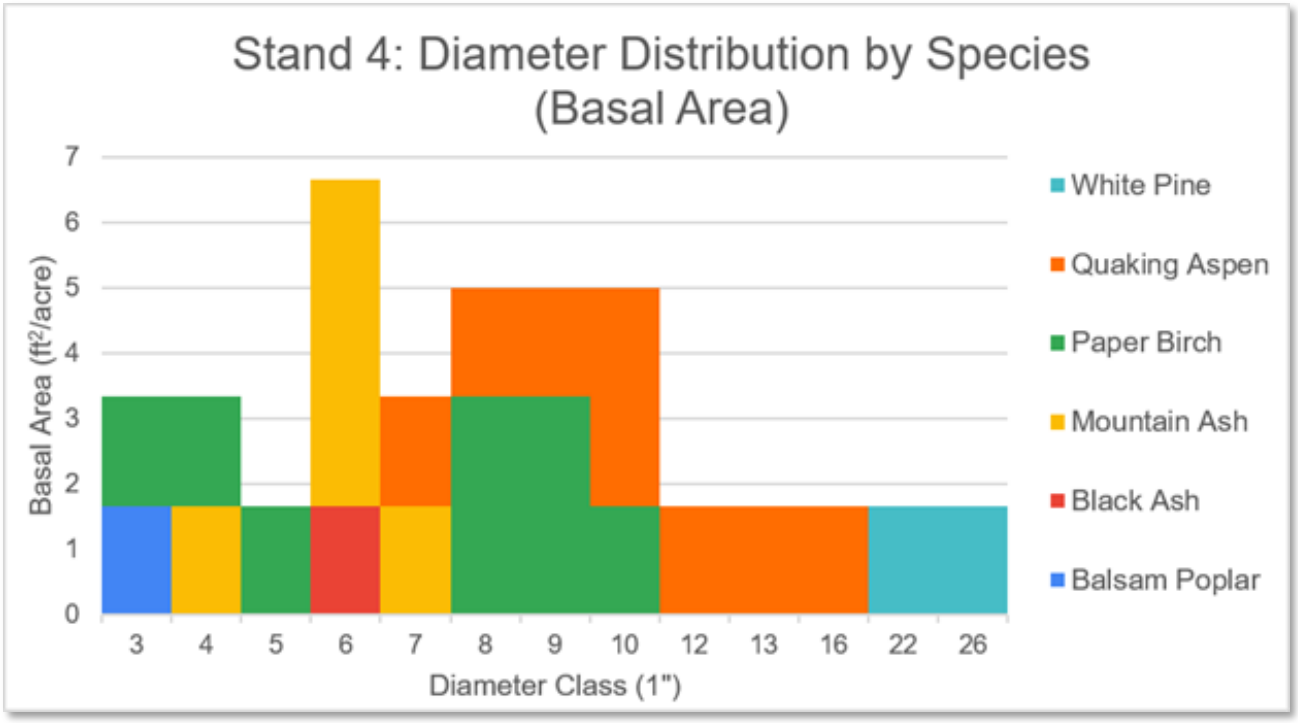
Current Recreational Uses or Management:
Haines Road runs parallel to the creek between the two steep embankments. There is a single trail crossing across Merritt Creek. Some trees were previously planted in the road right of way but have died or are not thriving.

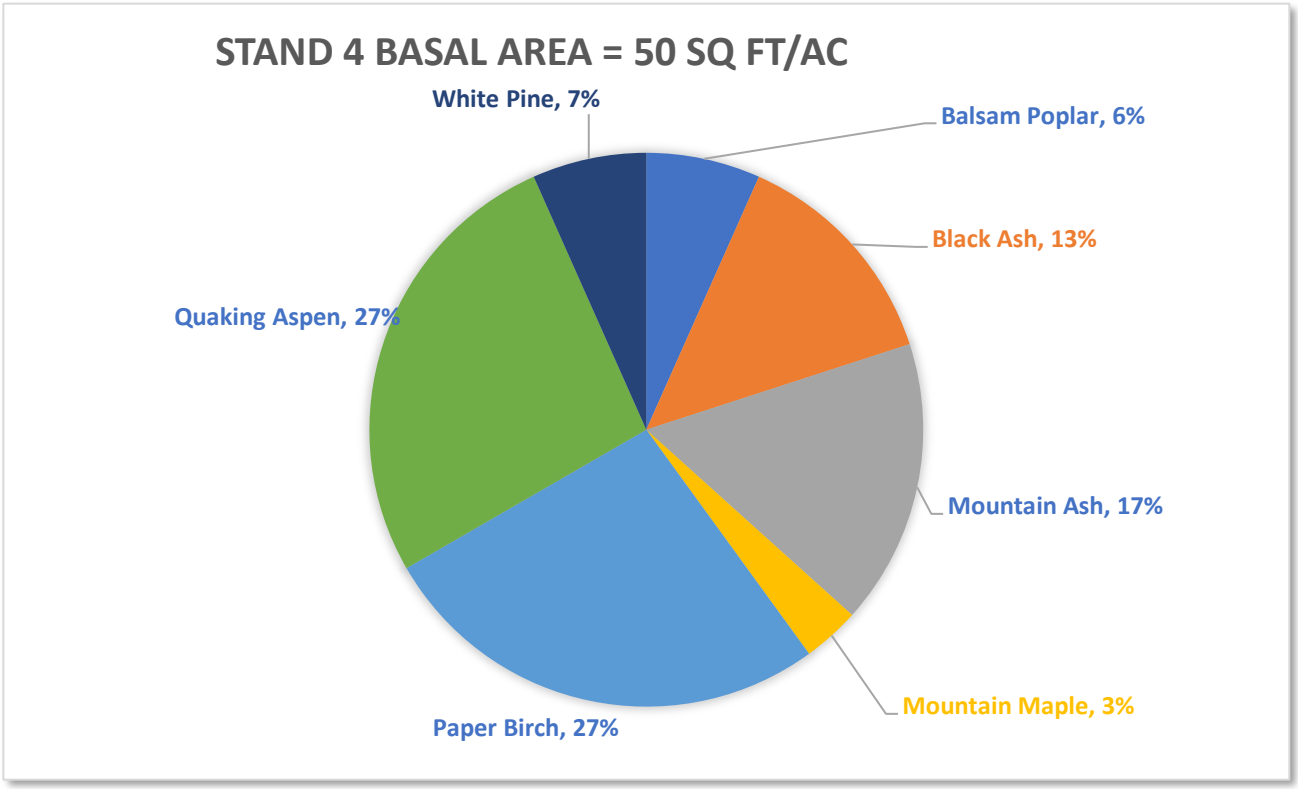
Adjacent land use concerns:
Haines Road and residential areas to the northwest may contribute runoff, pollution, trash/debris, and invasive species to the Merritt Creek watershed. The road right of way has a high concentration of non-native plants which may spread through the Merritt Creek watershed.

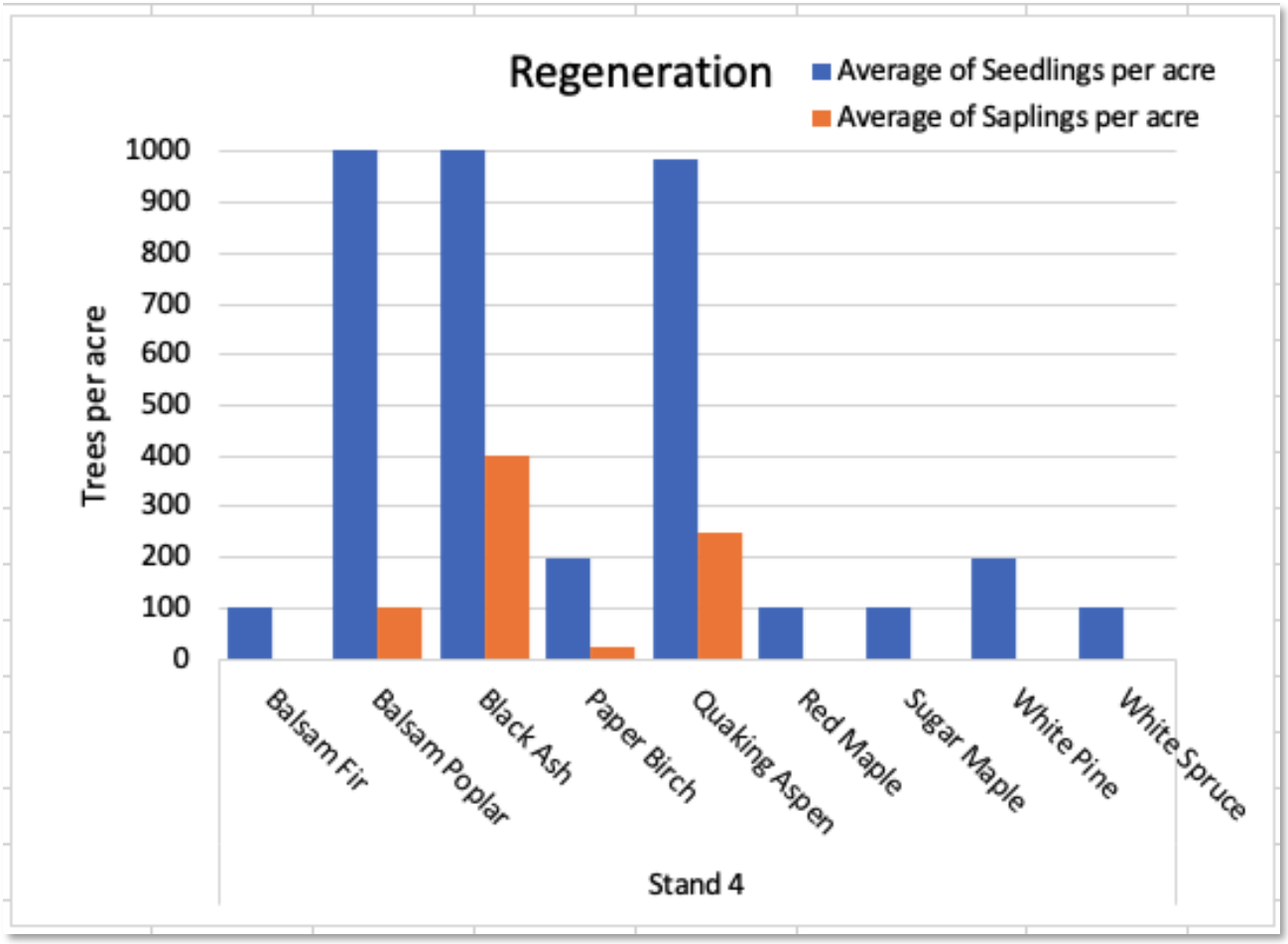
No action result (10-20 years): The stand is not likely to change much given the harsh conditions of the rocky outcrop environment and adaptation of existing plants to environmental extremes like drought, wind, and cold exposure. Greater tree mortality could occur in the event of an extreme drought or heat wave, or a wildfire with quaking aspen and paper birch as the primary regenerating species. Longer-lived conifers currently present as seedlings may achieve maturity if left undisturbed and form the next

Management Goals, Strategies, and Actions

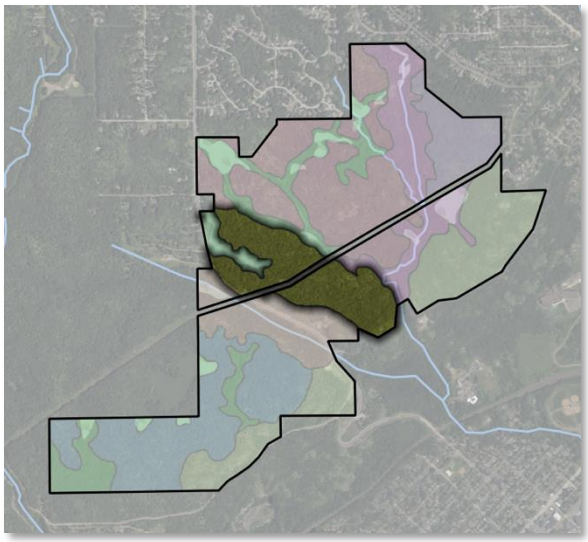
Goal	Strategy	Action	Notes
Ecosystem function; Restore/enhance native plant communities	Encourage bird and pollinator habitat	Maintain establishing vegetation through watering, pruning, mulching, etc	Recently planted trees in road right of way need maintenance

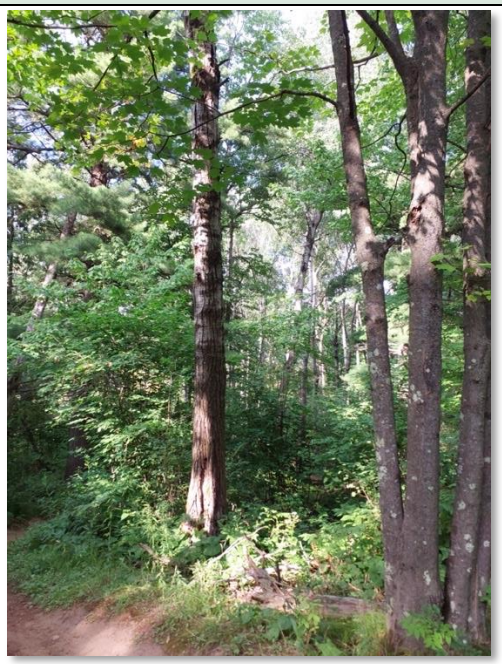

Stand 4: Diameter Distribution by Species
(Basal Area)
Basal Area (ft²/acre)
0
1
2
3
4
5
6
7
3
4
5
6
7
8
9
10
12
13
16
22
26
Diameter Class (1")
White Pine
Quaking Aspen
Paper Birch
Mountain Ash
Black Ash
Balsam Poplar


STAND 4 BASAL AREA = 50 SQ FT/AC
White Pine, 7%
Balsam Poplar, 6%
Black Ash, 13%
Quaking Aspen, 27%
Mountain Ash, 17%
Mountain Maple, 3%
Paper Birch, 27%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Black Ash
Paper Birch
Quaking Aspen
Red Maple
Sugar Maple
White Pine
White Spruce
Stand 4

Stand 5 Aspen-Birch (Hardwoods)





Stand Characteristics

Forest Type: Aspen-Birch (Hardwoods)

Size: 72 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	46.9	65%
MHn46b	14.5	20%
MHn47a	4.3	6%

Dominant Soil:

- F156D (68%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.
- F148F (19%): Ahmeek-Rock outcrop-Fluvaquents, frequently flooded, complex, 0 to 50 percent slopes. Silt loam or mucky silt loam to 4-6" over gravelly sandy loam or stratified silt loam to gravelly loamy coarse sand. Well drained to poorly drained.
- F141D (8%): Ahmeek-Normanna-Cathro, depressional, complex, pitted, 0 to 25 percent slopes. Silt loam to 4" over gravelly sandy loam and some mucky silt loam to 40". Well drained to very poorly drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest; F093AY013MN - Loamy Upland

Successional Stage (MDNR): Mature forest (75-195 years, MHn47) with patches of young forest (0-55 years)

Average Stand Diameter (DBH): 10" DBH (SE=1.4)

Average Stand Basal Area: 65 ft2/ac (SE=15.1)

Snags per acre: 19 medium (6-11" DBH), 4 large (12"+), black ash and aspen

Coarse woody debris: Low

Wildfire risk: Low

Invasive Species: Buckthorn is present in low quantities with occasional denser patches concentrated around powerline corridor

Pests & Disease: Emerald ash borer is present where ash occurs

Current Condition: This rich mesic forest hosts a unique mature stand of yellow birch (8-23" DBH) and white cedar (averaging 15" DBH) alongside quaking aspen and a supercanopy of white pine (over 30" DBH). Paper birch, bigtooth aspen, and sugar maple are also found as mature trees. Eastern hemlock historically was also characteristic of this forest type but none are currently present. The average tree diameter is the highest of all stands on the property, but tree density is overall low - characteristic of this forest type. Regeneration is generally low and dominated by black ash, quaking aspen, with some red maple, balsam poplar, and red oak. Beaked hazel is dense in canopy openings. Serviceberry, red-osier dogwood, *Prunus* spp., and buckthorn are also common in the midstory. Ferns are abundant in the understory including bracken fern, lady fern, interrupted fern, and oak fern, as well as bush honeysuckle, goldenrod, large-leaved aster, and *Rubus* spp.

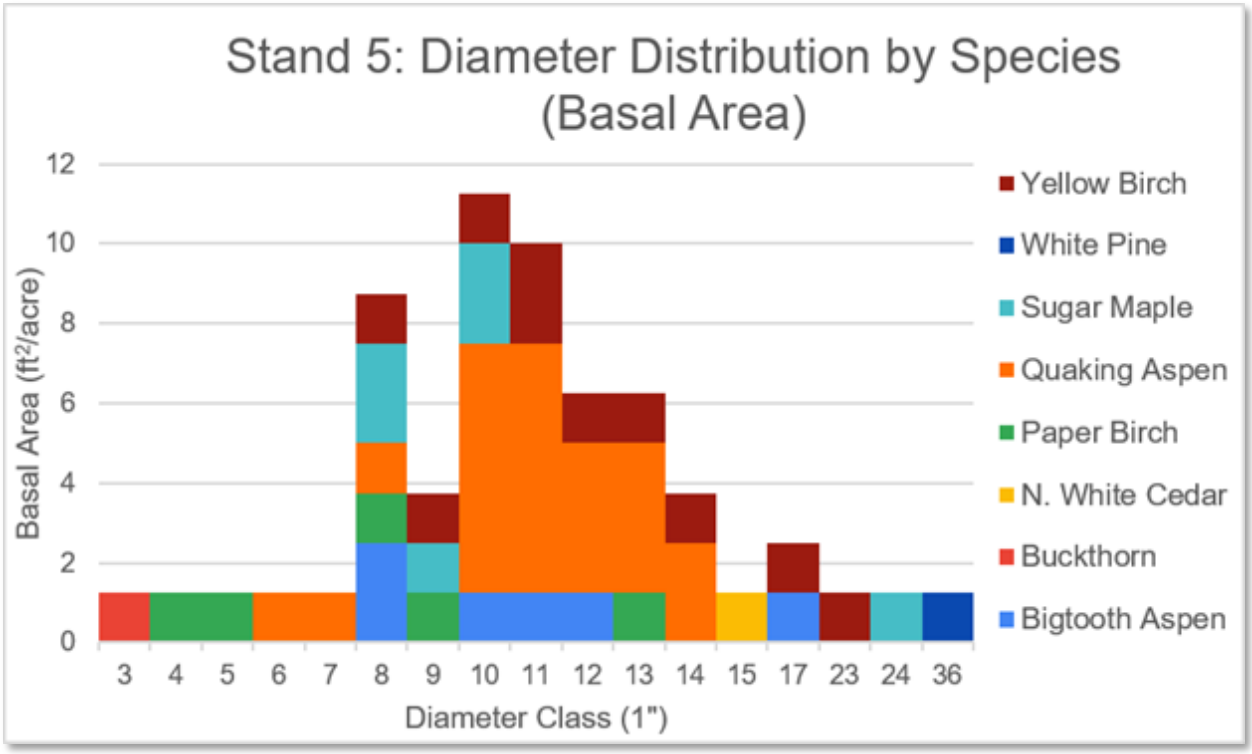
Current Recreational Uses or Management:
Several recreation trails cross through the stand, although this stand has lower trail density and larger areas between trails compared to the majority of the property.

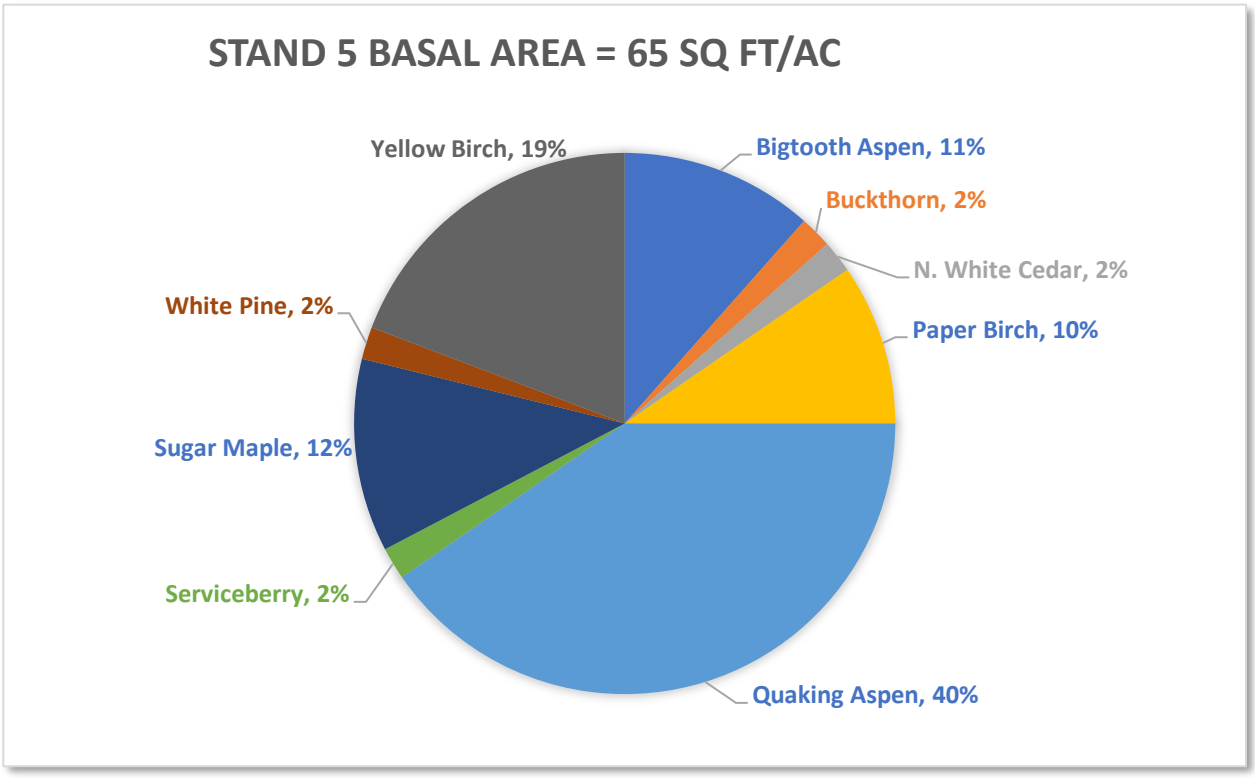
Adjacent land use concerns:
A powerline corridor bisects the unit and interrupts the mature forest characteristics with disturbance characteristics and high amounts of buckthorn.

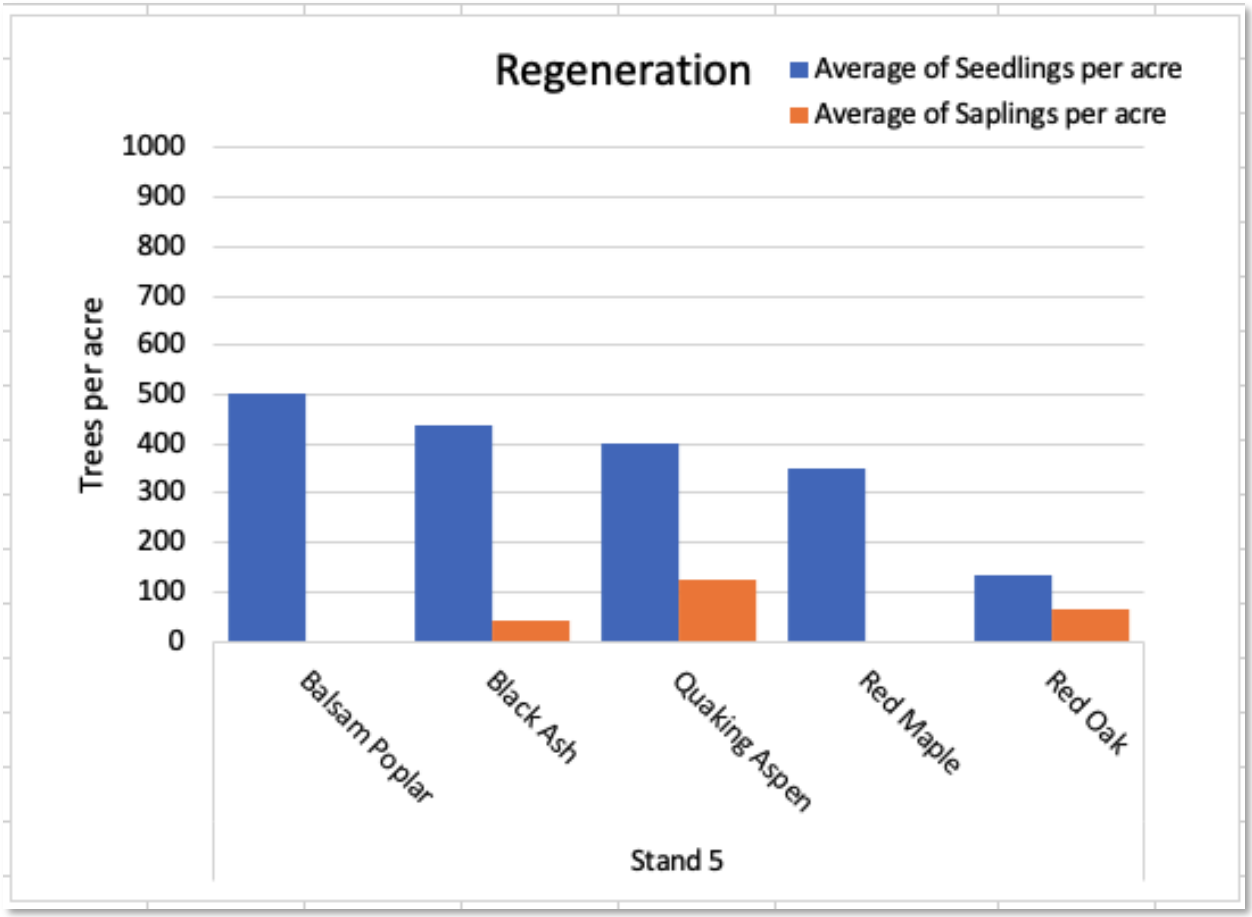
No action result (10-20 years): Yellow birch, quaking aspen, white cedar, and white pine will gradually age out and contribute coarse woody debris and snags to the forest, but are unlikely to regenerate due to deer browse and dense hazel growth. Sugar maple may become more abundant if able to establish. Quaking aspen, red oak, and red maple may become more dominant.

Management Goals, Strategies, and Actions

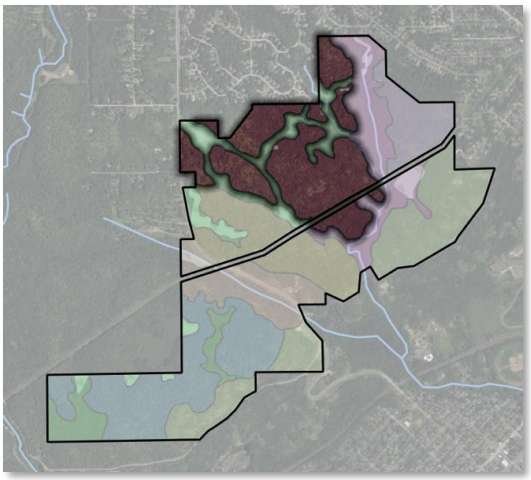
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal	along powerline and roadway
Regeneration	Protect seedlings and saplings (natural or artificial regeneration)	Large area deer exclosure - natural materials or fence	Prioritize areas with at least 50% sun


Stand 5: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
12
10
8
6
4
2
0
3 4 5 6 7 8 9 10 11 12 13 14 15 17 23 24 36
Diameter Class (1")
Yellow Birch
White Pine
Sugar Maple
Quaking Aspen
Paper Birch
N. White Cedar
Buckthorn
Bigtooth Aspen


STAND 5 BASAL AREA = 65 SQ FT/AC
Yellow Birch, 19%
Bigtooth Aspen, 11%
Buckthorn, 2%
N. White Cedar, 2%
Paper Birch, 10%
White Pine, 2%
Sugar Maple, 12%
Serviceberry, 2%
Quaking Aspen, 40%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Black Ash
Quaking Aspen
Red Maple
Red Oak
Stand 5

Stand 6 Aspen-Birch (Hardwoods)





Stand Characteristics

Forest Type: Aspen-Birch (Hardwoods)

Size: 127 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn47a	59.9	47%
MHn35b	43.3	34%
WFn55a	11.9	9%

Dominant Soil:

- F156D (51%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.
- F141D (32%): Ahmeek-Normanna-Cathro, depressional, complex, pitted, 0 to 25 percent slopes. Silt loam to 4" over gravelly sandy loam and some mucky silt loam to 40". Well drained to very poorly drained.
- F135A (14%): Hermantown-Canosia-Giese, depressional, complex, 0 to 3 percent slopes. Silt loam to 5-11" over gravelly sandy loam. Somewhat poorly drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest; F093AY013MN - Loamy Upland; F093AY006MN - Depressional Wet Hardwood Forest

Successional Stage (MDNR): Mature forest (75-195 years)

Average Stand Diameter (DBH): 8.7" DBH; SE 0.4"

Average Stand Basal Area: 102 ft2/ac, SE 12.5 ft2/ac

Snags per acre: 31 medium (6-11" DBH), aspen

Coarse woody debris: Low to medium

Wildfire risk: Low

Invasive Species: Low quantities of buckthorn and honeysuckle with isolated denser pockets

Pests & Disease: Emerald Ash Borer has caused significant ash mortality

Current Condition: This rich mesic hardwood stand is dominated by quaking aspen (average 5-10", up to 16" DBH) with paper birch and sugar maple as co-dominants. Yellow birch (11-15"), red maple, basswood, and ironwood are also present. Basal area is highest for this stand compared to any others on the property, though the stand is still relatively open, likely due to variable moisture from bedrock-controlled soils. The hardwood dominance of this stand is similar to Stand 4, but Stand 6 has fewer yellow birch and no (inventoried) white cedar or white pine. Quaking aspen, black ash, and a mix of rich hardwoods (birch, basswood, red maple, sugar maple, and red oak) form a modest regenerating cohort. Beaked hazel is thick in open canopy areas, with buckthorn, serviceberry, red-osier dogwood, and speckled alder also common

in the midstory. Grasses, bracken fern, large-leaved aster, strawberry, and goldenrod are common in the understory.

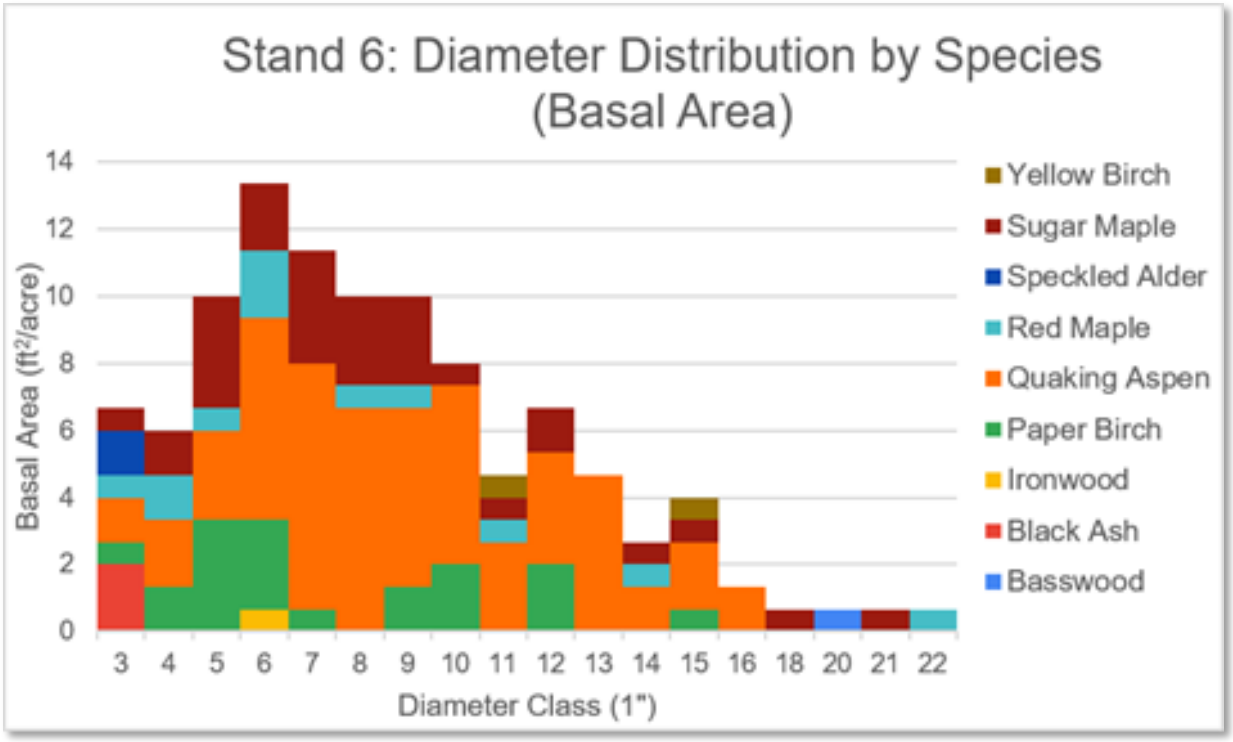
Current Recreational Uses or Management:
Several recreation trails cross through the stand.

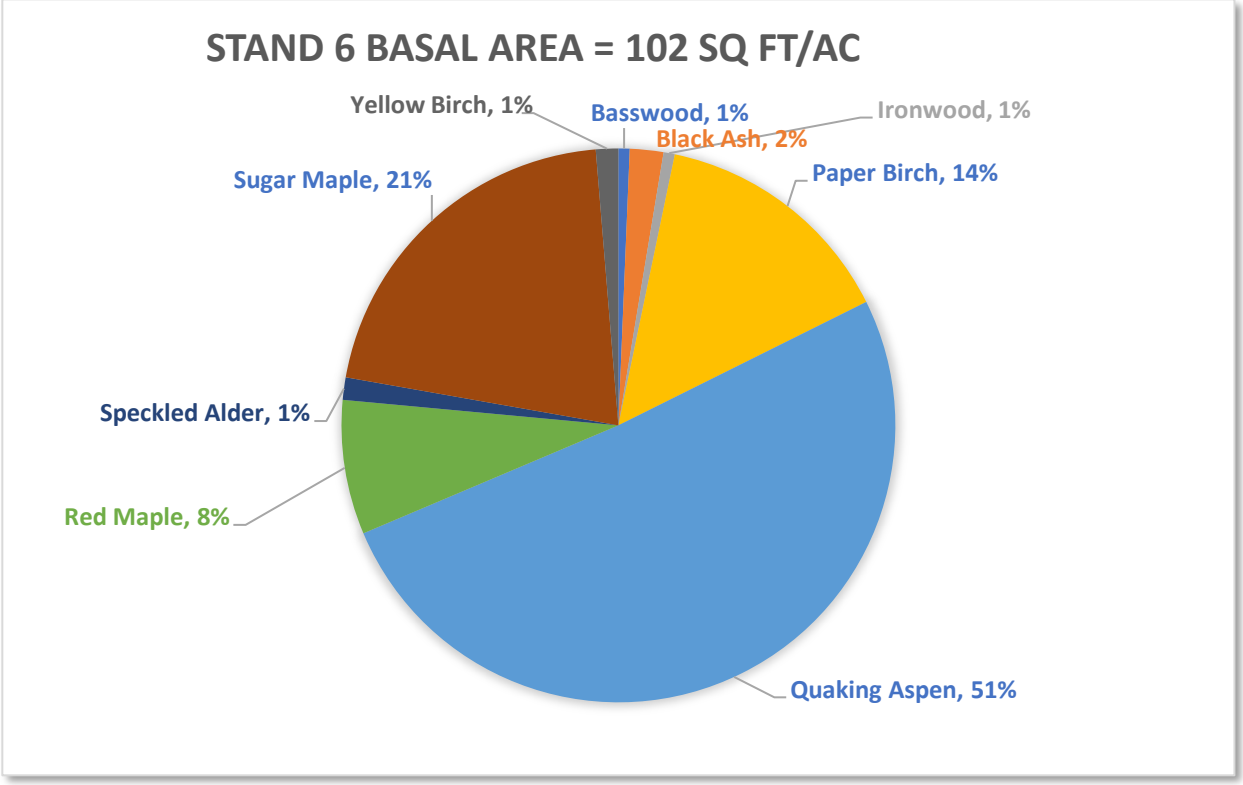
Adjacent land use concerns:
A powerline corridor bisects the unit and interrupts the mature forest characteristics with disturbance characteristics and high amounts of buckthorn.

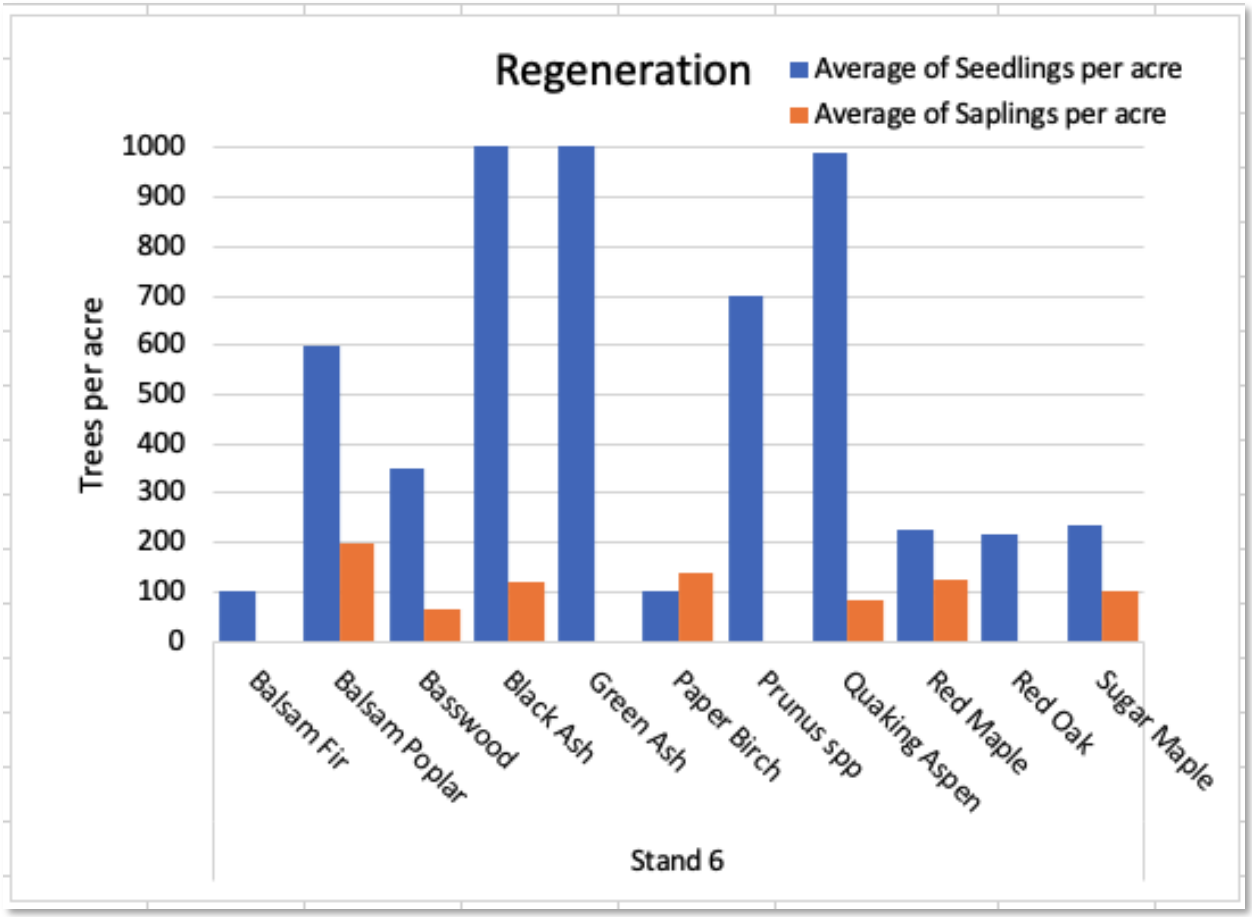
No action result (10-20 years): Hardwoods may successfully regenerate if cohorts are robust/abundant enough to withstand deer browse pressure and cold exposure in the relatively open conditions of the stand. Bedrock-controlled site conditions make the stand vulnerable to drought, so the stand may remain sparse and retain early- to mid-successional characteristics (aspen, birch, sugar maple, and basswood dominance).

Management Goals, Strategies, and Actions

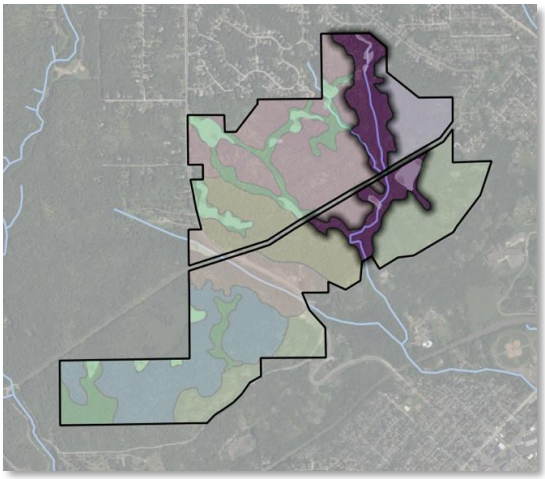
Goal	Strategy	Action	Notes
Forest resilience	Introduce tree species and genotypes well suited for future climate scenarios	Plant currently occurring species whose range naturally extends further south; Select seeds of currently occurring species from slightly more southern stock	
Regeneration	Artificial regeneration	Plant trees	Plant late successional conifers, yellow birch
Regeneration	Protect seedlings and saplings (natural or artificial regeneration)	Large area deer exclosure - natural materials or fence	Prioritize areas with at least 50% sun


Stand 6: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
0
2
4
6
8
10
12
14
3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 20 21 22
Diameter Class (1")
Yellow Birch
Sugar Maple
Speckled Alder
Red Maple
Quaking Aspen
Paper Birch
Ironwood
Black Ash
Basswood


STAND 6 BASAL AREA = 102 SQ FT/AC
Yellow Birch, 1%
Basswood, 1%
Ironwood, 1%
Black Ash, 2%
Paper Birch, 14%
Sugar Maple, 21%
Speckled Alder, 1%
Red Maple, 8%
Quaking Aspen, 51%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Fir
Balsam Poplar
Basswood
Black Ash
Green Ash
Paper Birch
Prunus spp
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
Stand 6

Stand 7 Aspen-Birch (Riparian)





Stand Characteristics

Forest Type: Aspen-Birch (Riparian)

Size: 69 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	30.7	44%
MHn46b	13.8	20%
WFn55a	9.9	14%
FPn73a	5.8	8%

Dominant Soil:

- F148F (46%): Ahmeek-Rock outcrop-Fluvaquents, frequently flooded, complex, 0 to 50 percent slopes. Silt loam or mucky silt loam to 4-6" over gravelly sandy loam or stratified silt loam to gravelly loamy coarse sand. Well drained to poorly drained.
- F156D (30%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.
- F134A (14%): Giese muck, depressional, 0 to 1 percent slopes. Muck to 1", silt loam to 11" over gravelly sandy loam. Very poorly drained.
- F33A (10%): Cathro muck, depressional, dense substratum, 0 to 1 percent slopes. Muck to 36" over mucky silt loam and stratified sandy loam. Very poorly drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest; F093AY013MN - Loamy Upland; F093AY004MN - Peatland

Successional Stage (MDNR): Young forest (0-55 years)

Average Stand Diameter (DBH): 8.0” DBH (SE=1.3)

Average Stand Basal Area: 50 ft2/ac (SE=15.5)

Snags per acre: 58 medium (6-11” DBH), 2 large (12”+), black ash and aspen

Coarse woody debris: Medium

Wildfire risk: Low

Invasive Species: Medium amounts of buckthorn and occasional honeysuckle, isolated pockets of thick buckthorn seedlings

Pests & Disease: Emerald ash borer where ash are present in creekbed

Current Condition: The east branch of Merritt Creek, similar to its west branch (Stand 4), is narrow with very steep and rocky embankments on both sides in its middle reaches, with flatter wetland-fed tributaries at the far north headwaters and south of the powerline corridor. The stand is overall sparse with low basal area. The creekbed and wetlands feature black ash, yellow birch (8-21" DBH), and balsam poplar (up to 14" DBH), with quaking aspen strongly dominant throughout all areas (3-11" DBH) and paper birch (6-9" DBH) present on drier embankments. The regeneration cohort is strongly quaking aspen, with smaller quantities of black ash, red maple, white spruce, and balsam poplar. Midstory is sparse to moderate with *Prunus* spp., serviceberry, mountain ash, sumac, and hawthorn on exposed slopes and beaked hazel, red-osier dogwood, willows, and pockets of thick buckthorn seedlings in deeper wetter soils. The steep ravines feature exposed bedrock and open-exposed plant communities of mosses and lichens, grasses, goldenrod, and yarrow, while surrounding mesic forests feature bush honeysuckle, lady fern, large-leaf aster, and bracken fern.

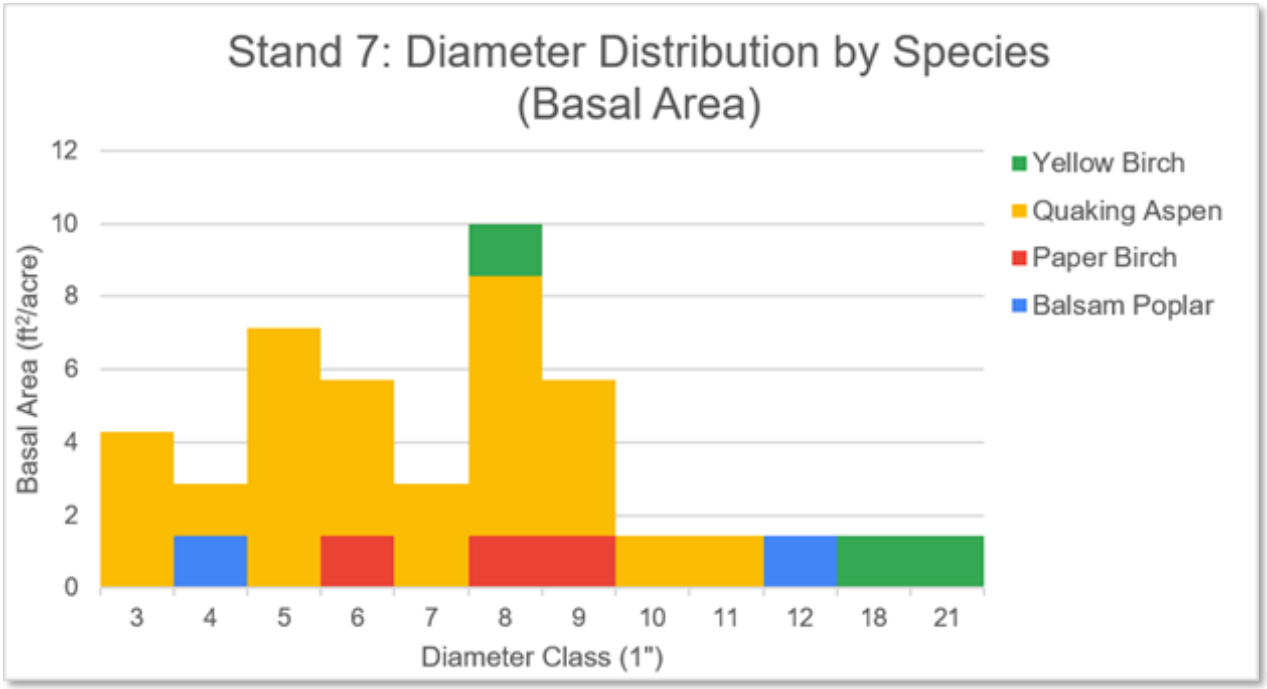
Current Recreational Uses or Management:
Several trails cross through the unit There is a trailhead at the north end of the stand. A powerline corridor crosses through the unit at the juncture of two creek tributaries and a wetland.

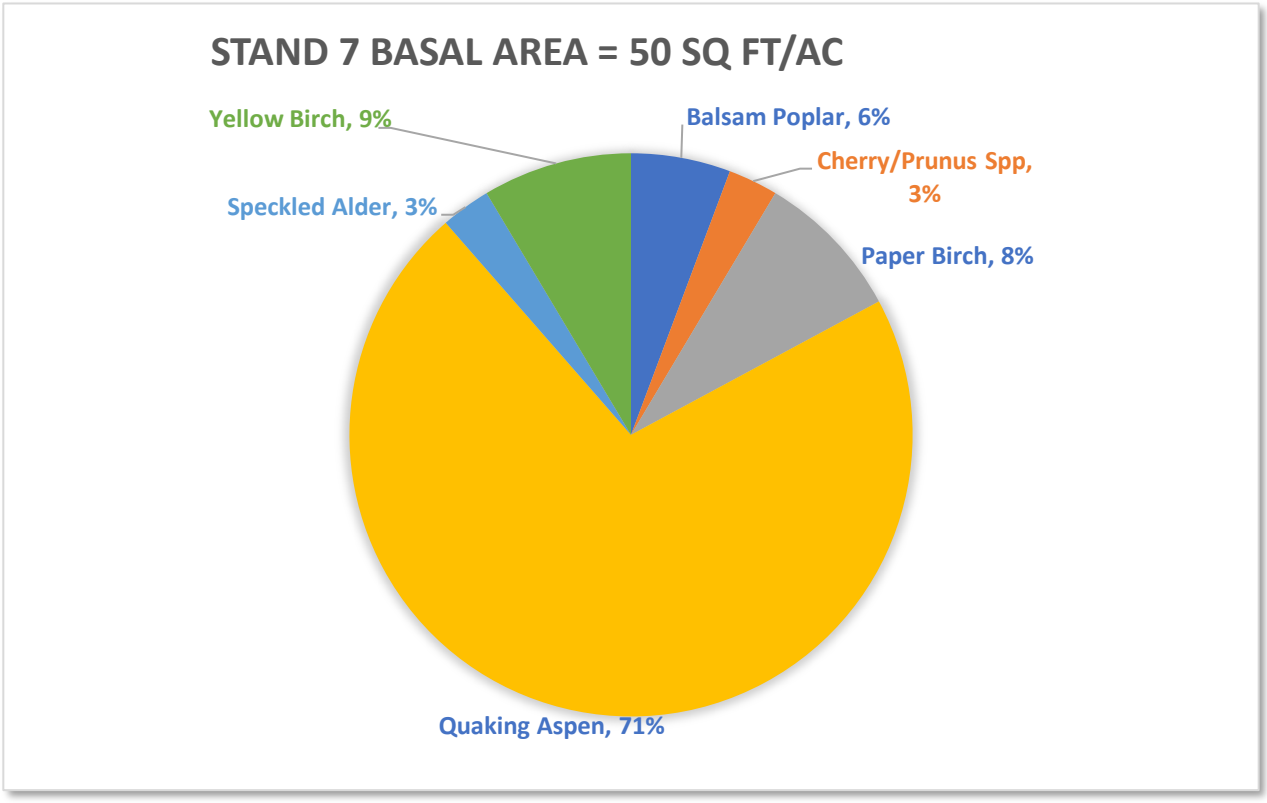
Adjacent land use concerns:
Moderately dense residential area and a trailhead at the headwaters of Merritt Creek to the north may contribute runoff, pollution, trash/debris, and invasive species to Merritt Creek. The powerline corridor may be impacting stream and wetland hydrology.

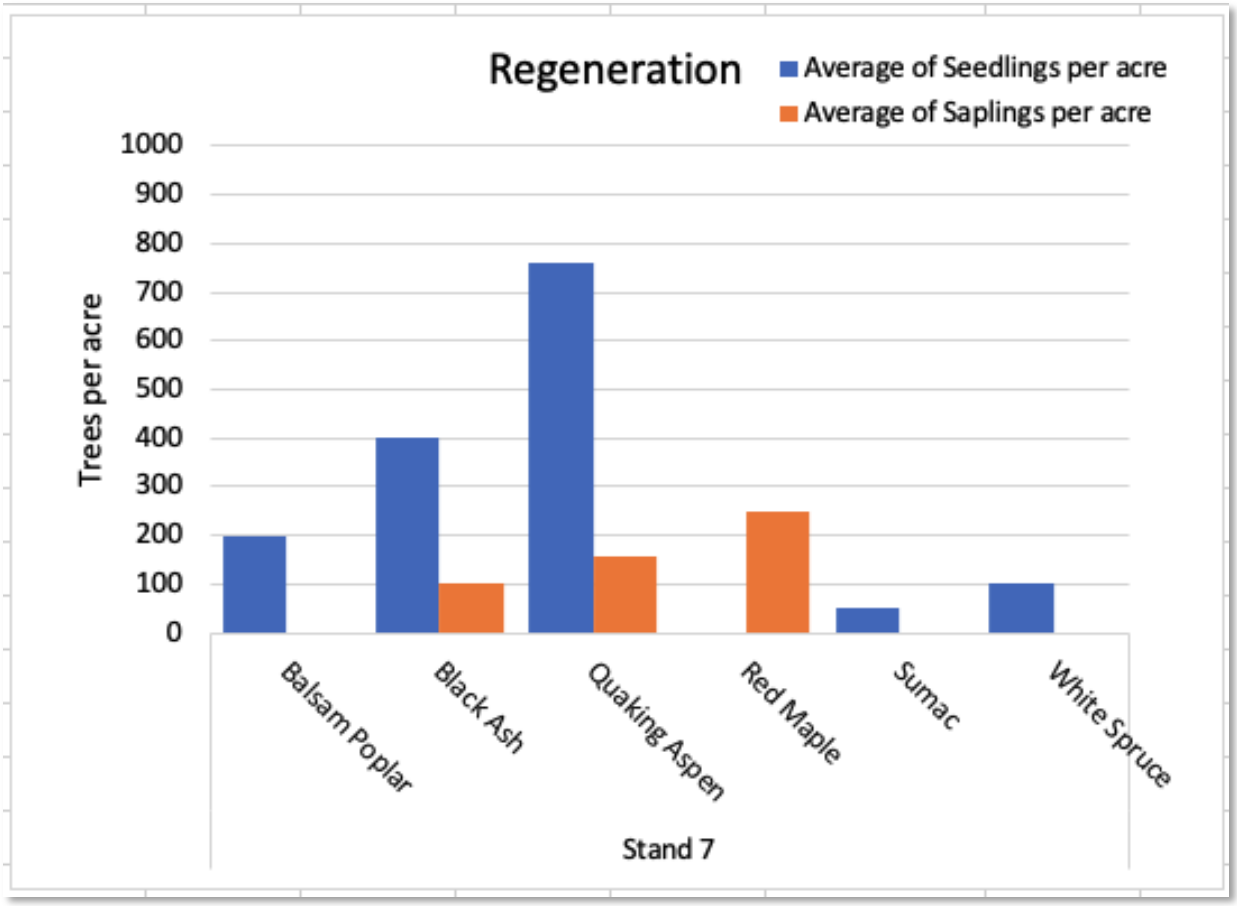
No action result (10-20 years): The tree composition is likely to remain low diversity and aspen dominated due to poor bedrock-controlled site conditions. Buckthorn may expand and become more dominant in wetland and floodplain areas, or balsam poplar and white spruce may eventually replace black ash as the dominant trees.

Management Goals, Strategies, and Actions

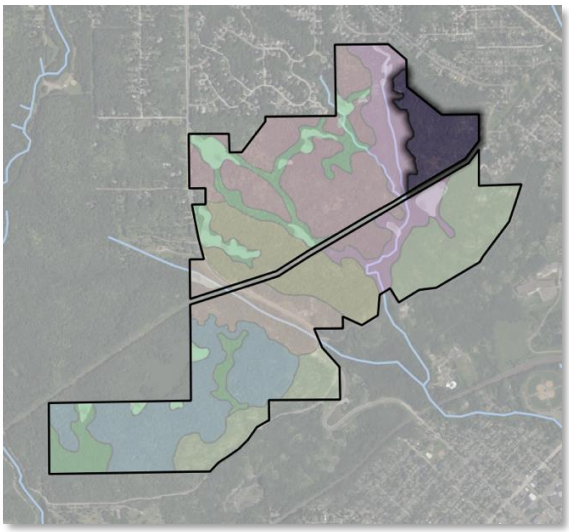
Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal	

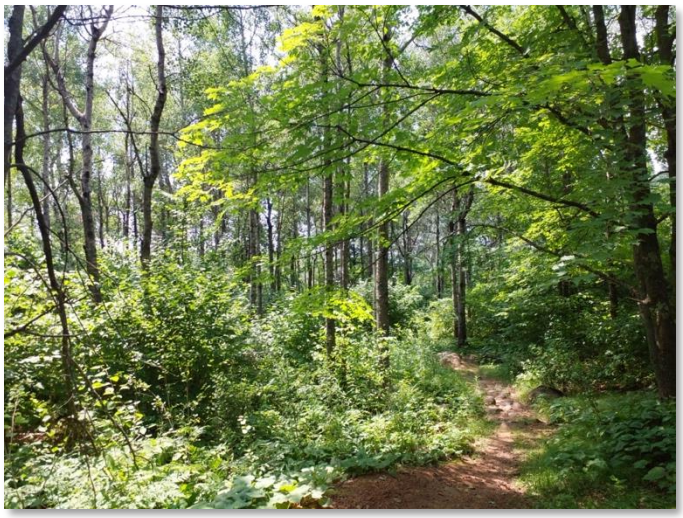

Stand 7: Diameter Distribution by Species (Basal Area)
Basal Area (ft²/acre)
12
10
8
6
4
2
0
3
4
5
6
7
8
9
10
11
12
18
21
Diameter Class (1")
Yellow Birch
Quaking Aspen
Paper Birch
Balsam Poplar


STAND 7 BASAL AREA = 50 SQ FT/AC
Yellow Birch, 9%
Balsam Poplar, 6%
Cherry/Prunus Spp, 3%
Speckled Alder, 3%
Paper Birch, 8%
Quaking Aspen, 71%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Balsam Poplar
Black Ash
Quaking Aspen
Red Maple
Sumac
White Spruce
Stand 7

Stand 8 Aspen-Birch (Hardwoods)





Stand Characteristics

Forest Type: Aspen-Birch (Hardwoods)

Size: 37 acres

NPC (MDNR)	*Acres*	*% of stand*
MHn35b	21.6	59%
ROn23b	8.6	23%
MHn47a	4.2	12%

Dominant Soil:

- F156D (86%): Rock outcrop-Ahmeek, bedrock substratum-Barto complex, 4 to 18% slopes. 0-65" to lithic bedrock; gravelly sandy loam with some silt loam on top in places. Well drained.
- F160F (11%): Rock outcrop-Mesaba-Barto complex, 18 to 60% slopes. 0-40" to lithic bedrock; gravelly sandy loam. Well drained.

Ecological Site (USDA): F093AY009MN - Bedrock Controlled Upland Forest

Successional Stage (MDNR): Young forest (0-55 years)

Average Stand Diameter (DBH): 7.5" DBH (SE=0.7)

Average Stand Basal Area: 71 ft2/ac (SE=14.9)

Snags per acre: 5 medium (6-11" DBH), aspen

Coarse woody debris: Variable amounts

Wildfire risk: Low

Invasive Species: Variable amounts of buckthorn

Pests & Disease: N/A

Current Condition: This is a poor-quality bedrock-controlled quaking aspen and paper birch forest on a ridgetop with small, sparsely-growing trees up to 9" DBH. Mountain ash, red maple, and occasional red oak are also able to persist in the rocky and exposed conditions. Quaking aspen, paper birch, and red maple were the only regenerating trees recorded, with strong aspen dominance. Staghorn sumac, serviceberry, beaked hazel, red-osier dogwood, hawthorn, and buckthorn form a moderate to dense midstory layer. Bush honeysuckle, large-leaved aster, and hardy disturbance tolerant plants like goldenrod, yarrow, and St. John's wort characterize the understory.

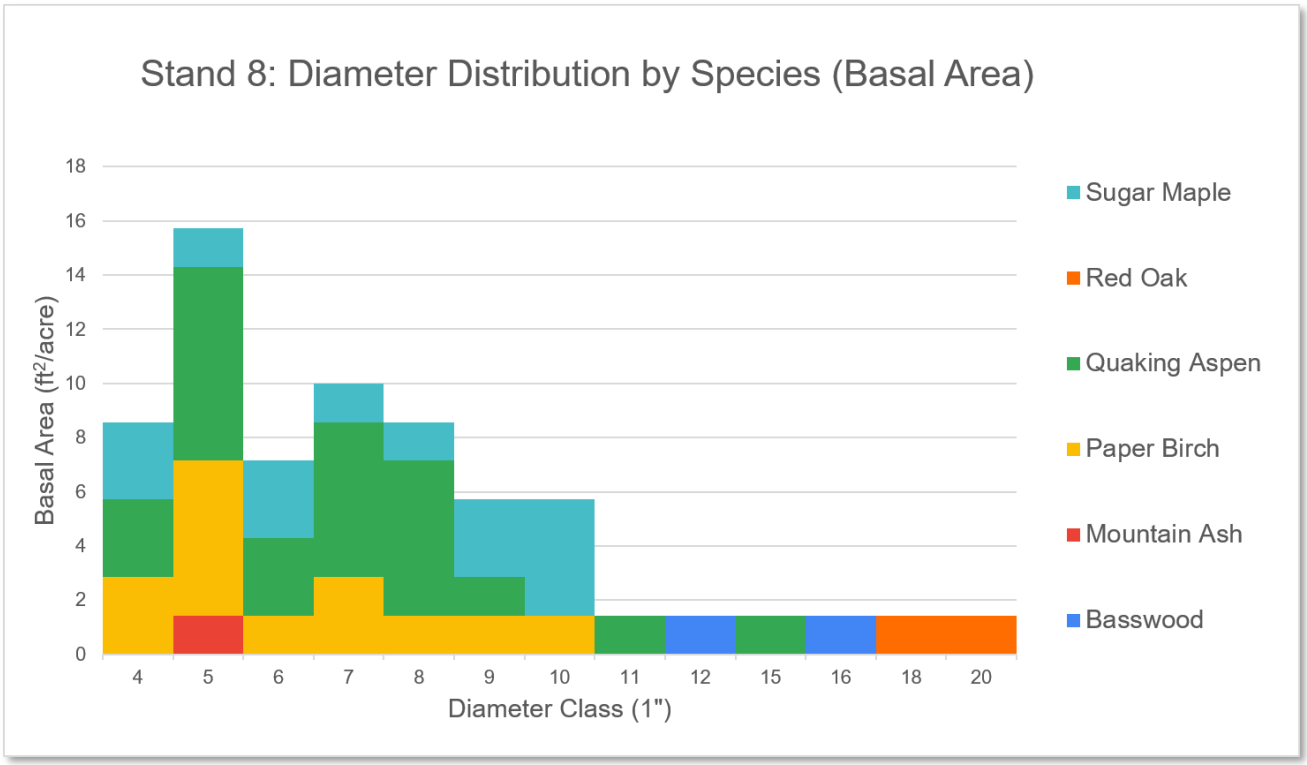
Current Recreational Uses or Management:
Several trails cross through the unit.

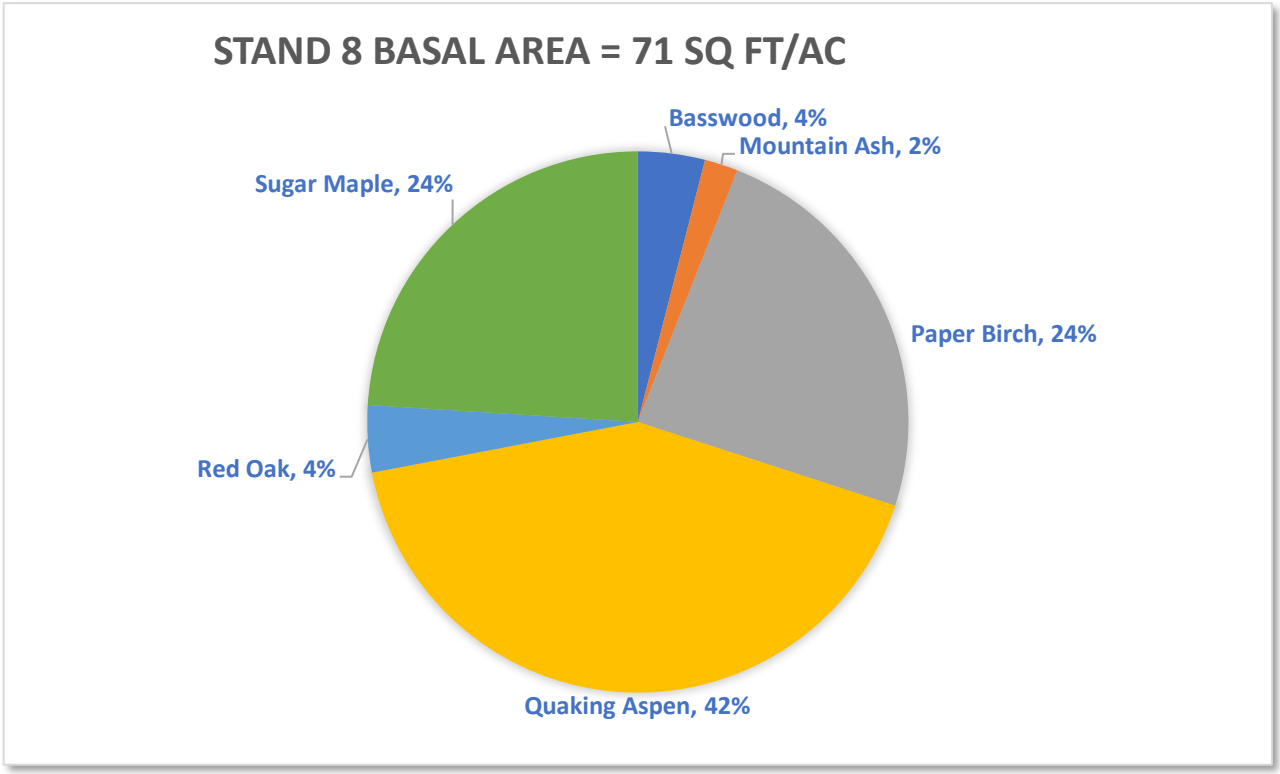
Adjacent land use concerns:
Residential areas to the north and east may be a source of off-trail visitors

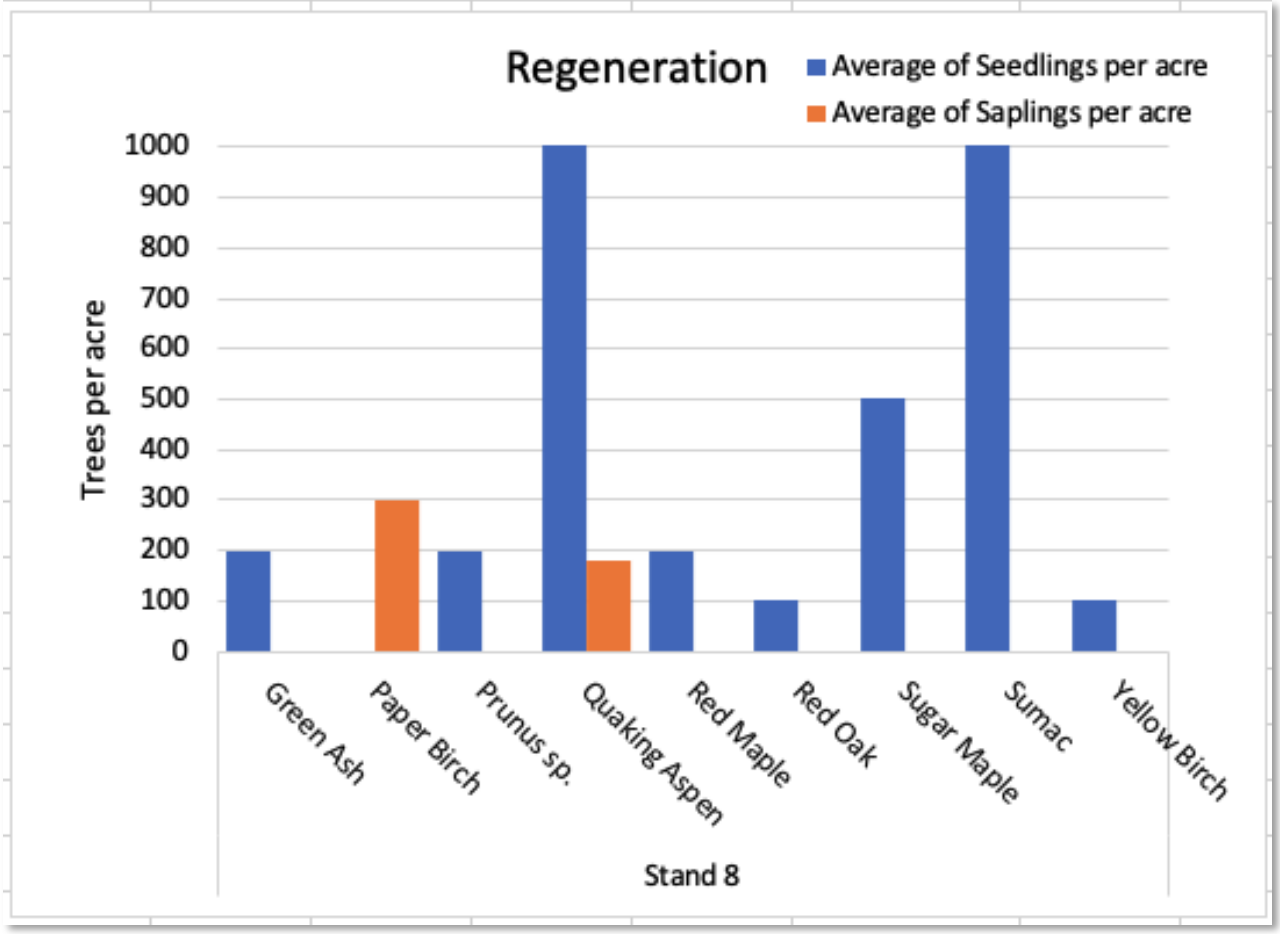
No action result (10-20 years): The stand is not likely to change much given the harsh conditions of the rocky outcrop environment and adaptation of existing plants to environmental extremes like drought, wind, and cold exposure. Greater tree mortality could occur in the event of an extreme drought or heat wave, or a wildfire with quaking aspen and paper birch as the primary regenerating species.

Management Goals, Strategies, and Actions

Goal	Strategy	Action	Notes
Restore/enhance native plant communities	Buckthorn Removal	Hand pull seedlings up to 1" diameter; Hand cut or chainsaw stems >1" diameter; Follow-up foliar herbicide treatment after initial removal	Supplement to burning in rocky outcrop areas; Cut stumps and herbicide treatment; hand pull seedlings
Restore/enhance native plant communities; Recreation	Restore and maintain fire-dependent plant communities	Prescribed burning	Rocky outcrops only, patch burns




STAND 8 BASAL AREA = 71 SQ FT/AC
Basswood, 4%
Mountain Ash, 2%
Sugar Maple, 24%
Paper Birch, 24%
Red Oak, 4%
Quaking Aspen, 42%


Regeneration
Average of Seedlings per acre
Average of Saplings per acre
Trees per acre
1000
900
800
700
600
500
400
300
200
100
0
Green Ash
Paper Birch
Prunus sp.
Quaking Aspen
Red Maple
Red Oak
Sugar Maple
Sumac
Yellow Birch
Stand 8

Appendices

A. Soil Maps
B. Soils Description Charts
C. Native Plant Communities by Property and Stands
D. Stands Maps
E. Management Maps
F. Basal Area Summary Chart
G. Regeneration Summary Chart

Spatial Data (Shapefiles)

A. Stand boundaries and attributes
B. Management activities with stand attributes
C. Inventory plot locations

Tabular Data (Excel)

A. Inventory data
B. Site index data


DULUTH FORESTRY PROGRAM