MINNESOTA DEPARTMENT OF NATURAL RESOURCES
SUSTAINABLE TIMBER HARVEST ANALYSIS

Phase 2 Draft Report

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LIST OF ACRONYMS

CSA: Cooperative Stand Assessment

ERA: Economic Rotation Age

FIA: Forest Inventory and Analysis

FIM: Forest Inventory Module

GAP: Gap Analysis Program

GIS: Geographic Information System

MN DNR: Minnesota Department of Natural Resources

MN DNR Planning Areas:

- AP Aspen Parklands
- BRP Blufflands-Rochester Plateau
- MDLP Minnesota Drift and Lake Plains
- MNIAM Minnesota and North-East Iowa Moraines
- NMOP Northern Minnesota and Ontario Peatlands
- NSU Northern Superior Uplands
- WSU Western Superior Uplands

NRA: Normal Rotation Age

RSA: Representative Sample Area

SDI: Simpson's Diversity Index

SFRMP: Section Forest Resource Management Plan

STHA: Sustainable Timber Harvest Analysis

LIST OF TECHNICAL TERMS

Age Class: A group of ages used to classify stands for the planning model. Age class grouping used in this report vary. The Native Plant Community goals, for example, use a different set of age class groupings than does the biodiversity metric.

Cover Type: A tree-species-based classification system specific to DNR's Forest Inventory Module. While a cover type is labeled with the primary species, it is understood that most cover types are comprised of an assemblage of species.

Development Type: All acres that have the same set of characteristics used to describe land in the forest management model. These acres need not be contiguous. Each development type is a model stratum.

Discount Rate: Interest rate used to convert future dollars into current dollars.

Goal: Within an optimization model, a numeric target or goal can become part of an objective function by minimizing deviations from the goal.

Management Regime: A specific set of management actions through time.

Optimization: A class of forest management models that seeks to optimize some set of measures while meeting specified constraints.

Period: The smallest unit of time in the forest management model. In this case five years. There are 20 five-year periods in the 100-year planning horizon.

Priority Harvest Volume: Volume of aspen, pine, and spruce harvested within 75 miles a mill.

Planning Horizon: The total period of time projected in the forest management model. In this case, projections cover a 100-year planning horizon.

Planning Latitude: A measure of how much flexibility is available in the projected harvest schedule. This is defined as the ratio between the acres schedule for clear-cut divided by the acres available for clear-cut.

Site Index: A measure of productivity for growing timber, expressed as the height of dominant and co-dominate trees at age 50. For example, site index 65 means that dominate and co-dominant trees in a stand are expected to be 65 feet tall at age 50.

Strata: A more general application of classification based on one or more characteristic. Members of strata typically need not be contiguous.

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1.0 ACKNOWLEDGEMENTS

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2.0 EXECUTIVE SUMMARY

The MN DNR is analyzing the sustainability of harvesting 1 million cords per year from MN DNR administered timberlands. This represents a 25% increase from the current harvest goal of 800,000 cords annually. If 1 million cords are determined to be unsustainable, the MN DNR will identify an alternative sustainable harvest goal. The MN DNR will provide a final decision to the Governor and Legislature on the sustainable harvest level by March 1, 2018.

The Stakeholder Advisory Group (SAG) (12-member panel representing a wide range of stakeholders in the forest), in consultation with the MN DNR, identified six broad forest management values to consider in the sustainable harvest analysis. These are timber productivity, natural resource economies, biodiversity, water quality, wildlife habitat, and forest health. Fundamentally, the model allows MN DNR and stakeholders to explore various ways of balancing these different values.

This analysis investigated three primary questions:

1. Could the MN DNR's lands support a harvest of 1 million cords per year?

In the short term, harvests above 1 million cords could be maintained for 15 to 20 years, without falling below the long-term harvest level of 880,000 and 910,000 cords per year. This includes site-level considerations for water quality, wildlife habitat, and biodiversity, but does not include marketability factors nor wildlife considerations mentioned below. The potential ability to harvest at a higher level is due to the large supply of mature and older wood currently on state lands. Some of this older forest is the result of conscious decisions to manage for certain habitat values, while some is the result of market conditions (e.g., undesirable species, distance from mills, etc.).

2. If not, what harvest levels could be maintained in the long term?

We found that the long-term harvest level that utilizes all of the acres available under current legal and regulatory restrictions could be between 880,000 and 910,000 cords per year. This also includes site-level considerations for water quality, wildlife habitat, and biodiversity, but does not include marketability factors nor wildlife considerations mentioned below.

3. What are the impacts of additional non-timber values on the harvest level?

As the six values listed above are incorporated, the timber harvest levels generally decrease. In particular, incorporating spatial distribution goals to provide biodiversity and habitat for older, forest-dependent wildlife species has the greatest impact on potential timber harvest volumes. Prioritizing these goals has the potential to reduce timber volumes by as much as 40-50% over the next 20 years (25-35% over the long term). This would amount to an annual harvest level of roughly 600,000 to 700,000 cords. The ability to meet water quality goals had minimal impact on harvest levels.

The information in this draft report is intended to communicate the range of potential harvest levels from MN DNR managed forests given a wide variety of model assumptions, statutory obligations, and operational considerations. It is a strategic assessment and does not and cannot account for all site-level operational considerations. It does not identify a recommended sustainable timber harvest level from MN DNR lands. The decision on the MN DNR sustainable timber harvest level will come after full consideration of the Stakeholder Advisory Group, public comments, and the final analysis report.

3.0 PURPOSE, NEED, AND HISTORY

The Minnesota Department of Natural Resources (MN DNR) manages more than 5.6 million acres of land. Of these lands, about 2.75 million acres are commercially managed forests, or timberlands, which is about 49% of MN DNR-administered lands and 15% of Minnesota forestlands. These lands are managed under a variety of statutes and policies to meet many different objectives, including ecological protection, timber production, habitat development, and recreation. By statute, timber harvest levels are to be sustainable over time, and MN DNR seeks predictable, sustainable levels of other resources as well.

Over the past several decades, MN DNR harvested between 600,000 and 1,000,000 cords of timber annually. Past analyses by MN DNR scientists indicated that 800,000 cords per year are a sustainable level of harvest, given MN DNR's current management objectives and practices.

Wood products from MN DNR timberlands are 28% of the in-state supply to Minnesota's wood processing industries. These industries account for about 64,000 jobs and $16.2 billion of annual economic impact. Competitiveness and growth in the forest sector depend to some extent on securing a reliable supply and, if possible, an increasing amount of forest products. Representatives of Minnesota's wood processing industries have suggested that MN DNR timberlands are capable of providing a sustainable annual harvest level of at least 1 million cords.

In November 2016, Governor Dayton directed the MN DNR to 1) determine whether MN DNR lands could sustain a harvest of 1 million cords, 2) identify the sustainable harvest level if 1 million cords are unsustainable, and 3) conduct this analysis with an independent third party. The MN DNR Commissioner must identify the sustainable timber harvest level by March 1, 2018.

To that end, MN DNR designed and advertised a consulting project, and selected Mason, Bruce and Girard, Inc. (MB&G) to conduct the analysis. MB&G is a natural resource consulting firm headquartered in Portland, Oregon. MB&G's Forest Planning team has conducted similar analyses for state, federal, tribal, and private land managers across the U.S. and internationally. Over the last 20 years, MB&G has prepared long-term harvest scheduling analyses for over 65 million acres on 160 different properties.

MN DNR assigned an internal project team to work with MB&G. The project team provided input, data, and direction to ensure that MB&G's efforts recognized previous work, current policies, and possible future opportunities. The project team also regularly solicited input from a Stakeholder Advisory Group representing a broad range of interests in Minnesota's forest resources.

The current study had two phases. In Phase 1, MB&G took the existing MN DNR harvest scheduling model, updated it with the most current inventory data, and conducted an assessment of the potential timber harvest from MN DNR lands. The primary objective of this effort was to determine what data were available, how they could be used in the modeling process, and how to proceed with modeling objectives. This preliminary analysis showed that without incorporating additional non-timber values, MN DNR could harvest 1 million cords annually for a limited time before dropping to a lower long-term sustainable level. The effort also determined that MN DNR did not yet have reliable methods for estimating the impact on timber harvest from additional objectives for wildlife habitat and watershed protection. MB&G reported Phase 1 results in a June 2017 Progress Report.

The Phase 2 effort built on Phase 1. Here, we modeled sustainable yield for 7 planning areas. We incrementally incorporated additional forest management values targeting natural resource economies, water quality, biodiversity, and wildlife habitat. We also explored the sensitivity of the projections to future growth assumptions, as well as alternative discount rates.

This analysis and the MN DNR Commissioner's decision on the sustainable timber harvest level will inform future MN DNR forest management plans.

4.0 DATA AND METHODS

In this section, we will list and describe the main components of the Sustainable Timber Harvest Analysis (STHA). We will start by providing a broad overview of the components of the analysis in the following section, followed by three sections describing the model components in detail.

4.1 Overview of the Sustainable Timber Harvest Analysis

The analysis conducted for this project can be split into three main components, namely, land base, yield analysis, and harvest scheduling. The land base component deals with describing and classifying the landscape, based on its underlying properties. The yield analysis assesses the growth and yield potential of the forests and associates these values with land units based on their classification. The harvest scheduling component aggregates the information from the land base and yield analysis components, and assigns a management plan to each land unit based on strategic objectives and growth potential.

The approach that was used for this analysis was to build a forest planning model, using a linear programming formulation in Remsoft's Spatial Planning System software. It was used to simulate various management alternatives (scenarios) and assumptions. The scenarios ranged from maximizing timber harvest only, to maximizing the creation of wildlife habitat, diversity of native plant communities and age classes, and protection of water quality. Assumptions varied along the growth and yield projections used, as well as the discount rate on financial returns. This provided us with a range of solutions that could be used by the MN DNR to inform future policy.

Key to a forest planning model is the concept of a planning horizon. That is the length of time over which the plan will schedule management activities and associated outcomes. In this case, we built a model with a planning horizon of 100 years. This horizon is divided into smaller time periods of equal length, in order to add temporal resolution to the results. For this model we selected a period length of 5 years, resulting in 20 planning periods. Period zero represents the current condition of the landscape, while period 20 represents the landscape 100 years from the present.

The purpose of the land base section was to establish the existing condition of the landscape, in terms of the attributes that are essential to the STHA. This provided the forest planning model with a starting point of analysis. In terms of the planning horizon, it represents period zero. The main tasks for this component were to extract the raw GIS data from the Forest Inventory Module (FIM) and summarize it by the key attributes that will be used by the model. This provided the data that was required to build the area and landscape sections of the model, as well as a first assessment of the properties and capabilities of the landscape.

The purpose of the yield analysis component was to evaluate the growth and yield projections currently used by the MN DNR and make recommendations for yield table adjustments. The yield tables are a key component of the forest planning model. They provide a snapshot of forest inventory within each stratum for each planning period. As such, they determine the harvest level within each period as well as the standing inventory, both of which are key parameters of the model. The yield tables also provide information about growth rates between periods, which is a key component in conjunction with the discount rate to determine the optimal period for timber harvest. The main tasks for the yield analysis component were to benchmark the MN DNR yield tables against published research and to make recommendations on how the yields could be aligned better with expected growth and yield. This resulted in a set of yield table adjustments that formed the foundation of a scenario that examined the impact of the yield assumptions (5.3.3).

The last component of the Sustainable Timber Harvest Analysis was to build and run the forest planning model. The function of this model was to provide the project team with a tool that could evaluate the impact of land management assumptions on parameters such as water quality, biodiversity, wildlife habitat and natural resource economies. These parameters were incorporated into the model through objectives, constraints, and goals. Objectives are the main drivers of the model solution and are the parameter that the model will either maximize or minimize, depending on the desired outcome. The constraints and goals place boundaries on the potential solution and limit the objective function to an acceptable solution. By using different objective functions and a range of constraints and goals, we were able to explore how different levels of water quality, biodiversity, wildlife habitat and natural resource economies could be realized through a range of land management assumptions. The model is explained in detail in section 4.4.

4.2 Land Base

The land base component of the analysis established the starting condition of the MN DNR lands incorporated into this analysis. As such, it established the state of the land at period zero on the planning horizon. The rest of this section will describe different elements of establishing the land base. Section 4.2.1 will describe the source of the data used for this analysis, while section 4.2.2 will summarize and evaluate the land base in terms of availability for management, age, site index, acres, and volume.

4.2.1 Forest Inventory Module Data

The forest inventory data and other supplementary spatial data used in this project were provided by the Minnesota Department of Natural Resources (MN DNR). The forest inventory data originates from the MN DNR's "Forest Inventory Module" system (also referred to as FIM data) and follows internal MN DNR classification schema. The FIM forest data is derived from the cooperative stand assessment (CSA) forest inventory program. This data is collected by MN DNR foresters or forest inventory contractors, summarized by individual forest stands, and updated on a continuous basis. Of the 5.6 million acres of land administered by the MN DNR, 5.4 million acres have FIM data. Notable areas of MN DNR administered lands without FIM data coverage include holdings within the Boundary Waters Canoe Area Wilderness, Myrtle Lake Peatland Scientific and Natural Area (SNA), and various smaller SNAs.

The FIM data is a non-statistical forest inventory used for management purposes and consists of summarized stand data only. The original individual plot data is not available. Only the summary data of individual forest stands is maintained. The FIM data used in this project originated from an April 7, 2017, download.

The FIM data was integrated with the MN DNR spatial Land Records System data to align each forest stand with one unique DNR land administrator and one unique means of acquisition. Additional MN DNR data including forest planning units, riparian zones, mill distances, watersheds, spatial hexagons, native plant communities, endangered and threatened species, and state species of special concern were spatially integrated through geoprocessing with the FIM data.

The final data product was provided to MB&G in shapefile format consisting of 200,598 polygons. This data and the documentation are readily available from the DNR's FTP site at ftp://ftp.dnr.state.mn.us/pub/SFRMPDATA/MBG_STHA/.

Once MB&G obtained these data we reorganized it to fit the needs of the model. The forest planning model called for 19 different attributes to be populated for each polygon within the shapefile. These attributes are described in section 4.4.2 and were populated primarily from the spatial data, as well as additional data provided by the MN DNR.

4.2.2 Inventory Analysis

In this section, we describe the inventory in terms of land area and associated timber volume, presenting these data at the statewide level and for planning areas, classified by survey year, age class, and site index. The total land area represented in some way by inventory was 5,290,074 acres. Around 4.8 million acres were classified as manageable, which represented the acres available for management after considering administrative restrictions, operable terrain, old growth, and representative sample areas (RSA). Around 3.73 million acres were classified as forested, which represented all the acres that had a forest cover type (exclude land with no cover type designation, vegetated non-forest, and bare land). Around 3 million were potentially commercial, which were all the acres with growth and yield estimates. Finally, around 2.75 million acres were classified as merchantable, which were all the acres that met all of the conditions for manageable, forested and commercial (Figure 2). Around 52% of the total acres were considered merchantable and allowed to contribute to sustainable timber yield calculations. The other 48% was allowed to contribute to various other objectives (e.g., watershed, older forest habitat goals). In the remainder of this section, we consider in detail the fraction of merchantable inventory acres.

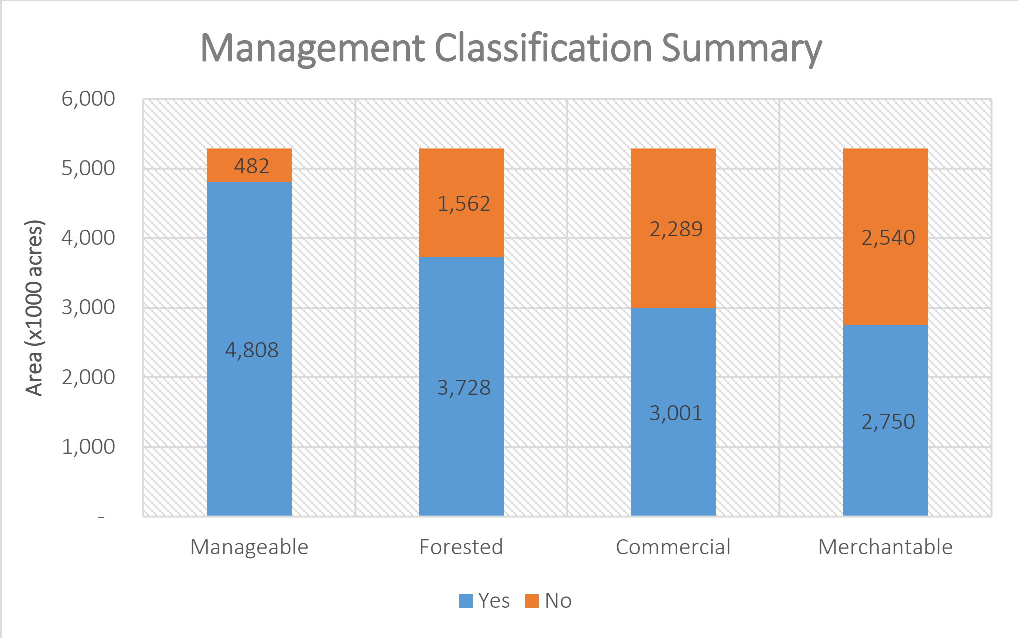


Figure 1. Division of MNDNR Acreage by Operability Class.

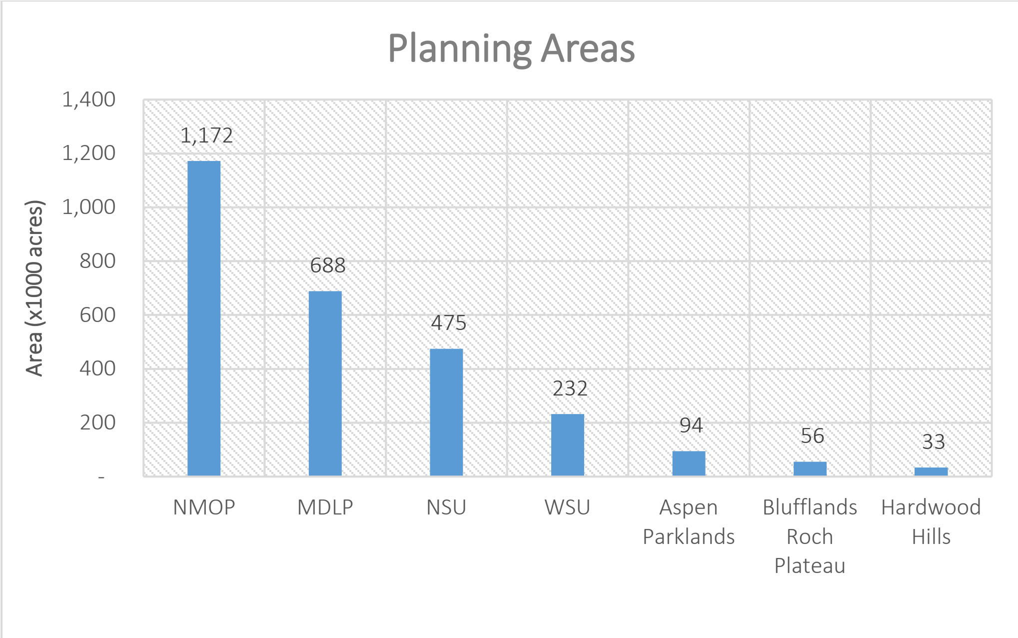


Figure 2. Histogram of Acreage by Planning Area.

Although there are seven planning areas with merchantable acreage, just four—NMOP, MDLP, NSU, and WSU (defined in List of Acronyms)—encompass 93% of the area. See Appendix Q: Map of MN DNR Planning Areas for the geographic location of the planning areas. The Woodstock model includes all seven planning areas, but in this summary, we focus on these top four planning areas in detail. By themselves, NMOP accounts for 42.6% of the total planning area, MDLP is 25%, NSU is 17.3%, and WSU is 8.4%.

Including all planning areas, inventory data used in the Woodstock model were collected over the period extending from 1976 to the present. Some of the inventory dates back to the original current format survey in the late 70's and early 80's. Over half of the acres were visited after 2004.

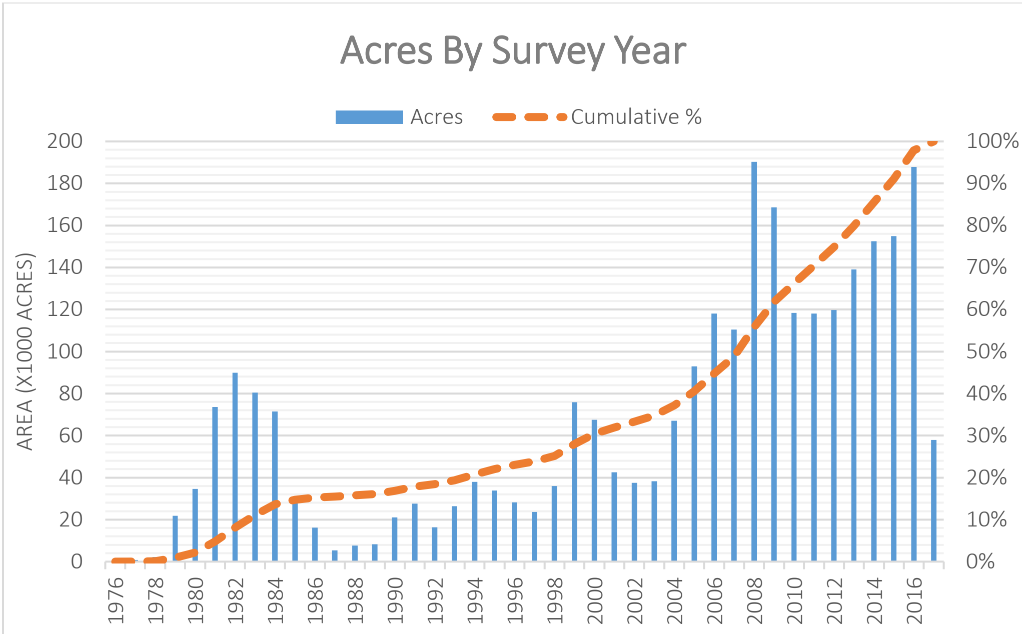


Figure 3. Number of Acres Surveyed Each Year After 1976.

From the perspective of age classes, again including all planning areas, the largest area falls into either the zero-to-five-year class or the older-than-120-year class (Figure 4). There is a roughly linear decline in area from the younger age classes through each of the eldest classes, meaning that recent stand-replacing activities have occurred at a faster pace than more historic activities. In terms of site index, there is a slightly bimodal distribution in area, with one peak around the 30'-35' class, and another around the 61'-65' class (Figure 4). This split distribution arises from merging different planning areas into a single distribution calculation, as we explain below.

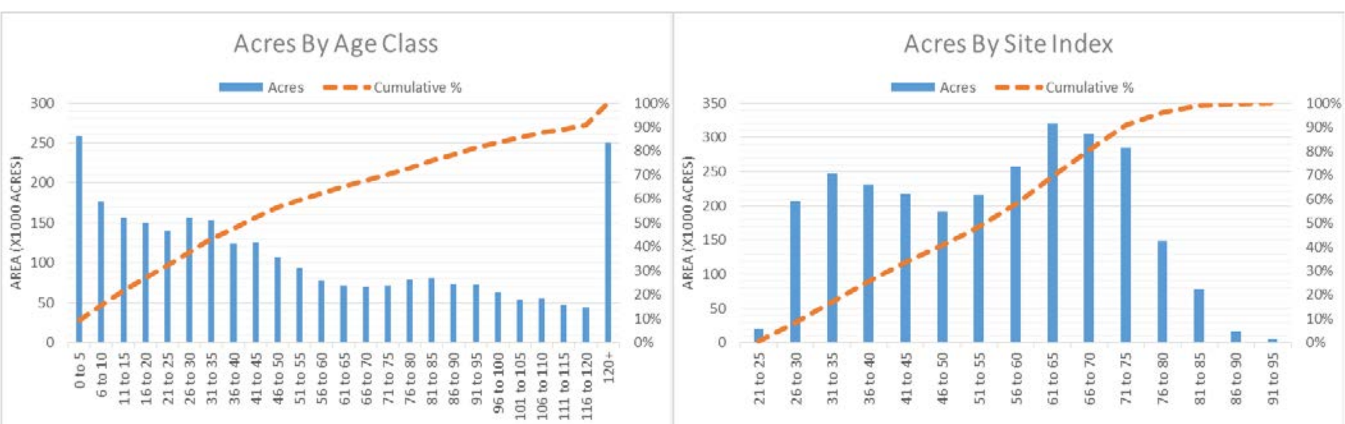


Figure 4. Merchantable acreage by age class and site index.

Considering the largest four planning areas, NMOP, MDLP, NSU, and WSU, the distribution of acreage by age class follows approximately the outlines of the whole merchantable land base, with some notable differences. These differences are characterized either by variable representation of the older age classes or by non-uniformities among intermediate ages. In terms of the young versus old representation, while both NMOP and the statewide merchantable area have around 9% in the zero-to-five-year-old category, NMOP has 13% of its area in the 120+ age class (Figure 5), while statewide that figure is only 9% (Figure 4). In contrast, MDLP has a similar zero to five percent, but only 6.4% in the 120+ class (Figure 5). NSU is most similar to the statewide pattern, with 9% in the zero- to five-year class and 8.0% in the 120+ class (Figure 5). For WSU, the zero- to five-year class contains 9.9% of the area, again a similar fraction to the statewide classification, but in this planning area, only 3.6% of the acreage is in the 120+ age class (Figure 5). In general, NMOP shows a higher proportion of older age classes, while MDLP, NSU, and WSU all show a disproportionately higher fraction of the youngest age class. It should be noted here that the zero-to-five-year-old age classes reported here include acreage that is considered “under development”, meaning acres that are slated for harvest but not yet cut (the model assumes these acres have been harvested). This contributed to the high proportion of zero-to-five-year age class and should be considered when interpreting the results in the rest of this section[1].

The distribution of intermediate age classes differs by planning area. In this case, NMOP most closely represents the statewide pattern, with uniform decline from zero through the older classes (Figure 5). The intermediate age classes for MDLP and NSU, however, are concentrated in the six- to 40-year classes, with over 50% of the acreage in these younger categories (Figure 5). The age class distribution in the WSU planning area shows a concentration of older age classes. While 40% of the acreage is represented by stands younger than 40 years, the 60-year to 100-year-old stands constitute around 30% of the remaining acreage, a much higher proportion than the other planning areas (Figure 5). A higher proportion of aspen cover type, which has a 40-year rotation, within a planning area will tend to concentrate the amount of acreage in younger age classes. Conversely, planning areas with a greater acreage of e.g. black spruce, with a 120-year rotation, will tend to have more acres in older age classes.

[1] These age class charts and statistics all use a modified stand age that reflects pending management actions. Nearly 112,000 acres of older forest have the stand age artificially set to 1 year old to reflect pending management actions. Since these acres are treated as young forest by the model, this over estimates the current 0 – 5 year age class acres shown in these graphs and charts. The non-modified 0 – 5 year age class acres is slightly less than the 6 – 10 year age class acres.

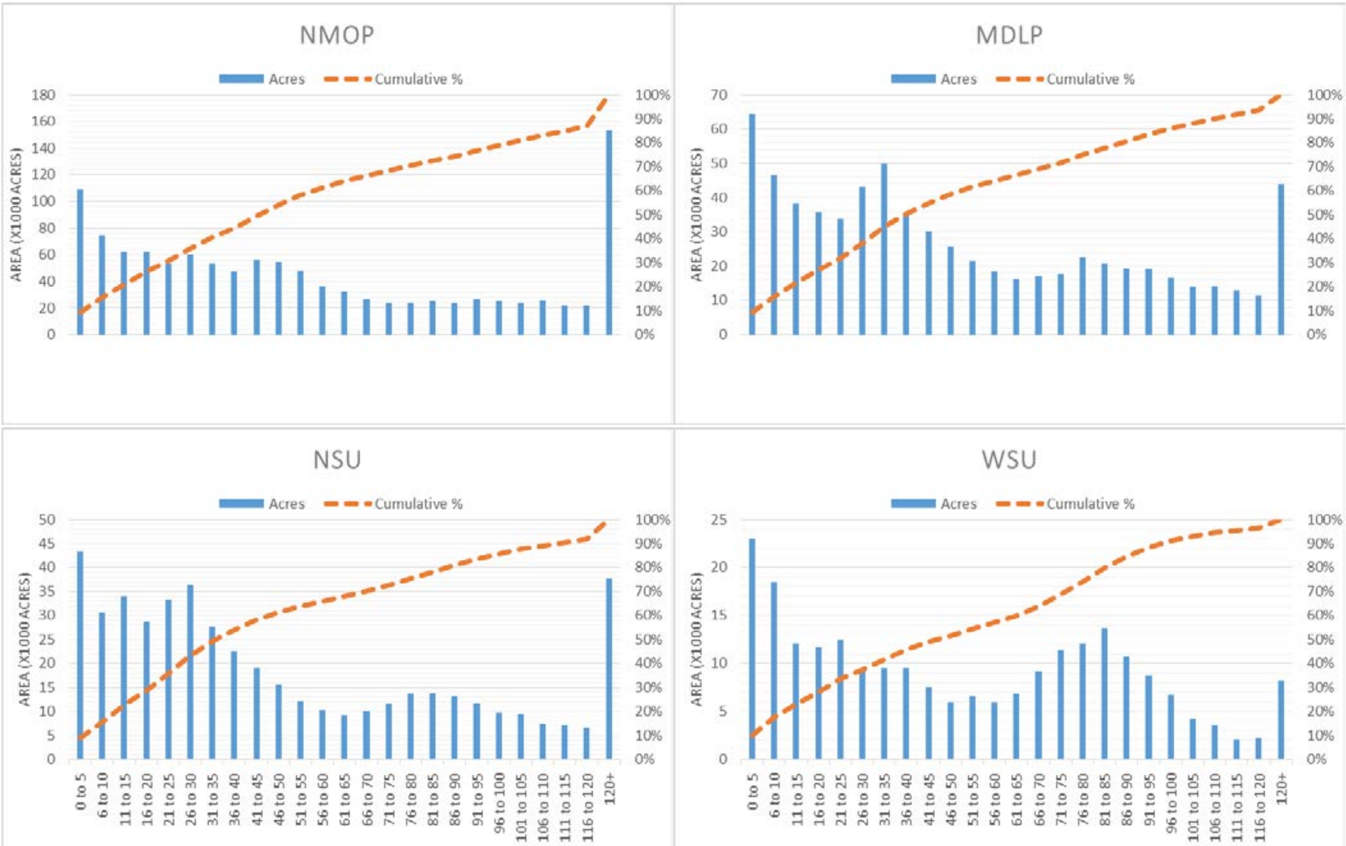


Figure 5. Acreage Histogram with Cumulative Percent by Stand Age Class

The source of the bimodal acreage by site class distribution (Figure 4) can be traced to differences in the major planning areas. The largest planning area, NMOP, has around 50% of its acreage in site index classes lower than 45’ (Figure 6). In contrast, MDLP, NSU, and WSU planning areas have less than 30% of their area in these lower site class groups, while site classes 60’ and greater constitute more than 50% of the area for MDLP and WSU, and more than 40% of the area for NSU (Figure 6). With 42.6% of the total merchantable acreage, the NMOP site class distribution exerts substantial influence on the statewide distribution, roughly in proportion to the 50.7% of acres classified as MDLP, NSU, and WSU combined.

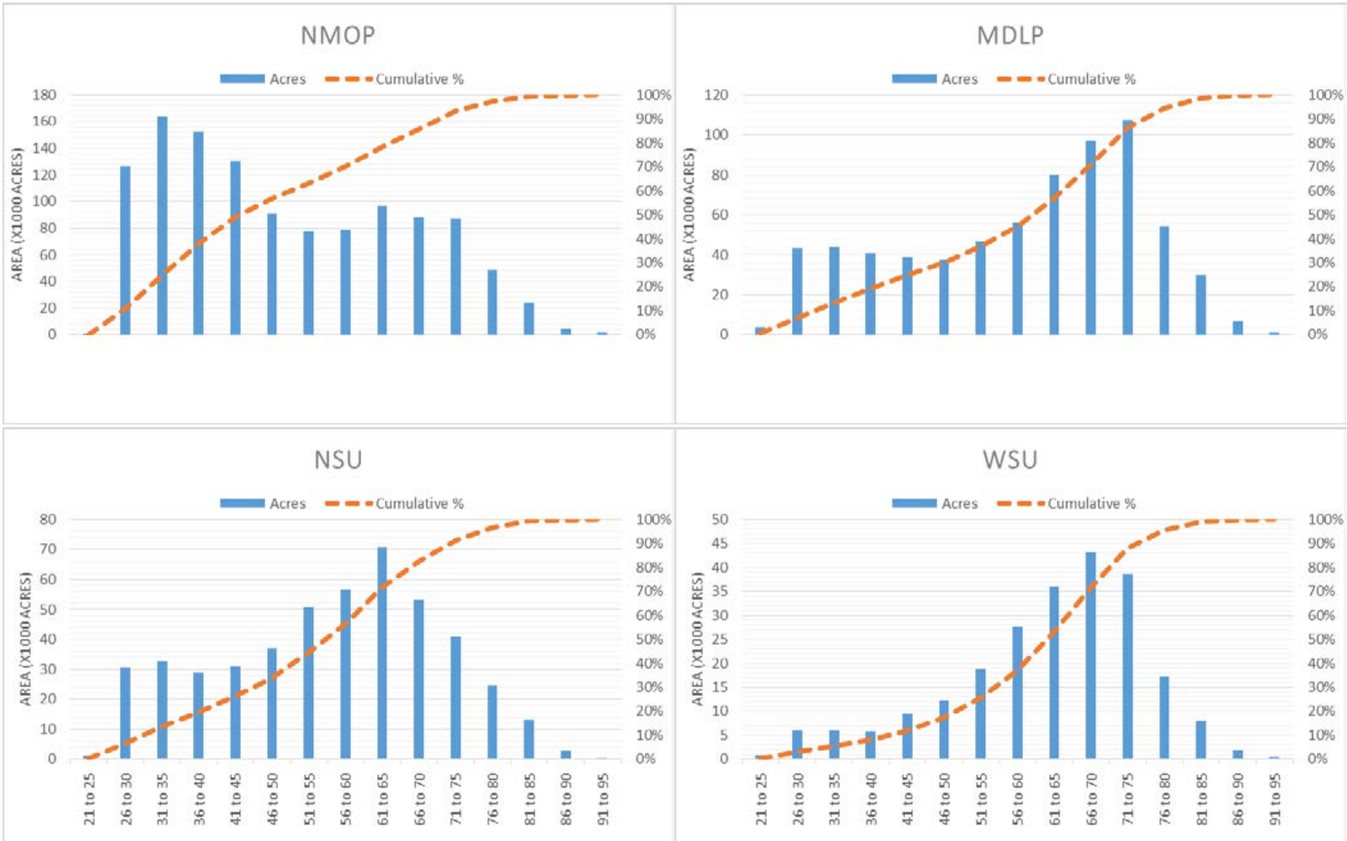


Figure 6. Acreage Histogram with Cumulative Percent by Site Index Class

Certain cover types are most dominant within each of the major planning areas. Just as NMOP, MDLP, NSU, and WSU represent more than 93% of the total merchantable area, just a few cover types within these planning areas are a substantial majority. In NMOP, the four most dominant cover types by area are aspen, black spruce lowland, tamarack, and white cedar, together covering 84.1% of the NMOP area (translates to 35.8% of the total statewide merchantable area, Figure 7). For MDLP, the top two cover types are aspen (43.6%) and tamarack (13.8%), together 57.4% of the planning area (translates to 14.4% of the total statewide merchantable area, Figure 7). The aspen cover type is the most common in both NSU (41.3%) and WSU (44.1%) planning areas (together these translate to 10.8% of the total statewide merchantable area, Figure 7).

In the remainder of this section, we focus on acreage and volume within these specific combinations of planning area and cover type. Collectively, these four cover types from NMOP, two from MDLP, and aspen from NSU and WSU encompass 1.7 million acres or 61.1% of the statewide merchantable area. Thus, with only eight cover type and planning area combinations, we can anticipate major consequences for management outcomes from the forest planning model. It is also possible to draw conclusions about the relative importance of a cover type in terms of harvest volume versus acreage. In some cases, the cord volume is proportional to its area, e.g. aspen and black spruce lowland in NMOP (Figure 7). When this is true, we should find these acres proportionally represented in harvest volumes. Other cover types, in contrast, have disproportionally more volume than their area suggests, e.g. white cedar in NMOP or oak and central hardwoods in WSU (Figure 7). These cover types will feature more prominently in harvest volumes than their area coverage suggests. Table 1 shows a crosswalk for the cover type names.

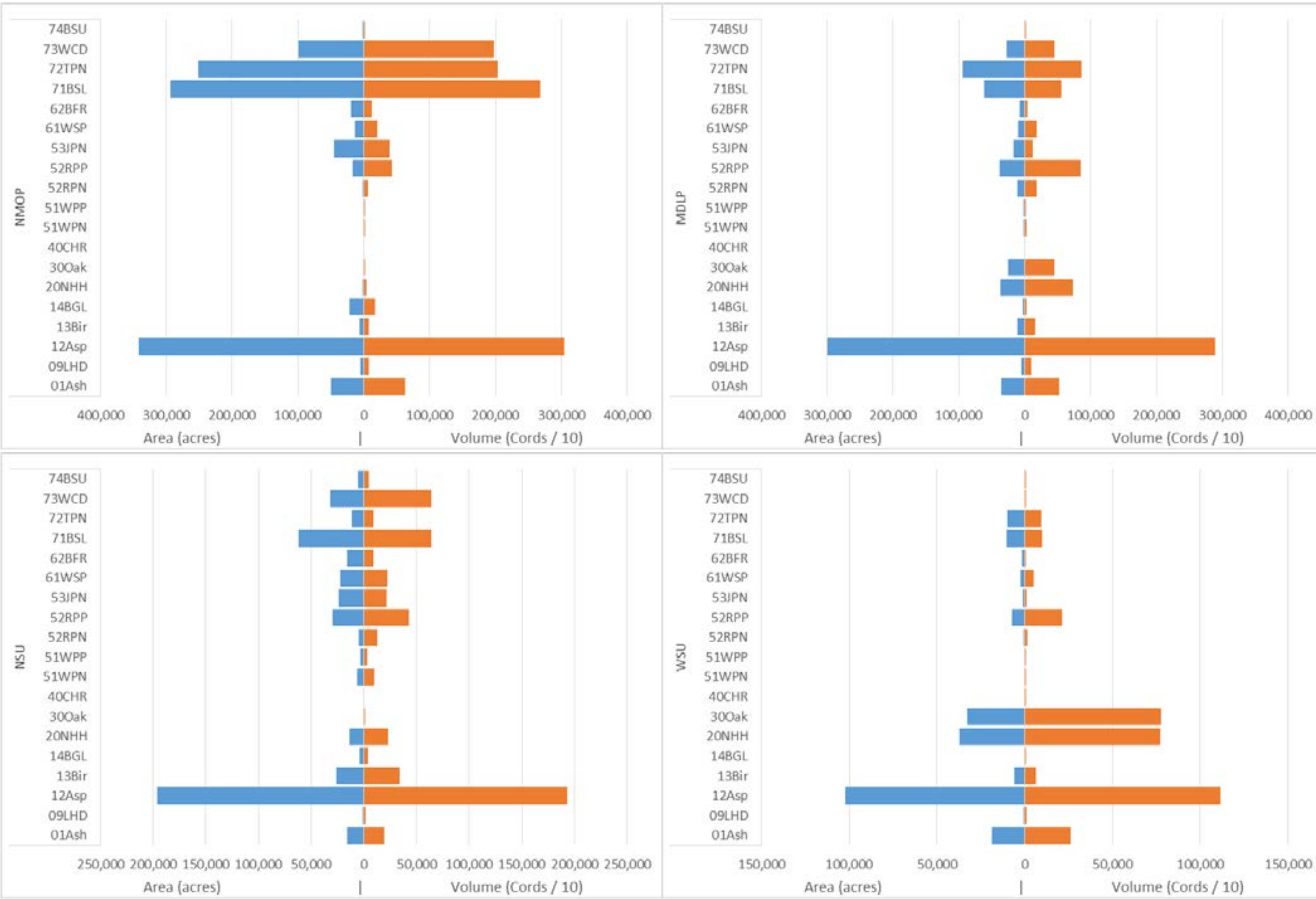


Figure 7. Comparative Histograms of Area versus Volume by Cover Type

Table 1. Cross-walk to cover type names

Woodstock Code	Simplified	Woodstock Code	Simplified
01Ash	01Ash	52RedPine	52RPN
09LowHrdw	09LHD	52RedPinePlt	52RPP
12Aspen	12Asp	53JacPine	53JPN
13Birch	13Bir	61WhitSpr	61WSP
14BlmGil	14BGL	61WhitSprPlt	61WSP
20NorthHrdw	20NHH	62BalFir	62BFR
30Oak	30Oak	71BlaSprLow	71BSL
40CentHrdw	40CHR	72TamPine	72TPN
51WhiPine	51WPN	73WhiCed	73WCD
51WhiPinePlt	51WPP	74BlaSprUpl	74BSU

The four main cover types in the NMOP planning area show markedly different demographic trends, reflecting a combination of different ecological characteristics as well as management histories. Aspen cover type (Figure 8) has the substantial majority of its acreage in age classes less than 40 years old, but these classes contain a small portion of the standing volume. The rotation age (Appendix A: Clear-Cut Management Regime) for NMOP aspen cover type (represented as the horizontal grey line, Figure 8) is 40 years, calculated as the acre-weighted average across site index. In terms of acreage, pre-rotation NMOP aspen constitutes 87% of the area but supports only 65% of the standing volume. Conversely, 35% of the standing volume is present on just 13% of the area. This demographic imbalance could indicate excess existing timber supply, with the caveat that aspen suffers from increased defect as trees senesce. For NMOP black spruce lowland cover type, pre-rotation stands represent 67% of the acreage and 47% of the volume, again suggesting an excess of post-rotation volume from a timber perspective (Figure 8). With a long rotation age of 90 years, however, black spruce lowland post-rotation acreage is the smaller component, and the forest planning model will need to wait for a larger fraction of the stand area to mature. The NMOP tamarack cover type has a similar profile, a long rotation age (80 years), with 64% of the area and 54% of the volume as pre-rotation (Figure 8), requiring a waiting period before harvest is possible. Conversely, 36% of the tamarack area and 46% of the volume are post-rotation, immediately available for harvest. The white cedar cover type in NMOP is managed with uneven-aged techniques, so rotation-based assessments are not relevant. Overall, major NMOP cover types hold a majority of their standing volume in post-rotation age classes.

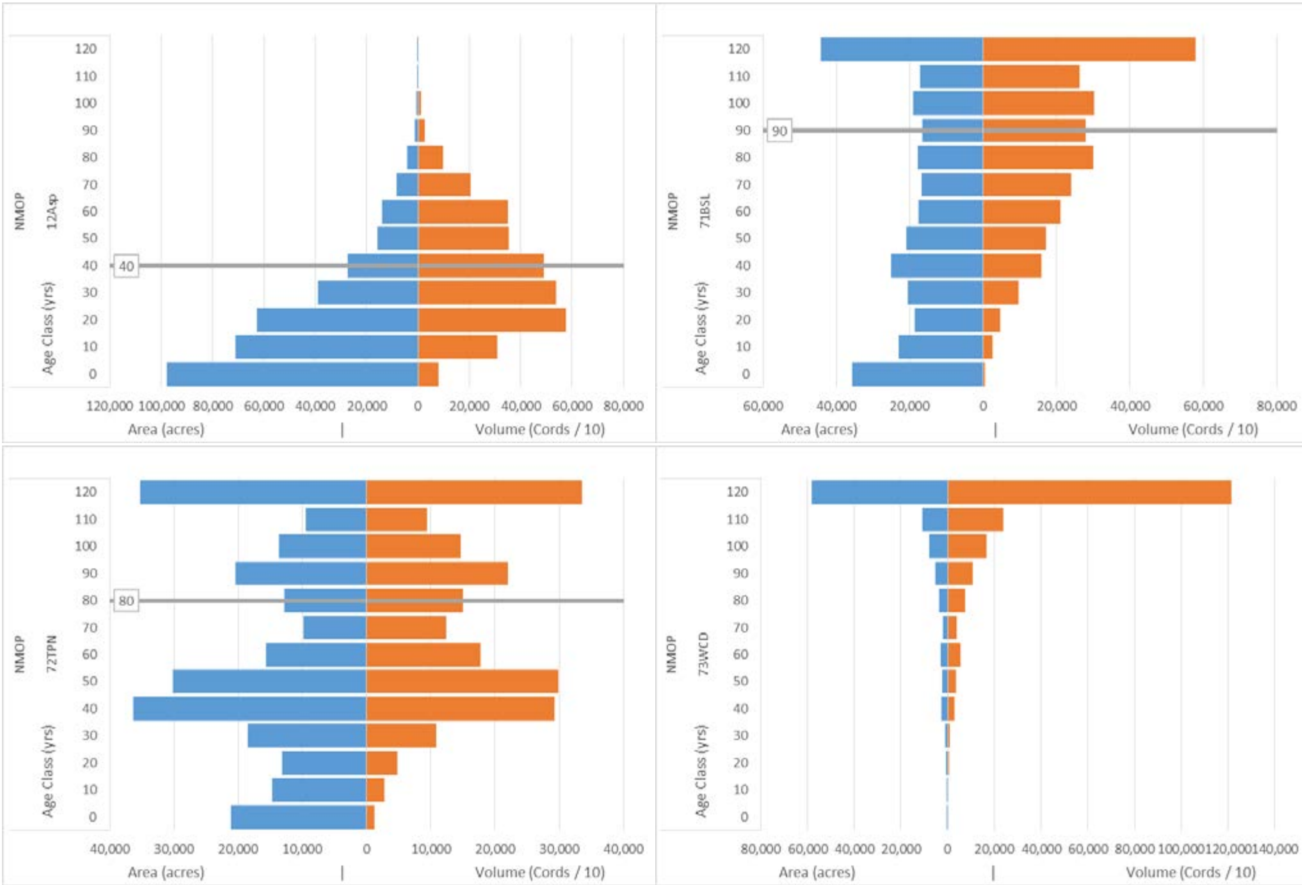


Figure 8. Demographic Pyramids with Rotation Age for the Top Four Cover Types

Different demographic patterns appear in the MDLP planning area. For tamarack (Figure 9), the six pre-rotation age classes represent 41% of the area but only 25% of the volume. Most of this cover type is available for immediate harvest. The aspen cover type in MDLP differs from its NMOP counterpart, however (Figure 9). Comparable area is pre-rotation (90%), but this area contains 73% of the standing volume. Post rotation aspen represents only 27% of the volume, so the forest planning model will need to meter aspen harvest as new acres reach rotation age. This constraint will become more influential, as the youngest age class is the largest area (Figure 9).

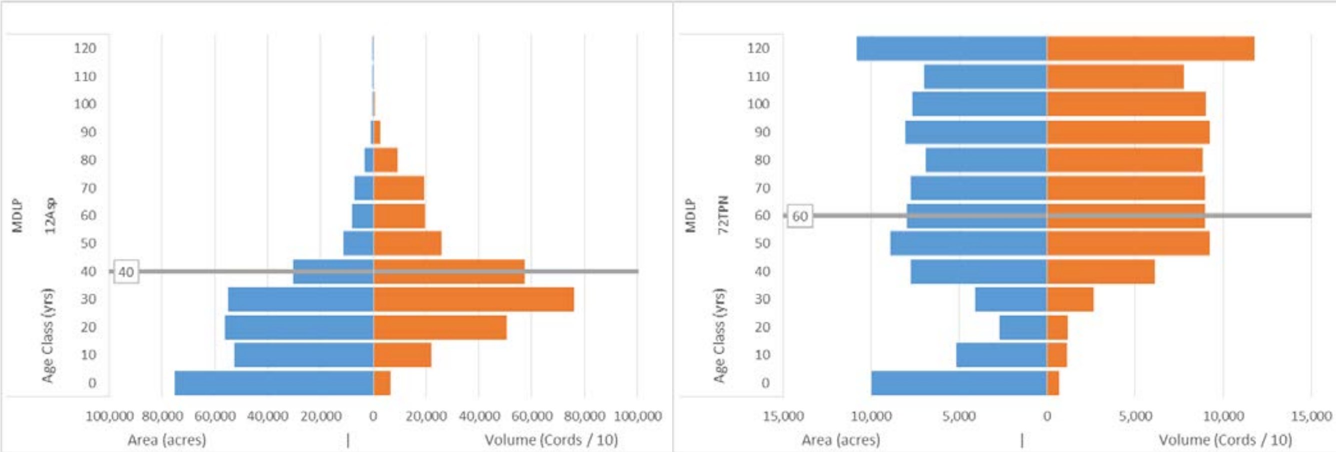


Figure 9. Demographic Pyramids with Rotation Age, MDLP Aspen, and Tamarack Pine

The aspen cover type in NSU and WSU planning areas is similar to MDLP, with most of the area and volume in pre-rotation age classes. The NSU aspen pre-rotation age distribution is more uniform, the largest acreage in the 20-year age class (Figure 10, left). For WSU, the pattern is more similar to NMOP and MDLP, with a larger fraction of aspen cover type area in the zero-year age class (Figure 10, right).

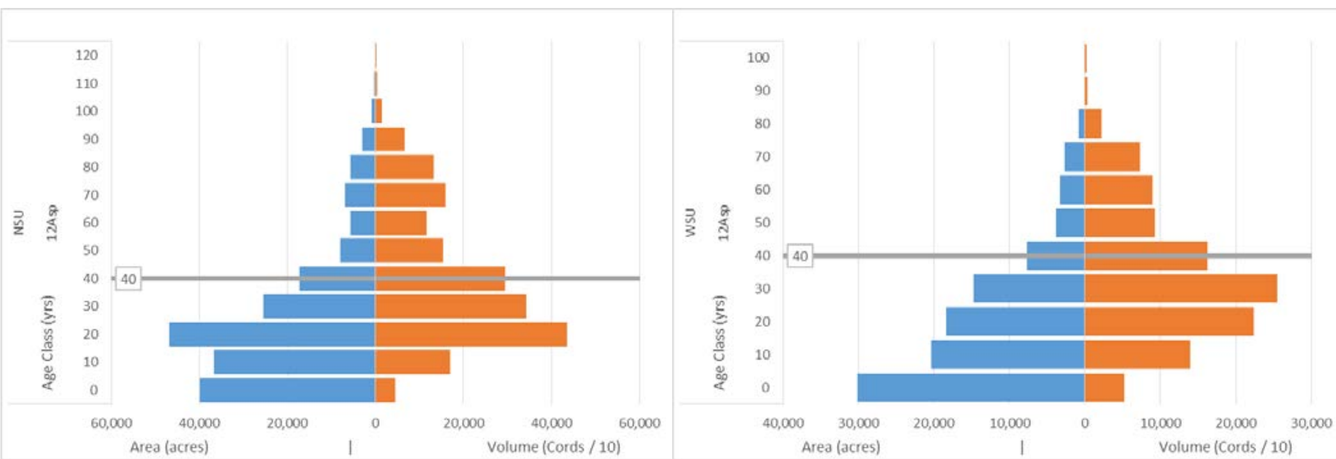


Figure 10. Demographic pyramids with rotation age for aspen cover type in NSU and WSU.

Area and volume data for each combination of cover type and age class, separated by planning area, are presented in tabular form in Appendix A for NMOP, MDLP, NSU, and WSU planning areas.

4.3 Yield Analysis

The yield analysis component of the analysis compared the yield tables provided by the MN DNR against published growth and yield projections. This allowed us to identify cases where the MN DNR yields diverged noticeably from published yields. In these cases, we suggested a multiplier that would align the MN DNR yields with the published yields. This approach is not a substitute for properly calibrated growth and yield projections, but it allowed us to perform a rudimentary analysis on the sensitivity of the forest planning results to yield tables and the potential magnitude by which future outcomes can be influenced by the yield assumptions. Future efforts should focus on refining the yield tables currently used by the MN DNR and testing them against observed yields.

This section is divided into three parts. Section 4.3.1 describes the process used to develop the current MN DNR yield tables. Section 4.3.2compares the MN DNR yield tables against published benchmarks. Section 4.3.3 makes suggestions for altering the MN DNR yield tables to align them with the published data.

4.3.1 MN DNR Yield Tables

The MN DNR uses distinct yield tables for each combination of planning area, cover type, and site index. Yield tables project strata level growth for basal area (square feet per acre) and volume (cords per acre). Data to develop these yield tables were sourced from the most recent Forest Inventory Module (FIM) (part of the state level cooperative stand assessment (CSA) program). The CSA program uses a double sampling variable radius plot methodology at sampling densities that vary depending on the size of the stand, to achieve a desired standard error on the attribute being measured (e.g. basal area, or estimated volume). Results of the sampling are summarized into stand level summations within the FIM database, and the original CSA measurements are not retained. Yield estimates were fitted using the FIM inventory data with functional forms from Walters and Ek[2] using least squares regression methods.

The models used by Walters and Ek to define yield tables are based on power functions, which were fit to the stand level inventory data using the R statistical computing environment as well as Statistical Analysis System (SAS®) software. The models for basal area and volume take on the same general form:

$$B = b_1 S^{b_2} A^{b_3} \quad [1]$$

Where:

$B =$ basal area (ft^2/ac) for all measured trees,
$S =$ site index (ft., base age 50), and
$A =$ stand age in years.

$$V = v_1 B^{v_2} H^{v_3} \quad [2]$$

Where:

$V =$ cords per acre for all trees ≥ 5 in. dbh, and
$H =$ average total height in feet units of dominant and co-dominant trees.

For volume (Equation 2), the height term was a calculated value based on equations from Ek (1971)[3]. When parameters were found to be insignificant at α = 0.05, they were excluded, and the affected model was fitted again. The original Walters and Ek formulation generates yield curves that continue to climb

[2] Walters, D.K., and A.R. Ek. 1993. Whole stand yield and density equations for fourteen forest types in Minnesota. Northern Journal of Applied Forestry 10: 75-85.
[3] Ek, Alan R. "A formula for white spruce site index curves." *For. Res. Note* 161 (1971): 2.

indefinitely. Undisturbed forest stands in Minnesota tend to enter a phase of volume and basal area decline at intermediate ages, however, so MN DNR used the Zobel, Ek, and O'Hara (ZEO) method (Zobel et al. 2014)[4] to introduce volume decline. The implementation of this technique is illustrated in Figure 11, where the dashed lines show the unadjusted growth estimates on the aspen cover type in MDLP, and the solid lines show the ZEO adjusted estimates. The top line represents site index 90 (base age 50), while the bottom line represents site index 20. The MN DNR used manager experience to govern the timing and magnitude of decline. For the forest planning model, MB&G used the yield tables as received.

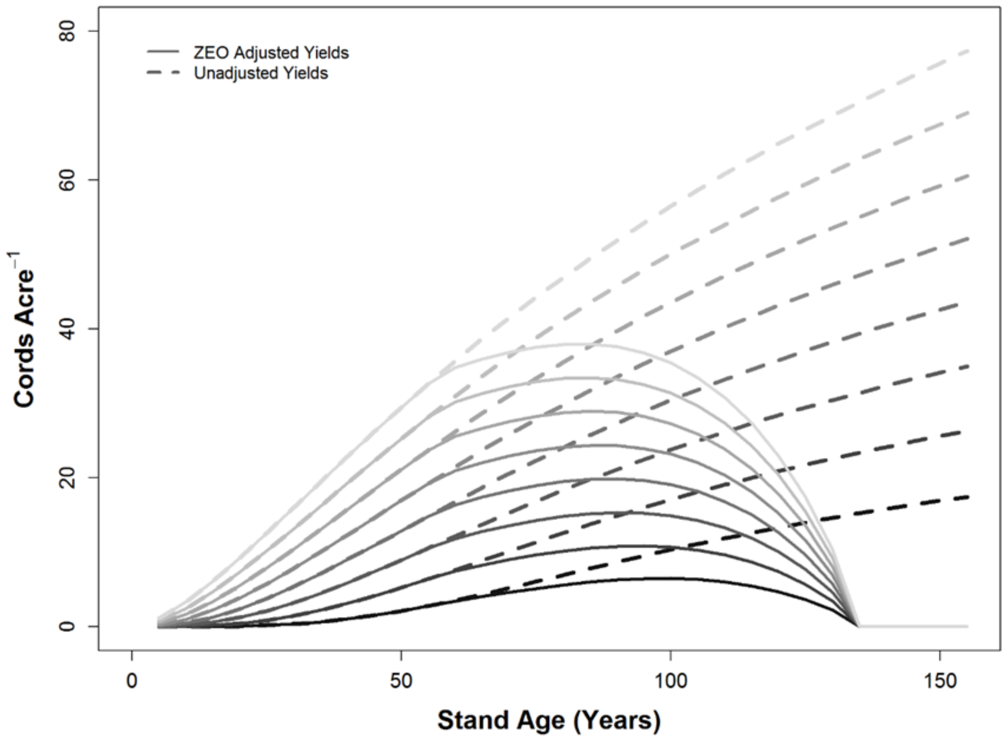


Figure 11. Illustration of ZEO yield adjustments

Final volumes by species are estimated using species compositions derived from FIA plots within the section for which yields are developed across all ownerships. In Minnesota, FIA plots are re-measured every five years as opposed to the national seven-year re-measurement, and at a higher intensity sampling rate, resulting in a resolution of 1 plot per 3,000 acres, as opposed to the national 1 plot per 6,000 acres[5].

4.3.2 Benchmarking of MN DNR Yields

Yield tables by cover type were used in the forest planning model as they were received by MB&G from MN DNR. We reviewed literature sources, also provided by MN DNR, to assess whether these yield tables

[4] Zobel, J.M., A.R. Ek, and T.J. O'Hara. 2014. Description and implementation of a single cohort and lifespan yield and mortality model for forest stands in Minnesota. Minnesota Forestry Research Notes No. 298.

[5] www.fia.fs.fed.us/program-features/basic-forest-inventory

can be supported by published results. Of the literature provided to us, four publications reported empirical yields for relevant cover types and could be converted to units of cords per acre. These papers provided a yield benchmark for aspen (Ek and Brodie 1974[6]), red pine plantation (Buckman *et al*. 2006[7]), aspen and natural red pine (Zobel *et al*. 2015[8]), and hardwoods (Gevorkiantz and Duerr 1937[9]).

In this section, we compare yield values from the literature to those from the MN DNR for aspen, natural red pine, plantation red pine, lowland hardwood, and northern hardwood. Within each cover type, we present the literature yield comparison relative to MN DNR yields from the four main planning areas: NMOP, MDLP, NSU, and WSU. For aspen, the site index 50 yields match well among Ek, Brodie, and MN DNR, and the site index 65 yields from Zobel *et al*. are proportional to MN DNR yields (Figure 12). The site index 60 yields from Ek and Brodie are similar to the site index 65 yields from Zobel *et al*., at least through age 60 years. We find MN DNR yields to be in accord with published values at least for ages up to 60 years, and site index values through 65.

[6] Ek, A.R., Brodie, J.D. 1975. A preliminary analysis of short-rotation Aspen management. Can J. For Res. 5, 245.
[7] Buckcman, R.E., Bishaw, B., Hanson, T.J., Benford, F.A. 2006. Growth and yield of red pine in the lake states. USFS General Technical Report NC 271.
[8] Zobel, J.M., Ek, A.R., O'Hara, T.J. 2015. Quantifying the opportunity cost of extended rotation forestry with cohort yield metrics in Minnesota. Forest Science. 61 (6): 1050-1057.
[9] Gevorkiantz, S.R., Duerr, W.A. 1937. A yield table for northern hardwoods in the lake states. Lake States Forest Experiment Station. 340-343.

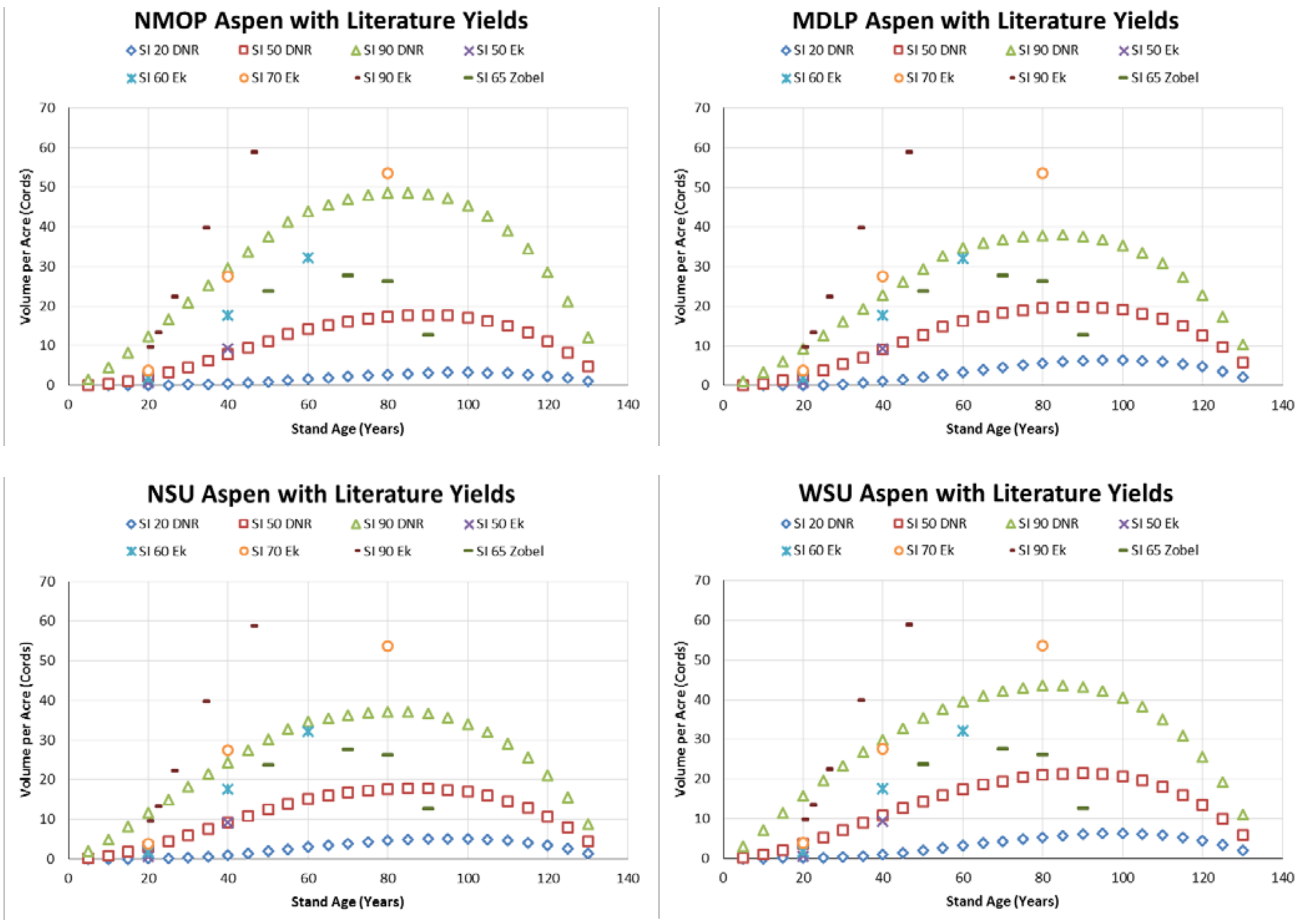


Figure 12. Literature yields for aspen cover type compared to MN DNR yields

At site index values higher than 60, however, the available literature (Ek and Brodie 1974) reports higher aspen yields than used for the MN DNR model. From Ek and Brodie, site index 70 aspen yields are parallel with site index 90 yields from MN DNR (Figure 12). Again, from Ek and Brodie, site index 90 aspen yields resemble MN DNR yields through age 20, but then rapidly increase through age 40 and end approximately twice as high as MN DNR values (Figure 12). Aspen standing volume begins to decline after a certain age. For MN DNR, the peak occurs around 90 years (Figure 12). No evidence to the contrary is present in Ek and Brodie, but the Zobel *et al*. site index 65 yield curve begins a rapid decline at age 70 and falls below the MN DNR site index 50 curve at 90 years. Overall, literature yields for aspen support MN DNR yields for site index less than 70, and for ages up to about 80 years. MN DNR aspen yields for site index values above 70 may be slightly low, and long-term yields may be high.

MN DNR yields for natural pine are similar between NMOP and NSU planning areas, much lower for the MDLP area, and somewhat higher for the WSU planning area (Figure 13). From our literature review, we have one example of natural red pine yield, corresponding to a site index 65 (Zobel *et al*. 2015). The WSU planning area shows the closest match to the literature's natural red pine yields, with the MN DNR site index 50 yield curve falling proportionally below the published site index 65 curve (Figure 13). For the NMOP and NSU planning areas, the published site index 65 curve is aligned with the site index 90 MN

DNR curve through a stand age of at least 120 years, while all yields for MDLP are substantially lower than the published curve (Figure 13). With a single curve available in the provided literature, we have insufficient information to determine whether natural red pine yields are defensible for all planning areas. The close alignment of WSU natural red pine yields with the published values supports the accuracy of MN DNR yields for this planning area but not necessarily for the others.

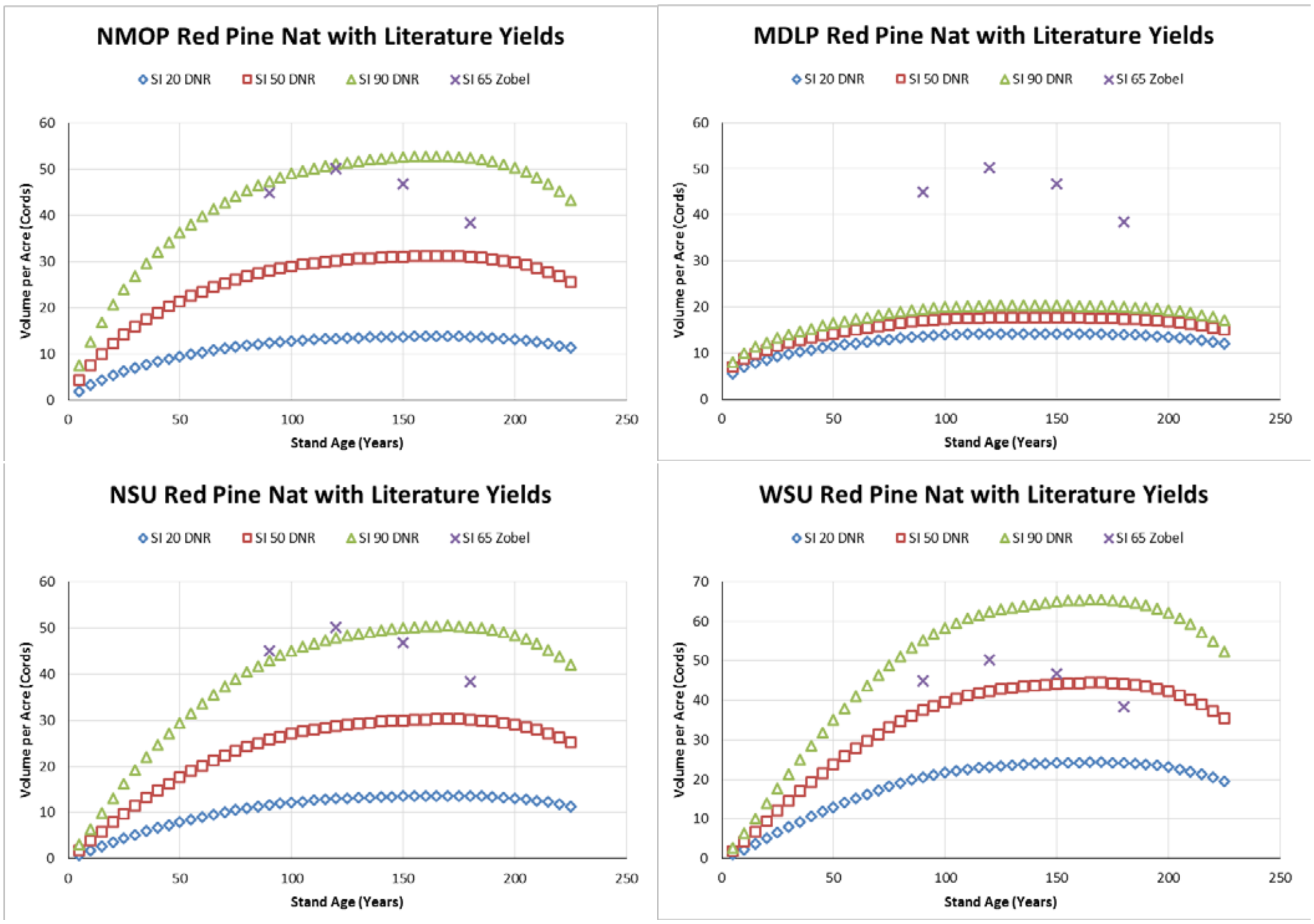


Figure 13. Literature Yields for Natural Red Pine Compared To MN DNR Yields

For the plantation red pine cover type, we found literature yield values (Buckman *et al*. 2006) for site index 40 through 80 in 10’ increments (Figure 14). None of these published yield curves corroborated MN DNR yields, however. The site index 90 yield curve for NMOP, NSU, and WSU planning areas was most similar to the site index 50 yields from Buckman *et al*., while the site index 90 curve for MDLP was aligned with the published site index 40 curve (Figure 14).

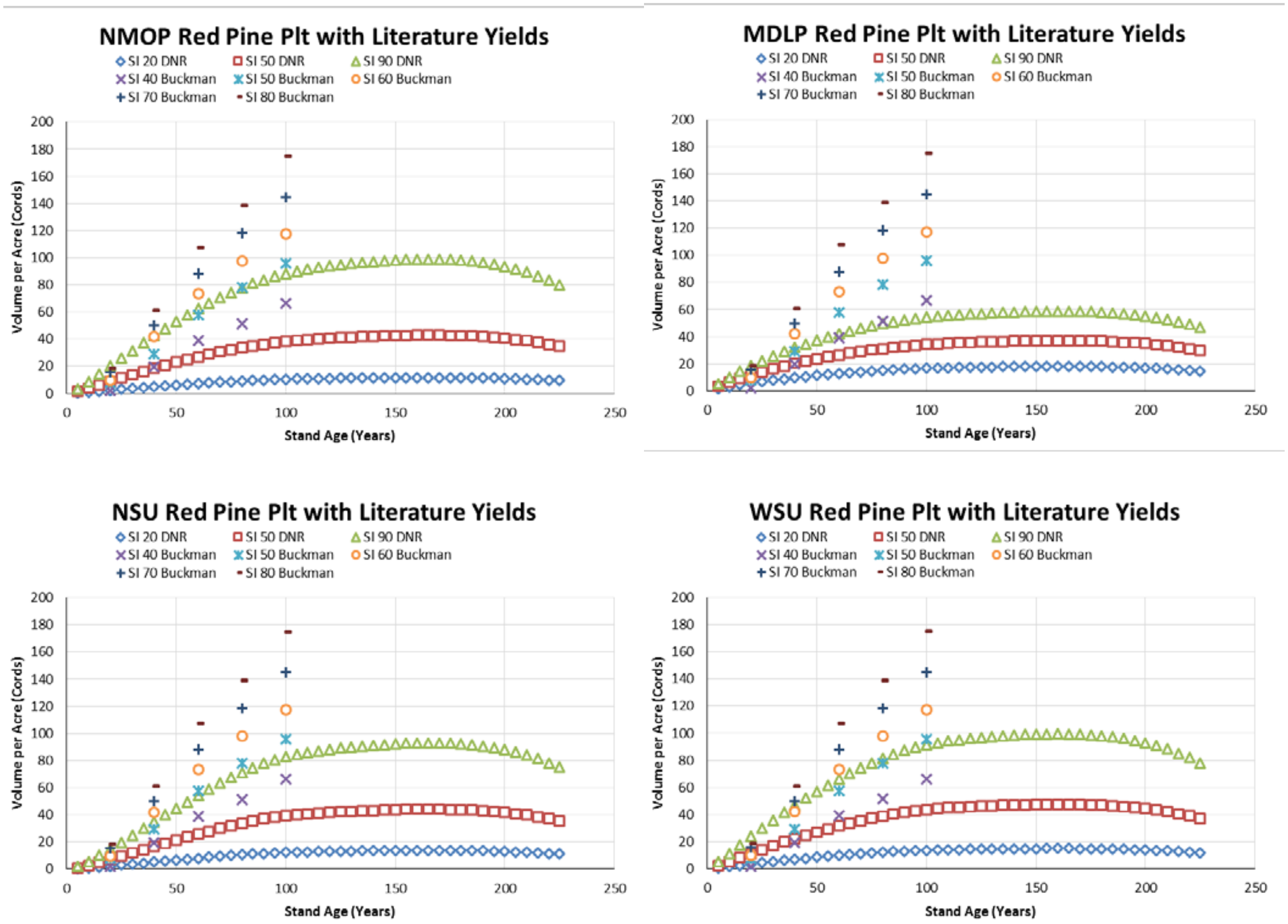


Figure 14. Literature Yields for Plantation Red Pine Cover Type Compared MN DNR Yields

The literature suggests that a natural red pine stand of site index 65 (Zobel *et al*. 2015) should have a peak yield at age 120 years of around 50 cords per acre (Figure 13). By comparison, we encounter published values for plantation red pine of nearly 70 cords per acre at age 100 and at site index 40, and up to 175 cords per acre at age 100 for site index 80 (Figure 14). Within the MN DNR yield tables, the range of yields across cover types in NMOP, for example, using site index 90 at age 100, ranges from 4 cords per acre (jack pine) to 116 cords per acre (black spruce lowland); plantation red pine yields 88 cords per acre, falling toward the higher end of the range. It seems unlikely that MN DNR yields could be as low as 50%, and it also seems unlikely that intermediate site index red pine plantation should show comparable yields to high-site index black spruce. We conclude that the MN DNR plantation red pine yields may be somewhat low but that the available literature values are higher than what would be realistic. We have used MN DNR yields as provided for the forest planning model, but caution that red pine plantation yields may be low.

Available yields for hardwood cover types in the set of literature provided to MB&G are limited (Gevorkiantz and Duerr 1937), with numeric values published for “Good site”, “Medium site”, and “Poor site”. Lacking further site index information, we have translated these classifications to site index values of 85, 45, and 25, respectively. We compared the literature site index 45 and 85 yields to MN DNR Northern hardwood yields (Figure 15), and the site index 25 yields to MN DNR lowland hardwood yields (Figure 16).

The NMOP planning area is similar to both MDLP and NSU for northern hardwood so we show NMOP as the representative. The WSU planning area has slightly higher yields, so we show it separately (Figure 15). Published site index 85 yields intersect NMOP northern hardwood site index 90 yields around age 70, and literature site index 45 yields intersect NMOP site index yields around age 60. These intersections are delayed by about 10 years for the WSU planning area. At stand ages less than 100 years, MN DNR yields are comparable to published Northern hardwood yields. Over longer time periods, the MN DNR yields may be conservative.

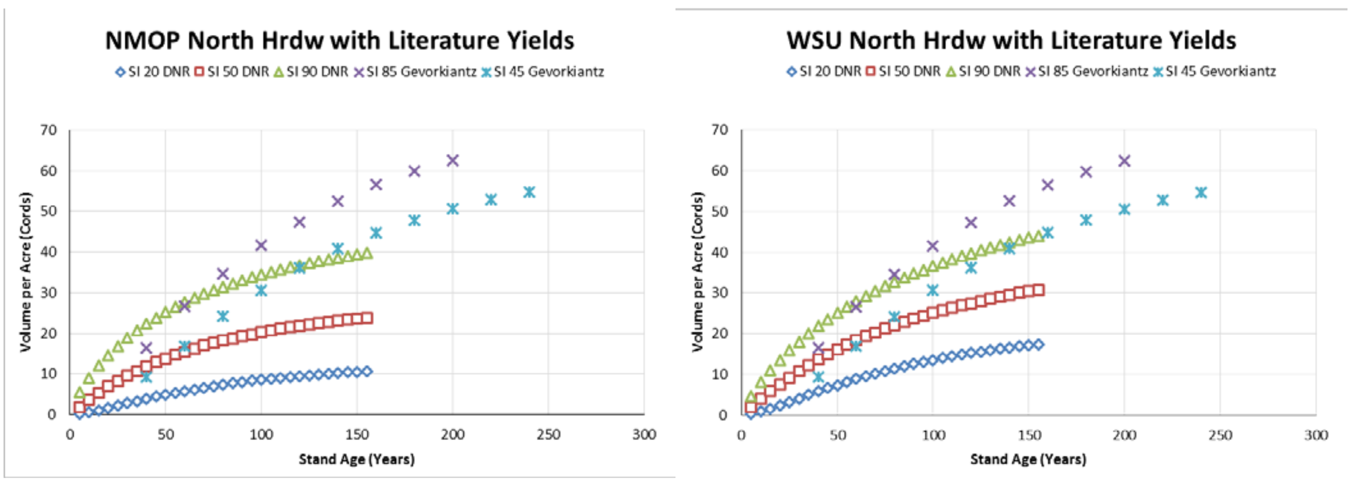


Figure 15. Literature Yields for North Hardwood. NMOP Closely Resembles MDLP and NSU

For lowland hardwoods, we compared the literature site index 25 yield curve to NMOP (now representing NSU and WSU) and to MDLP, which was slightly different from the others (Figure 16). Through approximately age 60, the published yields are comparable to site index 20 volumes from MN DNR.

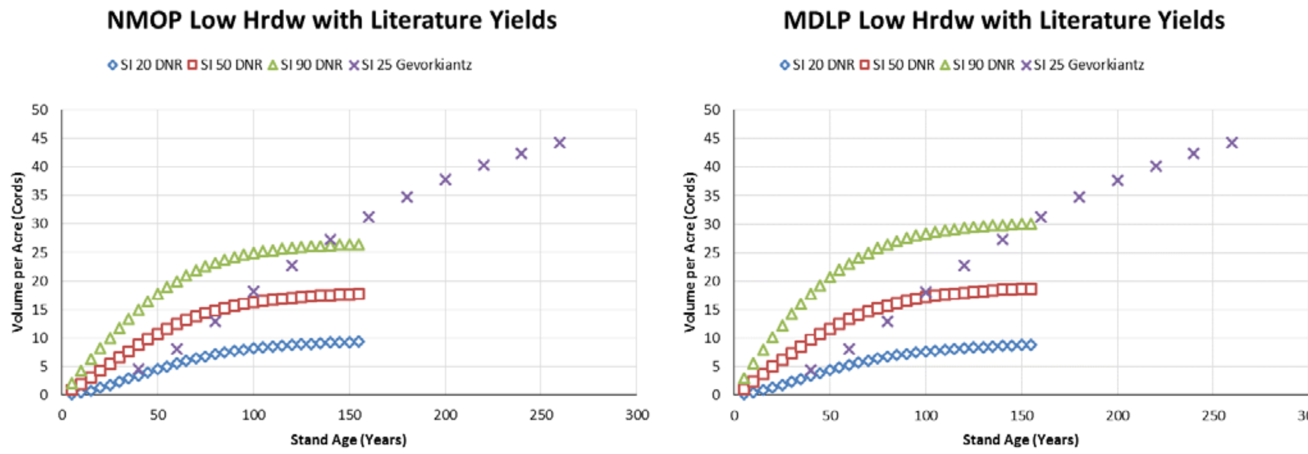


Figure 16. Literature Yields for North Hardwood. NMOP Closely Resembles NSU and WSU

Where published data are available, we can make a semi-quantitative assessment of how MN DNR yields compare to the literature. We have examined low (20), intermediate (50), and high (90) site index yield curves from the MN DNR yields, and contrasted these to published yields of comparable site index. In many instances, MN DNR yields are comparable to published values ("comp.", Table 2), or we have insufficient published data to make a direct comparison ("---", Table 2). In other cases, the MN DNR yields may be lower or higher than literature values, either for certain site index levels or at different stand ages. In the summary table below, cases where MN DNR yields fall below literature expectations are listed as "low", while yields higher than literature expectation are listed as "high" (Table 2).

Table 2. Comparison of MN DNR to Literature Yields

Literature Comparison		Site Index Range			Stand Age Range	
Cover	Planning area	20	50	90	Early	Late
Aspen	NMOP	---	comp.	low	comp.	high
Natural red pine	NMOP	---	low	---	low	low
Plantation red pine	NMOP	low	low	low	low	low
North hardwood	NMOP	---	comp.	comp.	comp.	low
Low hardwood	NMOP	comp.	---	---	comp.	low
Aspen	MDLP	---	comp.	low	comp.	high
Natural red pine	MDLP	---	low	---	v. low	v. low
Plantation red pine	MDLP	low	low	low	low	low
North hardwood	MDLP	---	comp.	comp.	comp.	low
Low hardwood	MDLP	comp.	---	---	comp.	low
Aspen	NSU	---	comp.	low	comp.	high
Natural red pine	NSU	---	low	---	low	low
Plantation red pine	NSU	low	low	low	low	low
North hardwood	NSU	---	comp.	comp.	comp.	low

Literature Comparison		Site Index Range			Stand Age Range	
Cover	Planning area	20	50	90	Early	Late
Low hardwood	NSU	comp.	---	---	comp.	low
Aspen	WSU	---	comp.	low	comp.	high
Natural red pine	WSU	---	comp.	---	low	low
Plantation red pine	WSU	low	low	low	low	low
North hardwood	WSU	---	comp.	comp.	comp.	low
Low hardwood	WSU	comp.	---	---	comp.	low

The yield tables that MB&G has used in the Woodstock model are typically comparable to published yields. Some exceptions include MN DNR plantation red pine and natural red pine yields that might be lower than suggested by the literature. Hardwood yields that may be comparable to the literature early in stand development, but lower than published yields at advanced stand ages. This literature review does suggest that the MN DNR yields have reasonable support from published values, and that sensitivity analysis might be pursued for aspen and red pine cover types.

4.3.3 Alternative Yield Tables

Where MN DNR yields differ from published yields, we propose alternative yield tables when the literature values are well supported. The MN DNR yield tables are more geographically localized than most of the literature yield examples, so it is unlikely that yields from all planning areas can be legitimately compared to the published values. The literature should not be a determining factor for differences in planning areas—those differences should be maintained because they derive from MN DNR data and localized sources of knowledge. In cases where literature and MN DNR yields are very closely matched, however, we can have confidence in the other published values as the source data might serve as an indicator for alternatives to MN DNR yields.

For aspen, the site index 50 MN DNR yield at age 40 for the NSU planning area is nearly identical to the Ek and Brodie value. The same comparison for site index 90 (NSU, age 40) shows around 45 cords per acre from Ek and Brodie, but only 25 cords per acre from MN DNR (Figure 12). Comparing the two available literature values at their closest common site index and age 40, we see around 18 cords per acre on site index 60 from Ek and Brodie, and 16.5 cords per acre on site index 65 from Zobel *et al*., but only 14.5 cords per acre on site index 65 from MN DNR. The literature values are largely in agreement, but MN DNR appears to be lower than the publications. Thus, for site index values less than or equal to 50, an alternative aspen yield table would remain the same, but for site index values 60 and above, an alternative yield would be multiplied by the ratio of published values to MN DNR at the reference age, or 1.176 (Table 3). This multiplier applies in the same way to aspen yields for all planning areas, maintaining the relative difference among planning areas but increasing yields for higher site index stands.

The available literature for plantation and natural red pine does not have adequate replication to determine whether there is internal consistency between at least two literature sources. We hesitate to alter red pine yields in direct proportion to literature values for both management types, but we can identify evidence in support of alternative yields. For planted red pine, the closest resemblance of literature values to MN DNR occurs at age 40, where MN DNR site index 50 yields 18.5 cords per acre and Buckman *et al*. site index 40 yields 29.3 cords per acre. The very high eventual yields from Buckman *et al*. are unlikely in these planning areas, but the early stage growth and relative ranking of yields below age 50 are more realistic. As an alternative for planted red pine, MN DNR yields are adjusted upwards using a multiplier that is the ratio of 40-year yields from MN DNR site index 50 and Buckman *et al*. site index 50, or a scalar value of 1.58, which would apply across all site index values (Table 3).

With only a single yield curve for natural red pine, it is not possible to select a scalar multiplier to adjust MN DNR yields in an alternative scenario. The natural red pine yields from Zobel *et al*. show that the rate of decline in natural red pine standing volume after age 120 is steeper than assumed in MN DNR yields. The closest alignment of natural red pine yields between MN DNR and Zobel *et al*. occurs for site index 90 in the NMOP planning area, where the two curves differ only by 2.5 cords per acre at age 90 (Figure 17). After age 120, the published yields decline at a sustained rate, which can be approximated by a 2% annual decline. To make MN DNR alternative red pine yields resemble the literature pattern, every yield curve would be modified to decline at a 2% annual rate after age 120 (Figure 17), which maintains relative differences between planning areas but factors in what is known about long-term stand dynamics from published sources.

For lowland and northern hardwoods and the cover types for which we had no available published yield data, no recommendations are made for alternative yields. The functional form taken by MN DNR yields results in faster early-stage growth rates for both hardwood types than seen in Gevorkiantz and Duell, and both types reach lower long-term standing volumes. Due to the 1937 publication date of the Gevorkiantz and Duell results, it is likely that their study was based on stand types that are no longer widely represented on the landscape. In the alternative yields scenario of the forest planning model, we do not recommend any alternative yields for most cover types, except for the scalar multipliers for aspen and planted red pine (Table 3) and the 2% annual decline rate for natural red pine (Figure 17) implemented after age 120 years.

Table 3. Scalar Multipliers and Percent Decline For Select Alternative Yields

Alternative Yield Formulation	Yield Table Element		
Cover Type	**SI ≤ 50**	**SI 50**	**Age ≥ 120**
Aspen	1	1.175	1
Natural red pine	1	1	-2%
Plantation red pine	1.58	1.58	1

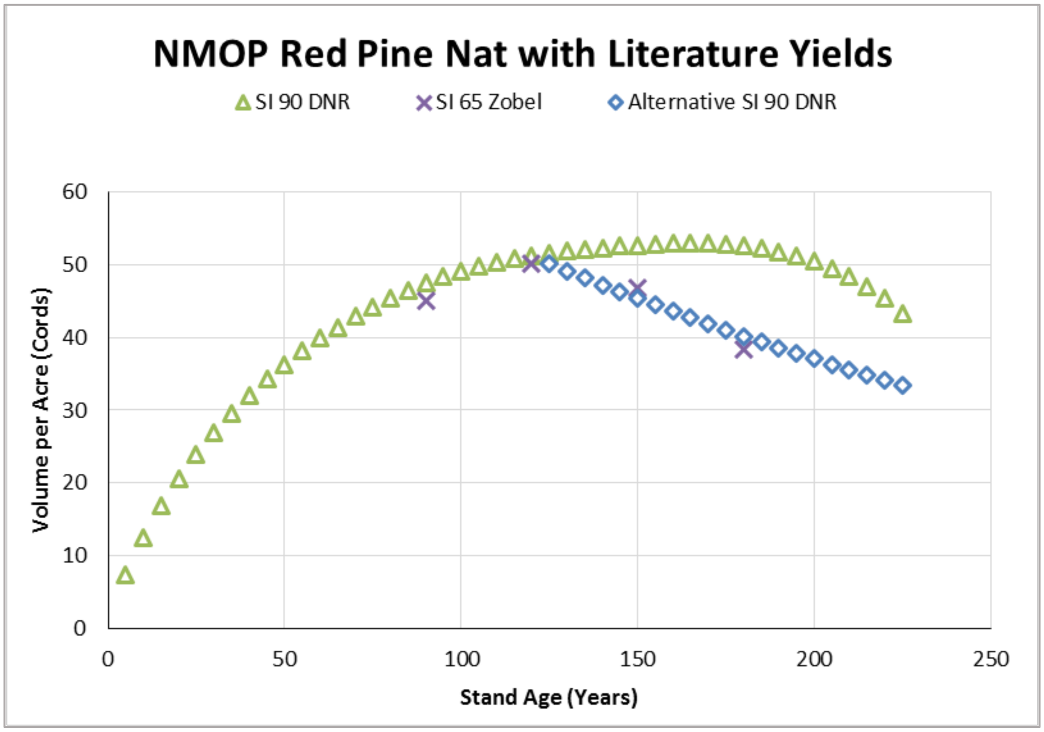


Figure 17. Alternative Natural Red Pine Yield Curve

4.4 Sustainable Timber Harvest Model

The analytical approach that was used for this project called for the optimization of various management scenarios. Each scenario implemented a different approach to meeting the strategic goals of the STHA. These goals were targeted towards maintaining natural resource economies, preserving water quality, increasing biodiversity, and protecting wildlife habitat. The scenarios also explored various assumptions on growth projections and investment management. Together these scenarios spanned a wide spectrum of management approaches and comparing them determined the bookends of the solution space as well as potential synergies or tradeoffs. To facilitate this type of analysis, the forest planning model had to be flexible in terms of objectives, constraints, and data, but also be capable of solving a large forest management problem. The following sections will describe the model that we constructed to meet these requirements.

4.4.1 Model Structure

The model that was selected for this project took the form of a linear programming (LP) formulation. These types of models are well suited to strategic/tactical forest management planning and can accommodate the analytical requirements of this project. The solutions provided by LP models are always optimal, given the underlying assumptions and data. Heuristic /random search models do not guarantee optimality and require more exploration of the solution space to determine the degree of optimality. The model was constructed with Remsoft's[10] Spatial Planning System. It provides tools for rapid development of an LP forest planning model, coupled with the ability to incorporate data from various sources, manage and run various scenarios, and report results in various formats. It also provides the ability to incorporate spatial data, which can be used to import the landscape level data, as well as report solutions spatially.

The structure of the forest planning model consisted of development types, actions, transitions, yields, objectives, and constraints. Development types are the building blocks of the management plan, each representing the condition of the land under various management assumptions at a given point in time. They are initialized by the current condition of the land (FIM data) and change over time in response to growth and management. Actions represent the management regimes and associated treatments that could be applied to development types. Transitions modify development types in response to an action. Each action is associated with a set of development types, which enables us to limit or shape treatments for Wildlife administered lands, endangered and threatened species, and state species of concern. Yields represent the projected condition of a development type in response to management at a given point in time and incorporate parameters such as available timber volume and stumpage revenue. Objectives establish the model outcome that will be optimized by the LP solver. In this model, it ranged from present stumpage revenue to forest-age diversity. Constraints place limitations on the optimal solution and ensure that certain conditions are maintained while the model seeks optimality. A wide range of constraints was used in this model and included ending inventory to ensure sustainable timber supply,

[10] http://www.remsoft.com/

even-flow of timber harvest for maintaining natural resource economies, harvest limitations on catchments for preserving water quality, native plant community and forest-age targets to increase biodiversity, and old forest habitat targets to preserve wildlife habitat.

The planning horizon selected for this model was 100 years. This was partitioned into 20 planning periods, each 5 years in length. The model represented the condition of land at the mid-point of each period. The length of the planning horizon was dictated by model size and duration of solving time.

In the following sections, we will describe how the development types, actions, transitions, yields, objectives, and constraints were implemented.

4.4.2 Development Types

The land-base used for this study was derived from the FIM shapefile (MB_FIM_1F) provided by the MN DNR (4.2.1). This file contained both the location and spatial extent of each stand, as well as ±220 attribute fields describing various aspects of the stand. The shapefile contained 195,078 polygons, after removing the Prairie Parklands planning area (no management options).

The data from the shapefile was reorganized into a series of themes, where each theme described a property or characteristic of the land that was essential to the forest planning model. A total of 19 themes were created, and the definition of each can be found in Table 4:

Table 4. Forest Planning Model Theme Definitions

Name	Description
Planning Area	Identifies planning areas. Used to limit model constraints and report results at a planning area level.
Cover Type	Identifies main vegetation type, including non-forested and bare land. Use to determine growth and yield estimates and management regimes and rotation age.
Site Index	50-year site index class. Used to determine growth and yield, as well eligibility for management regimes.
Regime	Identifies the management regime used for each acre.
Rotation	Tracks forest rotation through time. Used to determine eligibility for management regime options.
Administrator	Classifies land administrator as DNR Forestry or Wildlife. Used to determine management regimes and rotation age.
Means of Acquisition	Identifies Trust Lands. Used to optimize and report harvest from Trust Lands.

Name	Description
Operability	Identifies land that is not eligible for management regimes due to terrain conditions. Not used in the final formulation, because operability was also encoded in Theme 6.
Availability for Management	Identifies land that is unavailable for management due to administrative restrictions, inoperable terrain, old growth designation and classification as RSA. Used to determine eligibility for management regimes.
Catchment	Unique identifier for each catchment. Used to constrain and report the percentage of open catchments. Only priority catchments were included in the model.
Catchment Significance	Identifies priority catchments as containing a Lake of Biological Significance, Designated Trout Stream, Protected Tributary to a Designated Trout Stream, Lake of highest Phosphorus Sensitivity, or highly erodible soils. In addition, only catchments with more than 500 MN DNR acres and more than 5% of the area administered by the MN DNR were considered. Used to identify catchments that should be constrained with regards to the amount of open MN DNR land.
Riparian Management Zones	Identifies lands falling within Riparian Management Zones (RMZ). Used to restrict management within RMZs.
Endangered and Threatened Species	Identifies land with state-listed endangered and threatened species. Used to limit management regimes and intensity.
Species of Special Concern	Identifies the presence of state-listed species of special concern (SPC). Used to limit management options on lands with SPC present.
Eagle Nest Presence	Identifies the presence of bald eagle nests. Used to limit the management options on lands with eagle nests present.
Habitat Hexagons	Unique identifier for each habitat hexagon. Used to set goals and report on the percentage of hexagons within DNR lands meeting criteria for young and old forest species guilds.
NPC	Identifies Native Plant Community class (NPC). Used to set goals and report on the number of acres in each growth stage within each NPC.

Name	Description
Priority Cover Type	Identifies lands with a commercial cover type within 75 miles of the seven largest fiber users. Used to report commercially viable harvest volume.
Physiographic Class	Identifies terrain where soil moisture could constrain operability. Used to report harvest volume and acres that could be inoperable in certain seasons.

Table 5 contains a summary of how the acres were allocated within the major themes. It shows that of the 5,290,074 acres imported into the model, 2,750,066 (52%) were classified as merchantable (manageable, forested and commercial). In terms of administrator, 86% of the acres received the Forestry management regimes, and 14% the Wildlife regimes. 99% of the merchantable acres had no management restrictions due to endangered and threatened species, while 99.5% of the acres had no restrictions due to eagle nesting areas. State species of special concern caused reduced harvest on 4% of the merchantable acres. 79% of the acres were unencumbered by RMZ's, and 21% would receive reduced harvest levels to account for the presence of RMZ's. 32% of the merchantable acres fell within a priority catchment and would be subject to harvest constraints within watersheds. 74% of the merchantable acres fell within a mill procurement area. 58% of the acres were on dry soils, and 42% on wet.

Table 5. Acres by Selected Model Themes

	Total MN DNR Area	Merchantable Forest Area
Total		
Total Acres[1]	5,290,074	2,750,066
Administrator		
Division of Forestry	3,836,231	2,364,714
State Parks, SNAs, and Other DNR	426,395	
Division of Fish & Wildlife	1,027,448	385,352
Trust Land		
Non Trust	2,880,141	1,287,962
Trust	2,409,932	1,462,104
Endangered and Threatened Species		
No Management Allowed	51,658	10,786
No Restriction	5,144,452	2,715,632
Reduced Harvest Only	93,963	23,647
Bald Eagle Nest Site		
Full Management	5,209,427	2,737,159
No Management	2	2
Partial Management	80,645	12,906

	Total MN DNR Area	Merchantable Forest Area
Species of Special Concern		
Not Present	4,900,313	2,647,311
Present	389,760	102,755
Riparian Management Zones		
Not within an RMZ	3,292,167	2,158,975
Fully within an RMZ	917	18
Partially within a RMZ	1,996,990	591,073
Catchments		
Non-Significant	3,635,828	1,865,202
Significant	1,654,246	884,864
Mill Procurement Areas		
Non Priority Cover Type	3,106,932	705,518
Priority Cover Type	2,183,142	2,044,548
Physiographic Class		
Dry Soils (Xeric, Xeromesic, Mesic)	2,192,639	1,581,552
Wet Soils (Hydromesic, Hydric)	3,097,434	1,168,514

[1]Prairie Parklands is not considered in this analysis and are omitted from these calculations.

In addition to building the themes, we also associated total acres and current age with each polygon. Acres were determined by the spatial extent of the polygon. For age, we used the “under development” age from the FIM data, which assigned an age of zero to all stands that are in the current management plan. The model, therefore, assumes that all planned operations has already happened. Age was expressed as age in planning periods, which is the age in years divided by 5 (5 years per planning period). We also advanced the age of each polygon to the middle of the first planning period (added 2.5 years to age). This ensured that stands were represented at the mid-point of each planning period.

All of this information was imported into the forest planning model. During this process, the model aggregated the acres into strata, based on unique combinations of the thematic codes and age. These strata are referred to as development types since they represent the various stages of land development (current and future). Each development type is unique since it is defined by a unique combination of the themes and age. This resulted in 129,349 development types.

4.4.3 Actions & Transitions

The forest planning model utilized actions and transitions to simulate the silvicultural treatments associated with the management regimes. The actions were used to filter out the development types that were eligible for each management regime in each period, while the transitions changed the condition of development types in response to a management treatment. Six management regimes were modeled, namely clear-cut, aspen clear-cut with conversion, commercial thinning, partial harvest, uneven-aged harvest, and regulated uneven-aged harvest. The actions and transitions associated with each of these regimes are described below:

4.4.3.1 Clear-Cut

The clear-cut action simulated the application of a regeneration harvest. As such, it harvested the existing development type by removing all standing inventory (allowing for a 5% reserve for best management practice guidelines) and regenerated to a future development type by resetting the age. Eligibility for the clear-cut action was determined by planning area, cover type, site index, and administrator (forestry or wildlife). Each unique combination of these factors was associated with a minimum rotation age, which is listed in Appendix A: Clear-Cut . Additional limitations were as follows:

- Available for management
- Operable
- No endangered and threatened species restrictions

The actions for the clear-cut regime were partitioned into two main sets, one for the forestry administered lands, and another for the wildlife lands. The wildlife lands typically required longer rotation ages, while the forestry lands utilized ages that were 5 years shorter than normal or economic rotation age. The cover types that were eligible for clear-cut are shown in Table 6. This shows that ash, lowland hardwoods, natural red pine could only be clear-cut on forestry lands, while white pine, Scots pine, and offsite oak could only be clear-cut on wildlife land.

Table 6. Clear-Cut Cover Types for Forestry and Wildlife Administered Lands

Forestry	Wildlife
01Ash	
09LowHrdw	
12Aspen	12Aspen
13Birch	13Birch
14BlmGil	14BlmGil
20NorthHrdw	20NorthHrdw
30Oak	30Oak
40CentHrdw	40CentHrdw
	51WhiPinePlt
52RedPine	
52RedPinePlt	52RedPinePlt
53JacPine	53JacPine
	54ScotPine
61WhitSprPlt	61WhitSprPlt
62BalFir	62BalFir
71BlaSprLow	71BlaSprLow

Forestry	Wildlife
72TamPine	72TamPine
74BlaSprUpl	74BlaSprUpl
	79Offoak

Following the clear-cut action, development types were regenerated through a transition. Most development types were assumed to regenerate as the preceding cover type (i.e. no conversion). Ash, lowland hardwoods, planted white spruce, balsam fir, and tamarack were assumed to convert to a mix of multiple cover types after regeneration. The transitions for these cover types apportioned regenerated acres according to the percentages shown in Table 7.

Table 7: Clear-Cut Conversion Percentages by Cover Type

Source	Target	Percentage
01Ash	01Ash	90
	12Aspen	5
	73WhiCed	5
09LowHrdw	09LowHrdw	90
	12Aspen	5
	73WhiCed	5
61WhitSprPlt	61WhitSprPlt	35
	12Aspen	43
	52RedPinePlt	22
62BalFir	62BalFir	90
	12Aspen	10
72TamPine	72TamPine	92
	71BlaSprLow	4
	73WhiCed	4

4.4.3.2 Partial Harvest

The partial harvest action simulated a treatment that removed most of the trees but retained a substantial over-story component... Eligibility for partial harvest was determined by planning area, cover type, site index and administrator. Each unique combination of these factors was associated with a minimum and maximum harvest age, which is listed in Appendix C: Partial Harvest Management Regime. Additional limitations were as follows:

- No prior treatments (i.e. not managed through another management regime)
- Available for management
- Operable

- No endangered and threatened species restrictions

This action was only applied to wildlife administered lands and was unavailable to the BRP planning area. Partial harvests were not applied on Trust lands. The minimum harvest age was typically similar to those used for the clear-cut action. The cover types that were eligible for this action are shown in Table 8.

Table 8. Partial Harvest Cover Types for Forestry and Wildlife Administered Lands

Forestry	Wildlife
	12Aspen
	13Birch
	14BlmGil
	20NorthHrdw
	30oak
	40CentHrdw
	53JacPine
	61WhitSprPlt
	62BalFir
	71BlaSprLow
	74BlaSprUpl

Following a partial harvest, development types were regenerated through a transition. All development types were assumed to regenerate as the preceding cover type (i.e. no conversion).

4.4.3.3 Uneven-Age

The uneven-age action is part of a two-step management regime that simulates a group selection harvest across diameter classes. The objective is to create a multi-age stand with structural complexity. The first step is to remove a set portion of the existing stand to initialize the uneven-age management regime. This is accomplished through the uneven-age action. The second step is to implement periodic selection harvests on a set schedule. This is accomplished through the regulated uneven-age action and is described in section 4.4.3.4.

Eligibility for the uneven-age action was determined by planning area, cover type, site index, and administrator (forestry or wildlife). Each unique combination of these factors was associated with a minimum rotation age, minimum basal area, and minimum inventory volume. This is listed in Appendix D: Uneven Age Management Regime. Additional limitations were as follows:

- No prior treatments (i.e., not managed through another management regime)
- Available for management
- Operable
- No endangered and threatened species restrictions

The actions for the uneven-age regime were partitioned into two sets, one for the forestry administered lands, and another for the wildlife lands. The wildlife lands typically excluded BRP and required higher site index. The cover types that were eligible for uneven-age harvest are shown in Table 9. This shows that white cedar could only be harvested on forestry lands.

Table 9. Uneven-Age Cover Types for Forestry and Wildlife Administered Lands

Forestry	Wildlife
01Ash	01Ash
09LowHrdw	09LowHrdw
20NorthHrdw	20NorthHrdw
30oak	30oak
40CentHrdw	40CentHrdw
51WhiPinePlt	51WhiPinePlt
51WhiPine	51WhiPine
61WhitSpr	61WhitSpr
73WhiCed	

The transitions for most uneven-age actions kept the original development type intact, except for changing the management regime to group selection harvest. This ensured that the development type would only be eligible for regulated uneven-age harvest in future. Ash and lowland hardwoods were assumed to convert to a mix of multiple cover types after harvest. The cover type mix for these types are shown in Table 10:

Table 10. Uneven-Age Conversion Percentages by Cover Type

Source	Target	Percentage
01Ash	01Ash	90
	12Aspen	5
	73WhiCed	5
09LowHrdw	09LowHrdw	90
	12Aspen	5
	73WhiCed	5

The model also prevented future harvest for a period of 20 years. This allowed the development type to go through a period of ingrowth and accumulate merchantable volume before another harvest was allowed.

4.4.3.4 Regulated Uneven-Age

The regulated uneven-age action is the second step of the group selection harvest regime. Development types need to receive the uneven-age action before they can receive the regulated uneven-age action.

The regulated uneven-age regime simulates regular harvest entries on a set schedule, following the initial entry simulated by the uneven-age action (see 4.4.3.3).

Eligibility for the regulated uneven-age action was determined by planning area, cover type, site index, and administrator (forestry or wildlife). Each unique combination of these factors was associated with a minimum rotation age or first planning period in which the action could be taken. This is listed in Appendix E: Regulated Uneven-Age Management Regime. Additional limitations were as follows:

- Must have received the uneven-age action
- Available for management
- Operable
- No endangered and threatened species restrictions

The actions for the regulated uneven-age regime were partitioned into two sets, one for the forestry administered lands, and another for the wildlife lands. The wildlife lands typically excluded BRP and required a higher age at the time of treatment. The cover types that were eligible for uneven-age harvest are shown in Table 9. This shows that white cedar could only be harvested on forestry lands.

Table 11. Regulated Uneven-Age Cover Types for Forestry and Wildlife Administered Lands

Forestry	Wildlife
01Ash	01Ash
09LowHrdw	09LowHrdw
20NorthHrdw	20NorthHrdw
30oak	30oak
40CentHrdw	40CentHrdw
51WhiPinePlt	51WhiPinePlt
51WhiPine	51WhiPine
61WhitSpr	61WhitSpr
73WhiCed	

The transitions for the regulated uneven-age action kept the original development type intact, except for advancing the selection harvest count. There was no restriction on the number of harvests that a development type could receive. There was also no conversion of cover types. The model also prevented future harvest for a period of 20 years. This allowed the development type to go through a period of ingrowth and accumulate merchantable volume before another harvest was allowed.

4.4.3.5 Thinning

The thinning action simulated the application of a commercial thinning treatment. It removed a predetermined amount of volume from the development type and left the rest to continue growing. Eligibility for the thinning action was determined by planning area, cover type, site index, administrator (forestry or wildlife), and thinning history. Each unique combination of these factors was associated with a range of ages at which the thinning could be applied. These values are listed in Appendix B: Thin Management Regime. Most cover types allowed for up to three thinning entries, while the white pine, natural red pine and planted red pine allowed for up to six entries. Additional limitations were as follows:

- No prior treatments (i.e. not managed through another management regime) or previously thinned (less than maximum number of thins)
- Available for management
- Operable
- No endangered and threatened species restrictions

The thinning actions were partitioned into two sets, one for forestry administered lands and another for wildlife. Both sets used the same minimum and maximum age for each thinning entry, but the wildlife thinnings typically required a higher site index and a smaller range of planning areas. The cover types that were eligible for thinning are shown in Table 12. This shows that ash and lowland hardwoods could only be thinned on forestry land, while jack pine, Scots pine, and offsite oak could only be thinned on wildlife land.

Table 12. Thinning Cover Types for Forestry and Wildlife Administered Lands

Forestry	Wildlife
01Ash	
09LowHrdw	
20NorthHrdw	20NorthHrdw
30Oak	30Oak
40CentHrdw	40CentHrdw
51WhiPinePlt	51WhiPinePlt
52RedPine	52RedPine
52RedPinePlt	52RedPinePlt
	53JacPine
	54ScotPine
61WhitSprPlt	61WhitSprPlt
	79OffOak

The transitions for the thinning actions kept the original development type intact, except for advancing the thin count (theme 12). This allowed the model to keep track of the number of thinnings and prevented it from applying more entries than were allowed. The model also prevented future thinning for a period of 10 to 15 years, depending on cover type. This allowed the development type to go through a period of ingrowth and accumulate merchantable volume before another thinning was allowed. The ingrowth periods for the various cover types are shown in Table 13:

Table 13. Ingrowth Period by Cover Type

10 Year Ingrowth	15 Year Ingrowth
51WhiPinePlt	01Ash
52RedPine	09LowHrdw
52RedPinePlt	20NorthHrdw
53JacPine	30oak
54ScotPine	40CentHrdw
61WhitSprPlt	52RedPine
	61WhitSprPlt
	79Offoak

4.4.3.6 Aspen Conversion

The aspen conversion action was a special management regime that applied to the aspen cover type. Its purpose was to simulate climate adaptation management and diversify cover type composition on the landscape, particularly toward species predicted to be more adapted to future climate conditions. As such it applied a regular clear-cut treatment to the development type, followed by a transition that apportioned the harvested acres to a new set of cover types.

Eligibility for the aspen conversion action was determined by planning area, cover type, site index, and administrator (forestry or wildlife). Each unique combination of these factors was associated with a minimum rotation age. This is listed in Appendix F: Aspen Conversion Management Regime. Additional limitations were as follows:

- No prior treatments (i.e. not managed through another management regime)
- Available for management
- Operable
- No endangered and threatened species restrictions

Access to the aspen conversion action was further controlled through a constraint, which limited the amount of acres that could be harvested to 0.5% of the aspen cover type (for each planning area). AP and BRP planning areas were excluded from this action. This action was partitioned into two sets, one for the forestry administered lands, and another for the wildlife lands. The wildlife lands typically utilized longer rotation ages than the forestry lands. Following the aspen conversion action, development types were regenerated through a transition to a mix of new cover types. These cover types and the percentage of acres apportioned to each are shown in Table 14:

Table 14. Aspen Conversion Percentages

Source	Target	Percentage
12Aspen	20NorthHrdw	20
	30oak	20

Source	Target	Percentage
	51WhiPine	25
	52RedPine	15
	53JacPine	10
	61WhitSpr	10

4.4.4 Yield Tables

Yield tables are used by the forest planning model to determine the contribution that a single acre will make towards various outputs that are tracked by the model. Outputs include harvest volume, standing inventory, basal area and stumpage revenue. To calculate these outputs the model will multiply the acres in each development type with a yield table value. Some yield tables are static and do not change over time, such as stumpage revenue. Other yield tables, such as growth and yield projections, are dynamic and changes over time.

Not all outputs are associated with yield tables. Outputs such as open watersheds acres, old forest guild acres, and native plant community acres are solely calculated from the acres in each development and are not multiplied with a yield table value.

The yield tables used for the forest planning model took on various forms, depending on the model element they represented. These included standing inventory, thinning volumes, regulated uneven-age volume, and stumpage revenue. The rest of this section will describe these yield tables in more detail:

4.4.4.1 Standing Inventory

These yield tables represented the standing inventory (cords/acre) within each development type at each age point. They were defined by planning area, cover type, and site index, and each unique combination of these parameters was associated with a unique standing inventory yield table. This resulted in 1,530 yield tables. All tables started at age 5 years, while the maximum age ranged between 95 and 225 years depending on cover type. Site index ranged from 20 to 90, incrementing by 5 (15 classes). A total of 22 different cover types were included. Inventory yield tables were developed for AP, MDLP, NMOP, NSU, and WSU. BRP and MNIAM used the yield tables for WSU in the forest planning model. Each yield table contained columns for total volume in cords and basal area in ft^2, as well as a breakdown of the total volume into major tree species. The inventory yield tables was an essential component of the forest planning model and provided yield information for inventory, clear-cut, partial harvest, and uneven-age harvest calculations.

The values within these yield tables were derived through a two-step process. Step one was to extract the yield tables provided by the MN DNR (see 4.3.1) and reorganize them into a format suitable for the forest planning model. This established total inventory volume and basal area by age for each unique combination of planning area, cover type and site index. A selection of inventory yield tables is shown in Appendix I: Selected Inventory Yield Tables.

The second step was to split the total inventory number into volumes by tree species. This was accomplished through a series of tables that represented the proportional representation of each species by planning area and cover type. This data is shown in Appendix K: Species Composition by Cover Type. The methodology used to derive this data is explained in Appendix J: Species Mix by Cover Type Data. Species distributions by cover type were developed for MDLP, NMOP, NSU, and WSU. These planning areas also had species distributions for aspen, oak, black spruce lowland, northern hardwoods, and red pine natural that were defined by age class, to reflect the dynamic nature of species composition. AP, BRP, and MNIAM shared a generic species distribution by cover type table, with no allowance for fluctuation by age class.

4.4.4.2 Clear-Cut

The clear-cut yield tables represented the harvest volume (cords/acre) that was generated from a clear-cut harvest action (4.4.3.1). This data was derived from the inventory yield tables by reducing total volume and volume across tree species by 5%. This reduction accounted for leave tree best management practices guidelines. This reduction was increased to 33.3% on lands where state species of concern were present, and 50% on lands where federally endangered and threatened species were present. These yield tables were also used for the aspen conversion clear-cut action.

4.4.4.3 Partial Harvest

The partial harvest yield tables represented the harvest volume (cords/acre) from a partial harvest action (4.4.3.2). These volumes were derived from the inventory yield tables by removing only a fraction of the total volume and species volume. These fractions ranged from 65 to 80%, depending on cover type and planning area. This implies that 20 to 35% of the stand remained after harvest in the form of residual leave trees. These harvests were limited to Wildlife administered and Non-Trust acres. The removal percentages are shown in Table 15.

Table 15: Partial Harvest Removals by Cover Type and Planning Area

Cover Type	Planning Area	Removal %
12Aspen	AP	80
	MDLP	65
	MNIAM	65
	NMOP	65
	NSU	65
	WSU	70
13Birch	AP	80
	MDLP	70
	MNIAM	65
	NMOP	65
	NSU	65
	WSU	70
14BlmGil	AP	80

Cover Type	Planning Area	Removal %
	MDLP	65
	MNIAM	65
	NMOP	65
	NSU	65
	WSU	70
30oak	AP	70
	MDLP	70
	MNIAM	70
	NSU	70
	WSU	70
53JacPine	MDLP	65
	MNIAM	65
	NSU	75
	WSU	65
62BalFir	All Except BRP	65
71BlaSprLow	AP	65
	MDLP	65
	NMOP	75
	NSU	70
	WSU	70
74BlaSprUpl	MDLP	75
	NSU	75

4.4.4.4 Uneven-Age

The uneven-age yield tables represented the harvest volume (cords/acre) from the uneven-age harvest action (4.4.3.3). These volumes were derived from the inventory yield tables by removing only a fraction of the total volume and species volume. These fractions ranged from 25 to 50%, depending on cover type and administrative authority. This implies that 50 to 75% of the stand remained after harvest in the form of residual leave trees. The removal percentages are shown in Table 16.

Table 16. Uneven-Age Harvest Removals by Cover Type and Administrator

Cover Type	Administrator	Removal %
01Ash	F	50
	W	25
20NorthHrdw	F	50
	W	33
All Other	All	33

4.4.4.5 Regulated Uneven-Age

The regulated uneven-age yield tables represent the harvest volume (cords/acre) from the regulated uneven-age harvest action. Yield tables were defined by cover type, administrator and site index. The total harvest volume for these yield tables was provided by the MN DNR and was based on operational experience. These volumes were not derived from the standing inventory yield tables and did not cause a depletion in these yield tables. The rationale in this approach was that this harvest action would target natural occurring mortality, resulting in zero net gain in terms of growth. Appendix L: Regulated Uneven-Age Harvest Volumes contains the total volumes used. These volumes were also subdivided into species-level volumes, using the species mix data described earlier (4.4.4.1).

4.4.4.6 Thinning

The regulated uneven-age yield tables represent the harvest volume (cords/acre) from the thinning harvest action. Yield tables were defined by cover type, administrator and then entry count. The total harvest volume for these yield tables was provided by the MN DNR and was based on operational experience. These volumes were not derived from the standing inventory yield tables and did not cause a depletion in these yield tables. The assumption in this approach was that this harvest action would target natural occurring mortality, resulting in zero net gain in terms of growth. Appendix M: Thinning Harvest Volumes contains the total volumes used. These volumes were also subdivided into species-level volumes, using the species mix data described earlier (4.4.4.1).

4.4.4.7 Harvest Reduction

The harvest reduction yield tables accounted for the harvest restrictions associated with riparian management zones (RMZ's) and eagle nest areas. No harvest activities are allowed within these areas according to MN DNR policies, and the function of these yield tables is to implement these harvest restrictions. This was done by reducing harvest volumes by a fraction.

The boundaries of the RMZ's and eagle nesting areas were not included in the forest planning model, which made it impossible for the model to identify these areas and exclude them from the harvest actions. This was done to limit model size, since including these boundaries would have resulted in a substantially larger model, which would have taken too long to solve. Instead, the presence of RMZ's and eagle nesting areas was identified through a factor associated with each development type. This factor indicated the percentage of area lying within an RMZ or eagle nesting area. This allowed us to identify the fraction of each development type that could not be harvested. Since development types could lie within both an RMZ and eagle nesting area, we took the maximum of these two fractions as the area to be excluded from harvest. These fractions were applied against all harvest volumes to account for the trees that will remain unharvested.

This resulted in three types of harvest reduction yield tables. These are listed below, and the area associated with each can be found in Table 5:

- Full Management: These development types had no overlap with RMZ's or eagle nests, and was assigned a harvest reduction factor of zero (complete harvest).

- No Management: These development types feel completely within the boundaries of an RMZ or eagle nesting area, and was assigned a reduction factor of one (no harvest).
- Partial Management: These development types fell partially within an RMZ or eagle nesting area. Harvest volumes were reduced by the fraction of the area falling within an RMZ or eagle nest (partial harvest).

4.4.4.8 Stumpage Revenue

The stumpage yield tables ($/cord) accounted for the stumpage revenue resulting from all harvest actions. Stumpage values were received from the MN DNR and were defined by planning area, species, and harvest type. These values are shown in Appendix N: Stumpage Revenue. Stumpage revenue was based on species level volume and was calculated by multiplying species level revenue with the species level harvest volume.

4.4.5 Objectives & Constraints

In this section, we will describe the objective functions and constraints that were used by the forest planning model. In linear programming formulations, the model will optimize the objective function, subject to meeting the conditions of the constraints. The objective function is, therefore, the mechanism whereby the model finds the optimal solution. It will allocate acres to management regimes in such a way that optimizes the objective function. Objective functions can take many forms, ranging from maximized harvest volumes to minimized deviation from set goal. In this planning model we used an objective function that maximized present stumpage revenue in scenarios 1, 3 and 4; and an objective function that maximized forest-age-class diversity in scenario 2.

Constraints are the mechanisms that the model uses to keep the optimal solution within required bounds. Therefore, it places a limit on how the model can allocate acres to management regimes. The constraints used in this model took on many forms, ranging from even-flow on harvest volumes to setting goals for native plant community acres. By including and excluding these constraints from different model runs we were able to build a series of scenarios that explored the range of management options.

The objective functions and constraints used in the forest planning model are discussed below:

4.4.5.1 Objective Functions

Two types of objective functions were used. The first maximized the present value of the stumpage revenue, while the second maximized the forest-age diversity index. These functions are discussed in detail below:

4.4.5.1.1 Maximized Present Stumpage Revenue

Stumpage revenue resulted from the harvest actions described in section 4.4.3 (clear-cut, partial, uneven-age, regulated uneven-age, thinning, and aspen conversion). Each of these actions resulted in acres being harvested, and each harvest resulted in volume using the yield tables described in section 4.4.4. These volumes were reported as volume by species, which in turn was multiplied by the corresponding species stumpage to obtain the gross stumpage revenue for each planning period. This series of revenues was then discounted from the mid-point of each planning period using a discount rate of 3%. The sum of these discounted stumpage revenues formed the basis of the present stumpage revenue objective function, and the model maximized this value to reach optimality.

4.4.5.1.2 Maximized Forest-Age Diversity

In this model, diversity was measured with Simpson's Diversity Index (SDI). The SDI incorporates both species "richness" and "evenness", and quantifies diversity by taking into account the number of species ("richness"), but also how evenly the species are distributed across the population ("evenness"). SDI was selected for this project because it could be incorporated into a linear programming formulation (all factors are linearly related to each other). The general formulation for SDI is as follows:

$$D = \frac{\sum n(n-1)}{N(N-1)} \quad [3]$$

Where:

D: Simpson's Diversity Index
n: Number of organisms from a certain species
N: Total number of organisms from all species

SDI values range from zero to one, and the higher the value, the more diverse the population. For this project diversity was defined as the degree to which forest types acres (aggregations of cover type) were distributed equally across age classes. Here the forest types represented "richness", and the age classes "evenness". Diversity will, therefore, increase with the number of forest types, but also with the distribution of acres across the forest type age classes. SDI was therefore defined as follows for this project:

$$D_i = \sum_{jk} n_{ijk}(n_{ijk} - 1) \Big/ N_i(N_i - 1) \quad [4]$$

Where:

D_i: Diversity index for planning area i
n_{ijk}: Acres of forest type j in age class k in planning area i
N_i: Total acres across all forest types in planning area i

Diversity was therefore calculated and optimized at the planning area level. This was primarily due to the size of the model, which was too big to solve at a statewide level. Table 17 shows the forest type and age class definitions that were used:

Table 17. Forest-Age-Class Definitions

Forest Type	Cover Type	Age Classes			
		1	2	3	4
1	53JacPine 74BlaSprUpl	0-19	20-39	40-59	60+
2	51WhiPine	0-59	60-119	120-179	180+

Forest Type	Cover Type	Age Classes			
		1	2	3	4
	51WhiPinePlt				
	52RedPine				
	52RedPinePlt				
3	61WhitSpr 61WhitSprPlt 62BalFir	0-19	20-39	40-59	60+
4	71BlaSprLow 72TamPine 73WhiCed	0-59	60-119	120-179	180+
5	12Aspen 13Birch 14BlmGil	0-19	20-39	40-59	60+
6	20NorthHrdw 30Oak	0-44	45-89	90-134	135+
7	01Ash 09LowHrdw	0-29	30-59	60-89	90+

During implementation of the diversity index, it was discovered that the forest modeling software (Remsoft) could not accommodate the proposed formulation. This was due to the fact that the objective function, nor its components, could contain a division operator. An alternative approach was to calculate the acre distribution which would result in maximum diversity and to use an objective function that minimized deviations from these goals. Diversity was considered maximized when the acres for each forest type was equally distributed across each age class. These values are shown in Appendix O: Forest-Age Diversity Goals, for each planning area, forest type and age class.

As mentioned above, the forest planning model was solved at a planning area level in order to speed-up processing. This resulted in seven different forest-age diversity index values. To obtain a statewide diversity index we calculated the area weighted average of the results from the seven planning areas. Using the acre goals shown in Appendix O: Forest-Age Diversity Goals we calculated the theoretical maximum forest-age class diversity index. This value would be reached if the acres within each forest type was perfectly distributed between the four age classes. This value was calculated as 0.90 for the whole state. The reason for it not being 1.0 is that the distribution of acres between the forest types is not equal, and the conversion of cover types would never be sufficient to bring about parity. Using the same logic, we also calculated the theoretical minimum. This value was determined to be 0.62. Therefore, in using the forest-age diversity index we know that the value can never be higher than 0.90, and can never be lower than 0.62.

4.4.5.2 Constraints

Nine sets of constraints were developed for the forest planning model in order to incorporate the strategic goals of the sustainable timber harvest analysis. These constraints ranged from even-flow on timber harvest, to reaching age class distributions within native plant communities. These constraints are described in detail below:

4.4.5.2.1 Total Harvest Volume

The total harvest volume constraint ensured that harvested volumes remained consistent over the planning horizon, with no large increases or decreases. The rationale behind this is that a consistent timber supply is more beneficial to local economies and the MN DNR, because it promotes capital investment in processing facilities and harvesting equipment, and avoids large expansions and contractions in MN DNR operations. Total harvest volume was defined as the timber volume from all the harvest actions (clear-cut, partial harvest, uneven-age harvest, regulated uneven-age harvest, thinning and aspen conversion).

It was however noted that the MN DNR forest lands are currently overstocked in terms of merchantable timber. If the model required strict even-flow of harvest volume (each period exactly the same) it would not be able to take advantage of the full timber potential. We, therefore, introduced the concept of a departure in the harvest volume, which allowed the model the flexibility required to harvest surplus timber, before settling on the long-term sustainable harvest level. We refer to this type of constraint as even-flow with departure. The size of departure was set at 20%, which allowed the model to deviate from the average harvest level by 20% up or down. This constraint was implemented at the planning area level.

4.4.5.2.2 Species Harvest Volume

The species harvest volume constraint ensured that species volumes remained constant over the time. The rationale behind this is that different species are used by different processing facilities, and to ensure a consistent supply for all facilities we have to ensure that species volumes remain constant.

The constraint also used even-flow with departure. In this case, we allowed a departure of 30% since we wanted the species level constraint to be less binding than total volume constraint (it was more important to meet the total harvest constraint than the species level constraint). This constraint was applied at the planning area level.

4.4.5.2.3 Ending Inventory

The ending inventory constraint prevented the model from drawing down the standing inventory below the sustainable level. Linear programming models have a tendency to sharply reduce inventory over the last few planning periods since there is no requirement to provide timber harvest beyond the planning horizon. The best approach to avoiding this is to calculate the ending inventory that would sustain harvest into perpetuity. Unfortunately, we cannot make that calculation for this analysis, because thinning and regulated uneven-age harvest do not cause a reduction in inventory. The only alternative was, therefore, to force the model to sustain the inventory levels that supported the sustainable harvest through the end of the planning horizon. This was accomplished through a non-declining constraint on standing inventory, which prevented a decline in inventory over the last five planning periods. This resulted in a constant level of inventory following the departure harvest through to the end of the planning horizon. Standing inventory was defined as the total timber volume standing at the end of each planning period. This constraint was applied at the planning area level.

4.4.5.2.4 Aspen Conversion

The aspen conversion constraint limited the conversion of aspen to expected levels. Without this constraint, the model would be free to pick how many aspen acres are converted. By using this constraint we forced the model to convert only a predetermined number of acres.

Aspen conversion was therefore set at 5% of the acres every 50 years. I.e., every 50 years 5% of the total aspen cover type acres would convert. This was equivalent to converting 0.5% of the acres every planning period (5 years). The planning area conversion acres are shown in Table 18. These values were implemented as an "equal" constraint, which means the model had to convert exactly this number of acres per period. This constraint was applied at the planning area level.

Table 18. Aspen Conversion Acres per Period

Planning Area	Conversion Acres
MDLP	1,646.9
MNIAM	55.5
NMOP	1,728.9
NSU	1,069.7
WSU	595.9

4.4.5.2.5 Wildlife Management Regimes

The wildlife management constraint promoted the selection of less intensive management options on Wildlife administered lands. This was implemented by setting a constraint that limited the clear-cut acres to less than 30% of the total harvested acres during each planning period, which effectively reduced the rate of clear-cut by half compared to Forestry administered lands (typically ±60%). This constraint was applied at the planning area level. Additional details about wildlife regimes are embedded in descriptions of the various harvest actions in section 4.4.3.

4.4.5.2.6 Catchments

The catchment constraints minimized hydrological alterations resulting from timber harvest at the MN DNR level 8 watershed scale. This was achieved by implementing a goal that prevented the model from converting more than 60% of the acres on MN DNR lands in each watershed to "open land" (Verry, 2000[11]). "Open land" is defined as forested cover types less than 15 years old, as well as non-forest cover

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

types such as duff, moss, unknown, agriculture, industrial development, recreational development, roads and rock outcrops. Permanent water, non-permanent water, and none cover types were excluded from the calculation.

Only the priority catchments were considered in this constraint. Those are catchments containing a Lake of Outstanding or High Biological Significance, Designated Trout Stream, Protected Tributary to a Designated Trout Stream, Lake of highest Phosphorus Sensitivity, and soil erodibility scores less than or equal to 58. In addition, only catchments with more than 500 MN DNR acres and more than 5% MN DNR ownership were considered.

A total of 552 priority catchments were incorporated into the forest planning model. Each of them required its own catchment constraint. With this number of constraints, the likelihood of infeasibilities was high (unable to find a solution that does not violate the open land requirement). In addition, there was also a probability that some of the catchments would violate the constraint at the beginning of the planning horizon (before the model could find a feasible solution), or that some catchments would always violate the open land constraint (all land is open and cannot be altered). It was therefore decided to implement these constraints as goals. This meant that the model had the option to violate the constraint, but that it would reduce the value of the objective function. A multiplier of 9,999 was used for each goal, which meant that 9,999 would be removed from the objective function for each acre violating the catchment constraint. The goal was therefore essentially 10 times more important than the stumpage revenue (±$900/acre). This gave the model the incentive to adhere to the catchment constraint, while also giving it the flexibility to violate it where necessary. This constraint was applied at the planning area level.

4.4.5.2.7 Old Forest Guild

The old forest guild constraints promoted the spatial distribution of wildlife habitat associated with older forests. This was achieved through the habitat hexagons that were encoded into each development type[12]. Each hexagon covered an area of ±160,000 acres, and together they formed a grid that covered the whole state. By intersecting the MN DNR GIS data and hexagons each development type was assigned to a hexagon. The old forest guild constraints operated at the hexagon level, which promoted the development of habitat within each hexagon. This ensured that habitat was developed at a statewide level on MN DNR land.

The old forest guild requirements were defined by planning area. These are listed in Table 19.

Table 19. Old Forest Guild Requirements

Planning Area	Requirements
BRP	• >= 70% of hexagon in forest older than 40 years • >= 10% of hexagon in forest older than 90 years

[12] U.S. Geological Survey National Gap Analysis Program https://gapanalysis.usgs.gov/

Planning Area	Requirements
AP, MNIAM, WSU	• >= 35% of upland forest in hexagon older than 50 years • >= 10% of upland forest in hexagon older than 90 years • >= 33% of hexagon in conifer cover type
MDLP, NMOP, NSU	• >= 50% of upland forest in hexagon older than 50 years • >= 10% of upland forest in hexagon older than 90 years • >= 50% of lowland conifers in hexagon older than 80 years • >= 33% of hexagon in conifer cover type

The wildlife species listed under this guild was:

- Pileated Woodpecker
- Fisher
- American Martin
- Red-Shouldered Hawk
- Goshawk
- Connecticut Warbler

For each hexagon, a set of constraints were created that corresponded to the planning area requirements described above. A total of 273 hexagons were entered into the model, which expanded to 1,113 individual constraints. As with the catchment constraints, this would have been unsolvable without infeasibilities. These constraints were therefore also converted to goals. A multiplier of 9,999 was used, which meant that the objective function would decrease by 9,999 for each acre not meeting its goal. The goal was therefore essentially 10 times more important than the stumpage revenue (±$900/acre). This incentivized the model to meet the old forest guild goals, while still giving it sufficient freedom to remain feasible.

4.4.5.2.8 Young Forest Guild

For this project, we also defined a guild of species dependent on younger forest structure. This classification used the same hexagon approach as used for the old forest guild (4.4.5.2.7). We did not build any constraints or goals around the young forest guild, but we did report the number of hexagons that met the young forest conditions. These results should be reviewed carefully because they are an artifact of optimizing other goals, and any inferences about how young forest structure was promoted should be analyzed further.

The young forest guild requirements were defined by planning area. These are listed in Table 20.

Table 20. Young Forest Guild Requirements

Planning Area	Requirements
AP, MDLP, NMOP, NSU	• >= 35% of upland forest in hexagon older than minimum rotation age • Aspen/Birch cover types regulated (±20%) into four age classes:

Planning Area	Requirements
	o 0 – 15 o 16 – 30 o 31 – 45 o 45+
BRP, MNIAM, WSU	• >= 35% of upland forest in hexagon older than minimum rotation age • Aspen/Birch cover types regulated (±20%) into four age classes: o 0 – 15 o 16 – 30 o 31 – 45 o 45+ • >= 50% of oak forest in hexagon older than 30 years

The wildlife species listed under this guild was:

- Ruffed Grouse
- White-Tailed Deer

4.4.5.2.9 Native Plant Community

The native plant community (NPC) constraints promoted biodiversity by managing for age class distributions based on natural disturbance regimes. Each stand is associated with an NPC class based on imputation techniques developed by Wilson and Ek (2017)[13]. Each NPC class is associated with an age class distribution which approximates the historical forest age distribution at the time of the Public Land Survey in MN (1848 – 1907). These constraints establish goals for maintaining the proper amount of acres in each growth stage (age class) for each NPC class. Appendix P: NPC Growth Stages Goals lists the growth stages associated with each NPC.

A total of 69 NPCs were incorporated into the model. This resulted in 154 NPC constraints once the growth stages were applied. Each of these constraints called the percentage of the NPC acres meeting a given growth stage to be greater than or equal to a predetermined threshold. As with the catchment constraints, this would have been unsolvable without infeasibilities. The constraints were therefore converted to goals, which penalized the objective function by 9,999 for each acre not meeting its goal. This incentivized the model to promote the development of NPC growth stages, while still offering enough flexibility to remain feasible.

4.4.5.2.10 Forest-Age Diversity Index

The purpose of the forest-age diversity constraints was to maximize the diversity of forest age classes across MN DNR lands. These constraints operated in conjunction with the maximized forest-age diversity objective function described in section 4.4.5.1.2. Since we were unable to directly maximize forest age

[13] Wilson and Ek. 2017. Imputing plant community classification from associated forest inventory and physiographic data in Minnesota, USA. *Ecological Indicators*, 73-82.

diversity through an objective function, we had to establish a series of goals that directed management towards maximized diversity. This was the function of the forest-age diversity constraints. A constraint was built for each combination of planning area, forest type, and age class. The acres within each constraint had to be greater than or equal to the predetermined acre threshold (Appendix O: Forest-Age Diversity Goals). These constraints were converted into goals to facilitate maximization through the objective function. Each goal was associated with a penalty of 9,999 for each acre violating a constraint. The goal was therefore essentially 10 times more important than the stumpage revenue (±$900/acre). A total of 196 goals were built.

5.0 RESULTS

This section will present the results from four main modeling scenarios, which was partitioned into 18 sub-scenarios. We will begin by explaining how the model results should be used and not be used. This will be followed by an overview of the scenarios. The final four sections will detail the results from each main scenario.

5.1 Qualifications

This analysis relies on a forest management model developed and executed by MB&G, based on data, assumptions, policies, and objectives provided by MN DNR. Readers should be aware of the following qualifications:

- The forest management model was designed to address broad strategic and tactical planning questions, such as the nature of the relationship between timber harvest and other resource management objectives. This model was not designed to address operational planning questions, such as which specific stands should be harvested during the next five years.
- Spatial and tabular information about the DNR forest land base was provided by MN DNR from its current Forest Inventory Module Management Inventory. MB&G did not verify the data.
- The forest management model includes mathematical formulations of certain MN DNR management objectives and policies. While there is benefit to specifying a mathematical formulation of an objective or policy for the purpose of analysis, we recognize that the practical application of the objective or policy may necessarily stray from the strict formulation required for modeling. On average, however, the modeling is expected to correspond to the practice and results.
- The MN DNR updates forest plans on a 10-year cycle ensuring that the current plan always reflects the latest data, policies, and practices. To evaluate the long-term consequences of near-term activities, the forest management model for this analysis projects activities, outputs, revenues and forest conditions for a 100 year period. Model projections further into the future are inherently more uncertain. We do not, however, believe that there is bias in the projections.
- The forest management model does not simulate nor predict stochastic events such as fire, blowdown, ice storms, etc. This should not introduce bias into the results as MN DNR's current policies and practices focus on recovering salvageable wood after a catastrophic event. If there were a major event, then the plan could and should be re-evaluated to see whether future harvest levels could be maintained.

- In this analysis, we tested the sensitivity of the results to assumptions about timber growth, yield, and discount rates. We also project how much flexibility future managers will face in deciding where to place timber harvests. These sensitivity tests indicate that there are no unexpected consequences resulting from these key assumptions. More sensitivity could be done to evaluate long-term consequences of current assumptions.
- Each model run seeks to optimize one or two measures (e.g. timber revenue and NPC goals, or timber revenue and diversity goals) while meeting a set of constraints. A number of additional indicators of forest conditions are reported for each model run. But for indicators that were not part of the optimization deriving a specific model solution, the reported measure may be simply an artifact of the model solution – a reformulation of the model to also include that measure could very likely move that indicator towards a desired condition. For example, the young forest guild metric was not included as an objective in any scenario model runs. The reported young forest guild conditions may not be as favorable as they could be if they were incorporated into the model objective function.
- The economic information used in this model is used to help guide the model toward economically efficient management decisions. The model does not predict future timber prices, nor does it predict timber price responses to changes in MN DNR harvest levels. The watershed catchment indicator incorporated into the forest management model measures whether the Verry criteria for open land conditions (defined elsewhere in this report) are met on the MN DNR's fraction of priority catchments. It does not address whether the catchment as a whole meets the Verry criteria.
- This modeling effort represents MN DNR's first attempt at formalizing and modeling several different non-timber measures on a large scale. Further evaluation of these results may result in modifications to both the formulation and the set of non-timber measures to be used in future planning efforts.

5.2 Scenario Overview

In this analysis, we wanted to explore various management approaches to meeting the strategic goals that have been established. These goals were established through planning processes within the MN DNR, as well as outreach initiatives to external stakeholders. For the purposes of this study, these goals were distilled down to natural resource economies, water quality, biodiversity, and wildlife habitat. These scenarios spanned a wide range of management approaches and outcomes, and by comparing them we could analyze the range of possible outcomes as well as potential synergies and tradeoffs between goals.

To facilitate this analysis we had to compile a wide range of model scenarios, solve them with the model, and compare key parameters. Four scenarios were established for this project that explored the impact of the various goals, approaches to optimization, and assumptions on yield and returns. These scenarios are described in Table 21:

Table 21. Summary of Model Scenarios

Scenario	Name	Description
1	Timber Potential	Explored the impact of the strategic goals on timber production. This scenario followed a traditional approach to forest planning and harvest scheduling, by using timber harvest as the objective and non-timber values as the constraint. It, therefore, maximized the present stumpage revenue, subject to various constraints on water quality, diversity, and wildlife habitat.
2	Forest-Age Diversity	Explored the potential to increase forest-age diversity while meeting a sustained timber harvest levels. This scenario reversed the traditional approach to forest planning and harvest scheduling, by using non-timber values as the objective, and timber harvest as the constraint. Therefore, it maximized forest-age diversity, subject to meeting various timber harvest levels.
3	Yield Analysis	Explored the impact of alternative assumptions on growth and yield. This scenario used the basic formulation from Scenario 1, but with different yield tables. The alternative yields were discussed in section 4.3.3. It, therefore, maximized timber harvest, using alternative yield tables, while adhering to regulatory requirements.
4	School Trust Land Analysis	Explored the impact of different assumptions on the returns that the School Trust should expect. This scenario used the basic formulation from Scenario 1, but with different discount rates. It, therefore, maximized timber harvest using higher discount rates, subject to regulatory requirements.

Each of the scenarios was subdivided into a series of sub-scenarios. This allowed us to analyze the solution space associated with each scenario in finer detail. These sub-scenarios are illustrated in Figure 18. In this figure, the four main scenarios are separated by the blue rows. Below each main scenario is the series of sub-scenarios, each introducing a unique element that is not modeled in another scenario. They are numbered with x.y.z format, with each layer of numbering distinguishing a different assumption. The columns in this figure illustrate a different model component, and they are color coded to show differences and trends. These columns contain the following information:

- **Name** – The name of the main scenario that the following sub-scenarios belong to. Sub-scenarios are listed and numbered in x.y.z format below.
- **Objective** – The objective function used in the scenario. Two types were used. "Stumpage Revenue" maximized the present stumpage revenues from timber harvest, and "Diversity" maximized diversity by setting goals for the forest-age diversity index.
- **Regimes** – Two sets of regimes were identified for this analysis. "Forestry Management Regimes" used the forestry orientated regimes on all lands, regardless of administrative authority. "Forestry & Wildlife Regimes" allocated regimes in accordance with administrator, i.e. forestry on forestry administered lands, and wildlife on wildlife administered lands.

- **Timber Harvest** – Changed how the allocation of timber harvest was controlled. Two approaches were used. "Evenflow 20%" promoted consistent timber harvest volumes, but allowed for a departure to reduce excess inventory. This departure was limited to 20% up or down from the average harvest level. "1,000,000", "800,000", and "600,000" fixed the harvest levels at 1,000,000, 800,000 and 600,000 cords per year, allowing the model to maximize diversity.
- **Yields** – Specified the growth and yield assumptions used by the scenario. "DNR" used the yield tables supplied by the MN DNR, "Alt 1" used half of the yield adjustments suggested in 4.3.3, and "Alt 2" used the full adjustment suggested in 4.3.3.
- **Species Conversion** – Specified whether cover type conversions resulting from climate change and management focus were turned "On" or "Off". Turned on through actions and transitions.
- **Water Quality** – A set of management options and constraints that preserved water quality:
    - **Riparian Management Zones** – Specified whether no harvest within RMZ's was turned "On" or "Off". This was implemented through a harvest volume adjustment on development types that overlapped RMZ's.
    - **Cumulative Watershed Impacts** – Specified whether the constraints that controlled the amount of open land within each catchment were turned "On" or "Off". This was implemented through catchments constraints.
- **Biodiversity** – A set of management options that increased diversity:
    - **Endangered & Threatened Species** - Specified whether controls on harvest actions within areas with endangered and threatened species were turned "On" or "Off". This was implemented by preventing harvest on lands with these species present.
    - **Species of Special Concern** - Specified whether controls on harvest actions within areas with state species of concern were turned "On" or "Off". This was implemented by preventing harvest on some lands or allowing only partial harvest on others.
    - **Bald Eagle Nest** – Specified whether no harvest within eagle nest areas was turned "On" or "Off". This was implemented through a harvest volume adjustment on development types that overlapped with eagle nesting areas.
    - **Native Plant Community Class** – Specified whether the constraints that controlled the amount acres within each NPC growth stage were turned "On" or "Off". This was implemented through the NPC constraints.
- **Wildlife Habitat** – A set of management options and constraints that protected wildlife habitat:
    - **5% Reduction for Leave Trees** – Specified whether the 5% reduction of harvest volumes to account for leave tree best management practices were turned "On" or "Off". This was implemented through a harvest volume adjustment all harvest volumes.
    - **Old Forest** – Specified whether the constraints that controlled the amount of old forest guild acres within each wildlife hexagon were turned "On" or "Off". This was implemented through the old forest guild constraints.
    - **Young Forest** – Acres meeting the young forest guild conditions were reported on in all scenarios. No optimization, constraints or management controls were implemented.
- **Natural Resource Economies** – A set of reports on maintaining natural resource economies:

- **Mill Distance** – Harvest volume from priority cover types within 75 miles of mills were reported on in all scenarios. No optimization, constraints or management controls were implemented.
- **Physiographic Region** – Harvest volume from dry and wetlands were reported on in all scenarios. No optimization, constraints or management controls were implemented.

Scenarios marked with a dashed outline represent the regulatory requirements. All other scenarios either remove some of these requirements or adds additional assumptions. This establishes a baseline for comparison and helps us determine synergies and tradeoffs.

All of the sub-scenarios applied the ending inventory constraint. This ensured that the model did not draw down on standing inventory over the last few planning periods, and ensured that a consistent inventory was maintained.

Each scenario took approximately 24 to 48 hours to complete, depending on model complexity. We used three dedicated Remsoft licenses and modeling computers to run through all 18 scenarios. Total processing time was ±30 days.

Name Scenario 1 - Timber Potential	Objective Maximize	Regimes	Timber Harvest	Yields	Species Conversions	Water Quality		Biodiversity				Wildlife Habitat			Natural Resource Economies	
						Riparian Management Zones (RMZs)	Cumulative Watershed Impacts	Endangered & Threatened (ET) Species	Species of Special Concern (SPC)	Bald Eagle Nests	Native Plant Community (NPC) Class	5% reduction for Leave Trees/FMGs	Old Forest	Young Forest	Mill Distance	Physiographic Class
1.1.1	Stumpage Revenue	Forestry Management Regimes	Evenflow 20%	DNR	Off	Off	Off	Off	Off	Off	Off	On	Off	Report	Report	Report
1.1.2					On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
1.2.2	Stumpage Revenue	Forestry & Wildlife Management Regimes	Evenflow 20%	DNR	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
1.2.3					On	On	Off	On	On	On	Off	On	Off	Report	Report	Report
1.2.4.1					On	On	On	On	On	On	Off	On	Off	Report	Report	Report
1.2.4.2					On	On	Off	On	On	On	Off	On	On	Report	Report	Report
1.2.4.3					On	On	Off	On	On	On	On	On	Off	Report	Report	Report

Name Scenario 2 - Forest-Age Diversity	Objective Maximize	Regimes	Timber Harvest	Yields	Species Conversions	Water Quality		Biodiversity				Wildlife Habitat			Natural Resource Economies	
						Riparian Management Zones (RMZs)	Cumulative Watershed Impacts	Endangered & Threatened (ET) Species	Species of Special Concern (SPC)	Bald Eagle Nests	Native Plant Community (NPC) Class	5% reduction for Leave Trees/FMGs	Old Forest	Young Forest	Mill Distance	Physiographic Class
2.1	Diversity	Forestry & Wildlife Management Regimes	1,000,000	DNR	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
2.2			800,000		On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
2.3			600,000		On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report

Name Scenario 3 - Yield Analysis	Objective Maximize	Regimes	Timber Harvest	Yields	Species Conversions	Water Quality		Biodiversity				Wildlife Habitat			Natural Resource Economies	
						Riparian Management Zones (RMZs)	Cumulative Watershed Impacts	Endangered & Threatened (ET) Species	Species of Special Concern (SPC)	Bald Eagle Nests	Native Plant Community (NPC) Class	5% reduction for Leave Trees/FMGs	Old Forest	Young Forest	Mill Distance	Physiographic Class
3.1.1	Stumpage Revenue	Forestry Management Regimes	Evenflow - 20%	Alt 1	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
3.1.2				Alt 2	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
3.2.1	Stumpage Revenue	Forestry & Wildlife Management Regimes	Evenflow - 20%	Alt 1	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
3.2.2				Alt 2	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report

Name Scenario 4 - School Trust Lands Analysis	Objective Maximize	Regimes	Timber Harvest	Yields	Species Conversions	Water Quality		Biodiversity				Wildlife Habitat			Natural Resource Economies	
						Riparian Management Zones (RMZs)	Cumulative Watershed Impacts	Endangered & Threatened (ET) Species	Species of Special Concern (SPC)	Bald Eagle Nests	Native Plant Community (NPC) Class	5% reduction for Leave Trees/FMGs	Old Forest	Young Forest	Mill Distance	Physiographic Class
4.1.1	Stumpage Revenue	Forestry & Wildlife Management Regimes	Evenflow - 20%	4	Off	Off	Off	Off	Off	Off	Off	On	Off	Report	Report	Report
4.1.2				4	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report
4.2.1				6	Off	Off	Off	Off	Off	Off	Off	On	Off	Report	Report	Report
4.2.2				6	On	On	Off	On	Off	On	Off	On	Off	Report	Report	Report

Figure 18. Summary of Sub-Scenarios

5.3 Discussion of Model Results

The following sections will describe the results from the four models in terms of:

- Present Stumpage Revenue
- Harvest Volume
- Clear-Cut Operable Acres
- Average Clear-Cut Age
- Priority Harvest Volume
- Inventory
- Trust Land Inventory
- Cover Type Conversions
- Planning Latitude
- Open Watershed Goals
- Old Forest Guild Goals
- Young Forest Guild Goals
- Native Plant Community Goals
- Forest-Age Diversity Index

5.3.1 Scenario 1 – Timber Potential

The following sub-scenarios were developed for Scenario 1:

1.1.1 Used forestry management regimes. Objective was to maximize stumpage revenue. Timber volume was controlled by an even-flow with 20% departure constraint. Turned off species conversion, all water quality, all diversity and all wildlife habitat components (except for 5% leave trees). The purpose of this scenario was to establish the maximum sustainable harvest level.

1.1.2 Used the forestry management regimes. Enabled current MN DNR protocols (statutory requirements) by turning on species conversion, RMZ's, endangered and threatened species, bald eagle nests, and 5% leave tree requirement. The purpose of this scenario was to determine the maximum sustainable harvest level using typically MN DNR management policies and forestry regimes only.

1.2.2 Same as 1.1.2, but using forestry and wildlife management regimes. The purpose of this scenario was to determine the maximum sustainable harvest level using typically MN DNR management policies and both forestry and wildlife regimes.

1.2.3 Same as 1.2.2, but with state species of concern turned on. The purpose of this run was to examine the impact of state species of concern.

1.2.4.1 Same as 1.2.3, but with cumulative watershed impacts turned on. The purpose of this run was to examine the impact of watershed constraints.

1.2.4.2 Same as 1.2.3, but with old forest habitat goals turned on. The purpose of this run was to examine the impact of old forest constraints.

1.2.4.3 Same as 1.2.3, but with native plant community goals turned on. The purpose of this run was to examine the impact of NPC growth stage goals.

We also selected a scenario from Phase 1 to include in the results shown below. Here we selected 1d – Species Even Flow. This scenario maximized present stumpage revenue, while adhering to non-declining inventory over the last 5 planning periods, even-flow with no departure at the planning area level, and even-flow with 30% departure at the species volume level. This scenario was the best comparison with the Phase 2 scenarios that modeled the statutory requirements (1.1.2 and 1.2.2).

The detailed results for each scenario are shown in Appendix H: Detailed Scenario Results. Please note that sub-scenarios are not always numbered consecutively since these scenarios were extracted from a larger pool of original scenarios.

5.3.1.1 Present Stumpage Revenue

Under an even-flow timber harvest with 20% departure and the objective to optimize present stumpage revenue (PSR), PSR ranged from a minimum of $0.55 billion to a maximum of $0.99 billion (Figure 19). The unconstrained scenario (1.1.1) yielded maximum PSR of $0.99 billion. The scenario that includes regulatory requirements (1.1.2) has a marginally lower value of $0.95 billion (Figure 19). Adding the NPC goal (1.2.4.3) minimized PSR to $0.55 billion. Among the seven scenarios in this group, only the two scenarios with old forest (1.2.4.2) and NPC goals (1.2.4.3) limited PSR to below the $0.90 billion level, at 55.5% and 66.4% respectively. Scenarios clustered into either the $0.9 - $0.99 billion range without the old forest and NPC goals, versus those with old forest and NPC goals that fell in the $0.55 - $0.66 billion range. As a general rule, increasing the number and complexity of goals resulted in a lower PSR.

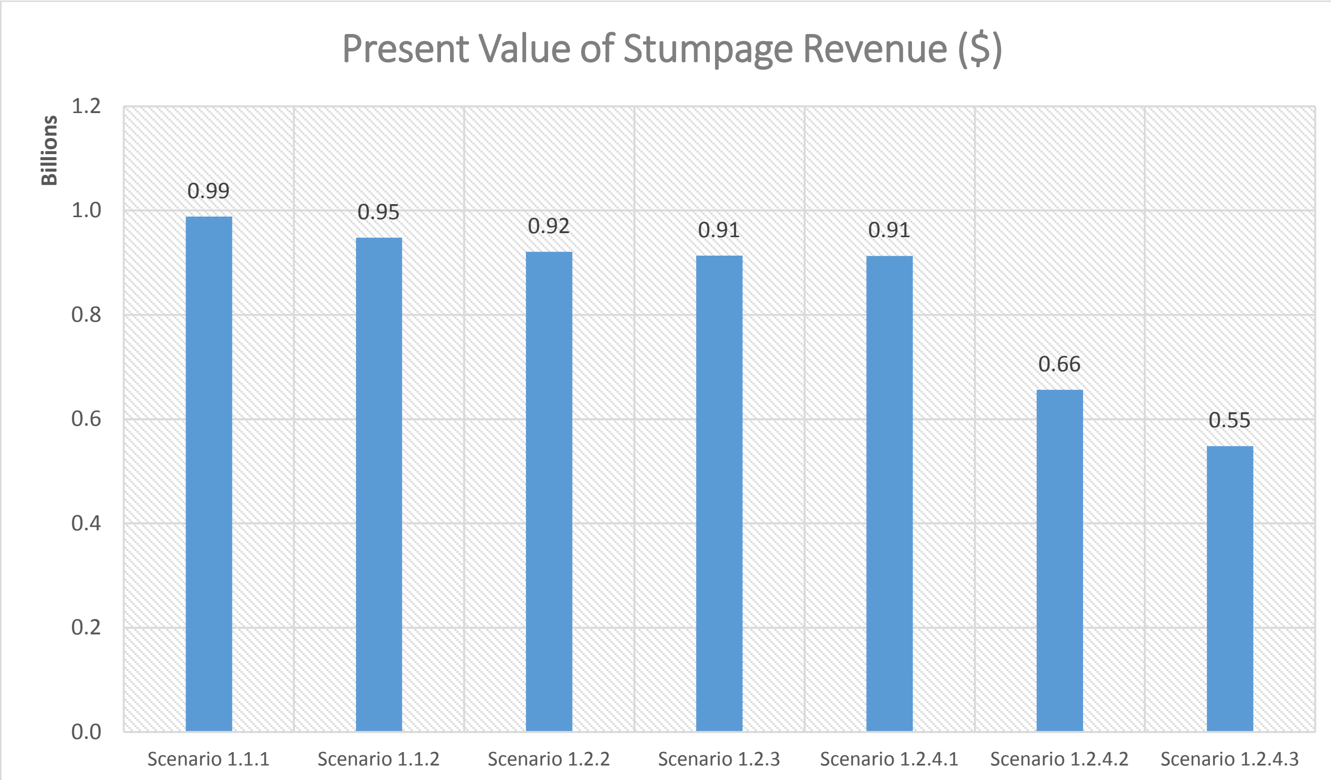


Figure 19. Scenario 1 – Present Value of Stumpage Revenue

5.3.1.2 Harvest Volume

Annual harvest rates varied largely by whether a scenario considered old forest or NPC goals. In scenario 1.1.1 the maximum harvest volume reached 1.16 million cords in the first 25 years but declined 20% to around 932,000 cords for the remainder of the planning horizon (Figure 20). Scenario 1.1.2 maintained a harvest level of ±1.13 million cords for the first 15 years, before dropping down to a ± 930,000 cords (years 20 and 25 were close to 1 million cords). Scenario 1.2.2 began at a harvest level of 1.10 million cords and declined to 900,000 cords after 15 years. The results for scenarios 1.2.3 and 1.2.4.1 were almost identical to that of 1.2.2. Most of the model's flexibility occurred over the first 15 to 25 years where current inventory can be harvested at maximal rates because stand ages are beyond rotation age. Once the current standing inventory is depleted, scenarios 1.1.1 through 1.2.4.1 converge on a similar annual harvest rate between 870,000 and 930,000 cords. In contrast, the scenarios with NPC and old forest goals begin and end at similar points, and show lower levels of divergence over the planning horizon. With the old forest habitat goal, harvest starts at 674,000 cords and varies from 6% below to 8% above the starting point. With the native plant community goal, harvest starts at 581,000 cords, varying 14% below to 2% above the starting point (Figure 20).

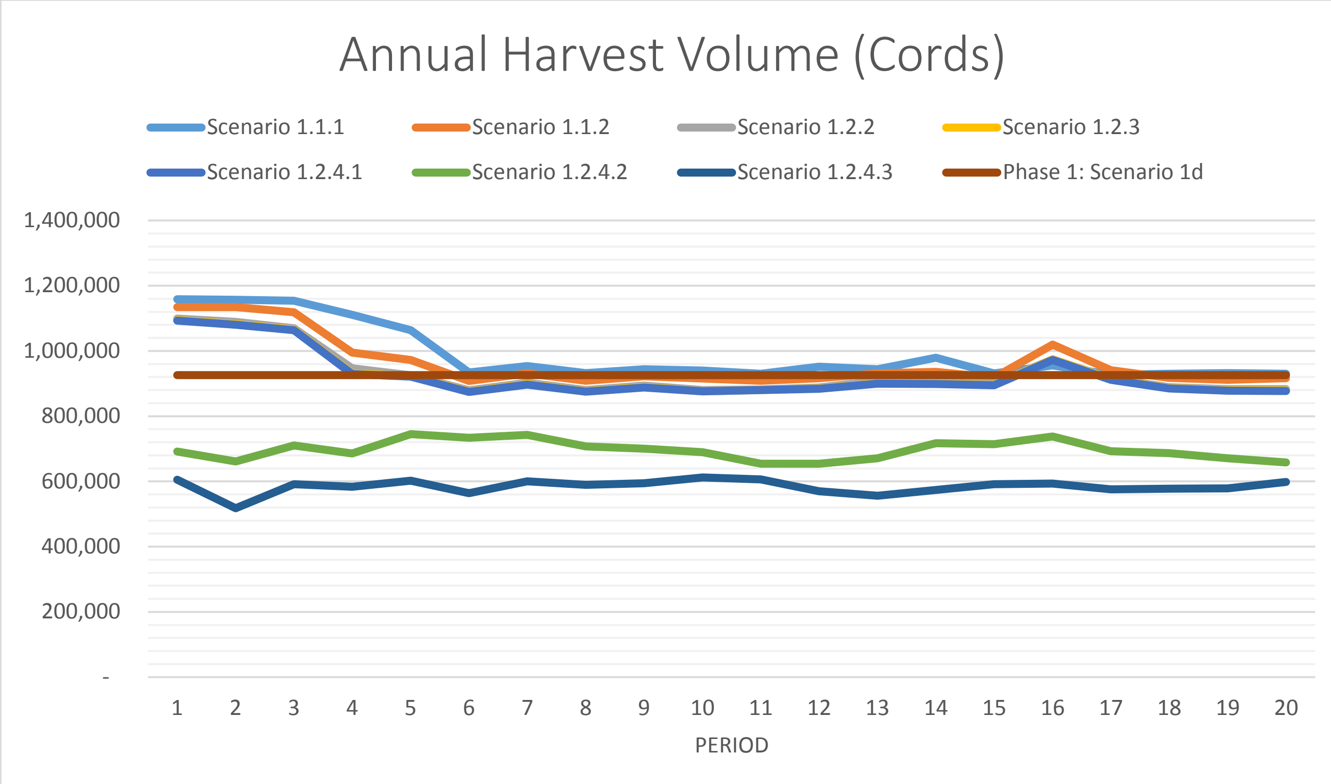


Figure 20. Scenario 1 - Annual Harvest Volumes

5.3.1.3 Clear-Cut Operable Acres

The clear-cut operable acres are the number of acres eligible for the clear-cut management action in a given period. Scenarios 1.1.1 through 1.2.4.1 all required essentially the same amount of land, reflecting the similar harvest rates achieved in these scenarios (Figure 20). Operable acres decreased over time until they settled at the sustainable level of ±300,000 acres. With the wildlife goals harvest levels were lower, so clear-cut operable areas were higher. In Scenario 1.2.4.2, the clear-cut operable acres were around 725,000 by year 100 (Figure 21). The NPC scenario had the largest clear-cut operable area, ending at 1.13 million acres (Figure 21). The amount of land required to implement a scenario is also expressed as planning latitude, see section 5.3.1.9.

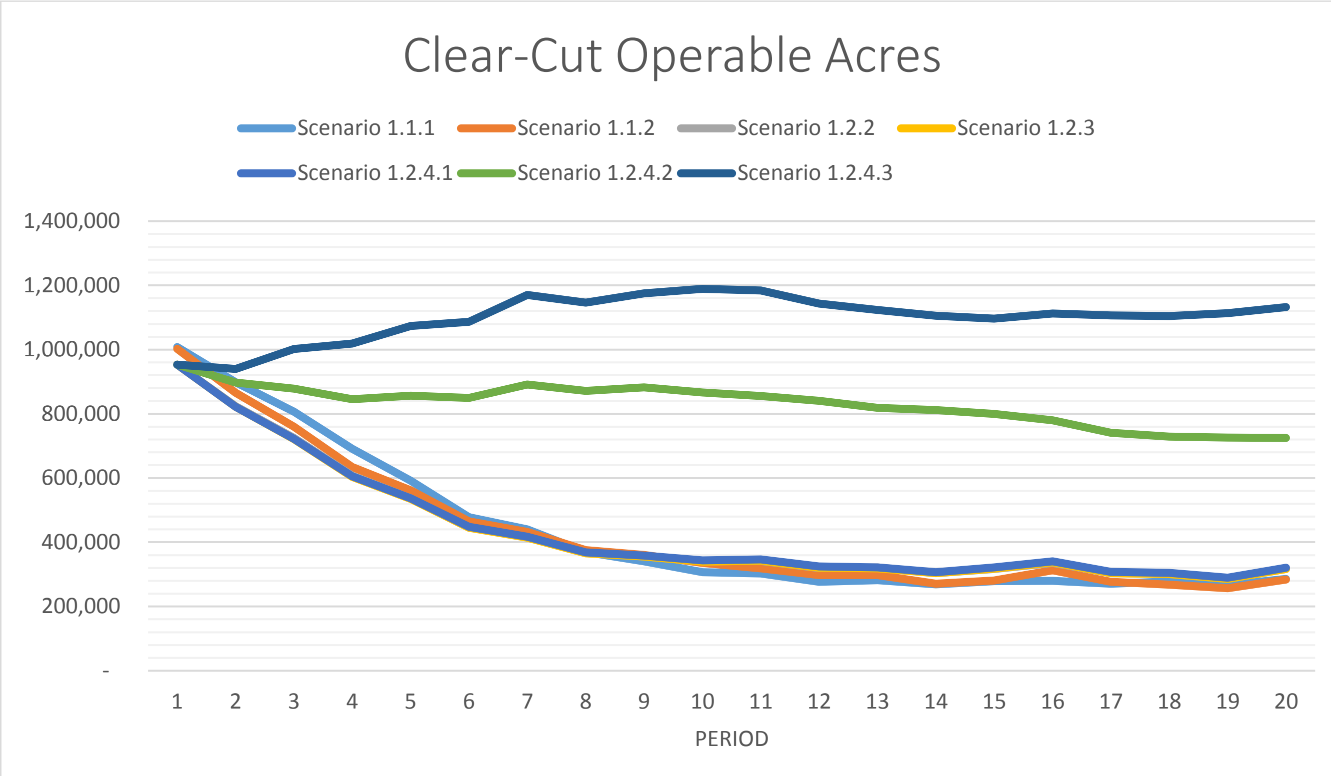


Figure 21. Scenario 1 - Clear-Cut Operable Acres

5.3.1.4 Average Clear-Cut Age

During inventory review, we saw that the median stand age for many cover types was beyond the typical rotation age for most planning areas. We expected that clear-cut age would decrease over time as the forest approached a regulated state. In all Scenario 1 alternatives, we do see an initial decline in clear-cut age (Figure 22). For scenarios 1.1.1 through 1.2.4.1, average clear-cut age converges to 53 years at 100 years, varying by less than 8 years (12%) at any time, with the greatest divergence occurring at 45 years (Figure 22).

Average clear-cut age is lower in the old forest scenario (1.2.4.2) than in the NPC scenario (1.2.4.3), although it increases quickly in the last period for old forest (Figure 22). We might expect an older clear-cut age for the old forest scenario, but the model has found an optimum solution that involves focusing clear-cuts within age classes that are outside of the old forest guild threshold. In contrast, the NPC scenario produces an older average clear-cut age in order to satisfy the age class distribution goals. At period 11 in particular for the NPC scenario 1.2.4.3, cutting in younger stands appears to be precluded, elevating average clear-cut age to 100 years for one period before declining again to the long-term average around 80 years (Figure 22). Although average clear-cut age is lower in the old forest scenario (Figure 22), representation of old forest guild is higher (Figure 30).

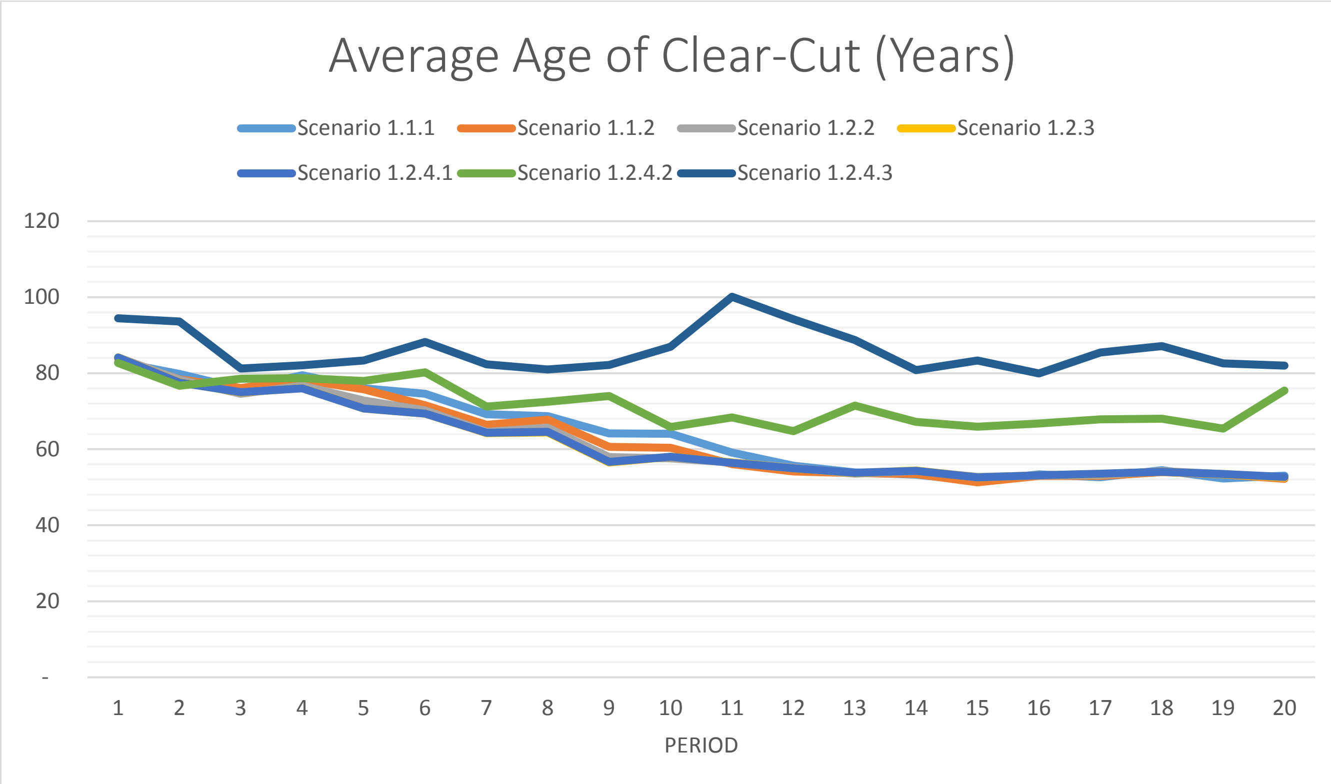


Figure 22. Scenario 1 - Average Clear-Cut Ages

5.3.1.5 Priority Harvest Volume

The percent of overall harvest volume that is sourced from commercial cover types that fall within 75 miles of any of the seven largest fiber consumers is termed priority harvest volume. In addition to being a geographic constraint, this volume also refers to the fraction that consists of species that are in demand by processors, which is chiefly aspen, pine, and spruce. Other species volumes are not reflected here.

The percentage priority harvest volume remained consistently between 60% and 70% over the long run. Scenarios 1.1.1 through 1.2.4.1 clustered together with slightly higher percentages. Scenarios 1.2.4.2 through 1.2.4.3 clustered together at lower levels, and also started off lower at between 50% and 60%.

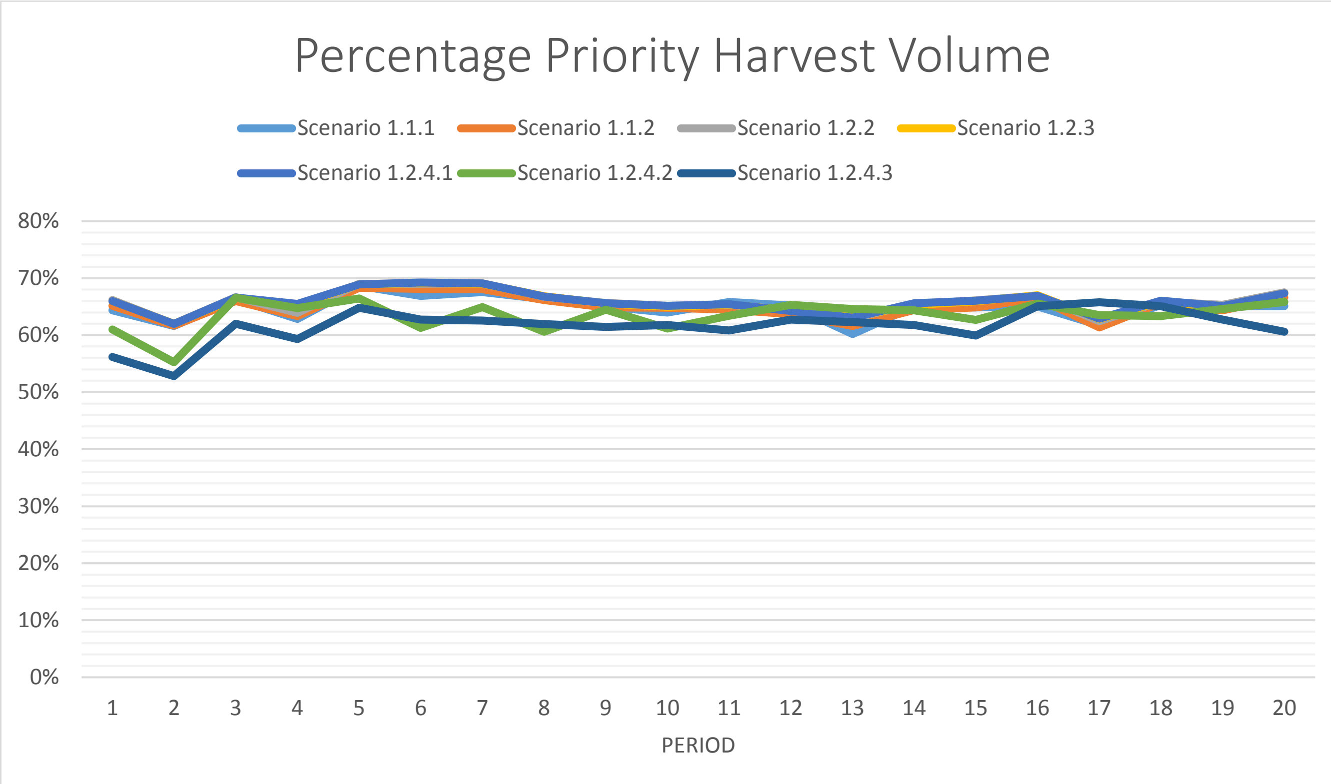


Figure 23: Scenario 1 – Percentage Priority Harvest Volume

5.3.1.6 Inventory

Long-term average annual harvest rates were very similar for scenarios 1.1.1 through 1.2.4.1, so we expect similar standing timber inventory levels across the planning horizon. Through at least period seven, standing timber inventory differs among scenarios 1.1.1 and 1.2.4.1 by less than one million cords (Figure 24). Divergence within this group of scenarios gradually increases to around 2.46 million cords by period 20, but this change represents just 7.8% of the period 20 maximum inventory. As a point of comparison, the Phase 1 output found a terminal inventory of 26.4 million cords, whereas scenario 1.1.1 terminates at 28.7 million cords. Scenario 1.2.2, which meets statutory requirements, terminates at 31.1 million cords, while the lowest harvest scenario in this group (1.2.4.1) ends at 31.2 million cords (Figure 24). The long-term inventory for scenarios with the old forest and NPC goals is comparatively higher, at 39.1 million cords and 43.2 million cords, respectively. Both of these scenarios had substantially lower annual harvest rates, so we should expect comparatively higher standing inventory to reflect this difference in harvest.

Growth rates can often be compared to harvest levels to determine if a forest management plan is sustainable. In such a case one would want to see that the total harvest level is lower than the growth rate (inventory is accumulating faster than it is depleted). This comparison is however not valid for the MN DNR, because residual inventory resulting from partial harvest, uneven-age harvest, regulated uneven-age harvest and thinning are not reflected in the total inventory. The growth shown here is, therefore, an underestimate, and should only be used to rank growth between scenarios.

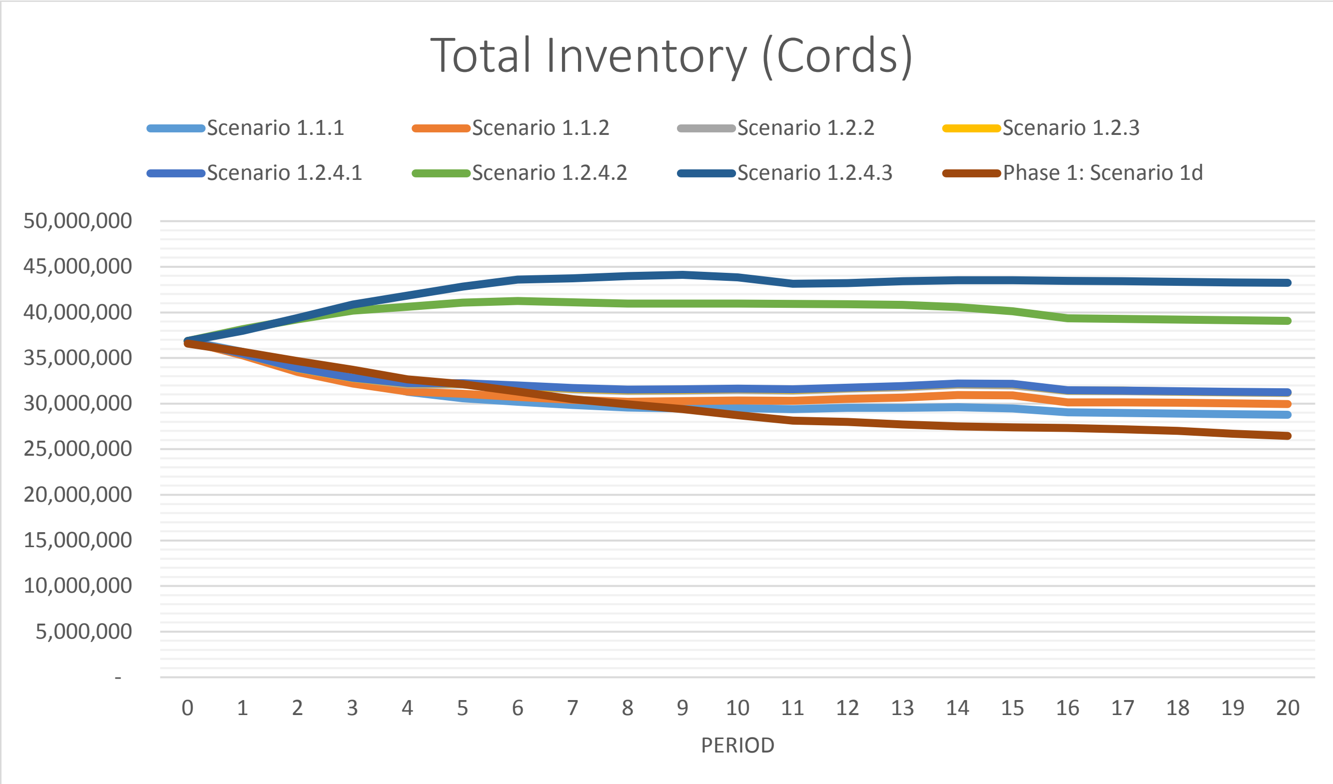


Figure 24. Scenario 1 - Inventory Volume by Period

Annual growth rates of forest stands are highest when the stands are young, and reach an asymptotic rate or net decline after the stand has matured. Given this growth trajectory, we expect that a forest plan featuring relatively high harvest rates — one that results in a greater number of young stands — should show a higher annual growth rate. Inversely, forest plans with low harvest rates that do not convert as many old stands to younger age classes should generate a lower annual growth rate.

These expectations are affirmed in the Scenario 1 (Figure 25). Scenarios 1.1.1 through 1.2.4.1 have higher annual harvest rates (Figure 20) and lower periodic inventory (Figure 24), meaning that more of the existing forest asset is harvested each year. The younger age class structure that results from these plans translates to faster annual growth rates (Figure 25). Throughout the planning horizon, these scenarios form a similar cluster by annual growth, differing by an average of 17,000 cords per year, and with a maximum difference of only 28,000 cords per year (Figure 25).

The old forest (1.2.4.2) and NPC (1.2.4.3) scenarios form a separate group in terms of annual growth rate, differing on average by 24,600 cords per year, and ending 100 years at 469,000 or 419,000 cords per year, respectively. Annual harvest in the NPC scenario (1.2.4.3) resulted in the highest inventory levels (Figure 24) and the lowest annual growth rate (Figure 25).

In general, certain sets of results are proportionally related: PSR is proportional to harvest rate growth but inversely proportional to inventory. Consequently, scenarios with higher PSR have higher harvest and growth but lower inventory, while scenarios with lower PSR have lower harvest and growth, but higher inventory.

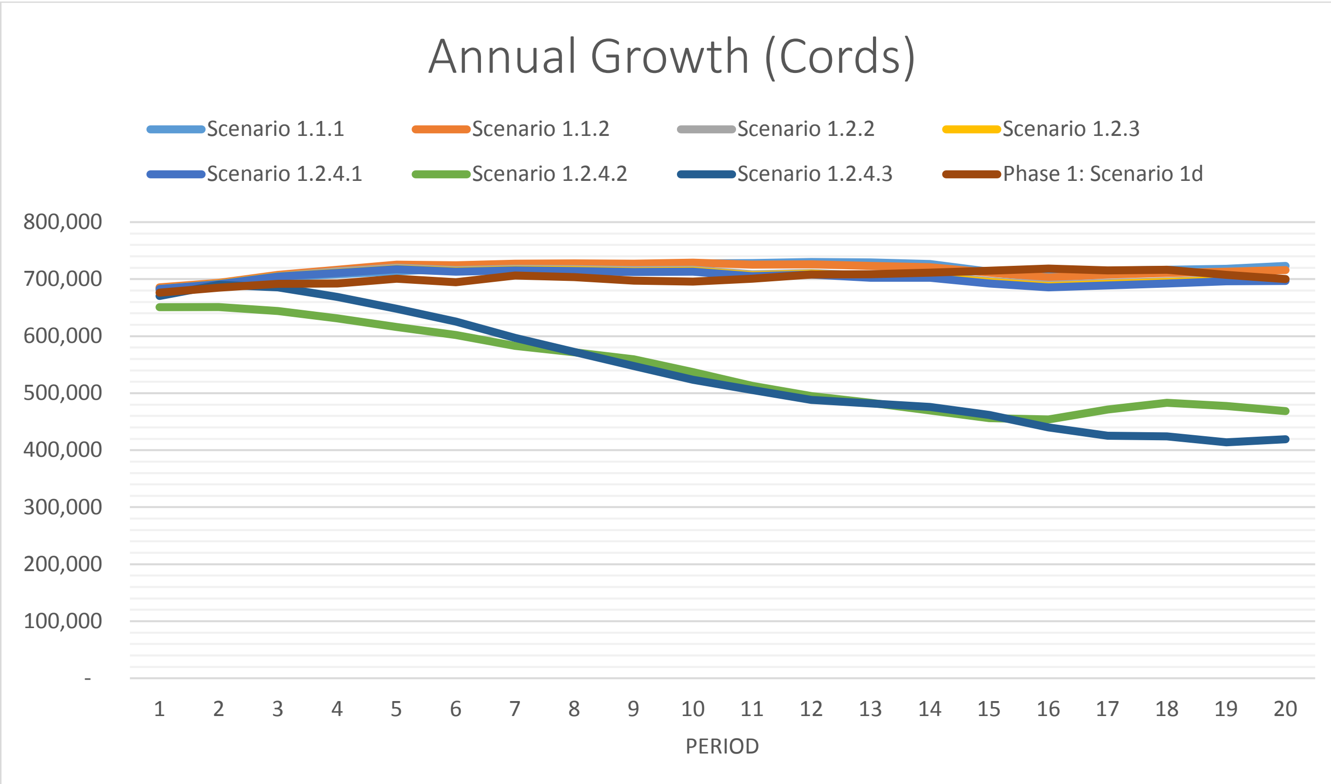


Figure 25. Scenario 1 - Annual Growth

5.3.1.7 Trust Land Inventory

The trust land inventory results show the inventory on trust lands only. These results followed a similar pattern to the statewide inventory results (Figure 24), with scenarios 1.1.1 through 1.2.4.1 clustered together, and scenarios 1.2.4.2 and 1.2.4.3 deviating from the rest. In this case, the scenarios 1.1.1 through 1.2.4.1 ended the planning horizon at 13.6 million cords to 14.1 million cords. Scenario 1.2.4.2 and 1.2.4.3 ended at 18.0 and 20.8 million cords respectively. These two scenarios carried ± 40% more inventory than the rest.

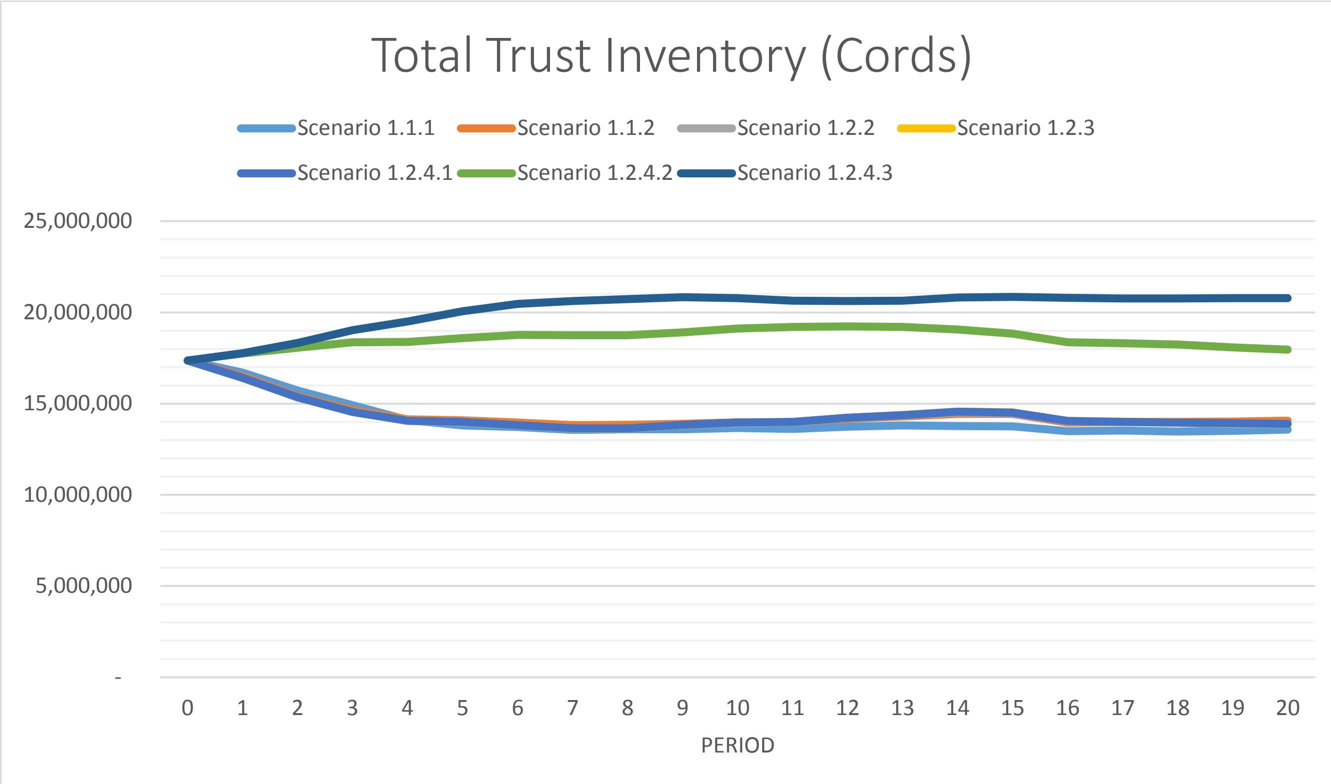


Figure 26. Scenario 1 - Trust Inventory

5.3.1.8 Cover Type Conversions

Certain cover types are given the option to convert to other cover types upon clear-cut. Scenario 1.1.1 had no conversions because the option was turned off. In the beginning, conversion ranges between 1,500 and 2,000 acres per year and declines to nearly the same rate of 1,100 acres per year for all scenarios after 100 years (Figure 27). The spike in cover type conversions occurring in period 7 is due to a large block of planted white spruce being harvested and converted to red pine and aspen. Conversion rates in scenarios 1.2.4.2 and 1.2.4.3 are generally lower, due to lower harvest levels.

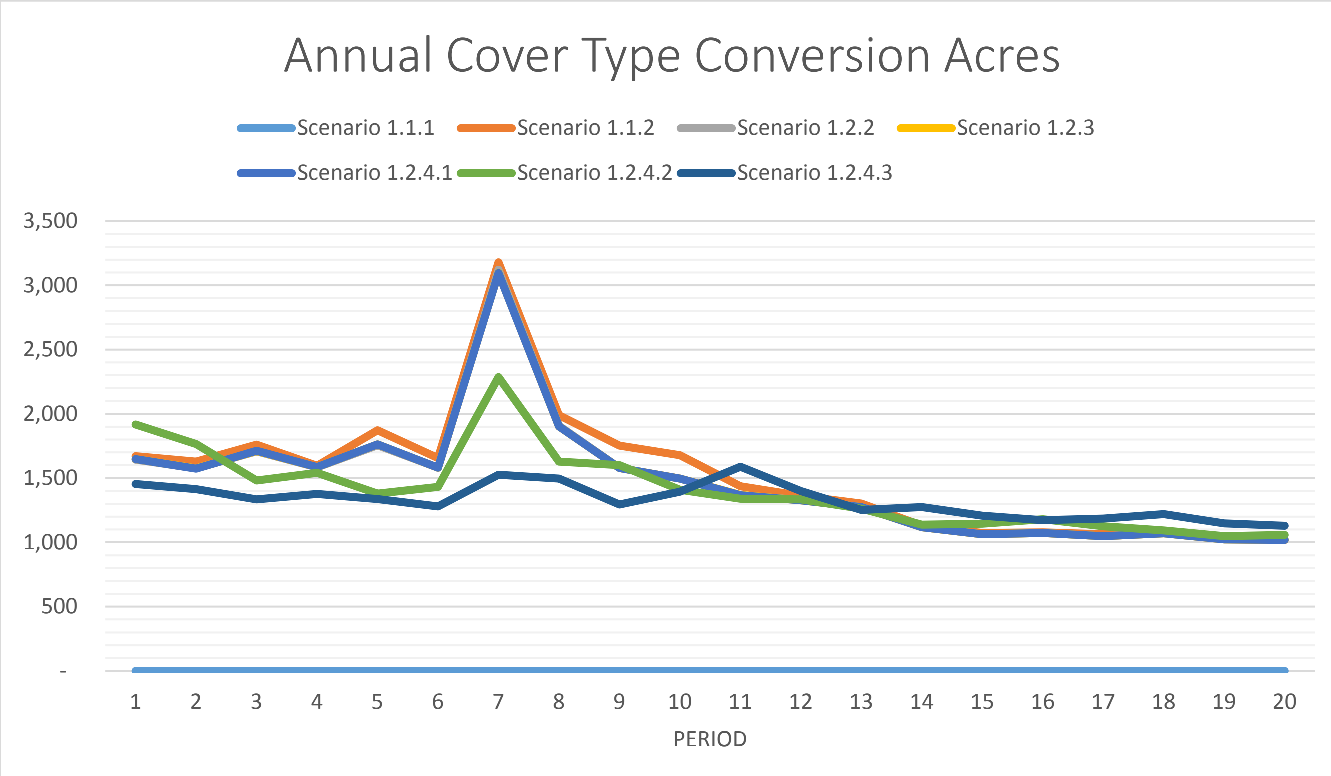


Figure 27. Scenario 1 - Cover Type Conversions

5.3.1.9 Planning Latitude

Harvest levels may be accomplished via a number of possible pathways, some requiring use of more acres under active management, while others require fewer actively managed acres. In this context, we define the term planning latitude to mean the proportion of acres clear-cut as a fraction of the clear-cut operable acres. A model result will be said to have high planning latitude (e.g. scenario 1.2.4.3, Figure 28) if it uses a smaller proportion of available acres. The higher the latitude, the lower the risk to operational implementation, because there are other options to select if the option selected by the model is not viable.

In the early years, all scenario 1 variants have a high degree of planning latitude, with between 12% and 25% of the operable clear-cut acres contributing to harvests. After 100 years, however, latitude diverges for several scenarios. Scenarios 1.1.1 and 1.1.2 have a low degree of planning latitude. After 100 years of management, these scenarios require around 82% of the operable area, meaning that 2.2 million out of 2.7 million operable acres must participate in the model to produce the reported harvest levels. In contrast, scenarios 1.2.2, 1.2.3, and 1.2.4.1 all achieve their harvest levels at around 66% clear-cut acreage, meaning these scenarios have more latitude or flexibility to reach these goals. These scenarios also have lower harvest rates, so there are more possible ways to manage the land base to reach these goals. Scenarios with the wildlife and NPC goals, 1.2.4.2 and 1.2.4.3, have the lowest harvest and therefore the most planning latitude, requiring 10% to 17% of the land base after 100 years (Figure 28).

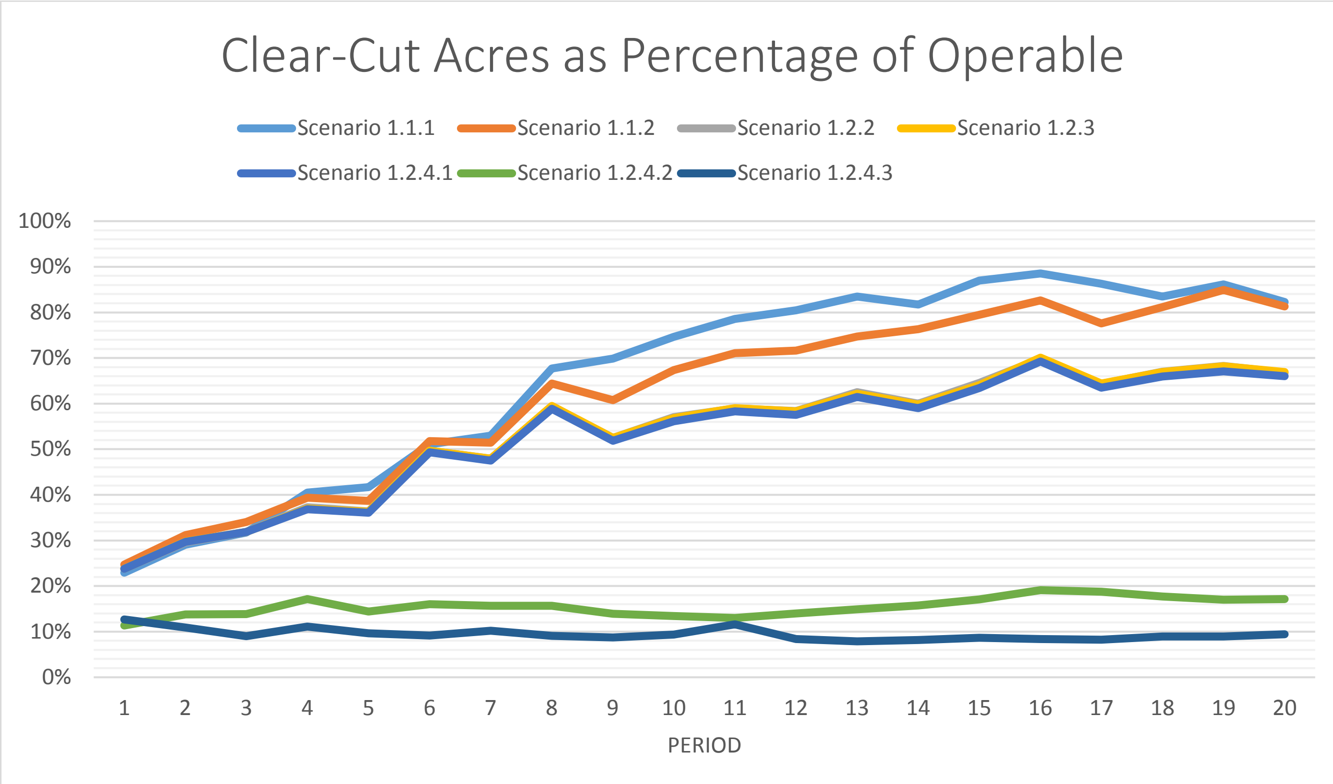


Figure 28. Scenario 1 - Planning Latitude

5.3.1.10 Open Watershed Goals

Scenario 1.2.4.1 included the goal to minimize cumulative watershed impacts in priority catchments by restricting the amount of open lands. This scenario reduced the number of priority catchments considered "open" to the greatest extent of any scenario and maintained 2.54% of the priority catchments in the open state after period four. Relative to scenario 1.1.1, which had a long-term average of 4.56% open priority catchments, the cumulative watershed impacts scenario (1.2.4.1) had a long-term average open catchments of 2.71% (Figure 29). Compared to the other scenarios, however, minimizing the watershed goal showed little difference, ending at exactly the same percent open priority catchments (2.54%) as the NPC scenario (1.2.4.3), and marginally lower than the old forest scenario (1.2.4.2), which had 2.9% open catchments. Scenarios without old forest or NPC goals did result in higher long-term average open watersheds (4.23% for all), and terminal open acreage ranged from 3.99% to 4.17% for 1.1.2 through 1.2.3 (Figure 29). The watershed scenario leads to outcomes more similar to the wildlife habitat alternatives from the perspective of open catchment percentage.

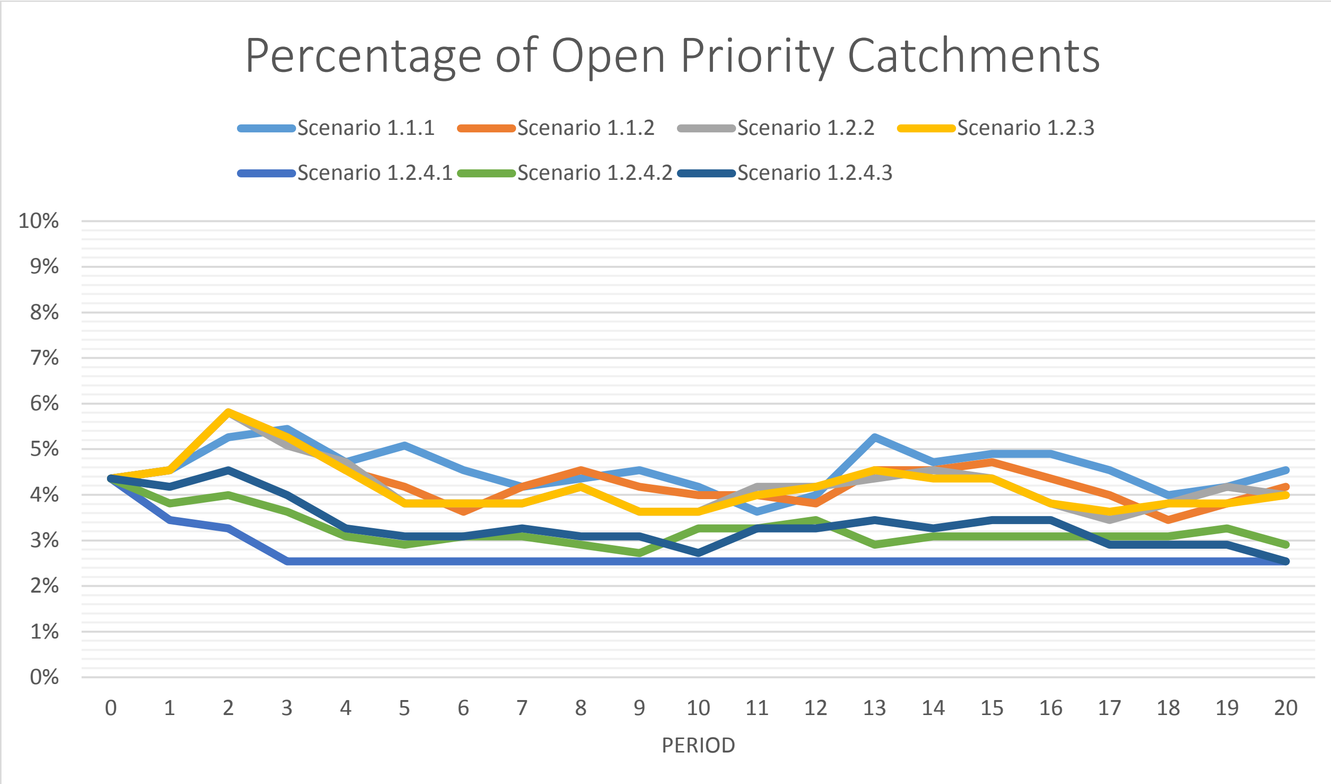


Figure 29. Scenario 1 - Open Watershed Prevalence

5.3.1.11 Old Forest Guild Goals

One of the greatest differences among the Scenario 1 alternatives emerged from the old forest goal. Although maximizing the spatial distribution of old forest habitat (1.2.4.2) was similar to the NPC scenario (1.2.4.3) in terms of PSR, harvest, inventory, and growth, there was a substantial difference in the number of hexagons that met habitat criteria for old forest-dependent wildlife. In period 20 of this scenario (Figure 30), 42% of hexagons met old forest habitat criteria. In contrast, the NPC scenario met old forest habitat criteria in 27% of hexagons, and all of the other scenarios met these criteria in 2.4 - 3.8% of hexagons. Adding the old forest goals increased the representation of old forest guilds by 38.9% relative to scenario 1.2.2 (Figure 30).

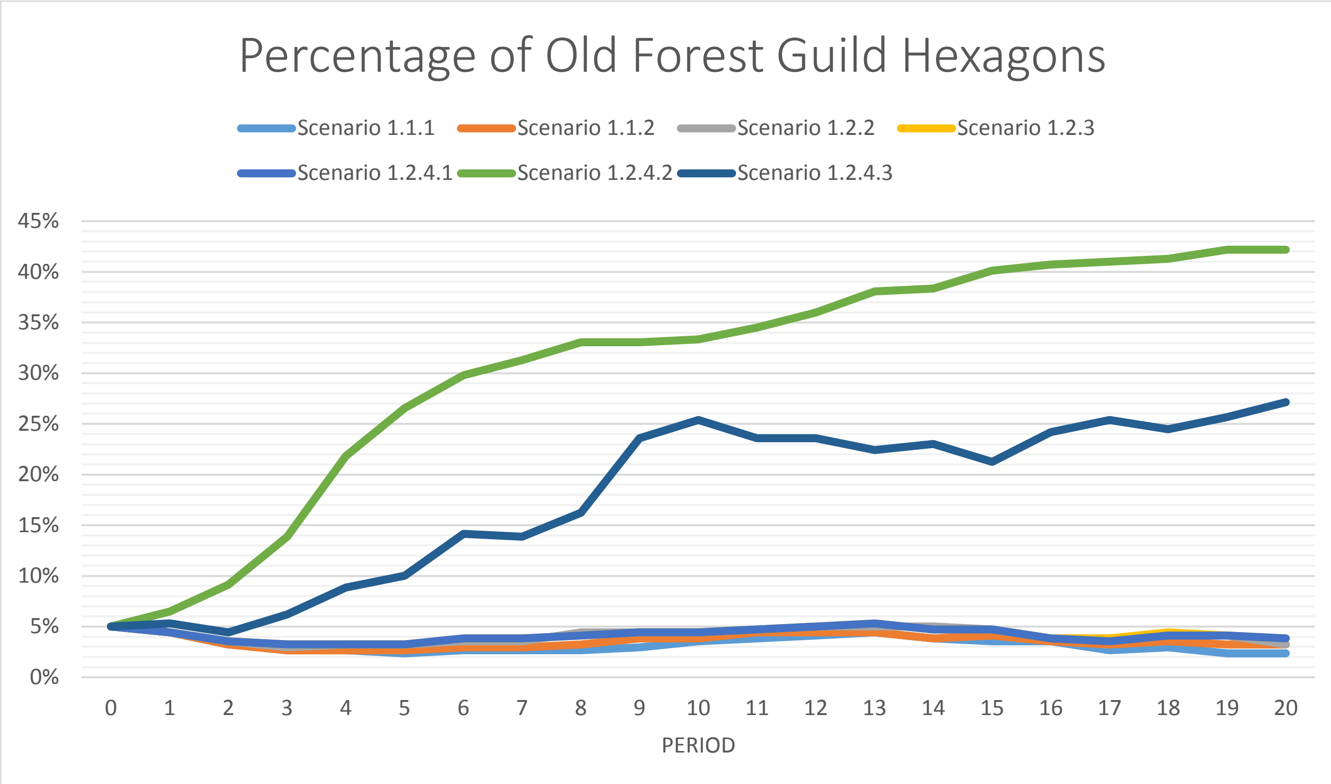


Figure 30. Scenario 1 - Old Forest Guild Proportion

5.3.1.12 Young Forest Guild Goals

None of the scenarios optimized for young forest guild goals, so the results reported here are artifacts of other management assumptions. The results show that the assumptions associated with the old forest guild scenario (1.2.4.2) had the greatest impact on the percentage of young forest guild hexagons. This scenario maintained ±20% of the land as young forest for the length of the planning horizon. This was followed by the NPC scenario (1.2.4.3) which fluctuated between 15% and 20%. The other scenarios fluctuated between 4% and 9%. The scenarios with wildlife management regimes (1.2.2, 1.2.3, 1.2.4.1) trended slightly higher (±6%) than the scenarios with forestry regimes only (1.1.1, 1.1.2) (±5%).

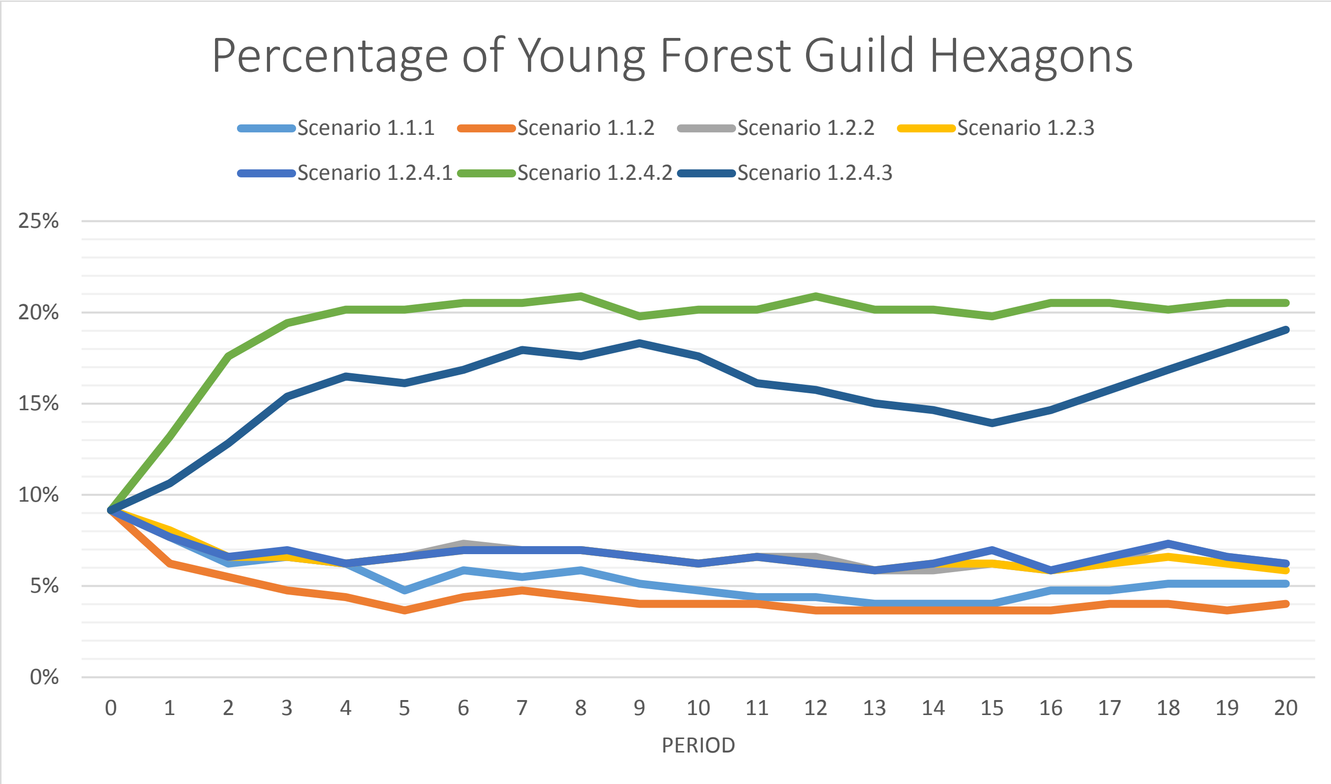


Figure 31. Scenario 1 – Young Forest Guild Proportion

5.3.1.13 Native Plant Community Goals

Model outcomes for NPC goals are measured as the absolute deviation in acres from the NPC growth stages goals. Therefore, the lower this number, the closer the landscape is to the desired NPC goals.

Old forest and NPC scenarios initially decrease NPC deviations (improved outcome), but after period seven, the NPC deviation increases for both 1.2.4.2 and 1.2.4.3. As we would expect, the lowest NPC deviations occurred in the NPC scenario (1.2.4.3), which attempted to optimize on NPC goals. Here, only 529,000 (11% of all NPC acres) acres are deviations (Figure 32). The old forest scenario ends period 20 with a higher NPC deviation than it began and is grouped closely with the other scenarios. At period 20, the NPC scenario forms its own single group (Figure 32), while the other scenarios are all within 10% of the maximum deviation.

Some scenarios arrive at partially improved outcomes for goals that were not optimized. For example, the NPC scenario achieves the lowest acreage deviation for NPCs (Figure 32), but also results in 27% old forest guild hexagons (Figure 30), even though this was not an explicit goal. In contrast, specifying an old forest goal produces the highest number of old forest hexagons, but fails to do very well in meeting NPC goals.

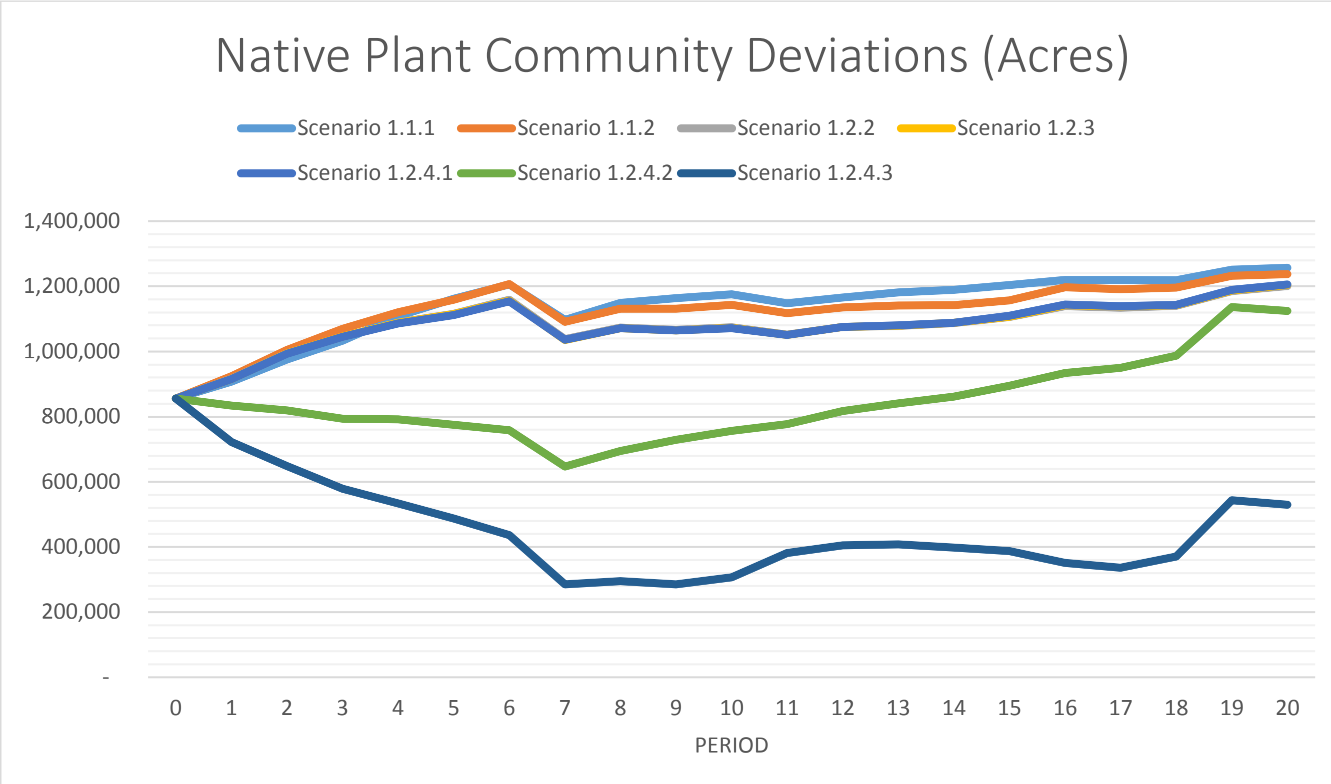


Figure 32. Scenario 1 - Native Plant Community Acreage Deviations

5.3.1.14 Forest-Age Diversity Goals

Adding NPC and old forest goals marginally improves forest age class diversity as measured by the forest-age diversity index. Scenario 1.2.4.3 (NPC goals), yields the highest diversity index, ending period 20 at a value of 0.88 (Figure 22) (theoretical maximum is 0.90). Other scenarios are not substantially different, with the old forest goals scenario ending at 0.87, and the unconstrained scenario 1.1.1 at 0.85 (Figure 33). In percentage terms, the NPC scenario is 97.8% of the theoretical maximum, and scenario 1.2.2 is 95.6% of the maximum. Therefore, age class diversity is a relatively insensitive metric compared to others reported above.

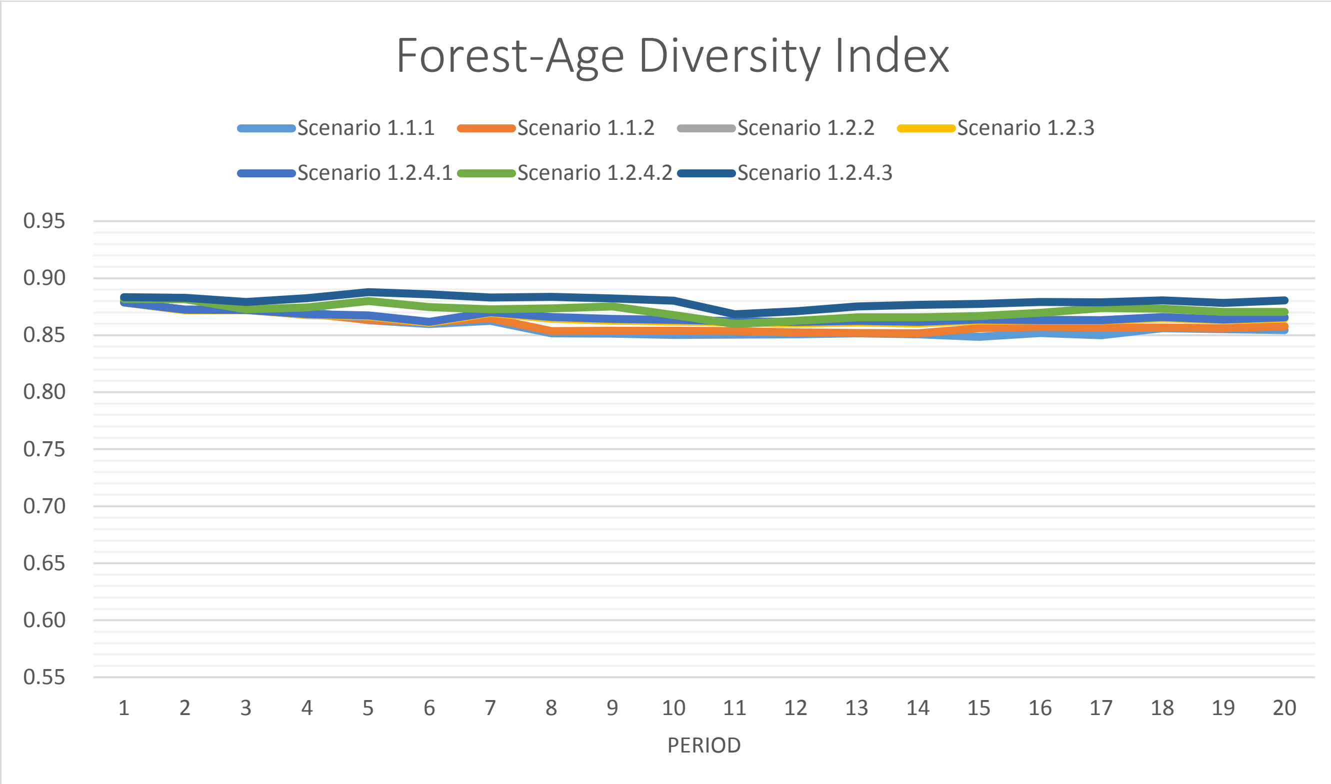


Figure 33. Scenario 1 – Forest-Age Diversity Index Range

5.3.2 Scenario 2 – Forest-Age Diversity

The following sub-scenarios were developed for Scenario 2:

2.1 Used forestry and wildlife management regimes. Objective was to maximize forest-age diversity. Timber volume was kept constant at 1 million cords per year. Enabled current MN DNR protocols (statutory requirements) by turning on species conversion, RMZ's, endangered and threatened species, bald eagle nests, and 5% leave tree requirement. The purpose of this scenario was to determine if forest-age diversity can be maximized while maintaining a harvest level of 1 million cords per year. Following the completion of the Scenario 1 runs, we learned that a 1 million cords per year harvest could not be sustained. We, therefore, elected to replace the 1 million cord harvest constraint with the harvest levels achieved in scenario 1.2.2. This scenario is most comparable to the Scenario 2 runs and achieved the maximum volume under the statutory constraints.

2.2 Same as 2.1, but with a constant harvest level of 0.8 million cords per year. The purpose of this scenario was to determine if forest-age diversity can be maximized while maintaining a harvest level of 0.8 million cords per year.

2.3 Same as 2.1, but with a constant harvest level of 0.6 million cords per year. The purpose of this scenario was to determine if forest-age diversity can be maximized while maintaining a harvest level of 0.6 million cords per year.

In the results below we used scenario 1.2.2 to compare back to Scenario 1 results. All of these scenarios used the forestry and wildlife management regimes, and the regulatory requirement constraints for watersheds, diversity, and wildlife. This allowed us to draw a comparison between Scenario 1 and 2 results, in order to assess the impact of the diversity-driven objective function.

The detailed results for each scenario are shown in Appendix H: Detailed Scenario Results.

5.3.2.1 Present Stumpage Revenue

For scenario 2.1, present value of stumpage was $0.91 billion (Figure 34). This was only marginally different from scenario 1.2.2. Annual harvest levels of 800,000 cords (2.2) and 600,000 cords (2.3) were sustainable over the 100-year planning interval. The present stumpage values of these lower harvest scenarios were $0.75 billion for scenario 2.2 and $0.54 billion for scenario 2.3 (Figure 34), a reduction of 18% and 41% from scenario 1.2.2.

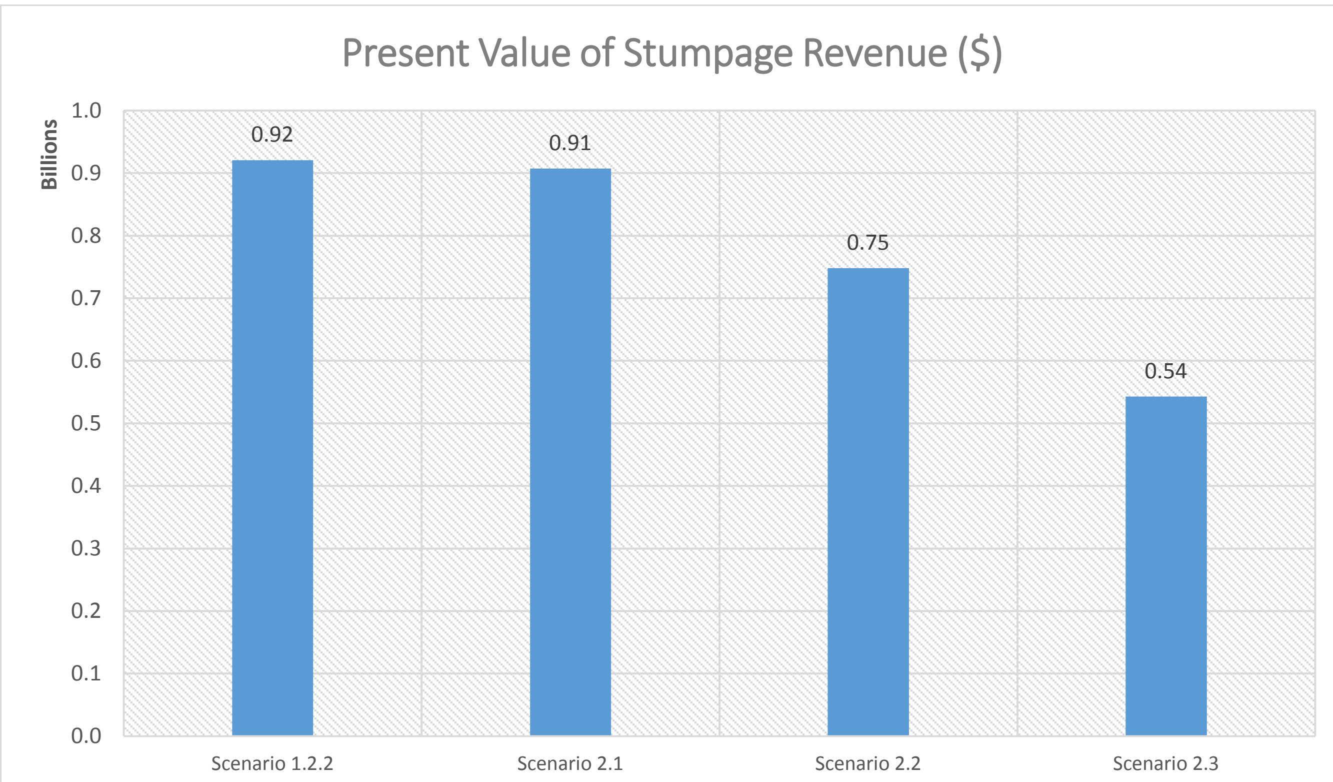


Figure 34. Scenario 2 - Present Stumpage Revenue

5.3.2.2 Harvest Volume

Scenario 2.1 harvest levels were identical to 1.2.2 (Figure 35), but also achieved higher forest-age diversity (5.3.2.14). This implies that there are opportunities to maximize diversity while maintaining optimal harvest levels. For scenarios 2.2 and 2.3, the model was able to sustain both the 800,000 and 600,000 cords per year harvest level for the full planning horizon (Figure 35). Scenarios 2.2 and 2.3 encountered no difficulties in maintaining harvest levels, so their long-term average harvest stays constant (Figure 35), and is equal to the harvest objective.

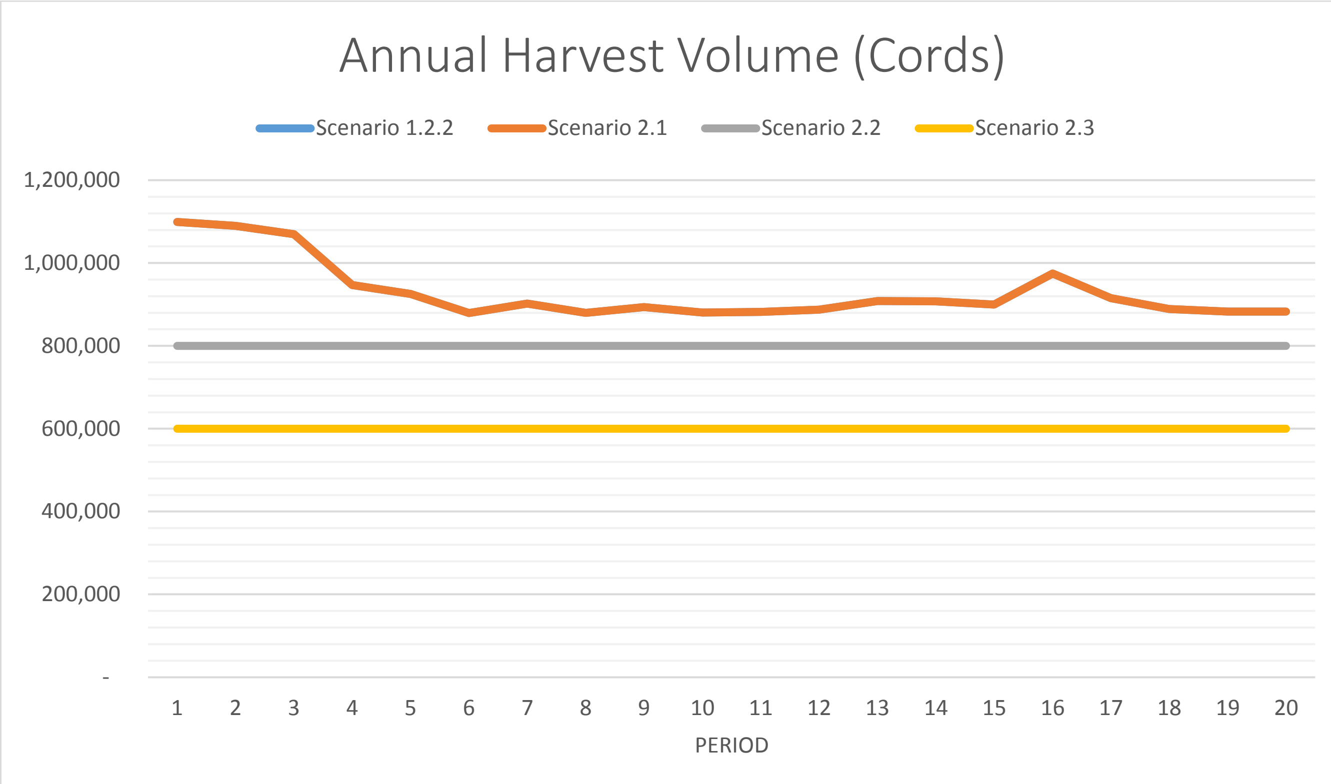


Figure 35. Scenario 2 - Annual Harvest Volumes

5.3.2.3 Clear-Cut Operable Acres

Recall that clear-cut operable acres represent the acres that are eligible for the clear-cut action. Scenarios with higher sustained harvest rates are defined by declining clear-cut operable acres (Figure 36) because these scenarios tend to harvest stands near to their minimum rotation age (Figure 37). After 100 years, clear-cut operable acreage in Scenario 2.1 is around 361,000 acres, only marginally higher than the baseline from scenario 1.1.2, which was 317,000 acres (Figure 36).

When biodiversity (stand age class diversity) was maximized under lower harvest levels, the clear-cut operable acres increased rapidly. For scenario 2.2, a harvest level of 800,000 cords per year resulted in 979,000 clear-cut operable acres by year 100; for scenario 2.3, a harvest level of 600,000 cords per year allowed for 1.07 million clear-cut operable acres by year 100 (Figure 36). The number of clear-cut operable acres are closely correlated with average clear-cut age (Figure 37).

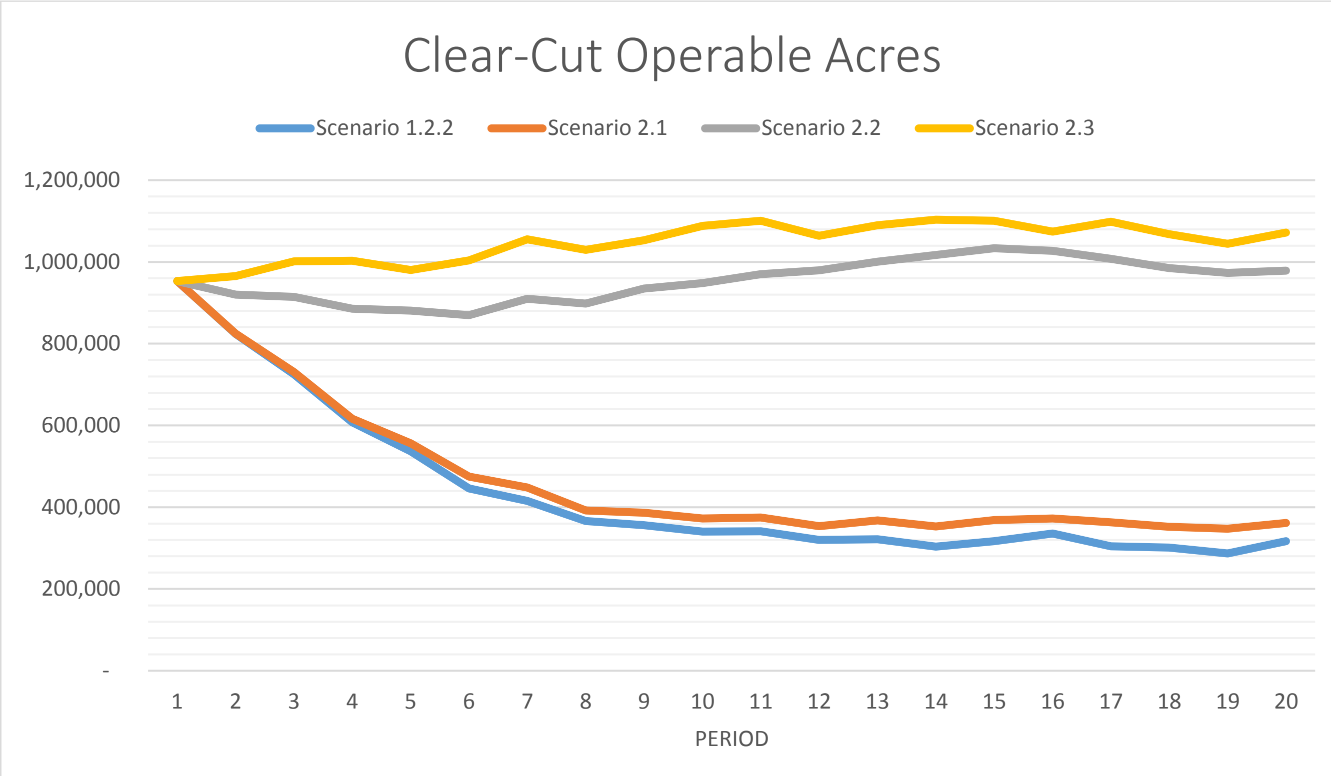


Figure 36. Scenario 2 - Clear-Cut Operable Acres

5.3.2.4 Average Clear-Cut Age

Through the first 20 years of the planning horizon, standing inventory contains adequate acreage that is already older than rotation age, so average clear-cut age is not substantially different among scenarios. After 20 years, however, scenario 2.1 began to require clear-cut of stands progressively closer to the rotation age. By approximately 75 years, scenario 2.1 (similar to 1.2.2) reaches an equilibrium average age of clear-cut around 55 years old, which can be thought of as the acre-weighted average rotation age across cover types in the planning areas. The result for scenario 2.1 is similar to the baseline scenario 1.2.2, but the models differed by the requirement to maximize biodiversity, so scenario 2.1 had a slightly higher average clear-cut age to increase biodiversity.

Scenario 2.2, which sustained an annual harvest level of 800,000 cords, had an intermediate average clear-cut age, averaging 75 years across the model interval, and ending near 70 years, 13 years older than scenario 2.1 (Figure 37). Sustaining a harvest level of only 600,000 cords per year, Scenario 2.3 had an average clear-cut age of 81 years and ended year 100 at an average clear-cut age of 81 years. Average clear-cut age in scenario 2.3 was 8% higher than Scenario 2.2 and 27% higher than Scenario 2.1.

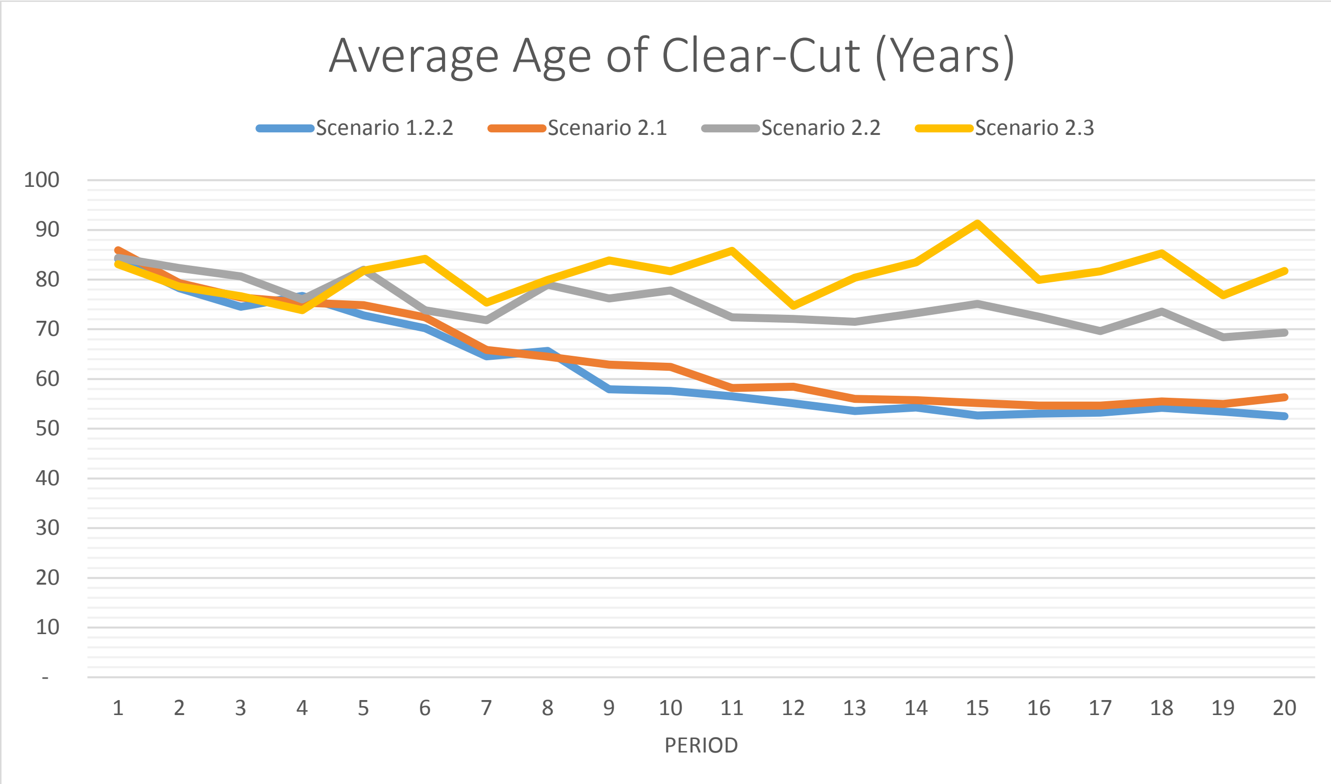


Figure 37. Scenario 2 - Average Clear-Cut Ages

5.3.2.5 Priority Harvest Volume

The fraction of total harvest volume that is within 75 miles of major processors and consists of preferred species—the priority harvest volume—is similar across each of the versions of Scenario 2. The 100-year average priority harvest volume ranges only a small amount, from a low of 63% in scenario 2.3 to 66% in scenario 2.1 (Figure 38). At a few times early in the planning horizon, scenarios 2.1 and 2.2 diverged to a limited extent from scenario 2.3, but not by more than 5% in a given period (Figure 38). Considering only the final 25 years, the priority harvest volume was 65% (2.1 and 2.2) or 64% (2.3) of the total. Compared to scenario 1.2.2, priority harvest volume is nearly identical for scenario 2.1 (Figure 38).

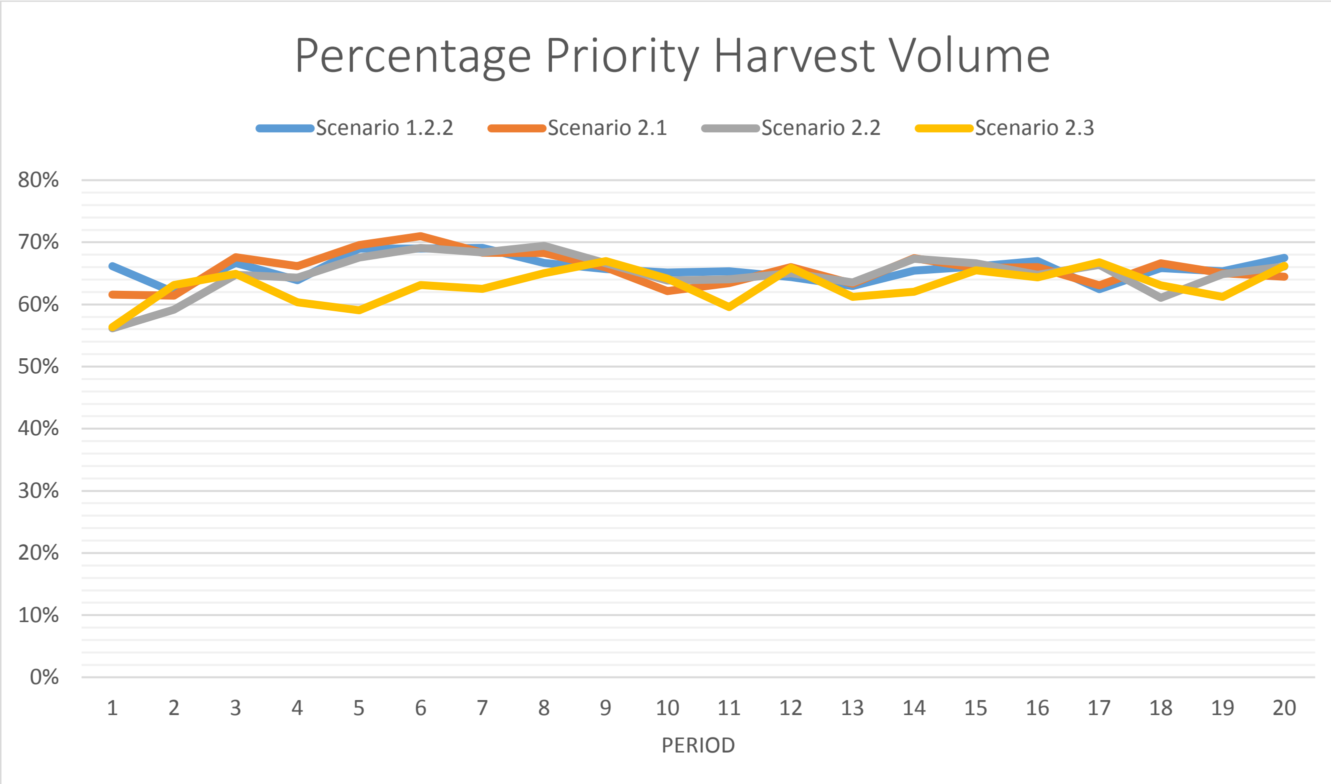


Figure 38. Scenario 2 - Priority Harvest Volume

5.3.2.6 Inventory

We should expect scenario 2.1 inventory to be similar to the baseline inventory from scenario 1.2.2 since harvest levels were nearly identical. Scenario 2.1 inventory began at 36.8 million cords, but after 20 years dropped to a steady long-term average of 32.1 million cords (Figure 39). Scenarios 2.2 and 2.3 had lower harvest levels, resulting in higher inventory. Again after 20 years, the long-term average inventory shows minimal fluctuation, staying at 38.6 million cords for scenario 2.2 and 41.3 million cords for scenario 2.3 (Figure 39).

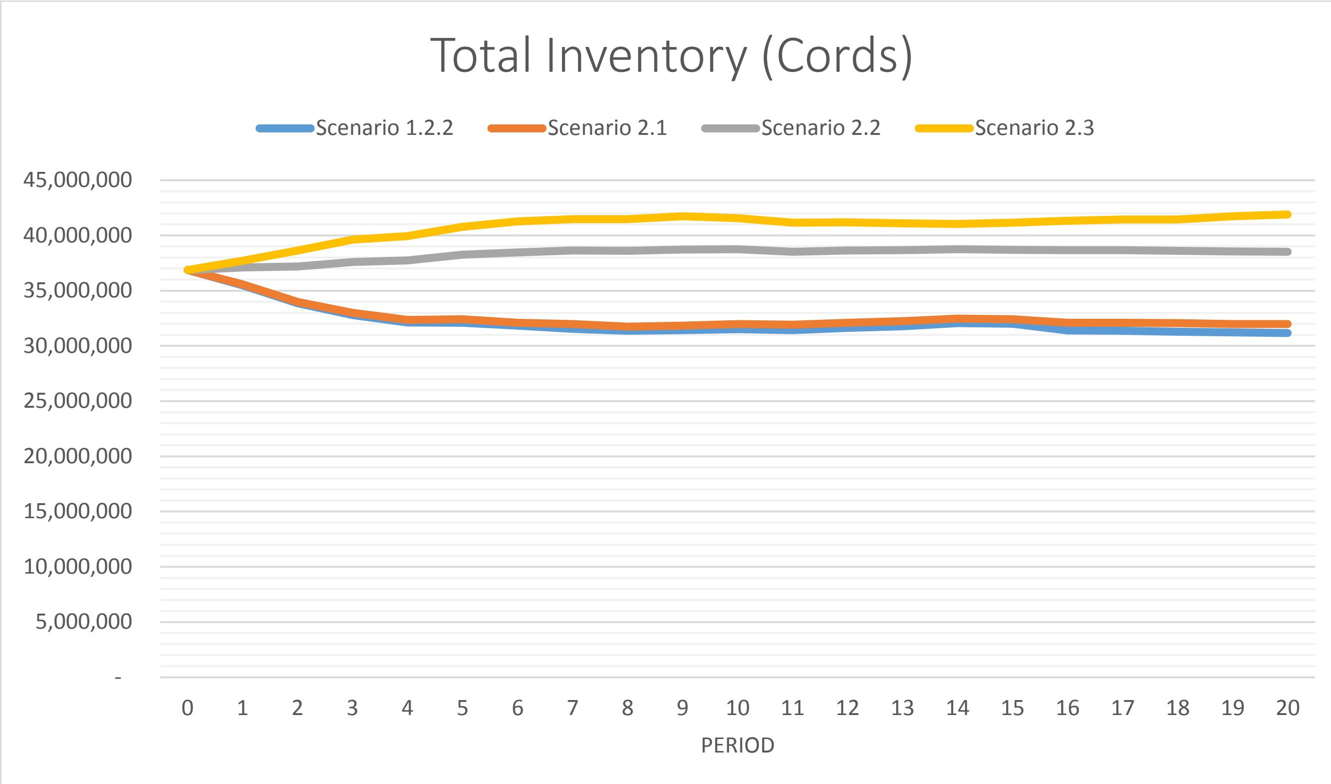


Figure 39. Scenario 2 - Inventory Volume by Period

Where inventory is high, stand turnover is low; stands reach more advanced ages, so annual growth rates are lower. With the smallest inventory (Figure 39) and the lowest average clear-cut age (Figure 37), scenario 2.1 should show the largest annual growth increment (Figure 40). Over 100 years, scenario 2.1 growth averages 712,000 cords per year. Scenario 2.2 has intermediate harvest levels and inventory, as well as intermediate annual growth, averaging 660,000 cords per year (Figure 40). Scenario 2.3 averages only 586,000 cords per year.

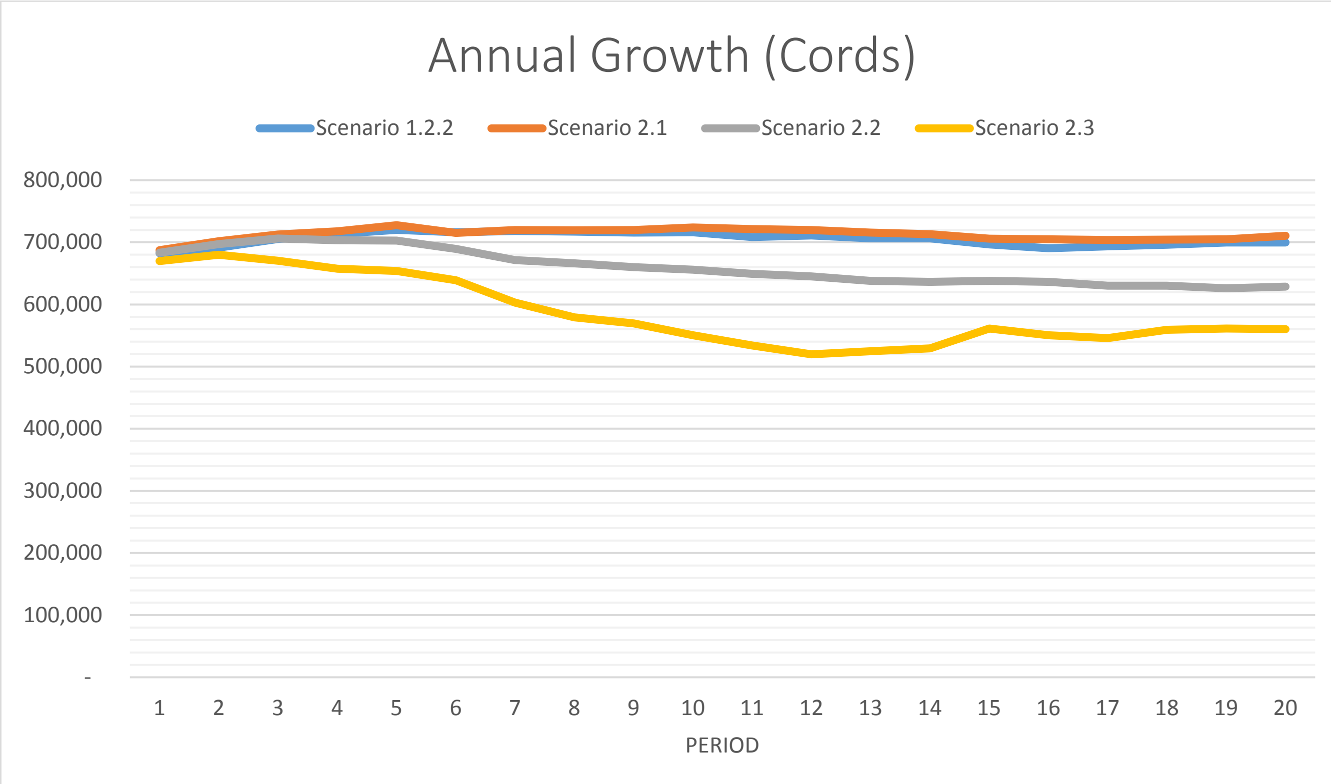


Figure 40. Scenario 2 - Annual Growth

5.3.2.7 Trust Land Inventory

Inventory located on school trust land is proportional to total inventory for each case of Scenario 2 (Figure 41). Scenario 2.3 total inventory increases from 36.8 million cords to a long-term average over the last 80 years (from year 20 to year 100) of 41.3 million cords, an increase of 12%. On trust lands, scenario 2.3 behaves in a similar way, starting at 17.3 million cords and increasing 13% to 19.7 million cords. Inventory build-up in scenario 2.2, again comparing the long-term average over the last 80 years, is 4.6% in total compared to 3.5% for trust lands. For scenario 2.1, inventory draw-down is 12.9% for the total inventory, but 17.4% for trust lands. In this scenario, inventory is reduced on trust lands by about 5% more than the total land base for scenario 2.1.

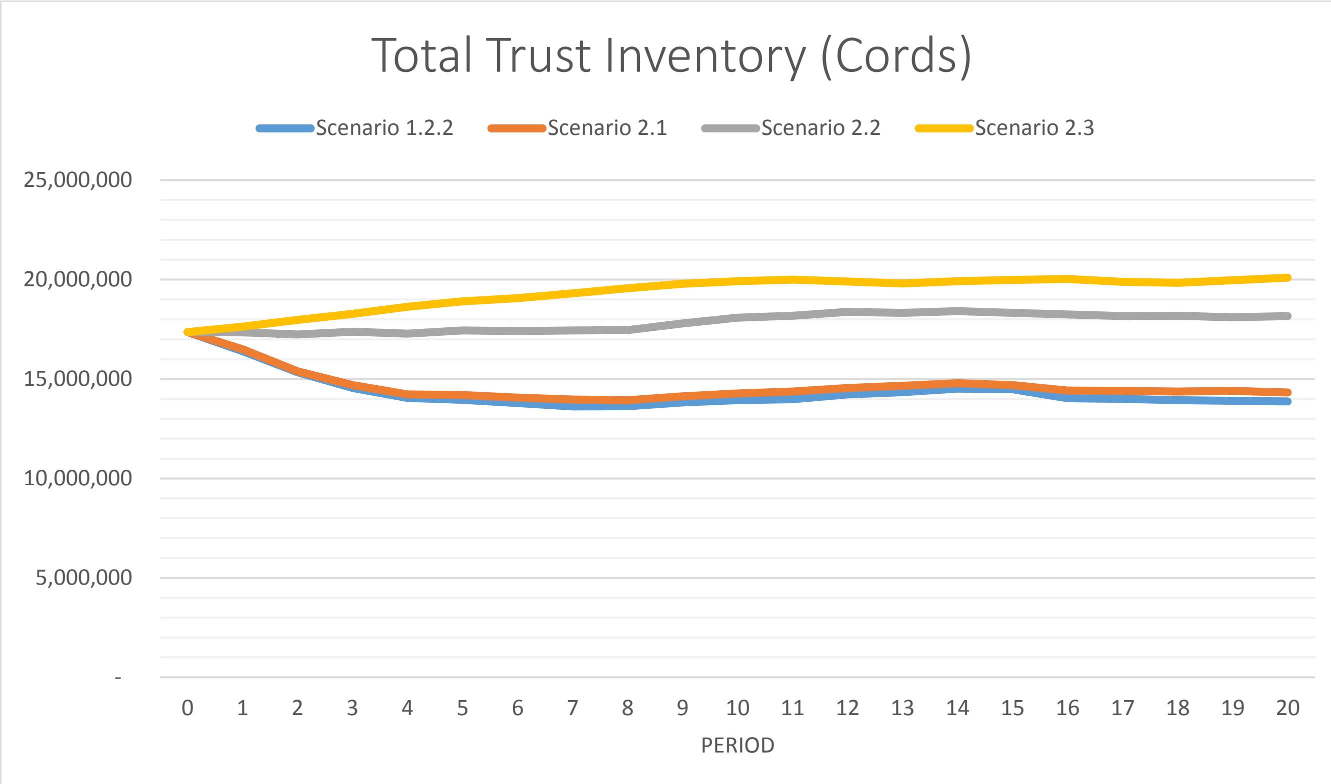


Figure 41. Scenario 2 - Inventory On Trust Land

5.3.2.8 Cover Type Conversions

Conversion among cover types typically proceeds at an average rate of 1,330 acres per year, although there is a single time point at 35 years in which conversions for scenario 2.1 more than double (Figure 42). Overall, the relative magnitude of cover type conversion (1,000 to 3,250 acres) to operable acres (approximately 2.7 million acres) is small, ranging from 0.04% to 0.12%. The temporary spike (Figure 42) in cover type conversion in scenario 2.1 (also occurs in scenario 1.2.2) is driven by the conversion of planted white spruce to aspen and red pine. In scenarios 2.2 and 2.3, lower harvest levels would not necessitate cover type conversions because harvest requirements can be met with existing inventory and cover type distributions.

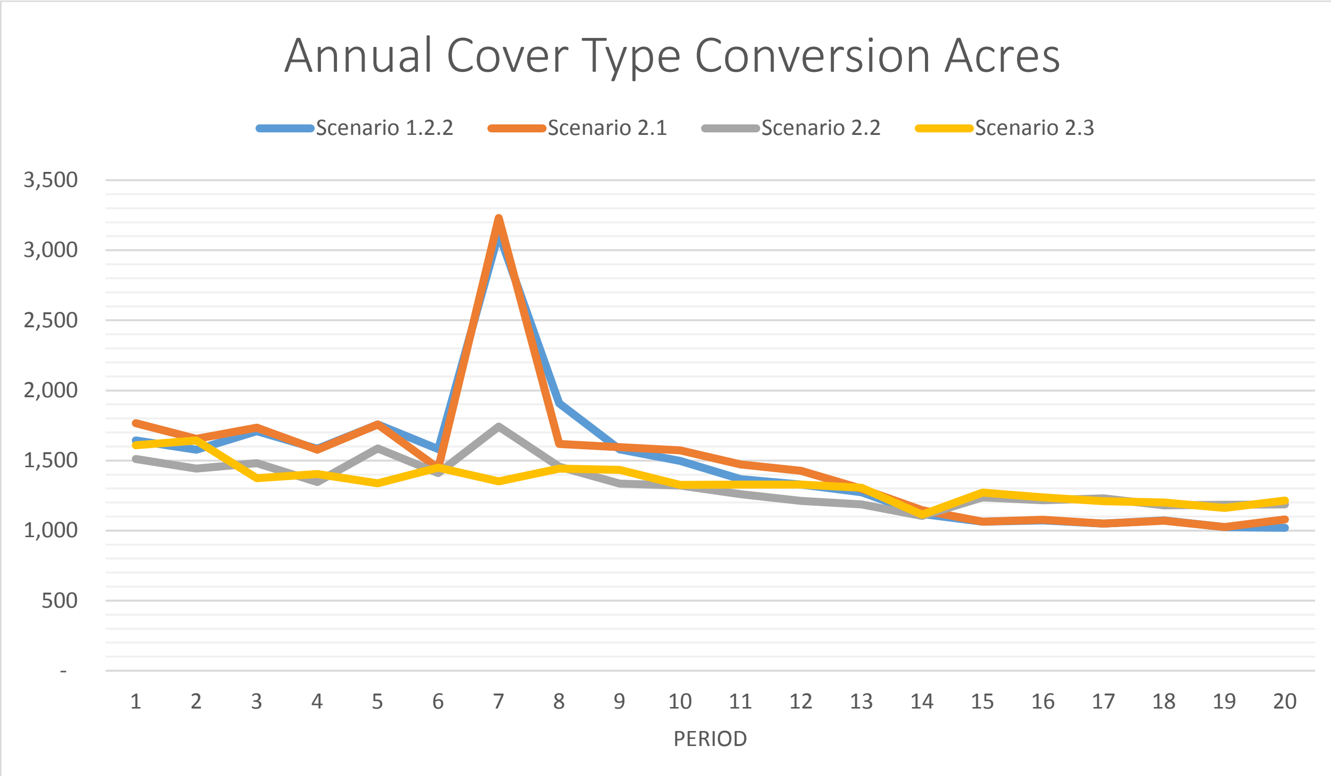


Figure 42. Scenario 2 - Cover Type Conversions

5.3.2.9 Planning Latitude

In Scenario 1, we defined planning latitude as the ratio of clear-cut acres to clear-cut operable acres, which was a measure of operational flexibility in the scenario. When clear-cut acres constitute a high percentage of operable acres, there is less latitude for implementing planning options. We would expect planning latitude to be highest at the beginning of the planning interval when the entire current standing inventory is available for decision making. Under scenarios with high harvest levels, planning latitude would tend to decrease because rotation lengths are reduced (Figure 37) and more acres must participate in active management (Figure 43). In scenario 2.1, the proportion of clear-cut acres begins at 24%, when existing inventory beyond rotation age can provide larger yields per acres. The proportion of clear-cut acres increases steadily to a long-term average of 54% during the final 50 years of the plan (Figure 43). In comparison, scenario 1.2.2 used a higher proportion of acres, suggesting that the diversity objective had a positive impact on latitude. Scenarios 2.2 and 2.3 had substantially lower proportions, which ranged between 9% and 18%.

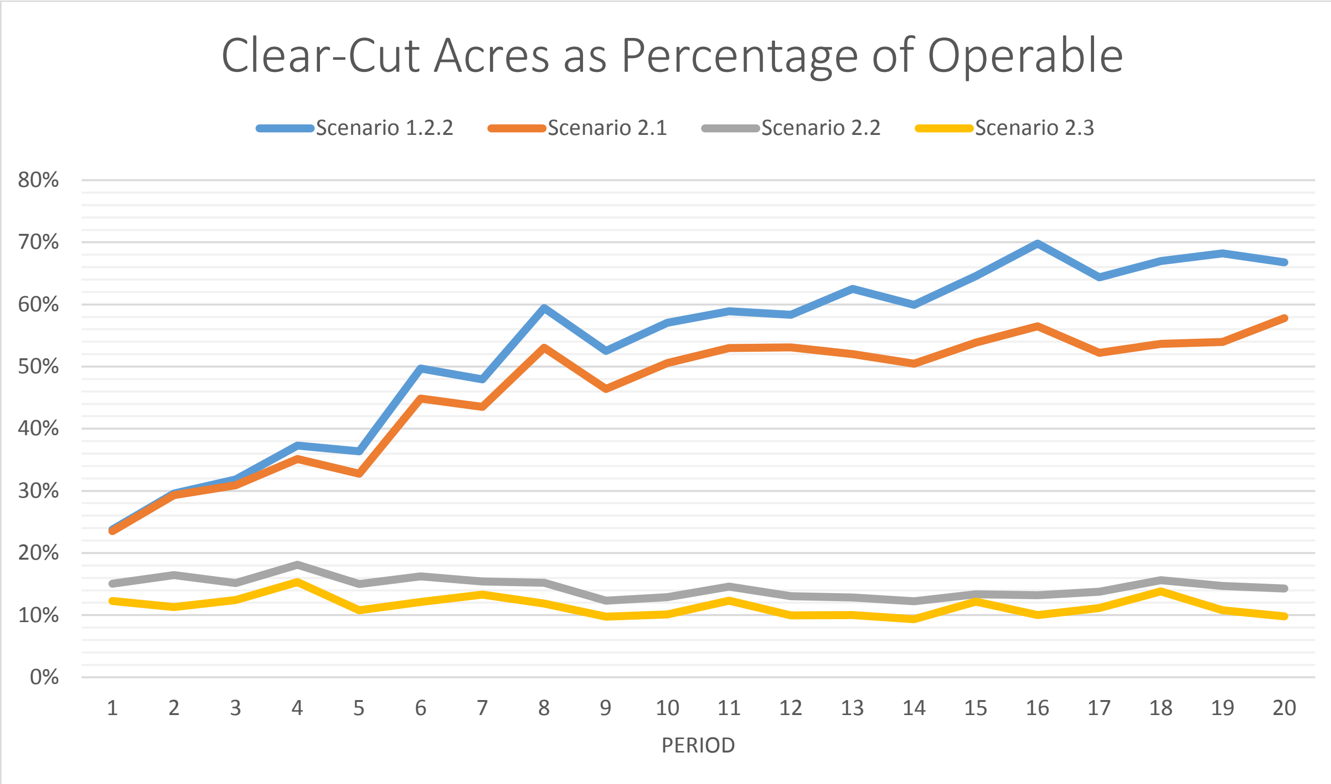


Figure 43. Scenario 2 - Planning Latitude

5.3.2.10 Open Watershed Goals

Whereas scenario 1.2.4.1 had the goal to minimize the impacts of harvesting on priority catchments, this goal was not applied on scenario 1.2.2, nor on any of the Scenario 2 cases. The prevalence of open watersheds in these scenarios would not be a consequence of actively attempting to minimize open watersheds. We see little difference in the percentage of open watersheds (minimum 3.48% for scenario 2.2, maximum 4.15% for scenario 2.1), and the percentage at 100 years is essentially identical, either 3.8% or 4% (Figure 44). In that scenario 1.2.4.1 (Figure 29) open watersheds were reduced to 2.54% of the area after 20 years. Scenarios 2.1 and 2.3 were each 3.8% at 100 years, or 1.27% higher than scenario 1.2.4.3; scenario 2.2 was 4.0% at 100 years, or 1.45% higher. The outcome in terms of open watersheds does not improve substantially when the quantity is a target for optimization, nor does it suffer when watersheds are not explicitly optimized.

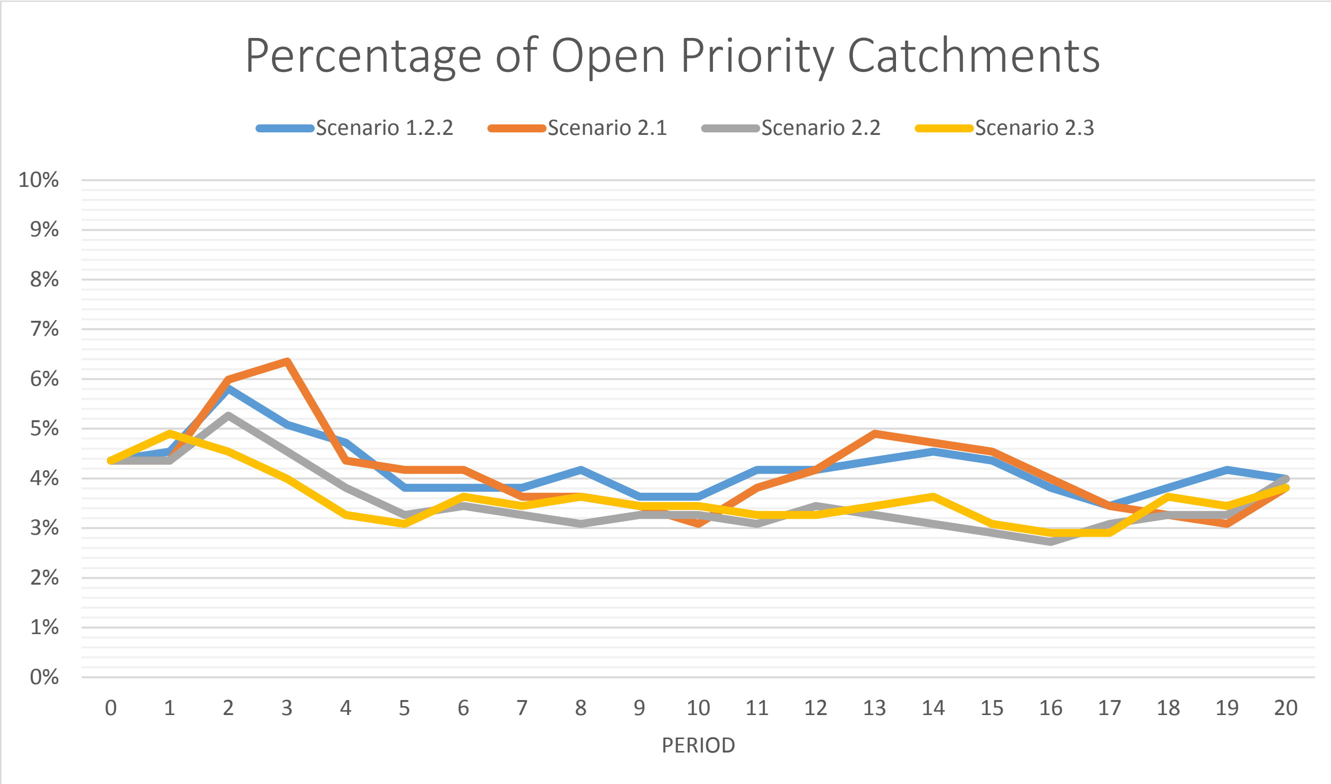


Figure 44. Scenario 2 - Open Watershed Prevalence

5.3.2.11 Old Forest Guild Goals

The objective of each case in Scenario 2 was to maximize forest-age diversity. This should result in an increase of every age class that happens to be underrepresented in the existing inventory. The current inventory has 5.0% of hexagons that have old forest guilds represented (Figure 45). When harvest levels are high (e.g. scenarios 2.1 and 1.2.2, for comparison), stands must be harvested at or not much beyond rotation age to maximize yields, preventing many stands from aging into the old forest guild. Scenario 2.1 initially loses old forest through about 35 years but manages to rebuild the old forest component until around 75 years (Figure 45). By year 100, however, hexagons with old forest declined to 2.95%. In contrast, after 40 years, both scenarios 2.2 and 2.3 increased old forest guild representation (Figure 45). In the latter 50 years, scenario 2.2 averaged 6.8% of hexagons with old forest and ended year 100 with 8.9%; scenario 2.3 averaged 9.0% and ended year 100 with 9.44% of hexagons containing old forest.

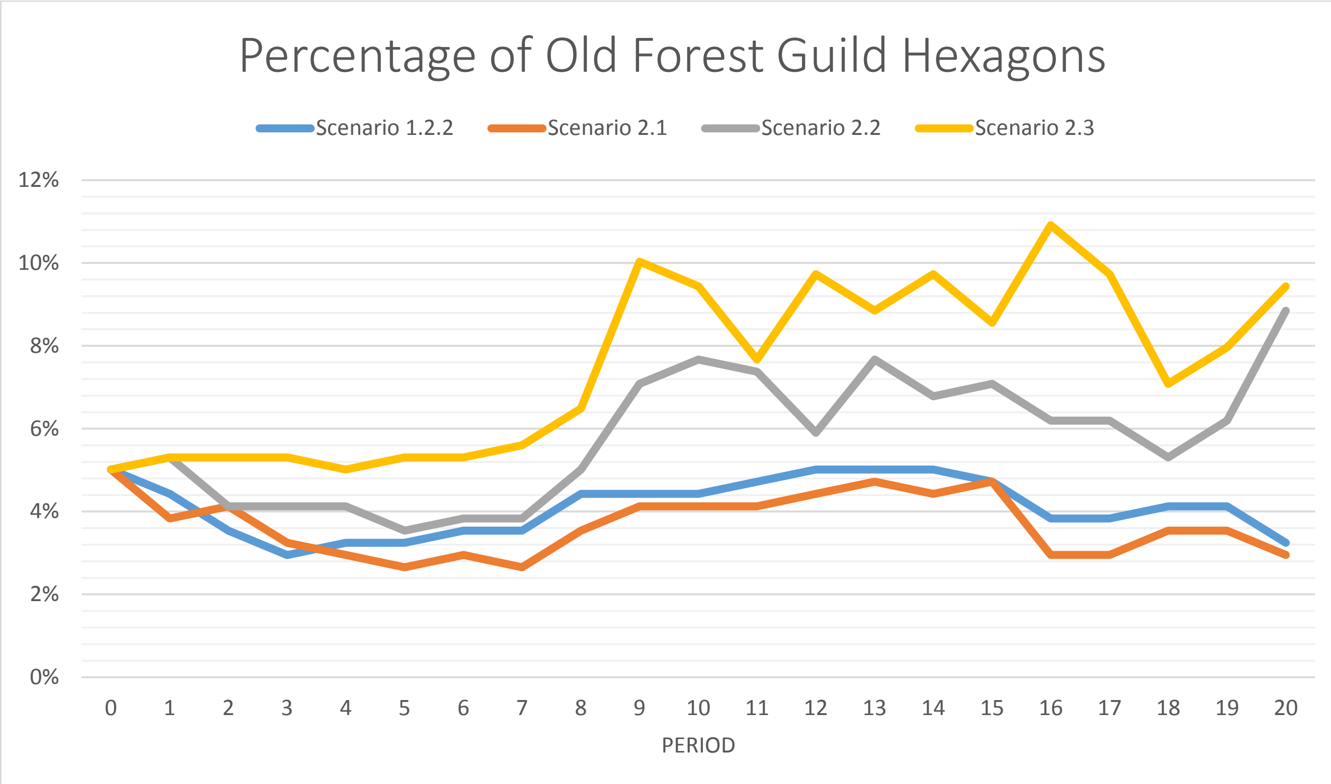


Figure 45. Scenario 2 - Old Forest Guild Proportion

5.3.2.12 Young Forest Guild Goals

None of the scenarios optimized for young forest guild goals, so the results reported here are artifacts of other management assumptions. The results show that lower the harvest level had the greatest impact on the percentage of young forest guild hexagons. Scenarios 2.2 and 2.3 ended at 12% and 16% respectively. In comparison, scenario 2.1 ended at 7%.

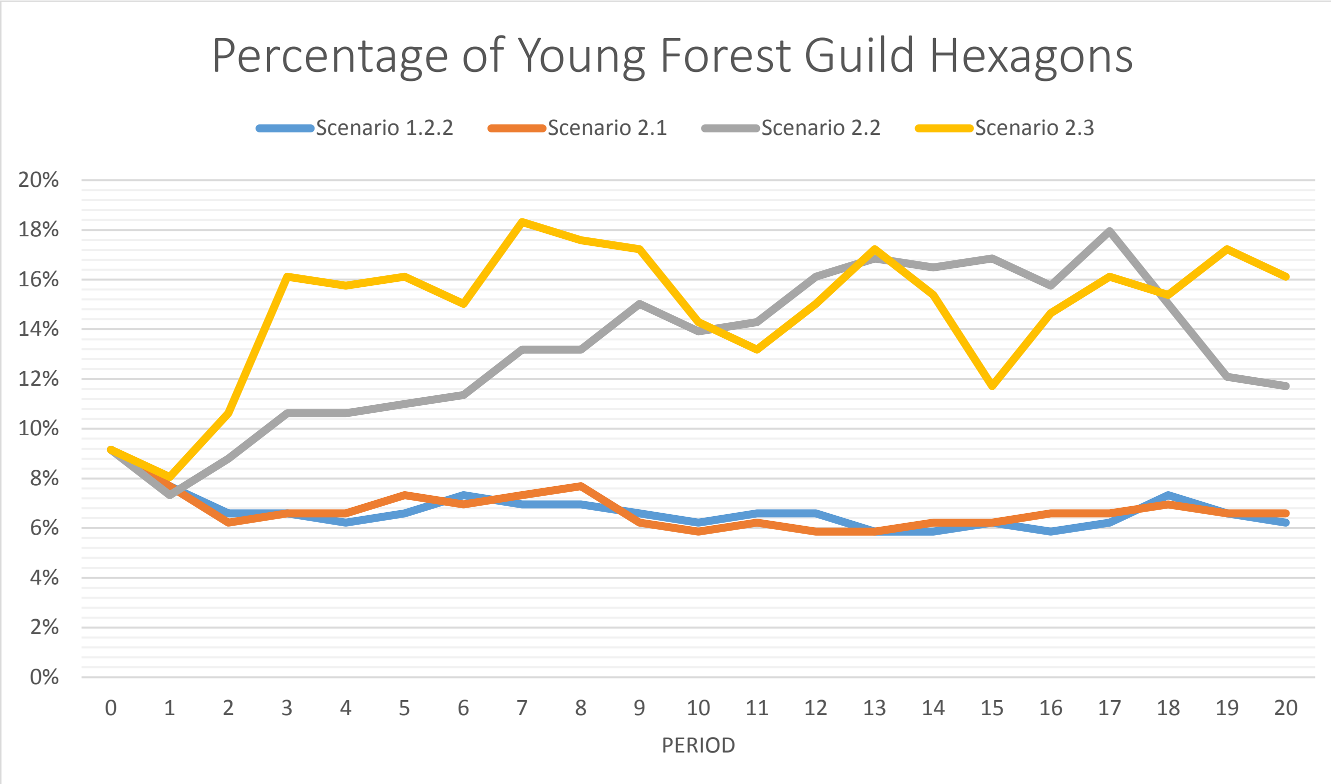


Figure 46. Scenario 2 - Young Forest Guild Proportion

5.3.2.13 Native Plant Community Goals

Both scenarios 2.2 and 2.3 were able to reach maximum diversity (see 5.3.2.14) and were also able to substantially reduce deviations from NPC goals (but not as much as applying NPC goals with the stumpage revenue objective) (±400,000 acres of deviations, Figure 32). The deviations for scenarios 2.2 and 2.3 are similar, ending at 997,000 acres and 925,000 acres, respectively (Figure 47). Scenario 2.1 attempted to maximize diversity while meeting a maximized harvest level (Figure 35). At 100 years, the NPC deviation for scenario 2.1 was 1.18 million acres, only slightly different from the 1.2 million acres in scenario 1.2.2. None of the Scenario 2 cases explicitly attempted to optimize NPC goals. In maximizing diversity, average NPC deviations for scenarios 2.2 and 2.3 were maintained over the long term at levels similar to the initial inventory. With the higher harvest requirement in scenario 2.1, NPC deviations increased.

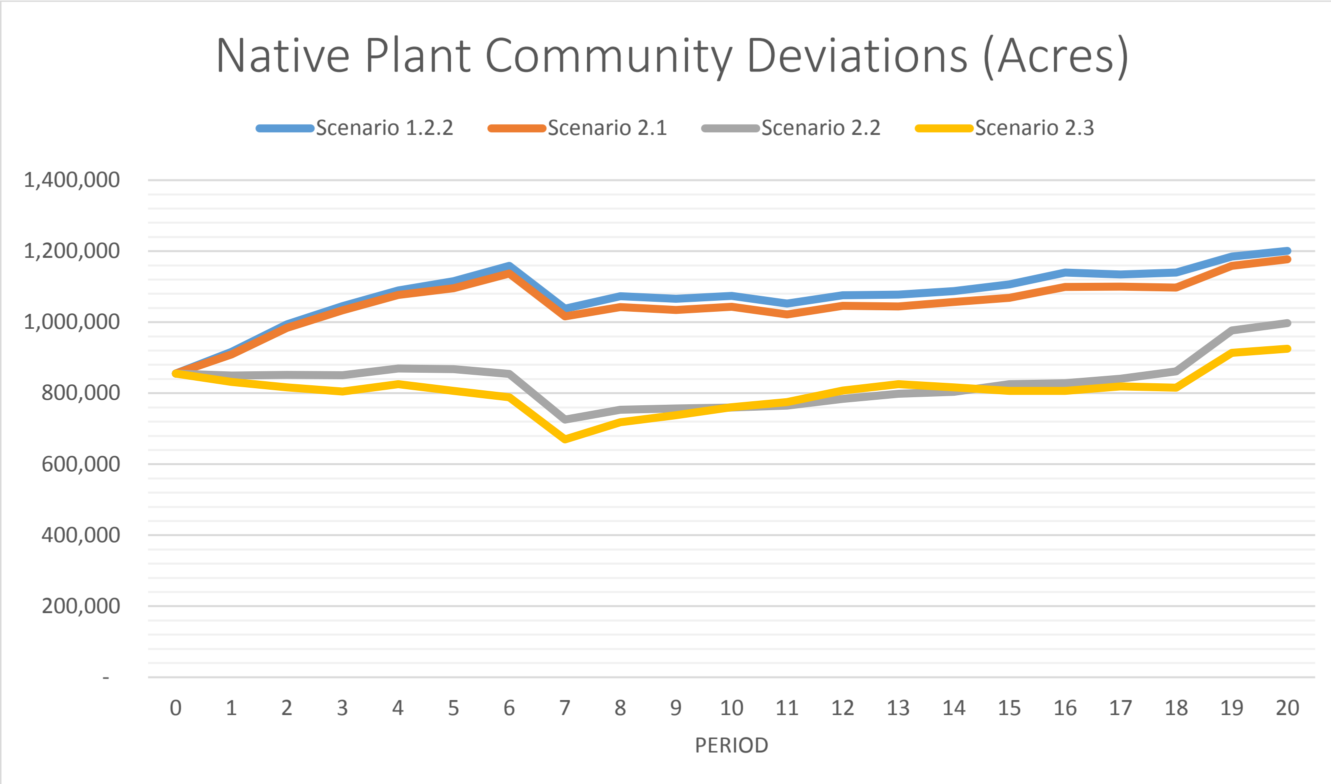


Figure 47. Scenario 2 - Native Plant Community Acreage Deviations

5.3.2.14 Forest-Age Diversity Goals

Maximizing forest age class diversity was the chief difference between Scenario 2 and 1.2.2, so we expect higher forest age class diversity index in these alternatives. In attempting to meet the maximized annual harvest, scenario 2.1 did not differ appreciably from Scenario 1.2.2 in terms of inventory, harvest, or average stand age, nor was there a substantial difference in forest-age diversity (Figure 48). Each scenario converges on a stable long-term value of forest-age diversity, with scenario 2.1 slightly higher (0.86 vs. 0.87 in period 20).

The theoretical range of the diversity index is 0.62 to 0.90, so a difference of 0.01 diversity index unit represents 3.57% of the diversity index scale. At year 100, forest age class diversity for scenario 2.1 was 0.87 index units, compared to 0.86 units for the baseline scenario 1.2.2. Translated to normalized percentage units, optimizing forest-age diversity in scenario 2.1 led to an increase in the diversity index of 1.11%.

Both scenarios 2.2 and 2.3 successfully maximized forest-age diversity while still sustaining annual harvest level requirements, so both scenarios reached close to the highest theoretical level of 0.9 on the forest-age diversity index (Figure 48). In index percentage terms compared to scenario 1.2.2, scenario 2.2 was 11.2% higher and scenario 2.3 was 11.3% higher.

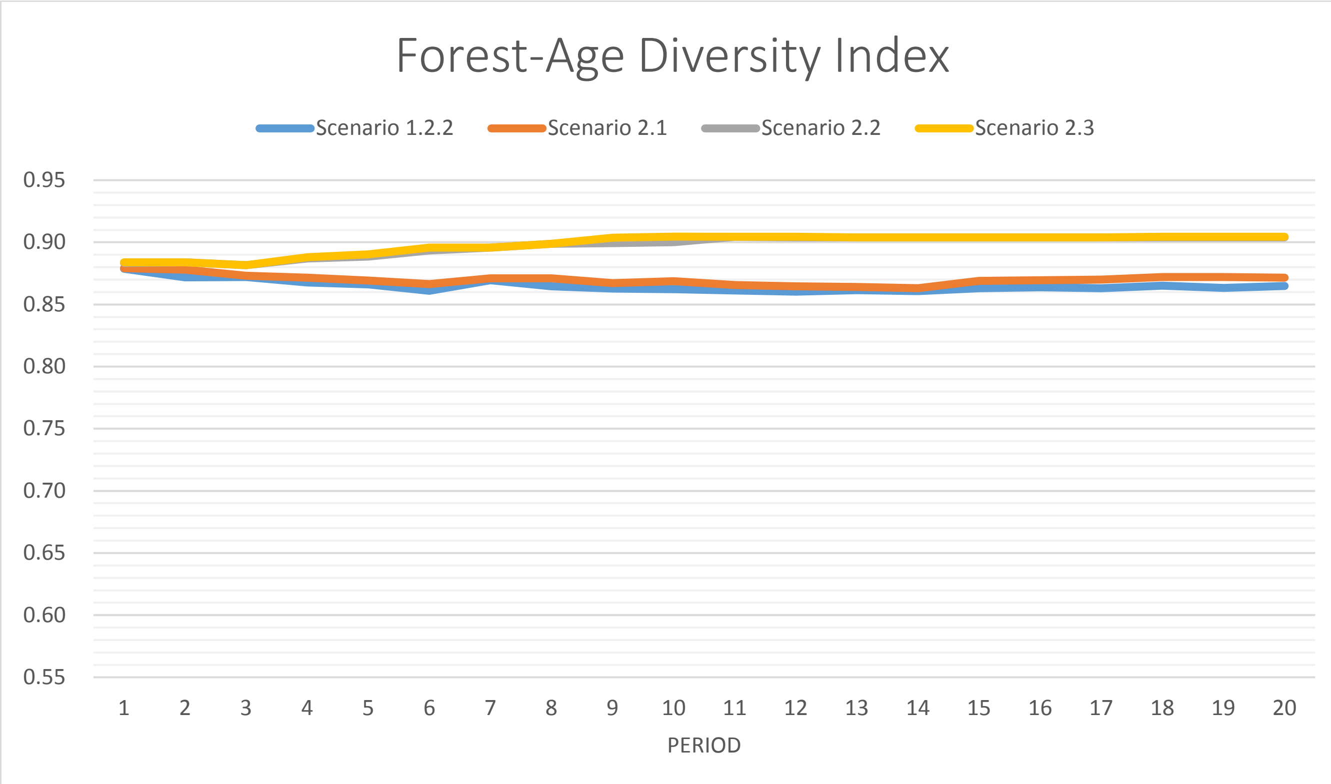


Figure 48. Scenario 2 - Forest Age Class Diversity Index Range

5.3.3 Scenario 3 – Yield Analysis

The following sub-scenarios were developed for Scenario 3:

3.1.1 Used the forestry management regimes only. Objective was to maximize stumpage revenue. Timber volume was controlled by an even-flow with 20% departure constraint. Enabled current MN DNR protocols (statutory requirements) by turning on species conversion, RMZ's, endangered and threatened species, bald eagle nests, and 5% leave tree requirement. Used the "Alt 1" yield tables, which allowed half of the yield adjustment calculated in 4.3.3. The purpose of this scenario was to examine the impact of half the yield adjustment while using the forestry management regimes.

3.1.2 Same as 3.1.1, but using the "Alt 2" yield tables, which allowed the full adjustment calculated in 4.3.3. The purpose of this scenario was to examine the impact of the full yield adjustment while using the forestry management regimes.

3.2.1 Essentially the same as 3.1.1, but using both the forestry and wildlife management regimes. Objective was to maximize stumpage revenue. Timber volume was controlled by an even-flow with 20% departure constraint. Enabled current MN DNR protocols (statutory requirements) by turning on species conversion, RMZ's, endangered and threatened species, bald eagle nests, and 5% leave tree requirement. Used the "Alt 1" yield tables, which allowed half of the yield adjustment calculated in 4.3.3. The purpose of this scenario was to examine the impact of half the yield adjustment while using the forestry and wildlife management regimes.

Same as 3.2.1, but using the "Alt 2" yield tables, which allowed the full adjustment calculated in 4.3.3. The purpose of this scenario was to examine the impact of the full yield adjustment while using the forestry and wildlife management regimes.

In the results below we used scenarios 1.1.2 and 1.2.2 to compare back to Scenario 1 results. All of these regimes used a stumpage revenue objective function, even-flow with 20% departure, and the regulatory requirement constraints for watersheds, biodiversity, and wildlife. Scenario 1.1.2 was used in comparison with scenario 3.1.1 and 3.1.2 because they all used the forestry only regimes. Similarly, scenario 1.2.2 was used to compare with scenarios 3.2.1 and 3.2.2 because they all used both forestry and wildlife regimes. This allowed us to draw a comparison between Scenario 1 and 3 results, in order to assess the impact of the yield adjustment.

The detailed results for each scenario are shown in Appendix H: Detailed Scenario Results.

5.3.3.1 Present Stumpage Revenue

Scenarios 3.1.1 and 3.1.2 result in higher stumpage than 3.2.1 or 3.2.2, due to the exclusion of the wildlife management regimes. Alternative yield set "Alt 1", with 50% of the alternative yield increase, forms the foundation of scenarios 3.1.1 (forestry only regimes) and 3.2.1 (forestry and wildlife regimes), resulting in present stumpage values of $1.04 billion and $1.01 billion respectively. The maximum alternative yield, "Alt 2", results in $1.13 billion for 3.1.2 (forestry only regimes) and $1.10 billion for 3.2.2 (forestry and wildlife regimes, Figure 49).

Compared to scenario 1.1.2, with "Alt 1" yields there was an increase of 9% for forestry-only regimes (3.1.1) and an increase of 10% for forestry and wildlife regimes (3.1.2). In contrast, compared to scenario 1.2.2, with "Alt 2" yields, forestry-only regimes increased stumpage value by 19% (3.2.1) and by 20% for forestry and wildlife regimes (3.2.2, Figure 49).

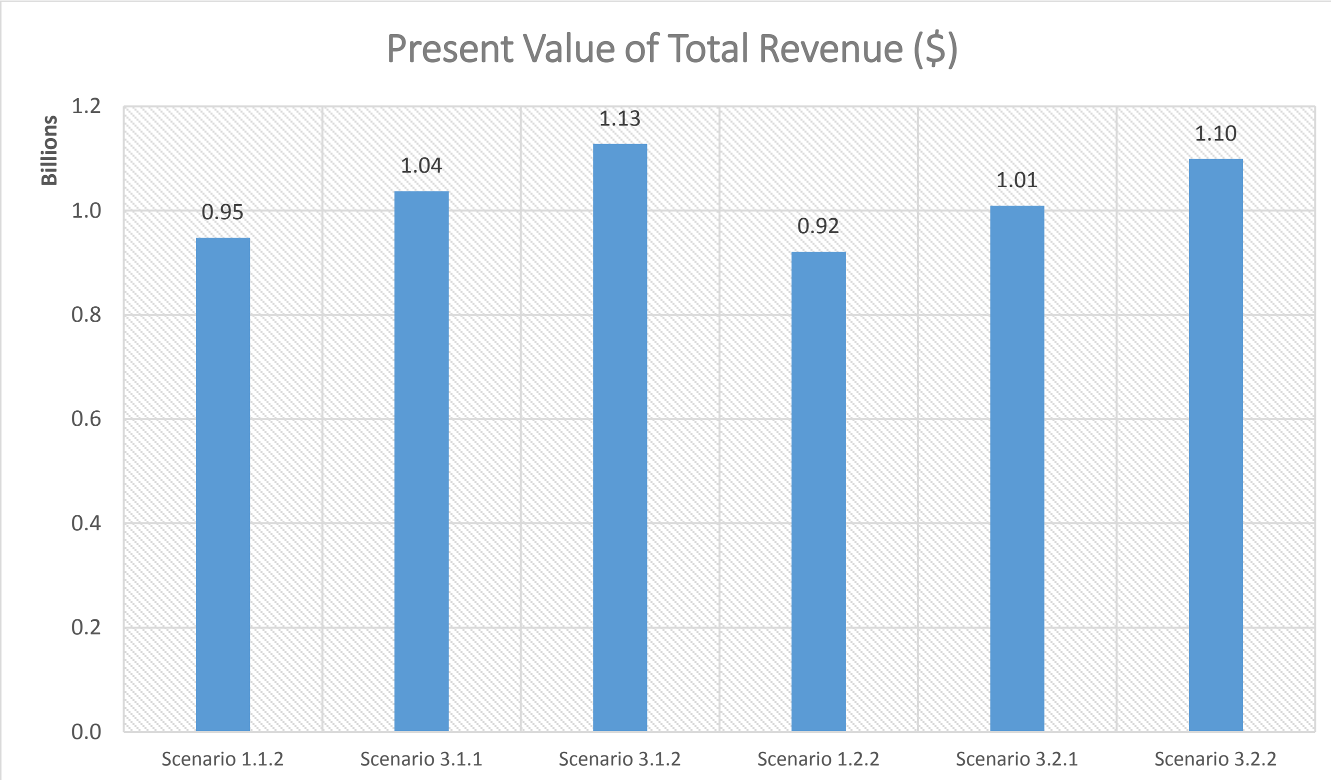


Figure 49. Scenario 3 - Present Value of Stumpage

5.3.3.2 Harvest Volume

All scenarios in the current comparison are required to maintain even flow of timber, fluctuating not more than 20% above or below an average value. We can rank scenarios from most to least restrictive: any x.2.z scenario is more restrictive than a corresponding x.1.z scenario because the x.2.z cases use regimes that use both forestry and wildlife regimes, while x.1.z cases use forestry only regimes. We expect scenarios with wildlife regimes to attain lower harvest levels. For example, scenario 3.2.1 harvest levels (forestry and wildlife) average 3.2% lower than 3.1.1 harvest levels (forestry only) using "Alt 1" yields (Figure 50). Using the higher yields from "Alt 2," we find that scenario 3.2.2 generates harvest levels that are 3.1% lower than scenario 3.1.2 across the 100 year planning time frame. All of the "Alt 2" scenarios delivered harvest levels in excess of 1 million cords per year for the whole planning horizon.

All of the alternative scenarios follow a similar trajectory in harvest levels, beginning around or above 1.2 million cords per year, but ending year 100 at or below 1 million cords per year. The extent of decline in harvest rate over time is nearly equal for all Scenario 3 cases, between 19.4% and 19.6%. The alternative yields simply shift the baseline yield curve to a higher harvest level without changing the way that harvests are configured at each time point. For evidence supporting this observation, compare the way in which harvest levels spike temporarily at year 80 (Figure 50). The curve for 3.1.1 is the same shape as the curve for 3.1.2, except displaced on the vertical axis (Figure 50).

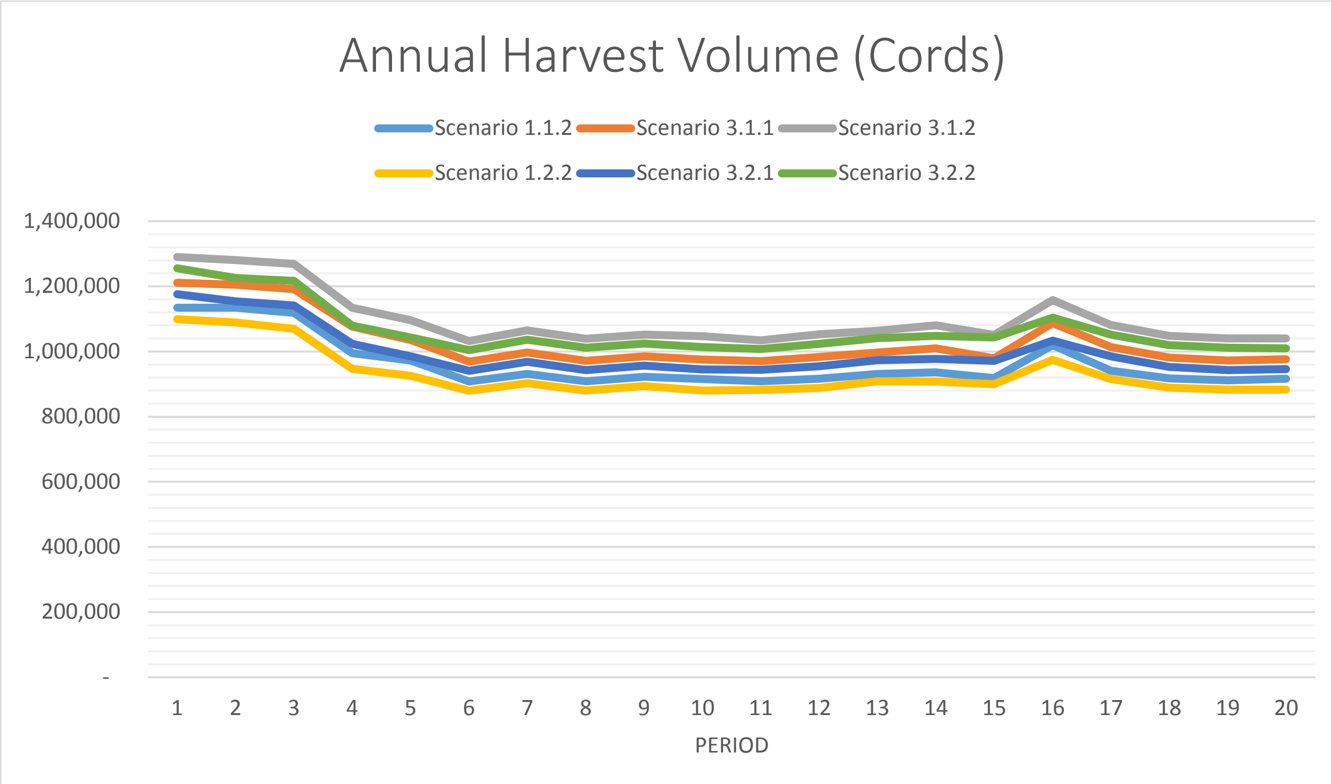


Figure 50. Scenario 3 - Annual Harvest Volumes

5.3.3.3 Clear-Cut Operable Acres

Scenarios 3.1.1 and 3.1.2 began at one million clear-cut operable acres, but this sum declined to 280,000 clear-cut operable acres, a 72% drop, by year 100 (Figure 51). Similarly, scenarios 3.2.1 and 3.2.2 began at 953,000 clear-cut operable acres but declined 66% to 318,000 clear-cut operable acres by year 100 (Figure 51).

Inventory and harvest volume differences among these scenarios are governed by “Alt 1” and “Alt 2” yield alternatives, but the underlying land use decisions within an alternative are nearly identical. Scenarios 1.1.2, 3.1.1, and 3.1.2 are the same in terms of land base — note that these clear-cut operable acres are virtually identical (Figure 51), differing by an average of 0.6%. In the same way, scenarios 1.2.2, 3.2.1, and 3.2.2 (Figure 51) are based on the same set of acres, differing on average by only 0.004%. When “Alt 1” and “Alt 2” yields are applied, however, two different harvest levels can result from the same set of source acres (Figure 50).

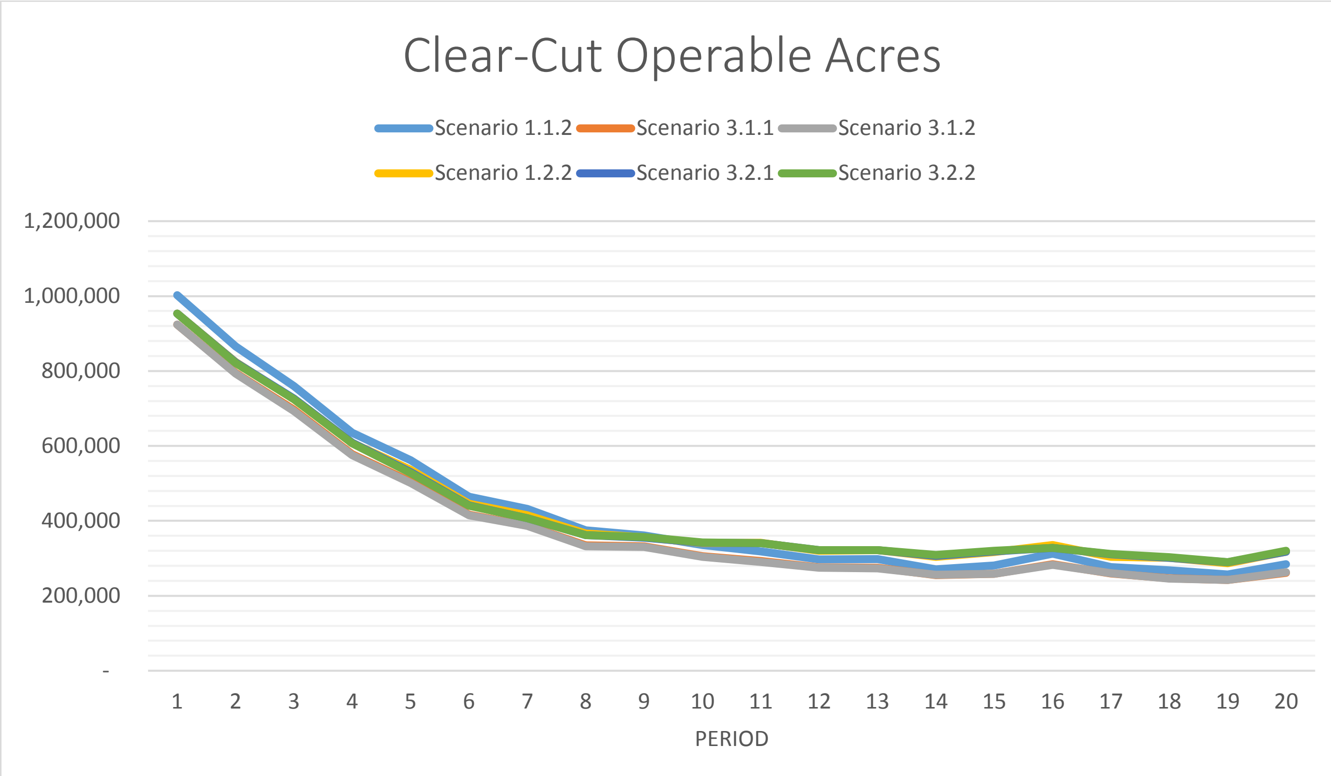


Figure 51. Scenario 3 - Clear-Cut Operable Acres

5.3.3.4 Average Clear-Cut Age

Clear-cut operable acres declined substantially after 100 years for all scenario 3 cases (Figure 51), largely as a consequence of reducing average stand age at harvest (Figure 52). At the beginning of the modeling period, a large fraction of stands in the current inventory exceeded the minimum rotation age. The average age of clear-cut is an integrated measure of the average stand age across cover types and planning areas. In the early years, stands are clear-cut around age 85 (Figure 52). As these older stands are harvested, the proportion of younger stands being clear-cut increases. By the last third of the planning horizon, stands are being clear-cut soon after they reach rotation age, averaging 52 years old over the final 30 years of the plan (Figure 52).

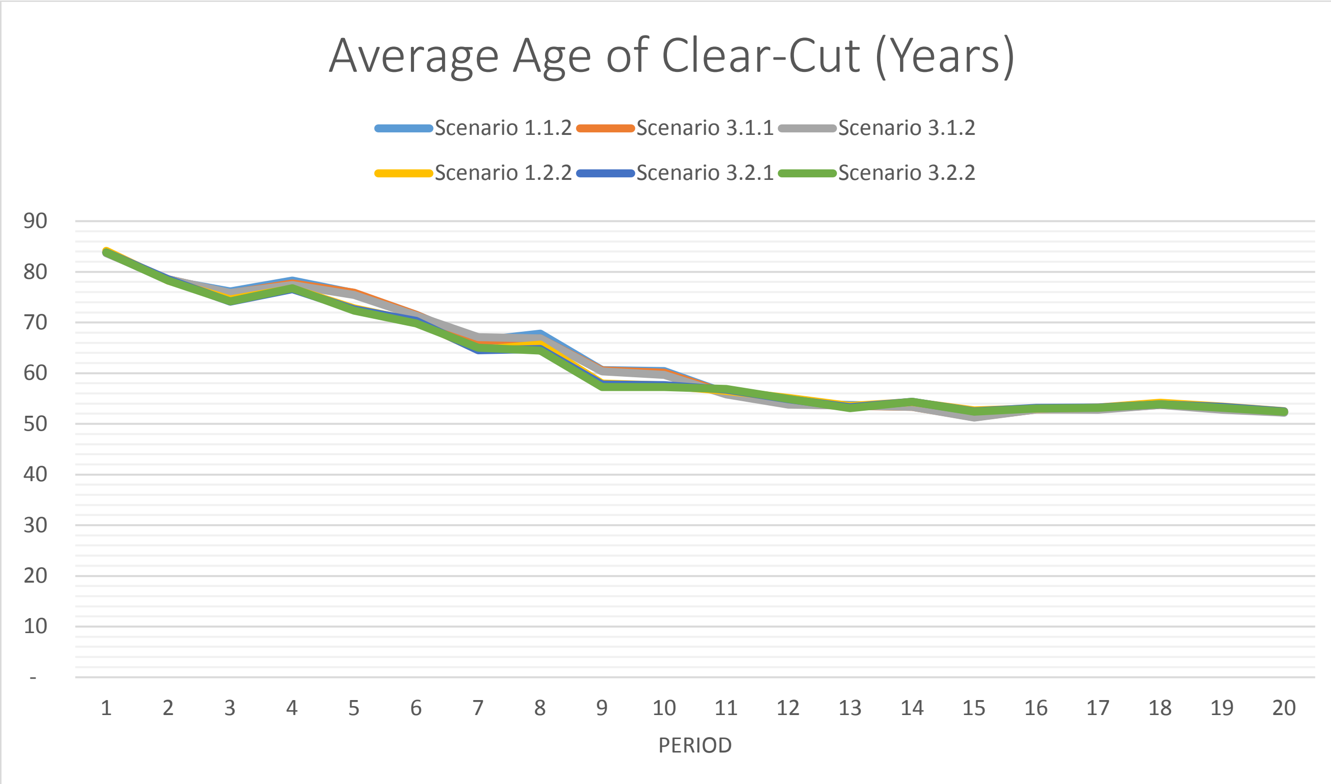


Figure 52. Scenario 3 - Average Clear-Cut Age

5.3.3.5 Priority Harvest Volume

Priority harvest volume is the amount of timber harvested from land within 75 miles of the seven largest timber processors, excluding volume from species that are not commercially viable for these facilities. On average, the fraction of priority harvest volume is maintained at around 67% merging all of the Scenario 3 cases. Each scenario may differ slightly from this average, but the most substantial negative deviation in relation to the average was just 5% (from scenario 3.1.1), while the largest positive deviation was 4% (from scenario 3.2.2, Figure 53). Note that the graph showing percent priority harvest volume is presented with a truncated vertical axis ranging from 56% to 72% (Figure 53), magnifying the apparent fluctuations. On a 100% scale, this quantity has low volatility over time.

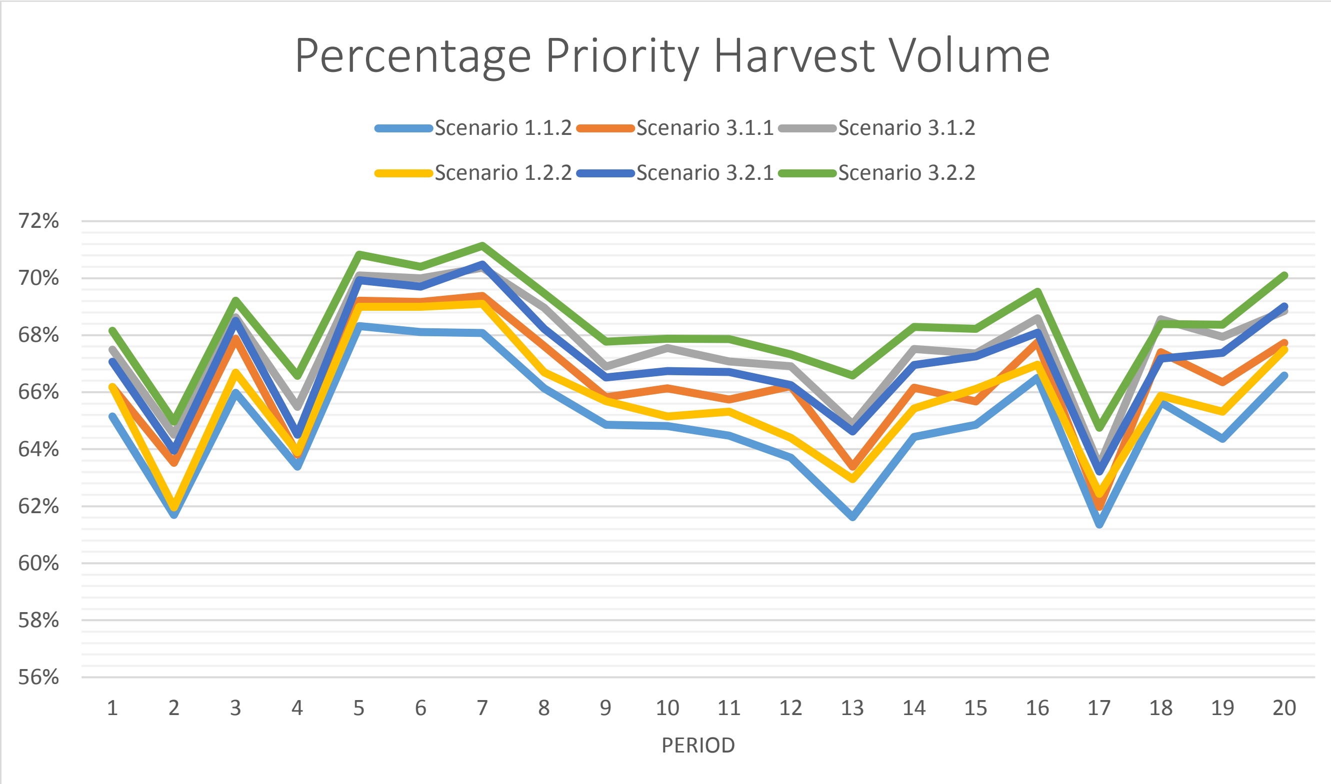


Figure 53. Scenario 3 - Priority Harvest Volume

5.3.3.6 Inventory

Maximal harvest levels occur within the first 20 to 25 years of the planning period (Figure 50), depleting inventory during the same period (Figure 54). At those early harvest levels above 1.2 million cords per year, inventory declined an average of 4.1% in each 5-year planning period for scenarios with forestry-only regimes, and 3.4% for scenarios with forestry-wildlife regimes. After 20 years, for all yield alternatives, inventory was approximately six million cords lower (Figure 54). Note that scenarios 3.2.2 and 3.1.2 started at the same position of 39.9 million cords—both of these scenarios used “Alt 2” yield tables, the largest alternative set. By year 100, inventory declined to 33 million cords for scenario 3.1.2 (Figure 54), a drop of 17%. For scenario 3.2.2 (Figure 54), using forestry and wildlife regimes, that decline was 14%, to a final inventory of 34.2 million cords.

Alternative yield “Alt 1” scenarios (3.1.1 and 3.2.1) also started at the same inventory level of 38.4 million cords (Figure 54). Early inventory depletions were in exact proportion to the “Alt 2” cases, a larger decline of 17% for 3.1.1, ending at 31.2 million cords (orange, Figure 54), and a smaller decline of 14% for 3.2.1 with forestry and wildlife regimes, ending at 32.5 million cords (Figure 54). The same divergence occurred between scenarios 1.1.2 and 1.2.2, using the original MN DNR yield tables. With forestry-only regimes, inventory declined 17% to 30 million cords (Figure 54), but the decline was only 14% using both forestry and wildlife regimes, resulting in a final inventory of 31.2 million (Figure 54).

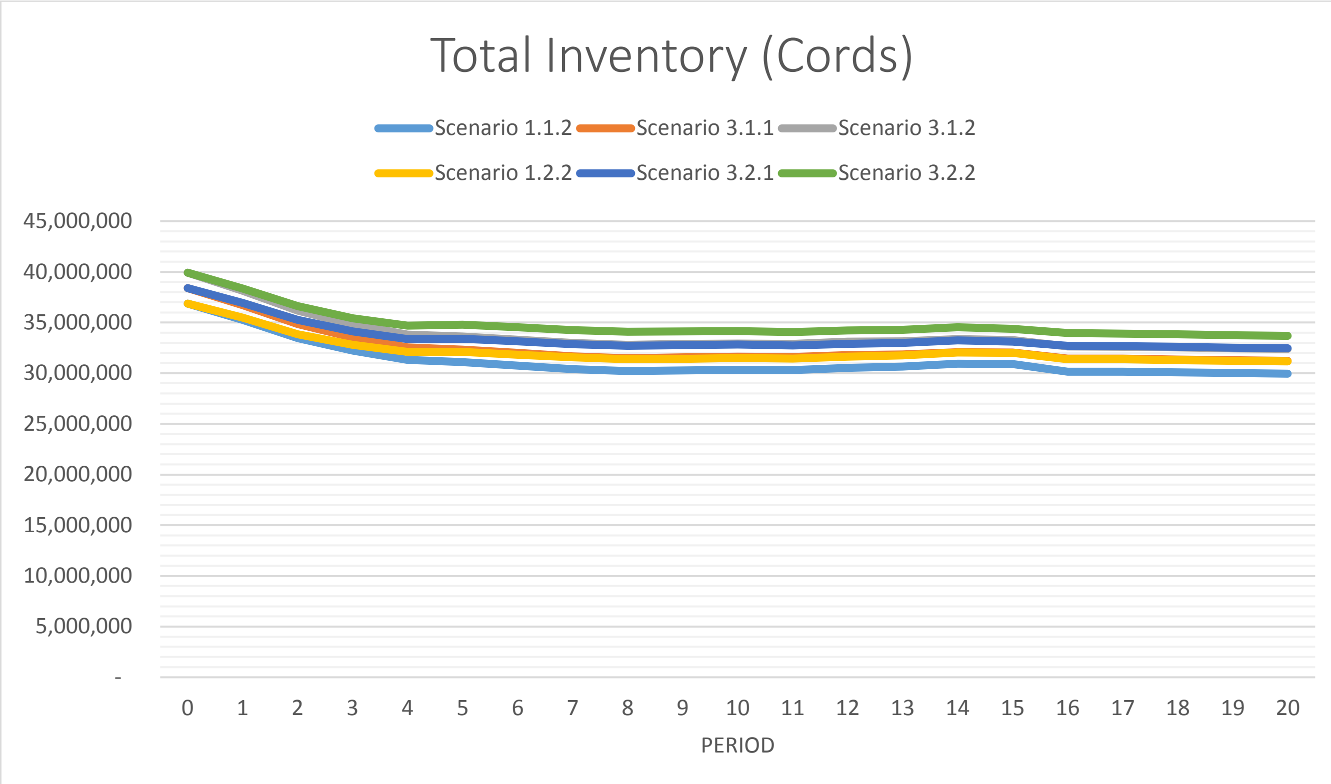


Figure 54. Scenario 3 - Inventory Volume by Period

5.3.3.7 Trust Land Inventory

Forest land managed for the school trust had a starting inventory of 18.1 million for scenarios 3.1.1 and 3.2.1, and 18.8 million cords for scenarios 3.2.1 and 3.2.2 (Figure 55). Trust land inventory constitutes 47% of the total volume. Whereas total inventory declined either 17% (forestry-only) or 14% (forestry-wildlife) by the end of the planning period, trust inventory declined 19%. Harvest levels on trust land forests are slightly higher than for the whole MN DNR land base.

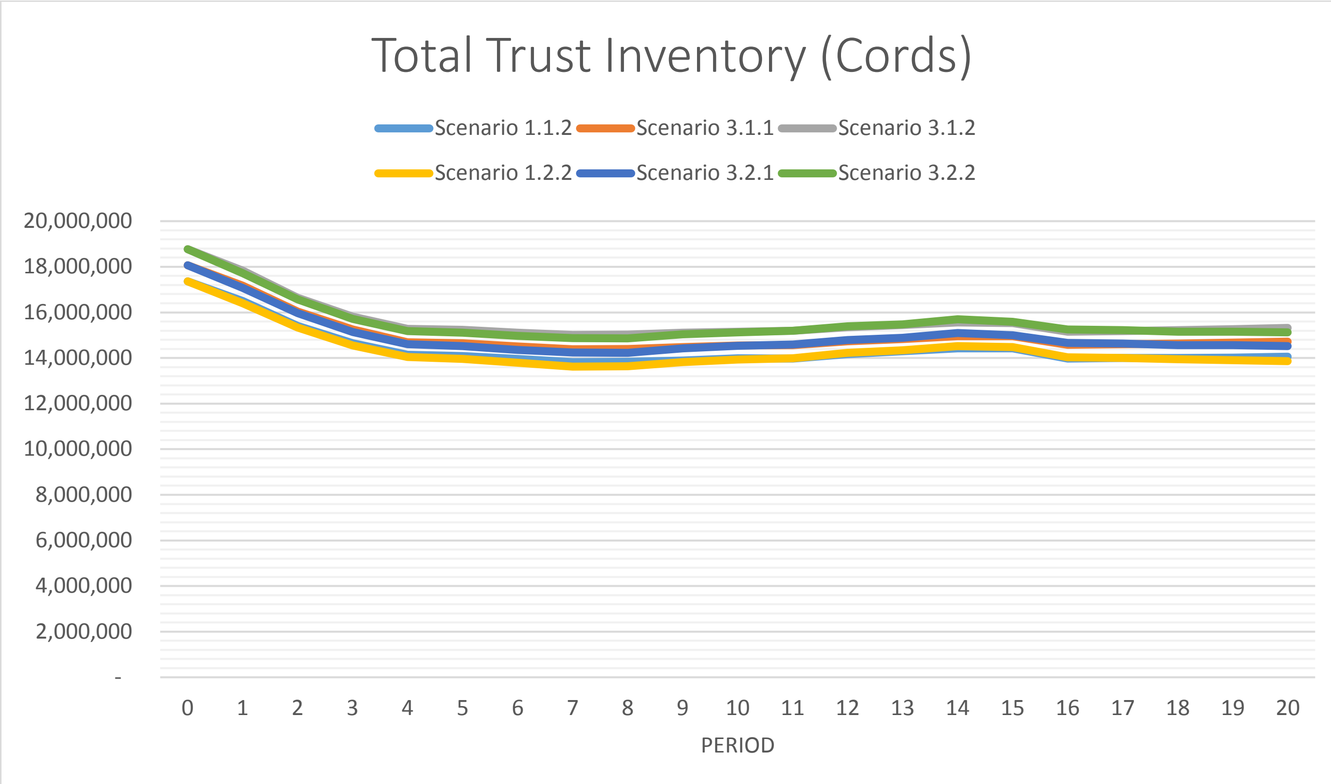


Figure 55. Scenario 3 - Inventory On Trust Land

5.3.3.8 Cover Type Conversions

As with Scenarios 1 and 2, in Scenario 3 we saw a gradual decline in cover type conversion rates with the exception of years 35 and 40 (Figure 56) when conversions almost doubled during one five-year period. Also similar to the other scenarios, the reason for this temporary increase in conversion appears to be the opportunity to shift some acreage out of planted white spruce into aspen and planted red pine. The relative proportion of new cover types changes somewhat in Scenario 3. Recalling scenarios 1.2.2 and 2.1, the fraction of acres converted to aspen or to planted red pine was roughly equal. Here, the conversion increase consisted of around 50% more planted red pine than aspen. Based on the alternative yields, this is a reasonable result. The alternatives involve increasing aspen yields only for site index >50 by a factor of 1.175 (Table 3). In contrast, planted red pine yields increase by a factor of 1.58 for all site index values (Table 3).

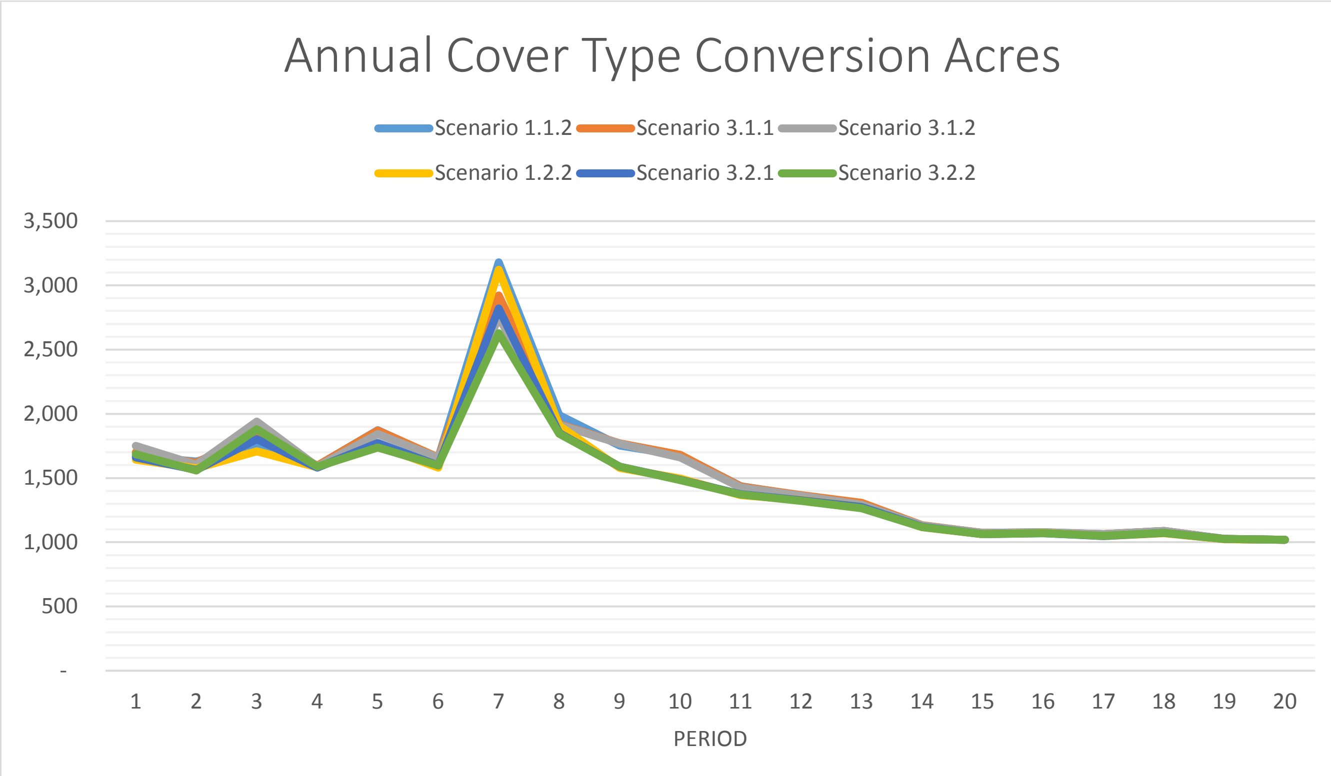


Figure 56. Scenario 3 - Cover Type Conversions

5.3.3.9 Planning Latitude

Scenarios 1.1.2, 3.1.1, and 3.1.2 were based on forestry-only regimes, and these three scenarios cluster together in terms of the fraction of clear-cut acres as a percentage of total operable acres (Figure 57). Although all Scenario 3 cases start from the same amount of clear-cut acres (25%), by year 100 the forestry-only scenarios increase the fraction of clear-cut acres to 80% (Figure 57). In contrast, scenarios 1.2.2, 3.2.1, and 3.2.2, based on both forestry and wildlife regimes, use a lower proportion of clear-cut acres, ending year 100 at 65% of operable area (Figure 57). It's interesting to note here that scenarios 1.2.2, 3.2.1 and 3.2.2 (forestry and wildlife) clustered together, while scenarios 3.1.1 and 3.1.2 (forestry only) diverged from their scenario 1 counterpart (1.1.2). The conclusion here is that alternative yields coupled with the forestry regimes allowed the model to take advantage of acres that it could not under the original yields.

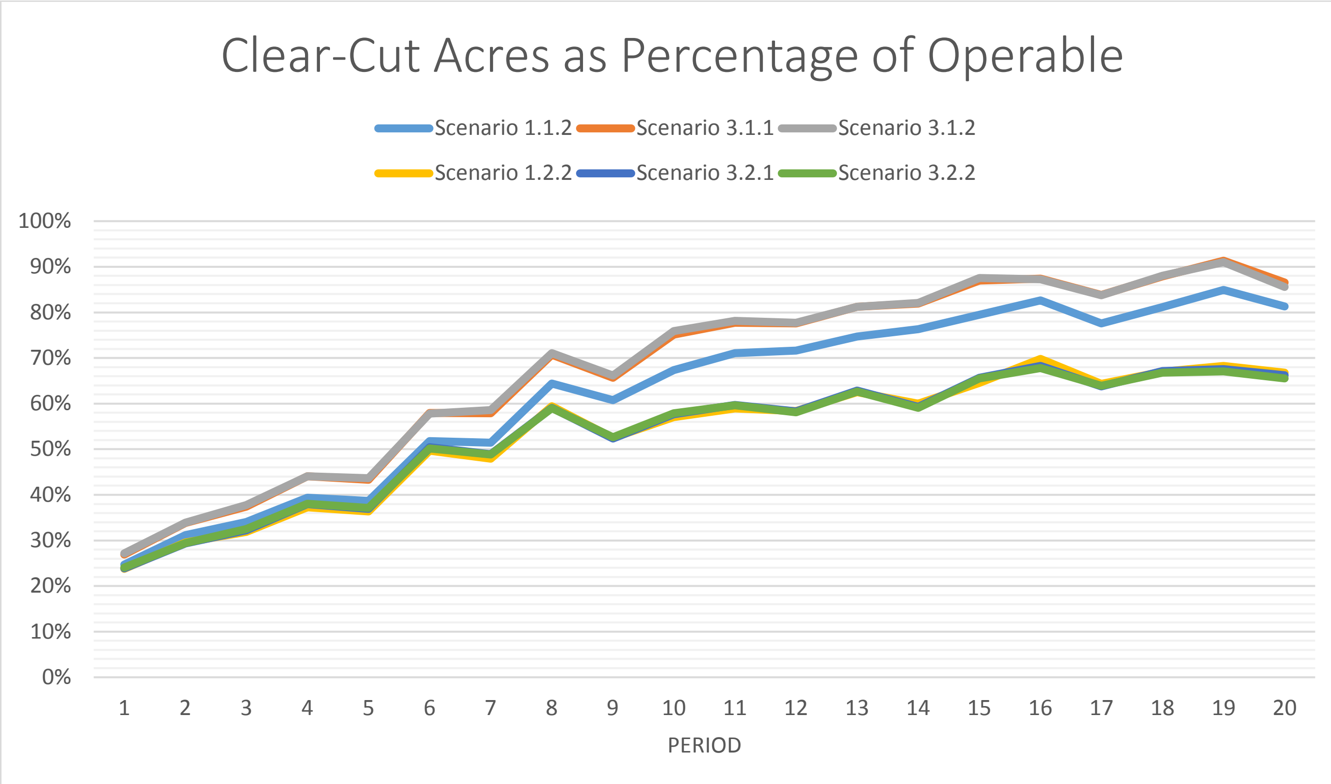


Figure 57. Scenario 3 - Planning Latitude

5.3.3.10 Open Watershed Goals

The variations in Scenario 3 were designed to test effects of alternative yields ("Alt 1", "Alt 2") on stumpage, harvest volume, inventory, and clear-cut acres. These scenarios also tested the difference between forestry-only regimes and combined forestry-wildlife regimes but imposed no constraints relating to watersheds, old forest guild, NPC, or diversity. In 5.3.3.10 through 5.3.3.14, we report the results for these parameters but emphasize that Scenario 3 was not designed to alter their outcomes.

With no constraints imposed to minimize open watershed acreage, we found that this quantity did not change appreciably for any Scenario 3 model, starting at 4.4% and ending at 4.0% (Figure 58), with a long-term average for all cases of 4.24%. In contrast, scenario 1.2.4.1, which was constrained to minimize open watersheds, reduced the percentage of open watersheds to 2.54% by 15 years and maintained that level through year 100 (Figure 29). Without the watershed constraint, the amount of open watersheds was 2.24% higher than scenario 1.2.4.2 at year 100 and 1.7% higher on average for all Scenario 3 cases.

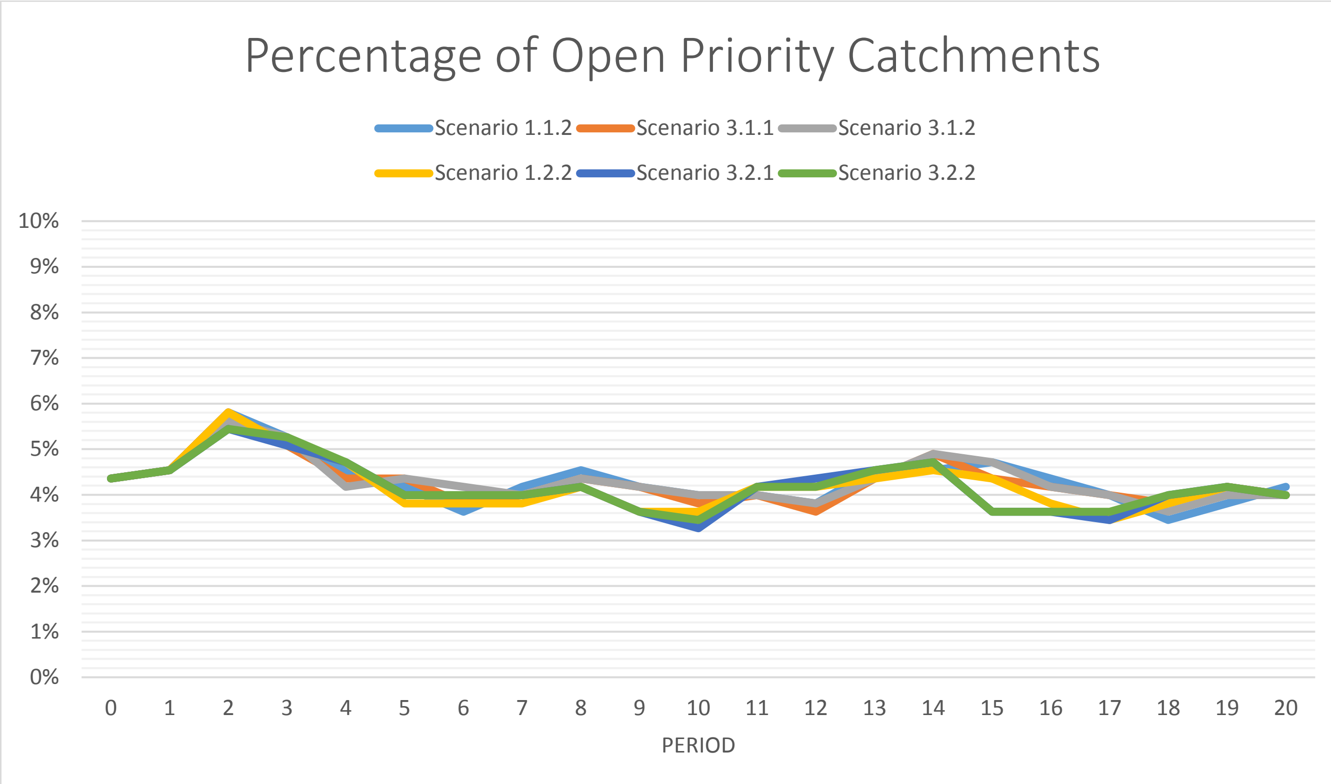


Figure 58. Scenario 3 - Open Watershed Prevalence

5.3.3.11 Old Forest Guild Goals

Scenario 1.2.4.2 was constrained to maximize the number of hexagons that contained stands in the old forest guild. With this constraint in place, scenario 1.2.4.2 increased old forest from a starting point of 5% to an endpoint of 42% (Figure 30). Although scenario 1.2.4.3 was designed to minimize NPC deviations, it also managed to increase old forest to about 27% (Figure 30). In contrast, without the old forest or NPC constraints, Scenario 3 models reduced old forest representation from 5% to between 2.9% and 3.6% (Figure 59). Differences between forestry-only regimes and combined forestry-wildlife regimes do appear at times during the planning interval. For example, the forestry-wildlife regimes (scenarios 3.2.1 and 3.2.2) average around 1% more hexagons with old forest guild than the forestry-only regimes (3.1.1 and 3.1.2), but this difference is erased at year 100 (Figure 59).

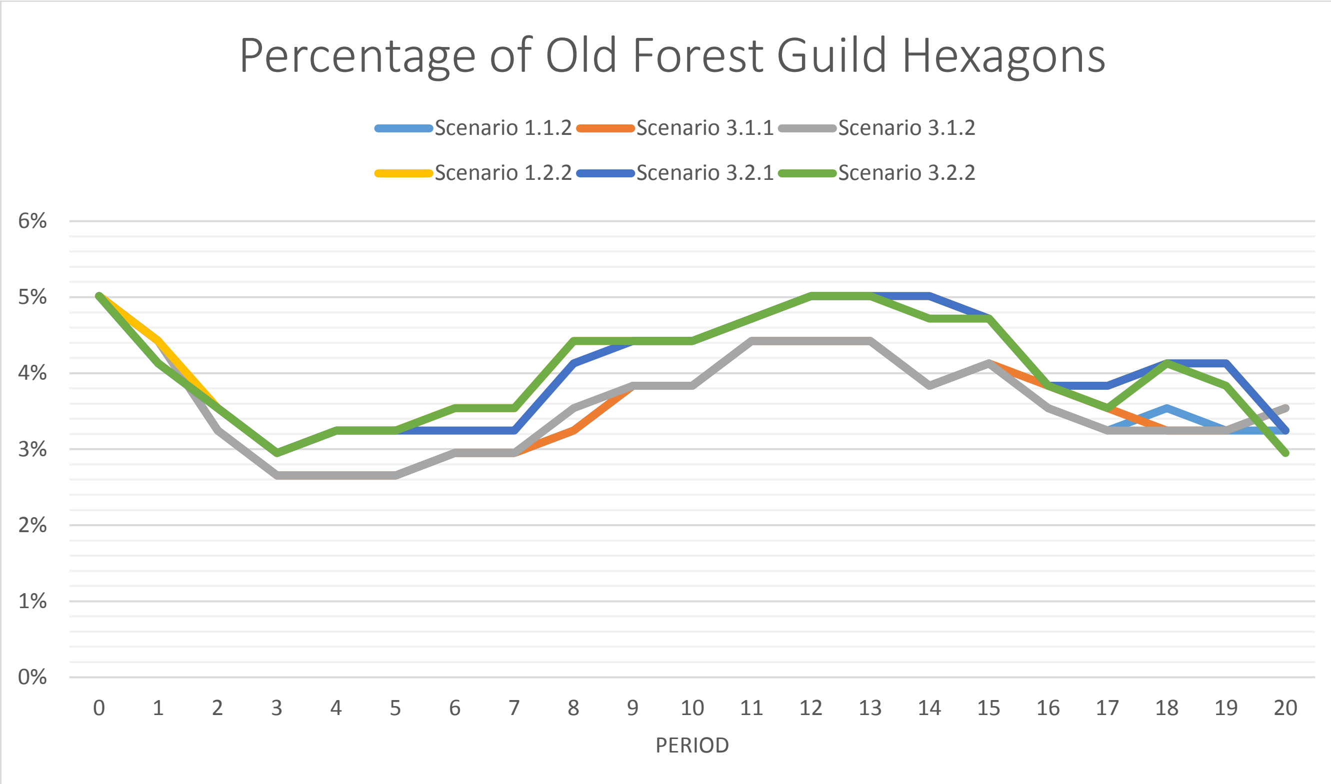


Figure 59. Scenario 3 - Old Forest Guild Proportion

5.3.3.12 Young Forest Guild Goals

None of the scenarios optimized for young forest guild goals, so the results reported here are artifacts of other management assumptions. The results show that the scenarios with forestry only regimes (1.1.2, 3.1.1, 3.1.2) clustered together and ended the planning horizon at ±4%. The scenarios that utilized both forestry and wildlife regimes (1.2.2, 3.2.1, 3.2.2) ended at ±7% (75% higher). All of the scenarios decreased from an initial level of 9%.

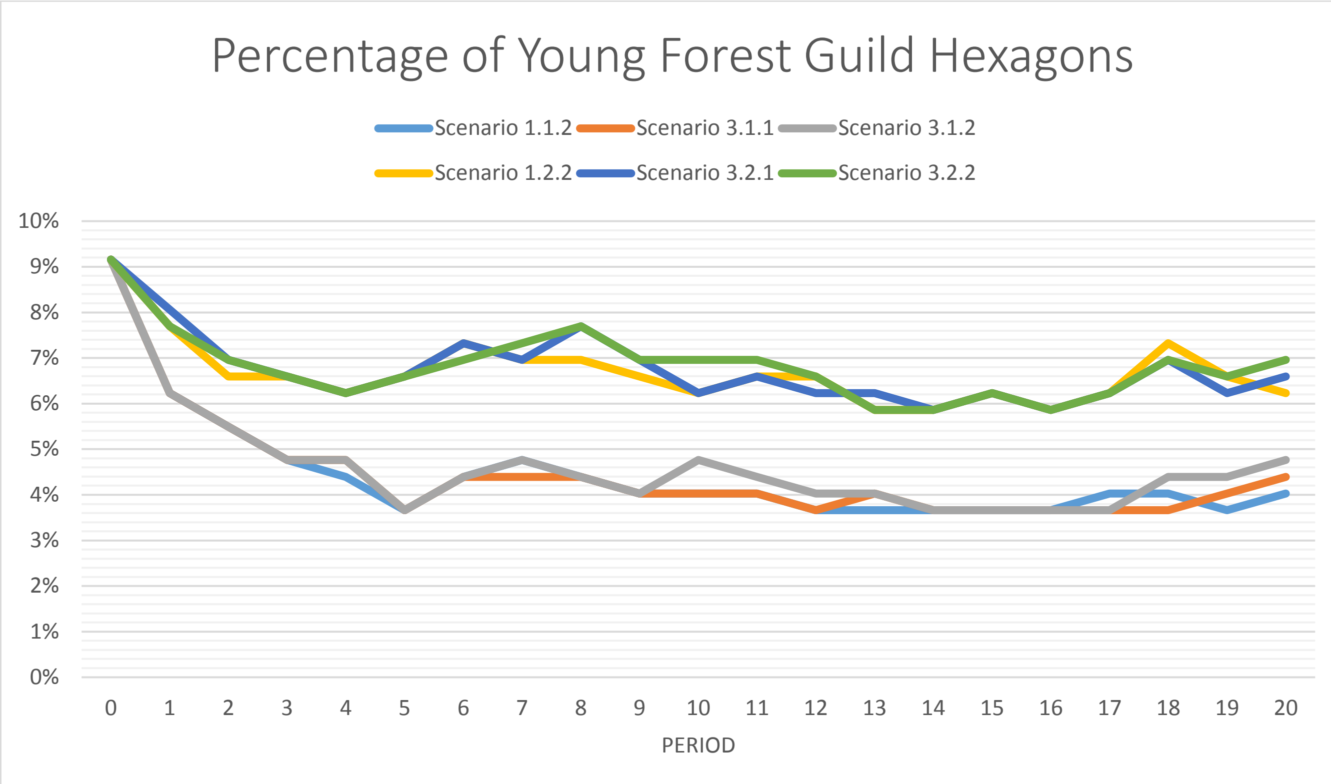


Figure 60. Scenario 3 - Young Forest Guild Proportion

5.3.3.13 Native Plant Community Goals

The only scenario designed to minimize NPC deviations was 1.2.4.3, and it reduced the deviation to 524,000 acres (Figure 32). The next lowest scenario, 1.2.4.2, only reduced NPC deviation to 1.12 million acres (Figure 32). Scenario 3 was not configured to reduce NPC deviations, and indeed we found that the lowest NPC deviation was scenario 3.2.2 or 3.2.1, at 1.2 million acres (Figure 61). Without the constraint to minimize NPC deviation the model has no incentive to do so.

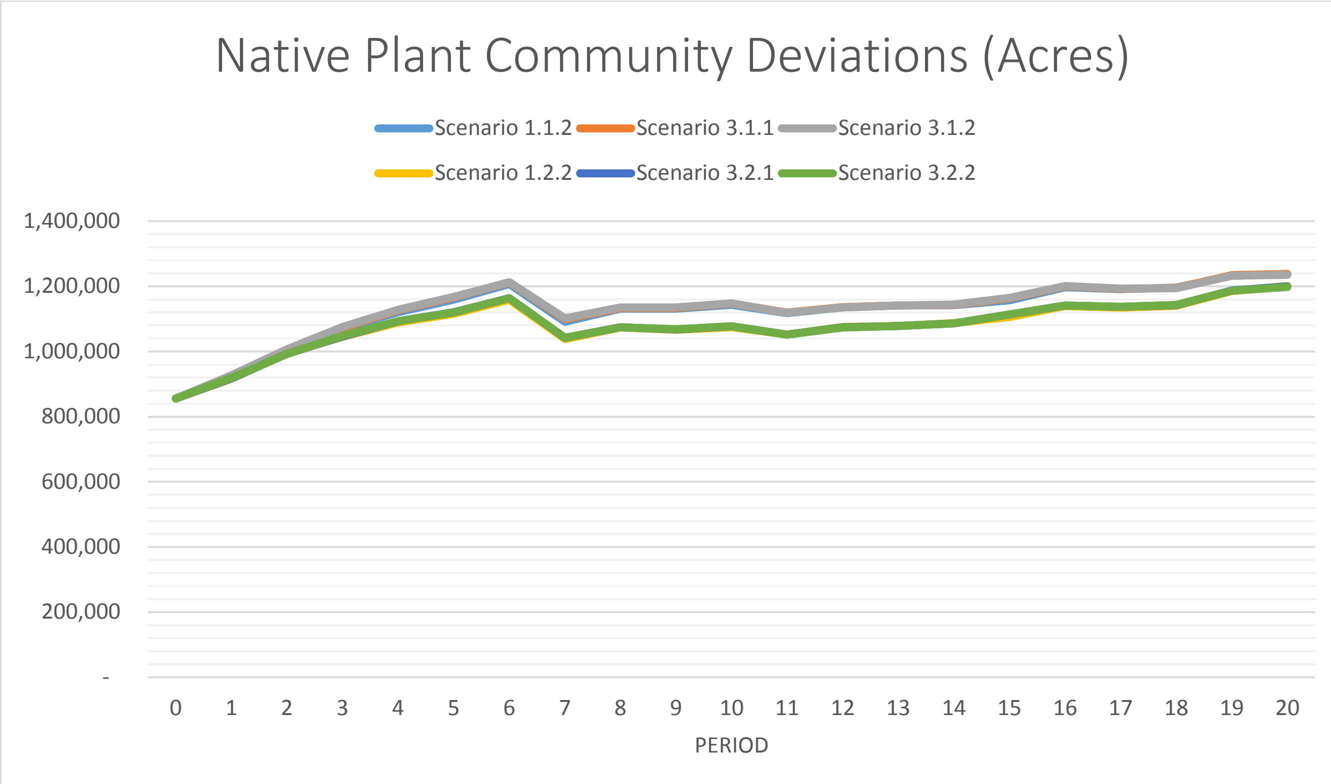


Figure 61. Scenario 3 - Native Plant Community Acreage Deviations

5.3.3.14 Forest-Age Diversity Goals

A similar result occurs for forest age class diversity index in Scenario 3 (Figure 62). These scenarios were not required to maximize diversity, so we saw a decline in the diversity index from 0.87 to 0.86 for 3.1.2, and from 0.88 to 0.87 for 3.2.2. In percentage terms, following the normalization where 0.01 index unit is equivalent to 3.57% of the theoretical index scale (5.3.1.14), Scenario 3 resulted in a decline of 3.57% in forest age class diversity.

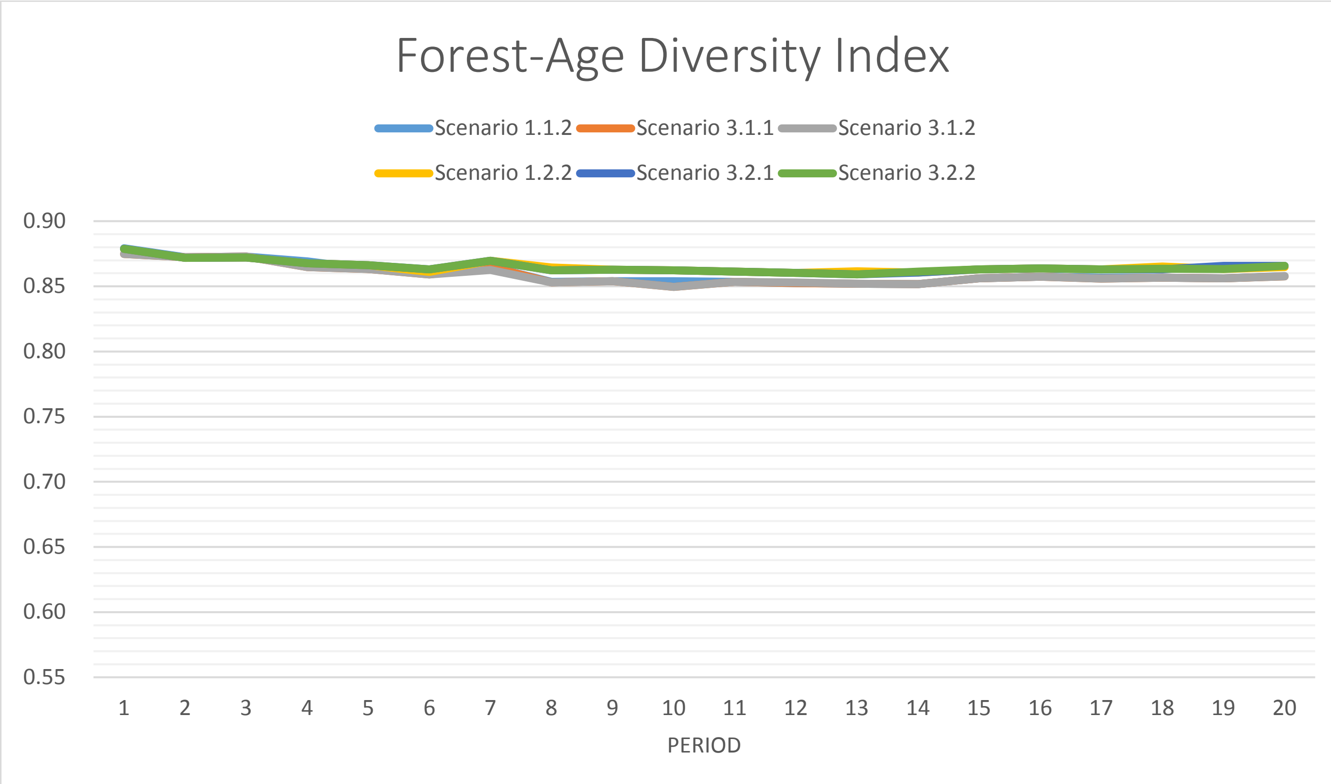


Figure 62. Scenario 3 – Forest-Age Diversity Index Range

5.3.4 Scenario 4 – School Trust Lands Analysis

The following sub-scenarios were developed for Scenario 4:

4.1.1 Used the forestry and wildlife management regimes. Objective was to maximize stumpage revenue with a discount rate of 4%. Timber volume was controlled by an even-flow with 20% departure constraint. Turned off species conversion, all water quality, all diversity and all wildlife habitat components (except for 5% leave trees). The purpose of this scenario was to establish the impact of the 4% discount rate on a maximum harvest scenario.

4.1.2 Used the forestry and wildlife management regimes. Objective was to maximize stumpage revenue with a discount rate of 4%. Timber volume was controlled by an even-flow with 20% departure constraint. Enabled current MN DNR protocols (statutory requirements) by turning on species conversion, RMZ's, endangered and threatened species, bald eagle nests, and 5% leave tree requirement. The purpose of this scenario was to establish the impact of the 4% discount rate with statutory requirements.

4.2.1 Used the forestry and wildlife management regimes. Objective was to maximize stumpage revenue with a discount rate of 6%. Timber volume was controlled by an even-flow with 20% departure constraint. Turned off species conversion, all water quality, all diversity and all wildlife habitat components (except for 5% leave trees). The purpose of this scenario was to establish the impact of the 6% discount rate on a maximum harvest scenario.

4.2.2 Used the forestry and wildlife management regimes. Objective was to maximize stumpage revenue with a discount rate of 6%. Timber volume was controlled by an even-flow with 20% departure constraint. Enabled current MN DNR protocols (statutory requirements) by turning on species conversion, RMZ's, endangered and threatened species, bald eagle nests, and 5% leave tree requirement. The purpose of this scenario was to establish the impact of the 6% discount rate with statutory requirements.

In the results below we used scenario 1.1.1 and 1.2.2 to compare back to Scenario 1 results. All of these regimes used a stumpage revenue objective function, even-flow with 20% departure. These scenarios differed by the application of management regimes, discount rates, and the application of statutory requirements. This allowed us to draw a comparison between Scenario 1 and 4 results, in order to assess the impact of the discount rate assumptions.

The detailed results for each scenario are shown in Appendix H: Detailed Scenario Results.

5.3.4.1 Present Stumpage Revenue

Comparing the differences directly between scenarios would be irrelevant because different discount rates were used (Figure 63). This is evident in the fact that 1.1.1 and 1.2.2 (3% discount rate) is higher than 4.1.1 and 4.1.2 (4% discount rate), which is higher than 4.2.1 and 4.2.2 (6% discount rate). What is of interest is the relative difference between 4.1.1 and 4.1.2 (4.1%), as well as 4.2.1 and 4.2.2 (5.9%), since it is driven by the application of the regulatory requirements. Here we see that the higher discount rate resulted in a sharper decrease in present stumpage revenue.

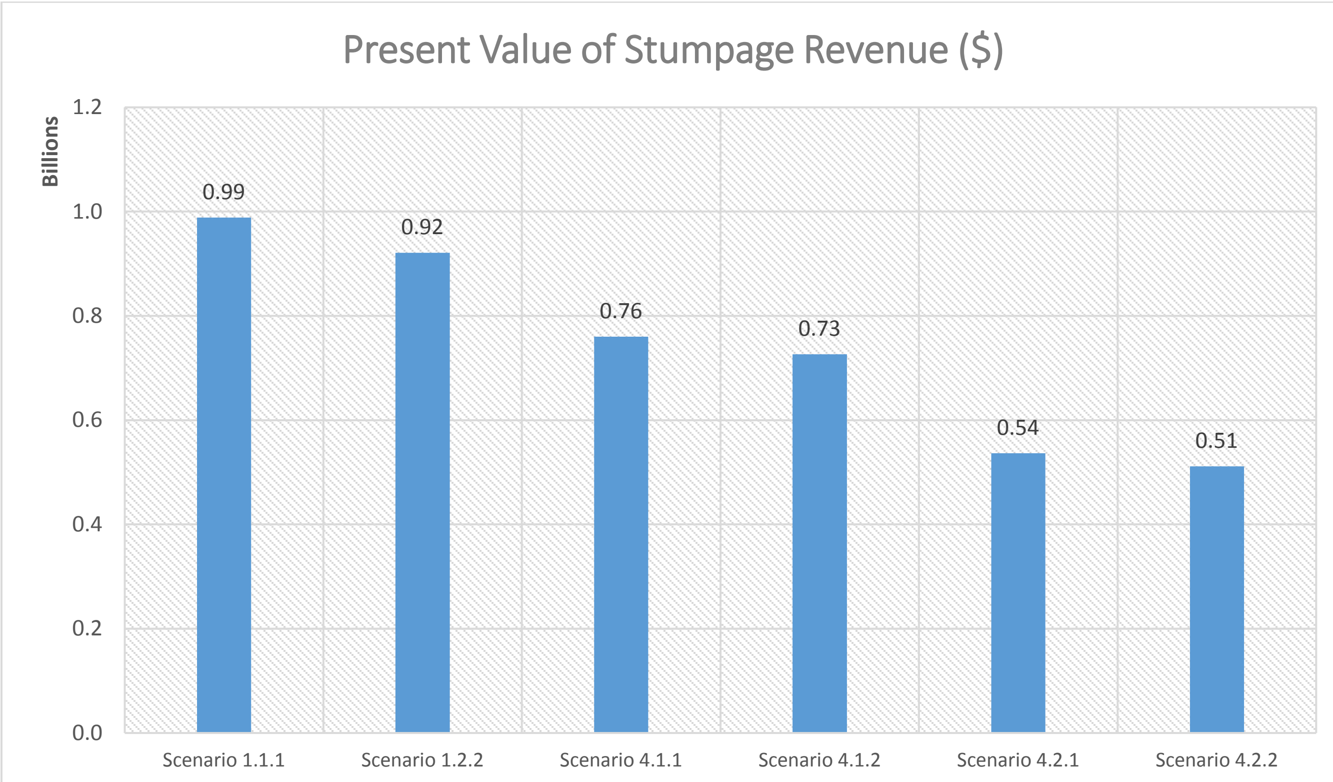


Figure 63. Scenario 4 - Present Value of Stumpage

5.3.4.2 Harvest Volume

In terms of harvest volume, we saw no response to the increase in discount rate. Scenarios 4.1.1 and 4.2.1 were higher than 4.1.2 and 4.2.2, but this increase was driven by the regulatory requirements rather than the discount rate.

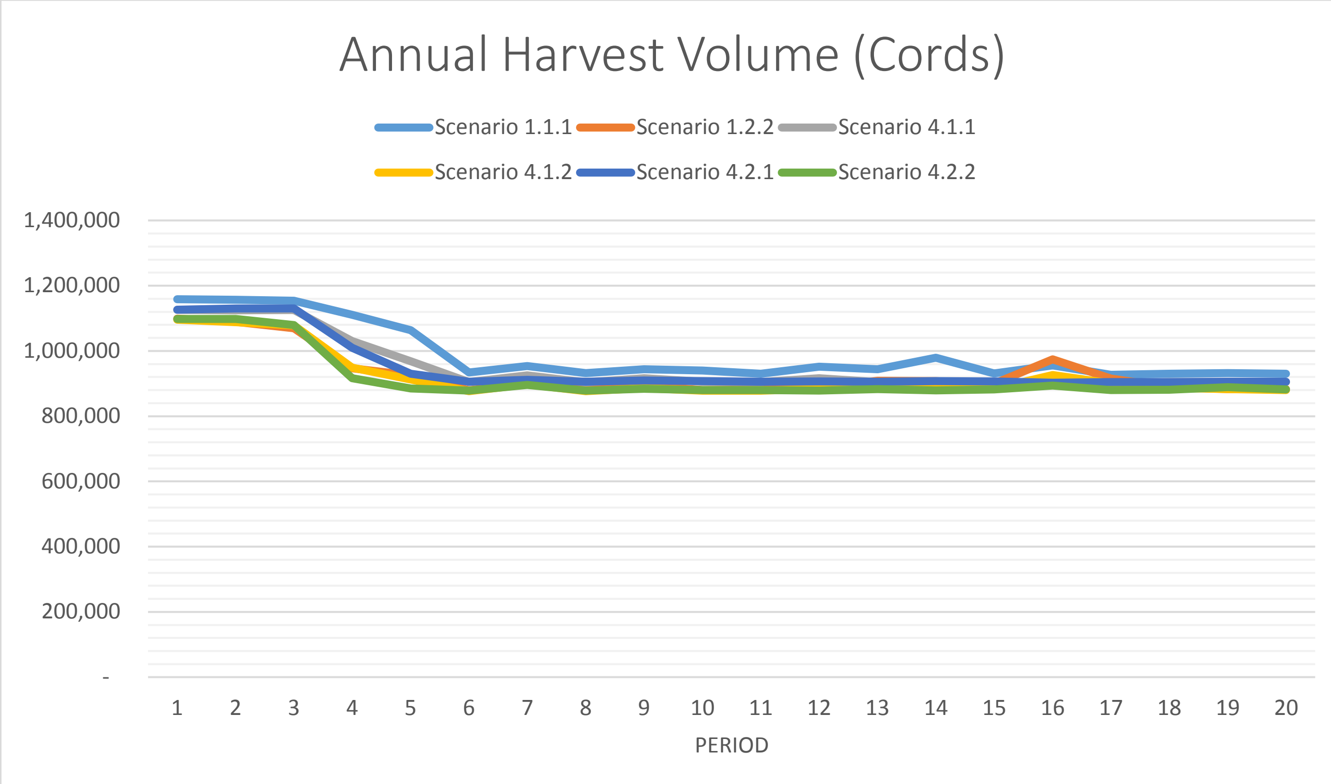


Figure 64. Scenario 4 - Annual Harvest Volumes

5.3.4.3 Clear-Cut Operable Acres

There was no change in the clear-cut operable acres that could be attributed to higher discount rates (Figure 65). Scenario 1.1.1 had more operable acres than the rest, but this is attributable to the fact that this scenario used only the forestry regimes (lower rotation ages make more acres available).

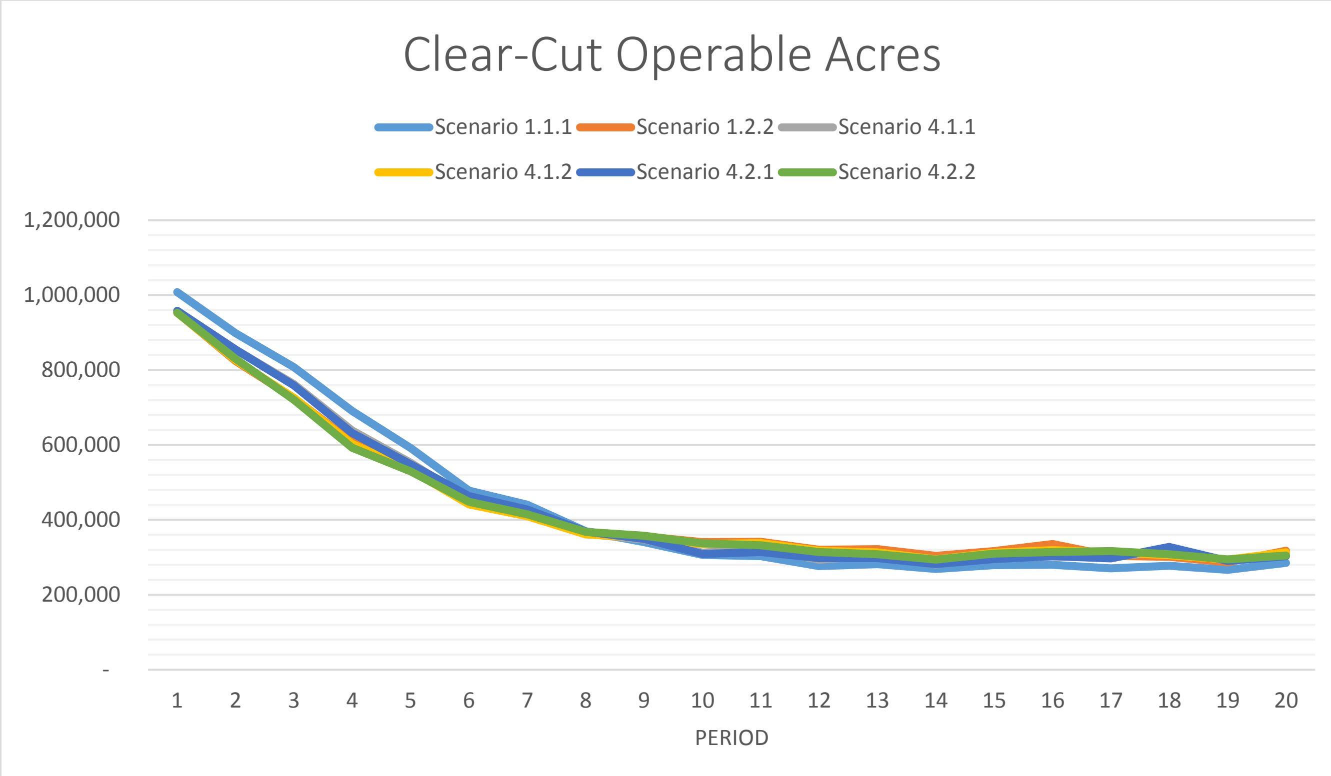


Figure 65. Scenario 4 - Clear-Cut Operable Acres

5.3.4.4 Average Clear-Cut Age

Average clear-cut age followed along the results previously observed, with discernable effect from the higher discount rates (Figure 66). Scenario 1.1.1 followed a slightly different trajectory, but this is primarily due to the fact that it used only the forestry regimes. Scenarios 4.1.1 and 4.2.1 were higher in some periods, but this difference can be accounted for by the regulatory requirement constraints.

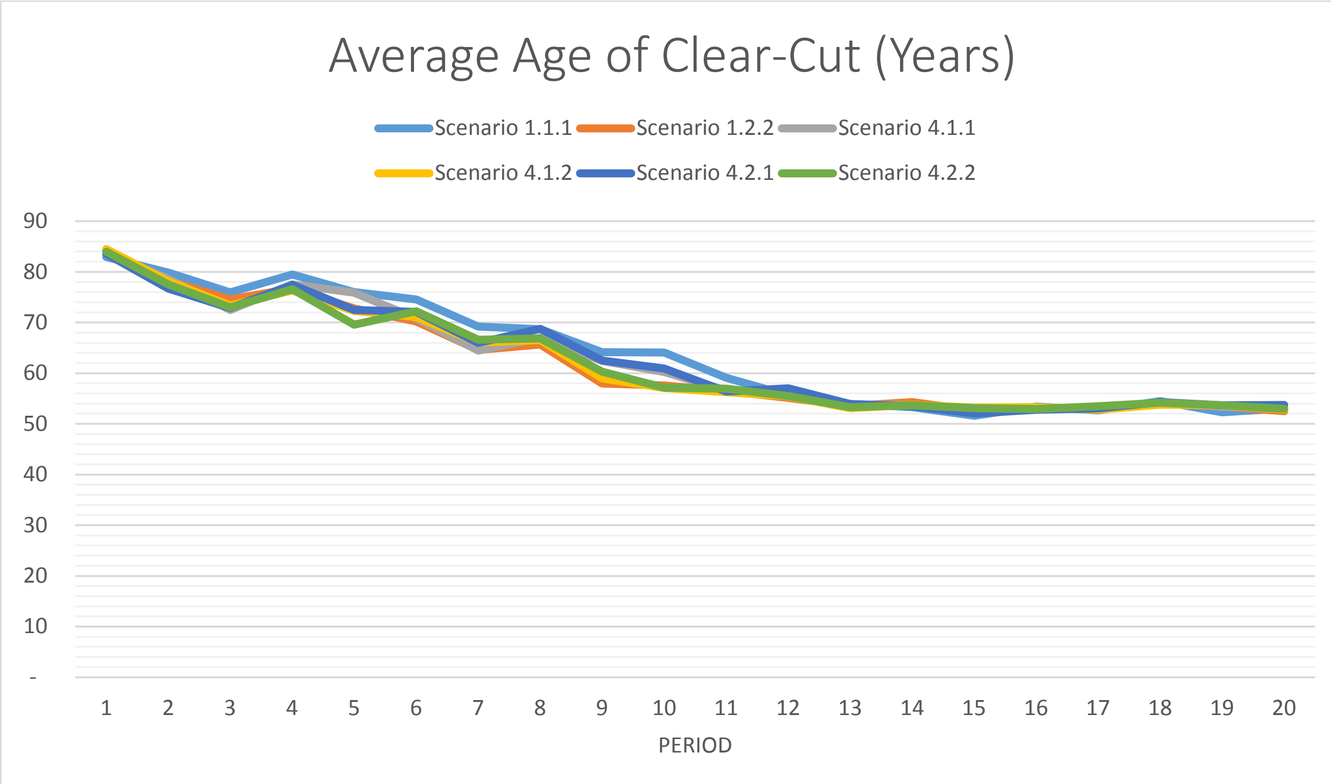


Figure 66. Scenario 4 - Average Clear-Cut Age

5.3.4.5 Priority Harvest Volume

Priority harvest volume is the amount of timber harvested from land within 75 miles of the seven largest timber processors, excluding volume from species that are not commercially viable for these facilities. On average, the fraction of priority harvest volume is maintained at around 66% merging all of the Scenario 4 cases (Figure 67).

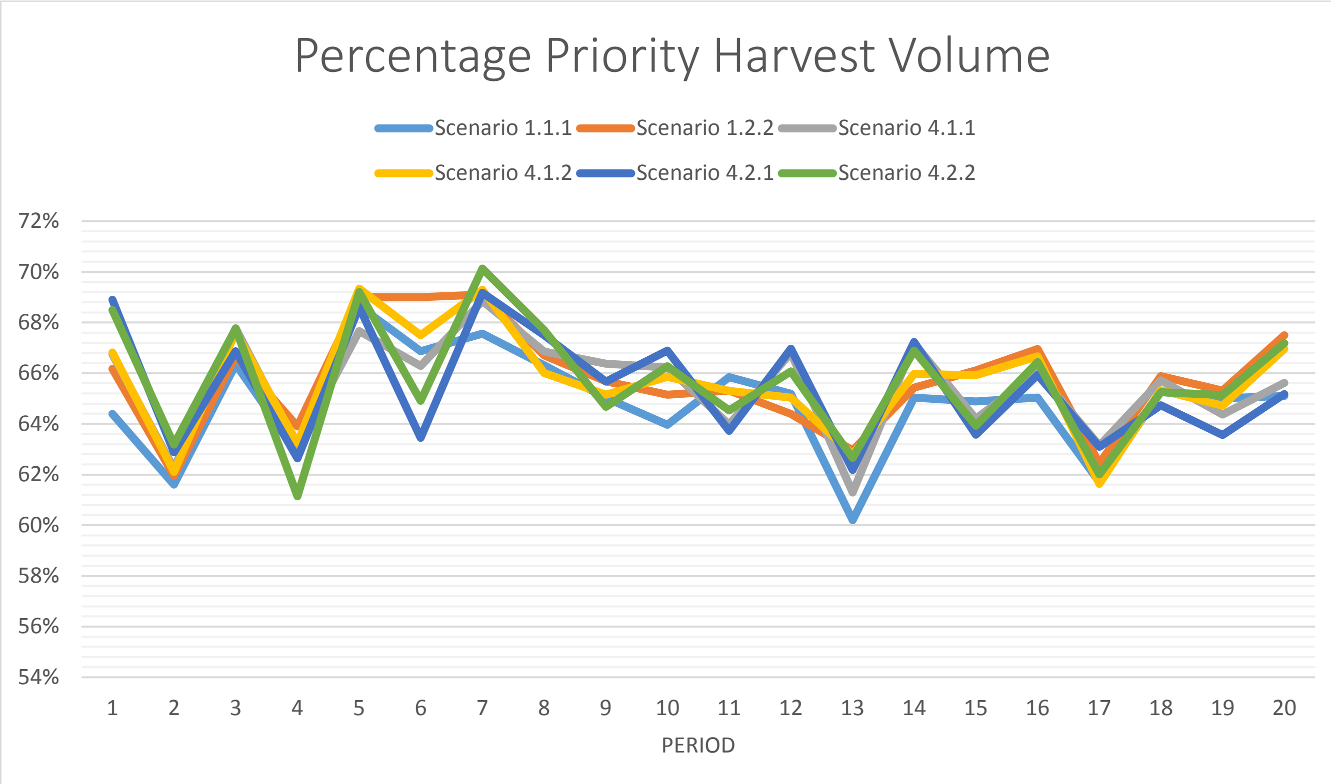


Figure 67. Scenario 4 - Priority Harvest Volume

5.3.4.6 Inventory

All of the scenarios exhibit a steady decline in inventory over the first 20 years, reflecting the accelerated harvest in that period (Figure 68). Scenario 1.1.1 ends at 28.8 million cords, 1.2.2, 4.1.2, 4.2.2 at ±31.4 million cords, and 4.1.1 and 4.2.1 at ±30.2 million cords. The difference in these ending inventories are however driven by the assumptions on management regimes and regulatory requirements, and not by changes in discount rate.

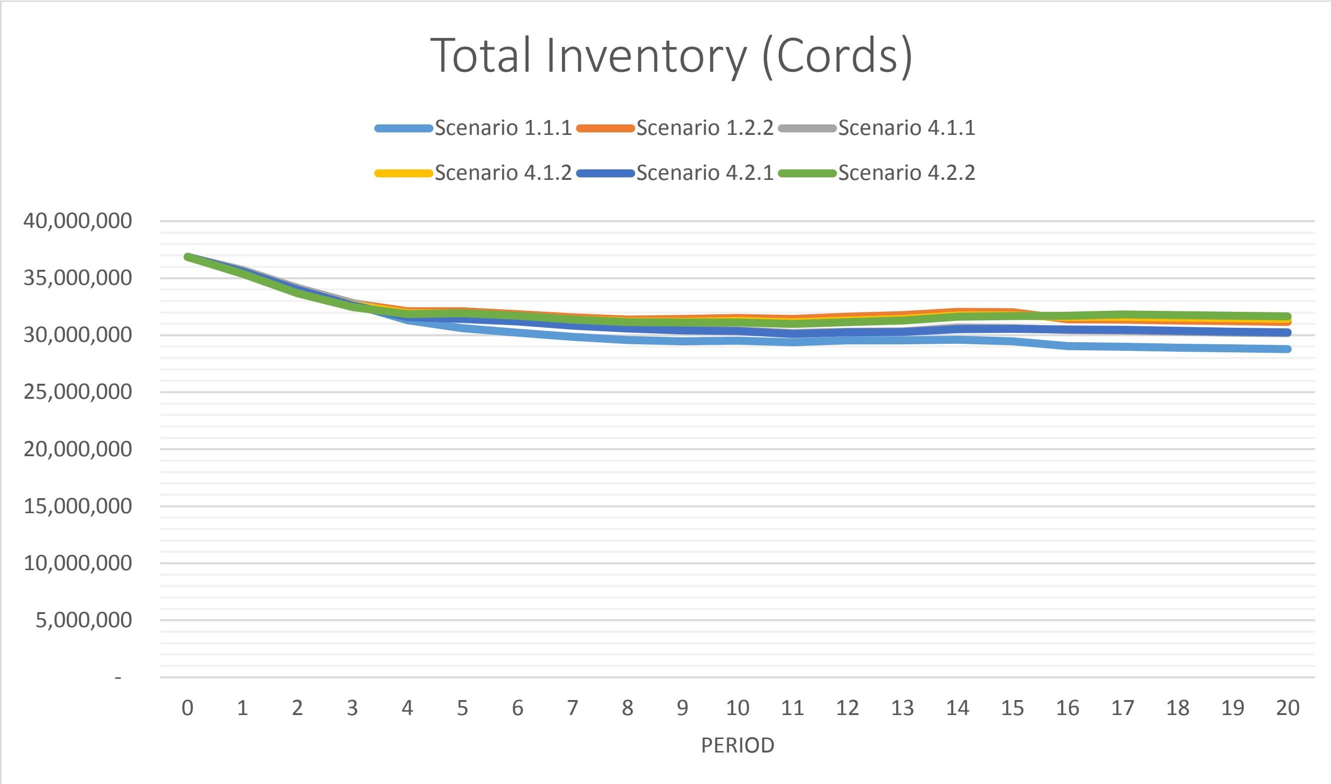


Figure 68. Scenario 4 - Inventory Volume by Period

5.3.4.7 Trust Land Inventory

The inventory on trust lands followed almost identical trajectories across all scenarios (Figure 69). The ending inventory was ±13.7 million acres, which is roughly 44% of the total inventory.

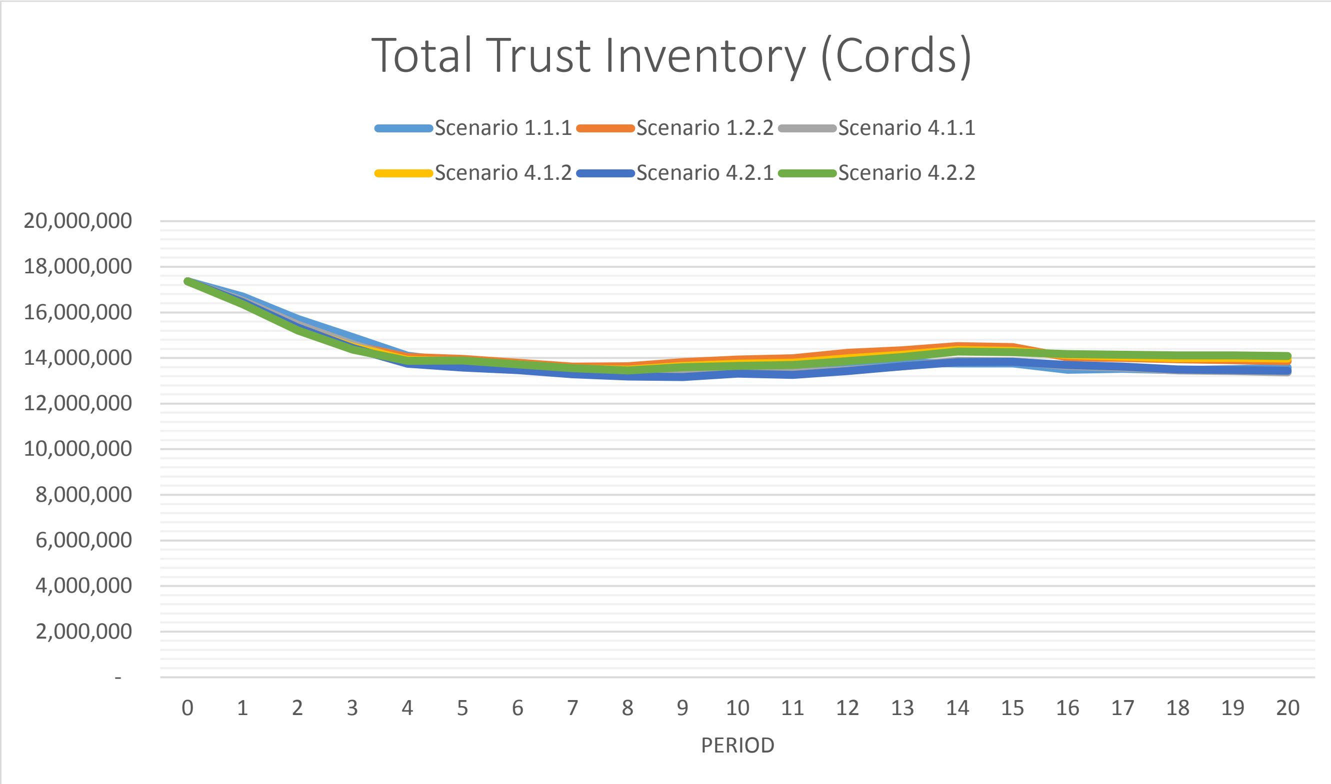


Figure 69. Scenario 4 - Inventory On Trust Land

5.3.4.8 Cover Type Conversions

There was no discernable difference in cover type conversions between scenarios 1.2.2, 4.1.2, and 4.2.2 (Figure 70). For scenarios 1.1.1, 4.1.1 and 4.2.1 cover type conversions were not available.

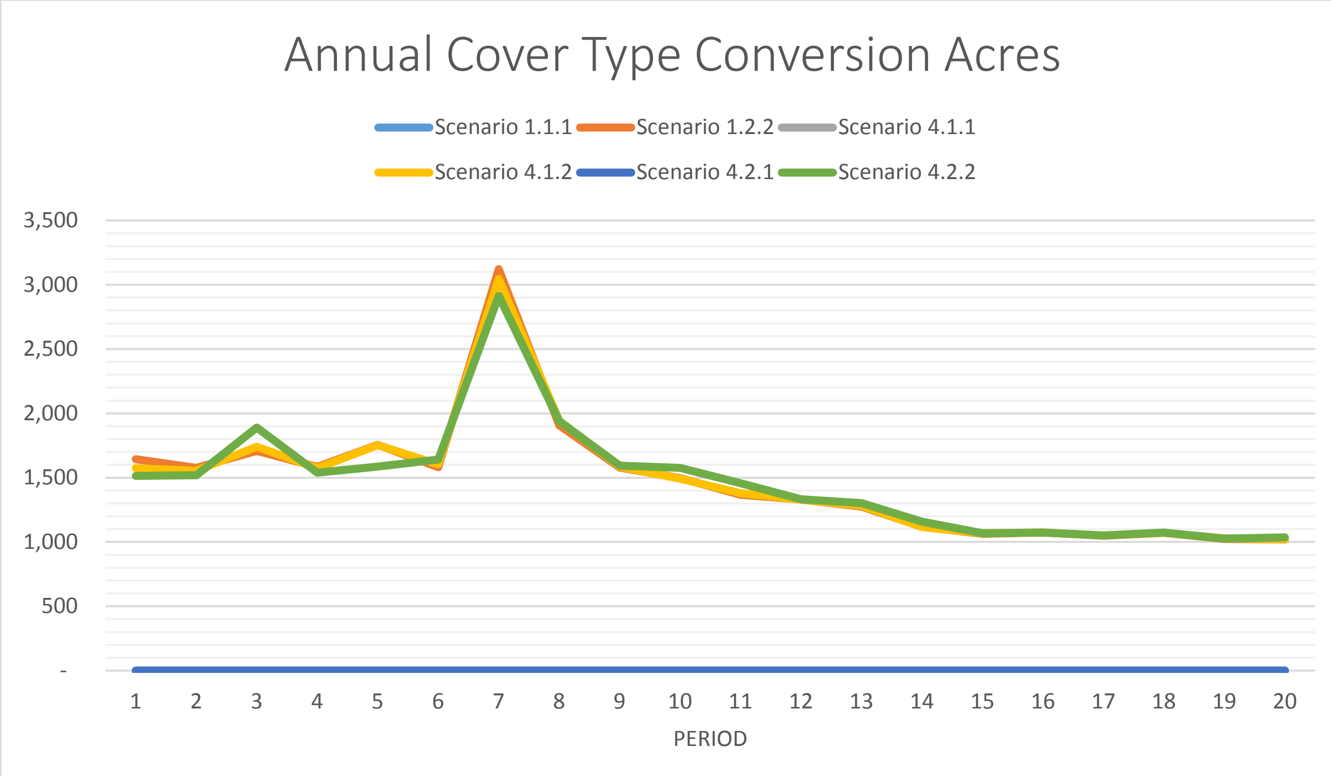


Figure 70. Scenario 4 - Cover Type Conversions

5.3.4.9 Planning Latitude

Scenario 1.1.1 ended at 82% of operable clear-cut acres utilized, while scenarios 4.1.1 and 4.2.1 ended at ±73%, and 1.2.2, 4.1.2 and 4.2.2 ended at ±68% (Figure 71). This difference was driven by the assumptions on management regimes and regulatory requirements, and not by the changes in discount rate.

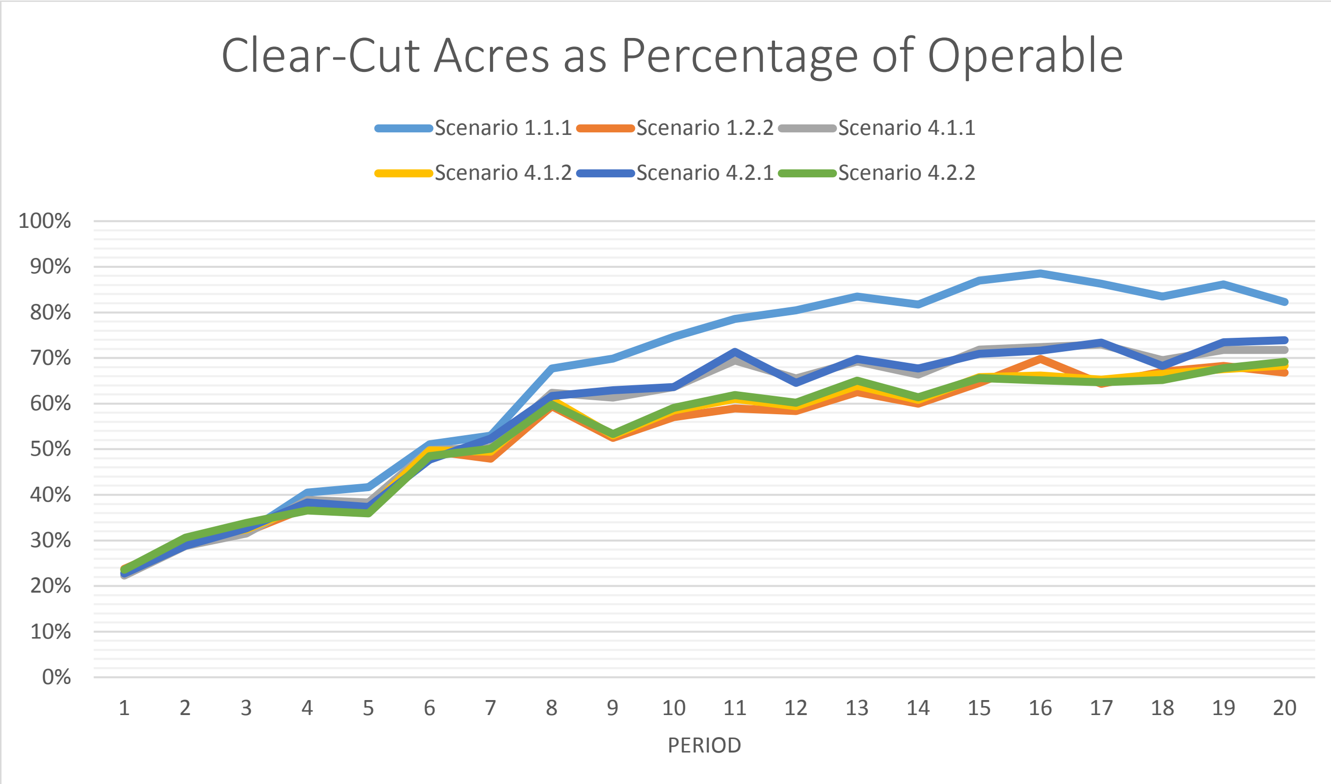


Figure 71. Scenario 4 - Planning Latitude

5.3.4.10 Open Watershed Goals

The scenarios in Scenario 4 were designed to test effects of alternative discount rates on stumpage, harvest volume, inventory, and clear-cut acres. These scenarios imposed no constraints relating to watersheds, old forest guild, NPC, or diversity. In the following sections we report the results for these parameters, but emphasize that Scenario 4 was not designed to alter their outcomes.

With no constraints imposed to minimize open watershed acreage, we found that this quantity did not change appreciably for any Scenario 4 model, starting at 4.4% and ending at 4.5% (Figure 72), with a long-term average for all cases of 4.3%. In contrast, scenario 1.2.4.1, which was constrained to minimize open watersheds, reduced the percentage of open watersheds to 2.54% by 15 years and maintained that level through year 100 (Figure 29). Without the watershed constraint, the amount of open watersheds was 1.96% higher than scenario 1.2.4.2 at year 100.

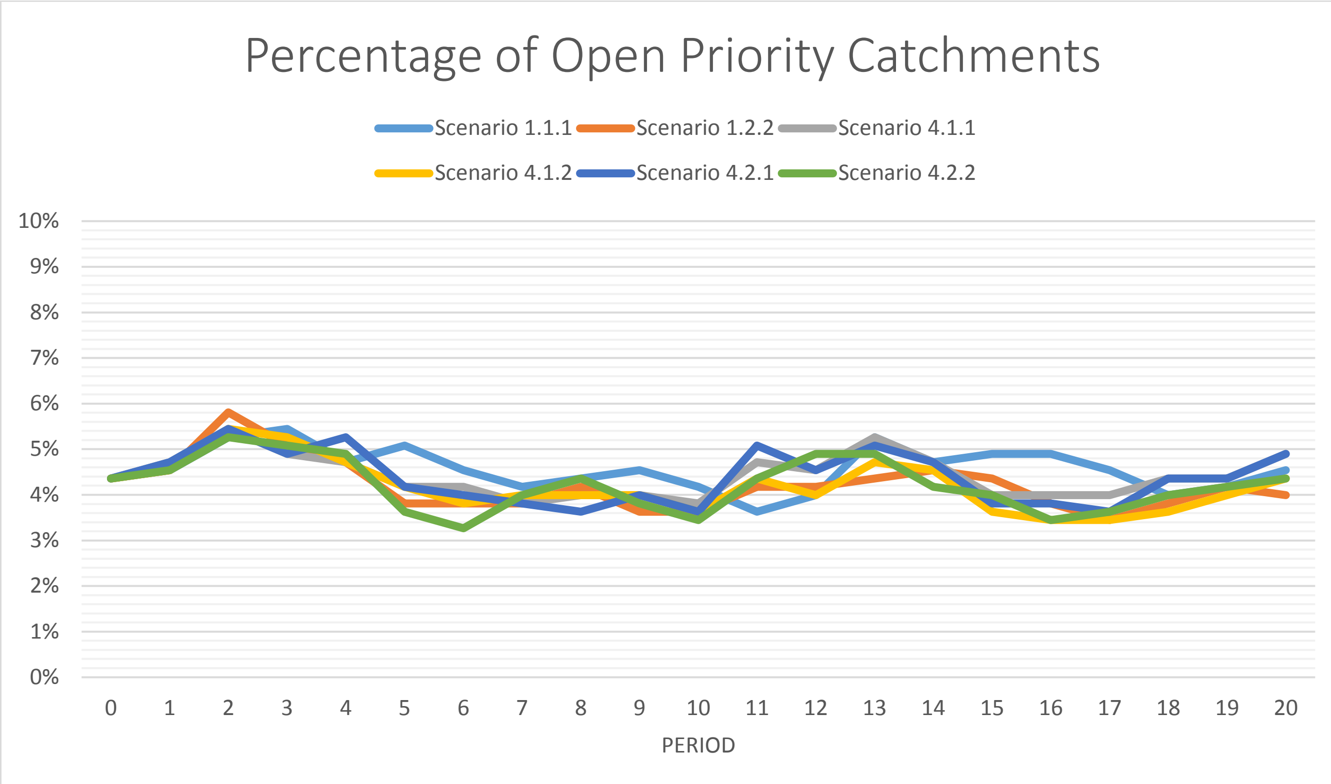


Figure 72. Scenario 4 - Open Watershed Prevalence

5.3.4.11 Old Forest Guild Goals

Scenario 1.2.4.2 was constrained to maximize the number of hexagons that contained stands in the old forest guild. With this constraint in place, scenario 1.2.4.2 increased old forest from a starting point of 5% to an endpoint of 42% (Figure 30). Although scenario 1.2.4.3 was designed to minimize NPC deviations, it also managed to increase old forest to about 27% (Figure 30). In contrast, without the old forest or NPC constraints, Scenario 4 models reduced old forest representation from 5% to between 2.9% and 3.5% (Figure 73).

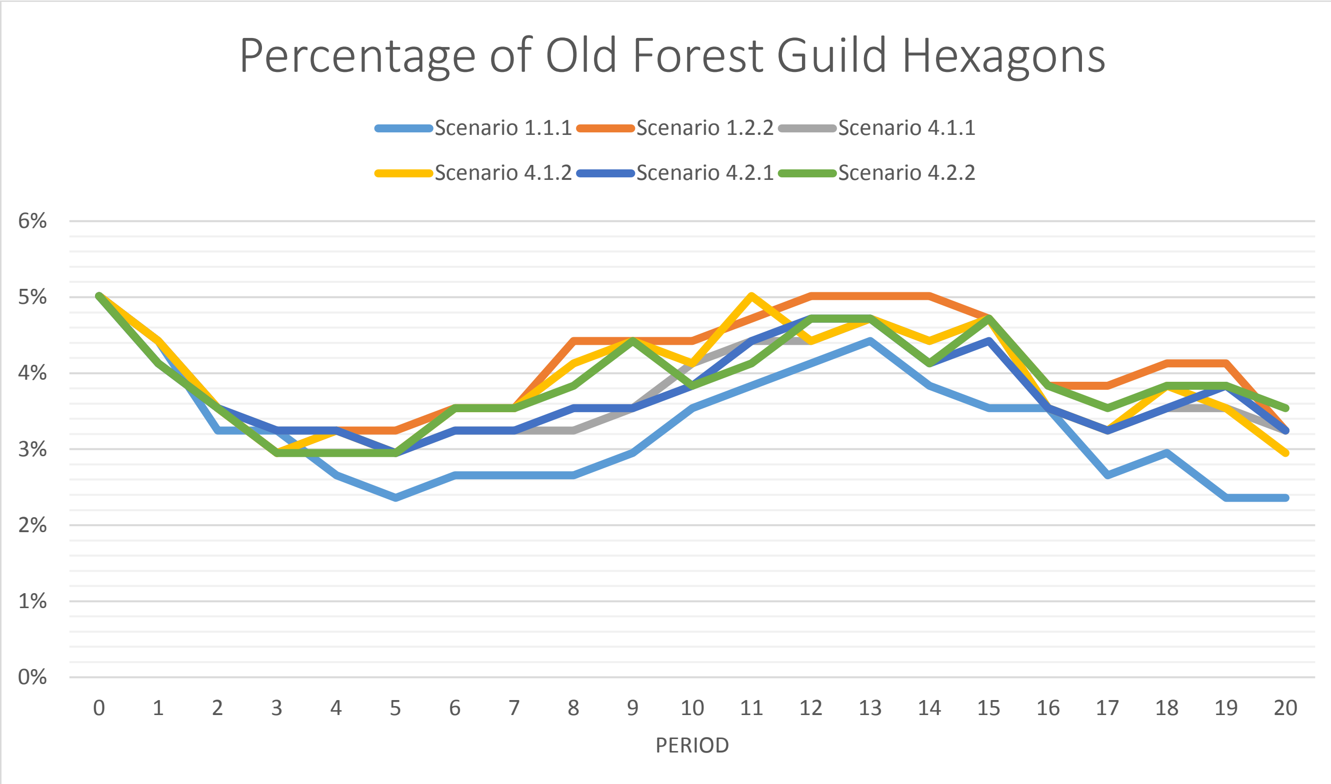


Figure 73. Scenario 4 - Old Forest Guild Proportion

5.3.4.12 Young Forest Guild Goals

None of the scenarios optimized for young forest guild goals, so the results reported here are artifacts of other management assumptions. The results show that the scenarios with regulatory requirements (1.2.2, 4.1.2, 4.2.2) clustered together and ended the planning horizon at ±7%. The scenarios that did not use the regulatory requirements (4.1.1, 4.2.1) ended at ±8% (12% lower). All of the scenarios decreased from an initial level of 9%.

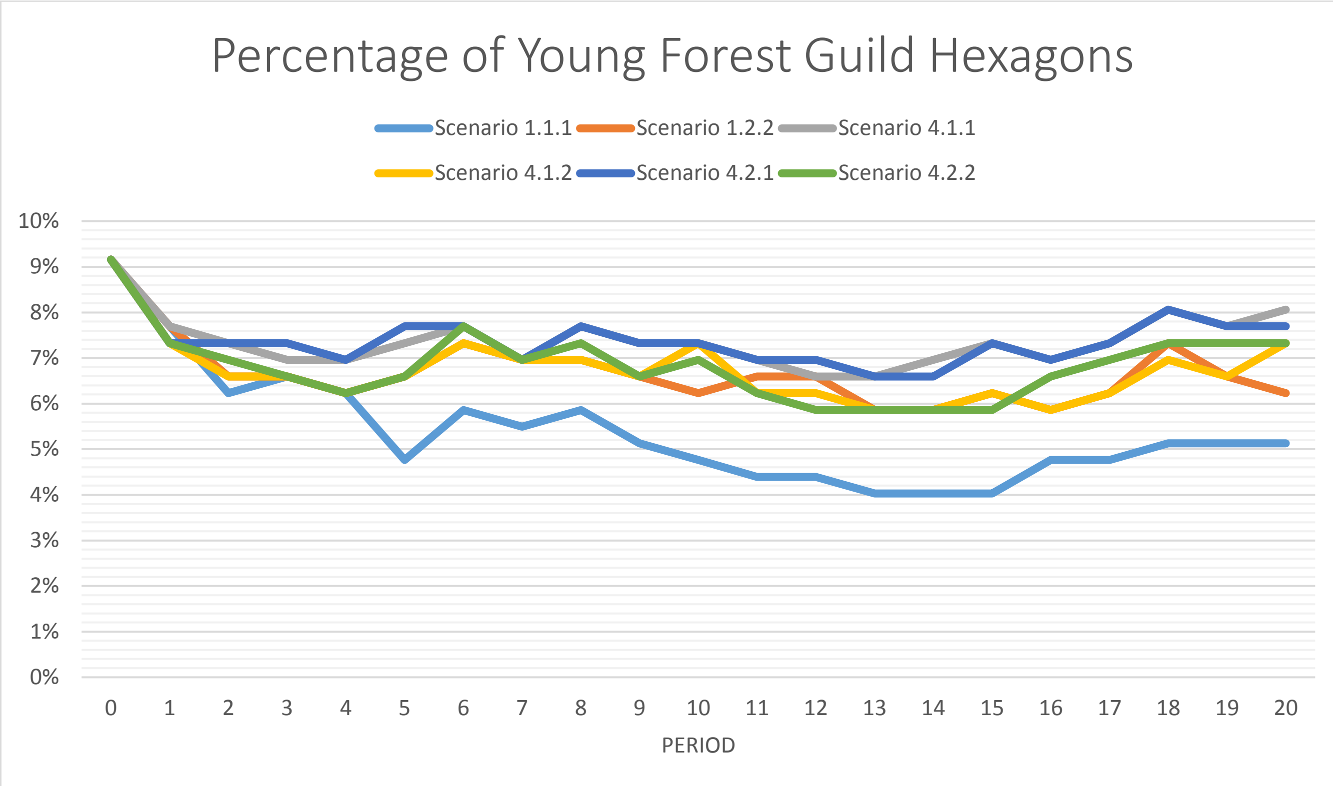


Figure 74. Scenario 4 - Young Forest Guild Proportion

5.3.4.13 Native Plant Community Goals

The only scenario designed to minimize NPC deviations was 1.2.4.3, and it reduced the deviation to 524,000 acres (Figure 32). The next lowest scenario, 1.2.4.2, only reduced NPC deviation to 1.12 million acres (Figure 32). Scenario 4 was not configured to reduce NPC deviations, and indeed we found that the lowest NPC deviation was at 1.2 million acres (Figure 75). Without the constraint to minimize NPC deviation the model has no incentive to do so.

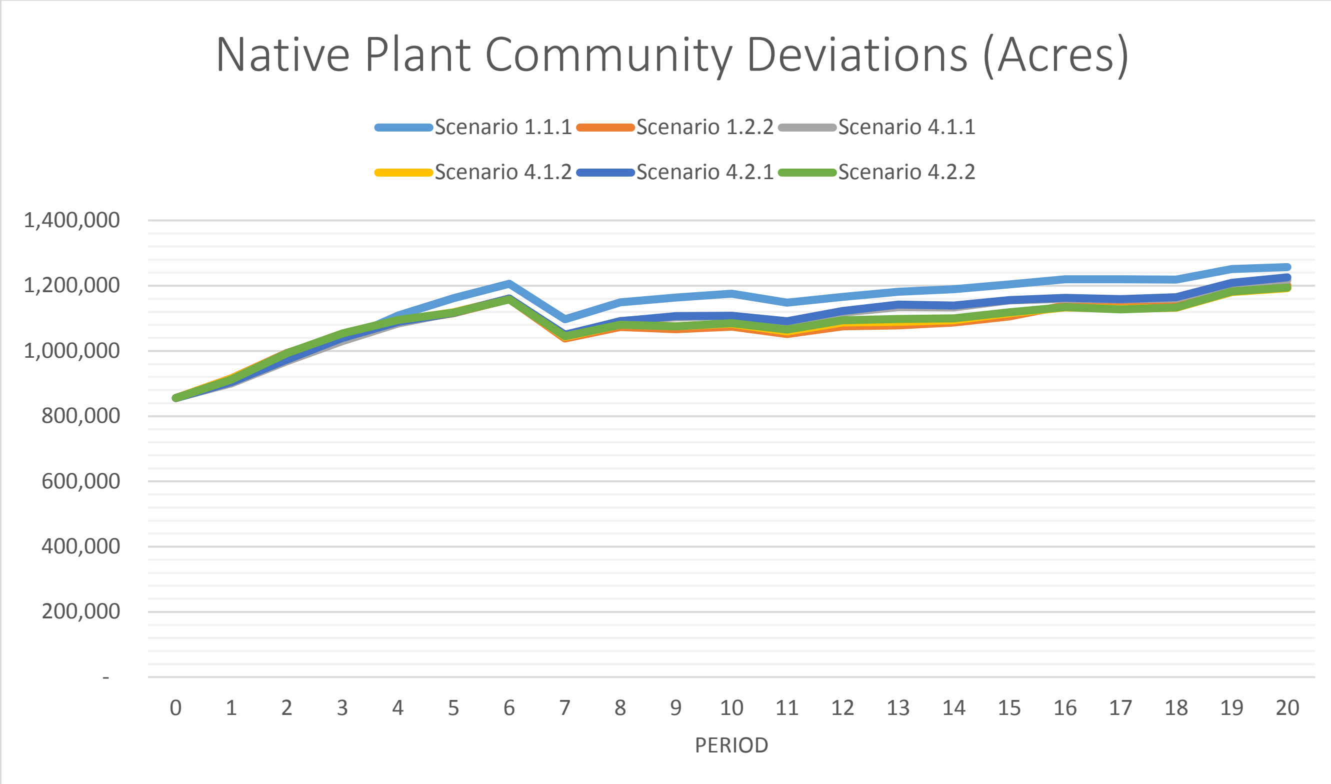


Figure 75. Scenario 4 - Native Plant Community Acreage Deviations

5.3.4.14 Forest-Age Diversity Goals

A similar result occurs for forest age class diversity index in Scenario 4 (Figure 76). These scenarios were not required to maximize diversity, so we saw a decline in the diversity index from 0.88 to 0.86 for 4.1.1 and 4.2.1, and from 0.88 to 0.87 for 4.1.2 and 4.2.2. In percentage terms, following the normalization where 0.01 index unit is equivalent to 3.57% of the theoretical index scale (5.3.1.14), Scenario 4 resulted in a decline of 3.57% to 7.14% in forest age class diversity.

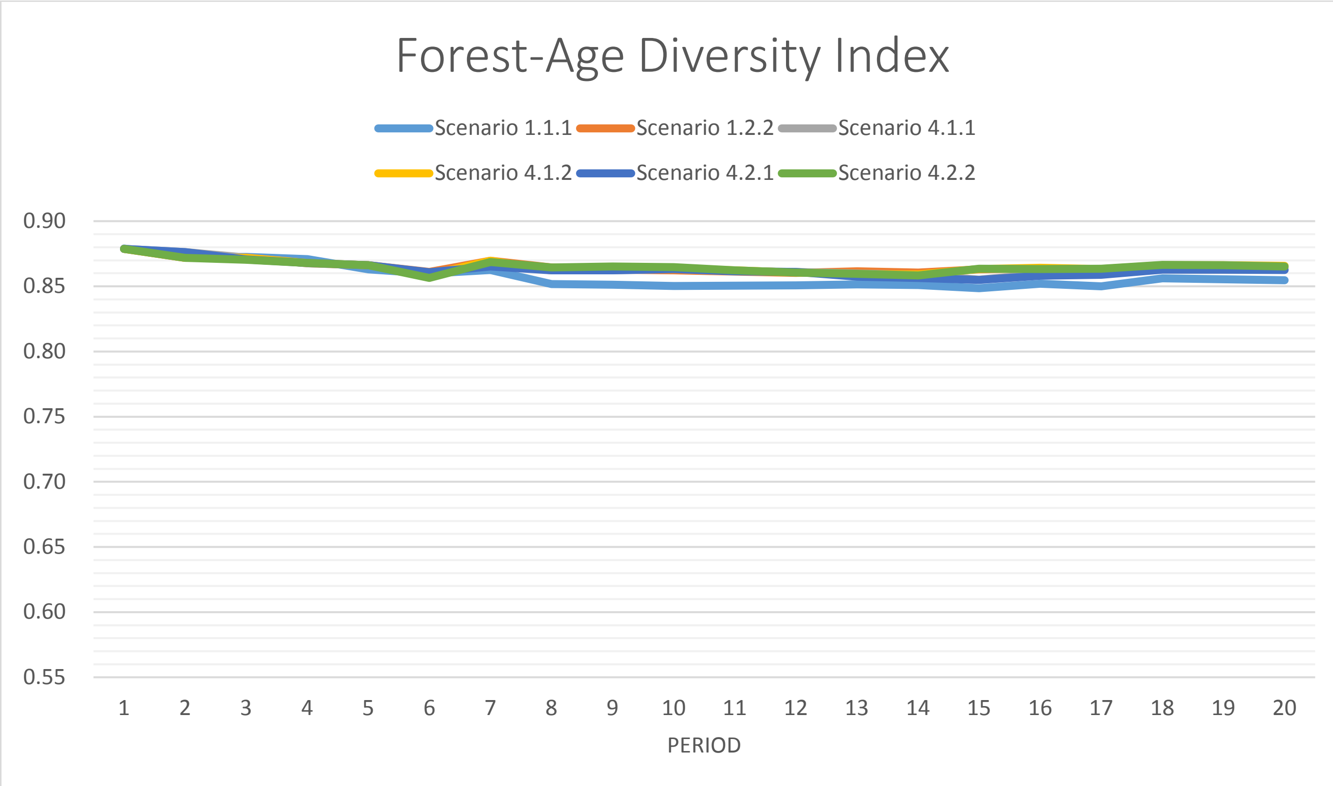


Figure 76. Scenario 4 – Forest-Age Diversity Index Range

6.0 KEY OBSERVATIONS

The purpose of this project was to explore the potential for a harvest level of 1 million cords per year on a sustainable basis. Sustainability was defined by the MN DNR and its stakeholders as meeting a wide range of objectives, which included maintaining natural resource economies, preserving water quality, increasing biodiversity, and protecting wildlife habitat.

Key to this study is the fact that the MN DNR forests have a large number of acres beyond the minimum rotation age. The existence of these mature and older forest acres provides MN DNR with a great deal of flexibility in terms of harvest over the next 20 years. These forest acres also provide opportunities to move more quickly toward achieving some non-timber objectives than if the forest was regulated to current rotation ages. Our objectives were to quantify the opportunities for both timber harvest and other resources and to delineate the interactions between timber and the other resource objectives.

6.1 Sustainable Harvest Levels

Current annual DNR harvest is about 800,000 cords. We found that the long-term sustainable harvest that utilizes all of the acres available under current legal and regulatory restrictions could be between 880,000 and 910,000 cords per year (scenarios 1.1.2 and 1.2.2). This includes site-level considerations for water quality, wildlife habitat, and biodiversity, but does not include marketability factors nor wildlife considerations mentioned below. In the short term, harvests above 1 million cords could be sustained for 15 to 20 years, without ever falling below the long-term sustainable level.

However, our analysis went on to incorporate values other than timber. The sustainable harvest level is most sensitive to resource objectives that target wildlife habitat and required the development of mature and older forests:

- **Old Forest Guilds** – Currently, only 5% of the hexagons have forest conditions that meet the criteria for old-forest dependent species. Scenario 1.2.4.2 was designed to get as many hexagons as possible into the desired condition. After 100 years, the model found that 42% of the hexagons met the old-forest guild criteria.

  Emphasizing the old-forest conditions had a substantial impact on the sustainable harvest level. Harvest levels averaged about 696,000 cords and the model did not find an opportunity to depart from even-flow in the early periods. Given that meeting the old-forest conditions requires longer rotation ages, the negative correlation between harvest and old-forest is expected.

- **Native Plant Communities** – A set of NPC goals describes a desired age class distribution based on pre-settlement conditions and natural disturbance regimes. The current forest misses the desired distribution by some 855,000 acres. Scenario 1.2.4.3 seeks to minimize deviations from these targets by managing how acres age. By harvesting less, the model gets within about 300,000 acres of the desired distribution.

Harvest levels for Run 1.2.4.3 averaged about 584,000 cords, and there is no near-term departure from even flow.

Run 1.2.4.3 suggests a positive correlation between meeting the NPC goals and the old-forest guild goals. While our analysis was not designed to test the strength of the correlation, it is clear that the two objectives are at least somewhat complementary.

Two of the strategic goals, on the other hand, had little impact on harvest levels:

- **Priority Catchments in an Open Condition** – Currently, about 4.4% of the priority catchments on MN DNR lands are considered to be in an "open" condition—having an excess of younger forest and open land than is desirable from a water quality standpoint. By formulating the model to minimize the number of priority catchments considered open (scenario 1.2.4.1), we found that the model could get that number down to and hold at 2.5% over time. This had very little impact on the total harvest level.

  When we did not explicitly include watershed objectives, the number of open priority catchments within MN DNR lands ranged from 4-5%. This may be an artifact of our modeling procedure. Given the results of Run 1.2.4.1, we expect that nearly any scenario could be formulated to approach the 2.5% figure.

- **Forest-Age Diversity** – In this analysis, a forest-age diversity index is based on an objective of having an equal number of acres in each of four age groups. Scenarios 2.2.2 through 2.2.4 explore the impact of three different harvest levels on the forest-age diversity index. At harvest of 600,000 or 800,000 cords, the index is generally at the theoretical maximum. With harvest at 1 million cords, the index is very close to the theoretical maximum, suggesting that the age class structure never strays far from the desired range, regardless of harvest.

6.2 Yield Projections

Projections of future timber yields are fundamental to the harvest projections included in this report. DNR generates yields based on observations from the current timber inventory – an approach sometimes called empirical yields. While questions have been raised about the MN DNR's yield projections, our scope of work did not include developing independent yield projections. We did test the sensitivity of the model results to the yields and found that a change in the yields resulted in a proportionate change in the projected harvest. Within a reasonable range of adjustment, there are no disproportionate impacts on harvest levels.

6.3 Discount Rates

Assumptions on discount rates can result in different management plans since forest planning models will aim to harvest stands before their growth rate falls below the discount rate. In this analysis, we examined the impact of higher discount rates and found that it had no impact on the model results. This is most likely due to the slower growth rates in MN, resulting in the model having no opportunity to beat the discount rate.

6.4 Going Forward

This assessment of the capabilities and opportunities of MN DNR's commercial forest land suggests that the MN DNR could contemplate increasing timber harvest levels in the short term, without falling below sustainable harvest levels in the long term. However, maintaining current harvest levels, or increasing above current harvest levels, will impact the agency's ability to move the forest toward goals for biodiversity and habitat for both young and old forest-dependent wildlife. This assessment should help MN DNR understand the opportunities for finding the right balance between these objectives.

Appendix A: Clear-Cut Management Regime

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
01Ash	AP	All	F	55
01Ash	BRP	All	F	75
01Ash	MNIAM	All	F	55
01Ash	NMNDLP	55minus	F	45
01Ash	NMNDLP	60plus	F	75
01Ash	NMNOP	All	F	55
01Ash	NSU	All	F	80
01Ash	WSU	70minus	F	115
01Ash	WSU	75plus	F	145
09LowHrdw	AP	All	F	55
09LowHrdw	BRP	All	F	75
09LowHrdw	MNIAM	All	F	55
09LowHrdw	NMNDLP	55minus	F	45
09LowHrdw	NMNDLP	60plus	F	75
09LowHrdw	NMNOP	All	F	55
09LowHrdw	NSU	All	F	80
09LowHrdw	WSU	70minus	F	115
09LowHrdw	WSU	75plus	F	145
12Aspen	AP	60minus	F	45
12Aspen	AP	60minus	W	45
12Aspen	AP	65plus	F	35
12Aspen	AP	65plus	W	35
12Aspen	BRP	60minus	F	45
12Aspen	BRP	60minus	W	50
12Aspen	BRP	65plus	F	35
12Aspen	BRP	65plus	W	40
12Aspen	MNIAM	60minus	F	45
12Aspen	MNIAM	60minus	W	50
12Aspen	MNIAM	65plus	F	35
12Aspen	MNIAM	65plus	W	40
12Aspen	NMNDLP	60minus	F	45
12Aspen	NMNDLP	60minus	W	50
12Aspen	NMNDLP	65plus	F	35
12Aspen	NMNDLP	65plus	W	50

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
12Aspen	NMNOP	60minus	F	45
12Aspen	NMNOP	60minus	W	60
12Aspen	NMNOP	65plus	F	35
12Aspen	NMNOP	65plus	W	60
12Aspen	NSU	60minus	F	45
12Aspen	NSU	60minus	W	60
12Aspen	NSU	65plus	F	35
12Aspen	NSU	65plus	W	55
12Aspen	WSU	60minus	F	45
12Aspen	WSU	60minus	W	50
12Aspen	WSU	65plus	F	35
12Aspen	WSU	65plus	W	45
13Birch	AP	All	F	40
13Birch	AP	All	W	45
13Birch	BRP	All	F	55
13Birch	MNIAM	All	F	40
13Birch	MNIAM	All	W	45
13Birch	NMNDLP	All	F	45
13Birch	NMNDLP	All	W	50
13Birch	NMNOP	All	F	45
13Birch	NMNOP	All	W	50
13Birch	NSU	55minus	F	50
13Birch	NSU	55minus	W	55
13Birch	NSU	60plus	F	55
13Birch	NSU	60plus	W	60
13Birch	WSU	All	F	45
13Birch	WSU	All	W	50
14BlmGil	AP	60minus	F	45
14BlmGil	AP	60minus	W	40
14BlmGil	AP	65plus	F	35
14BlmGil	AP	65plus	W	30
14BlmGil	BRP	60minus	F	45
14BlmGil	BRP	65plus	F	35
14BlmGil	MNIAM	60minus	F	45
14BlmGil	MNIAM	60minus	W	45
14BlmGil	MNIAM	65plus	F	35
14BlmGil	MNIAM	65plus	W	35

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
14BlmGil	NMNDLP	60minus	F	45
14BlmGil	NMNDLP	60minus	W	45
14BlmGil	NMNDLP	65plus	F	35
14BlmGil	NMNDLP	65plus	W	45
14BlmGil	NMNOP	60minus	F	45
14BlmGil	NMNOP	60minus	W	55
14BlmGil	NMNOP	65plus	F	35
14BlmGil	NMNOP	65plus	W	55
14BlmGil	NSU	60minus	F	45
14BlmGil	NSU	60minus	W	55
14BlmGil	NSU	65plus	F	35
14BlmGil	NSU	65plus	W	50
14BlmGil	WSU	60minus	F	45
14BlmGil	WSU	60minus	W	45
14BlmGil	WSU	65plus	F	35
14BlmGil	WSU	65plus	W	40
20NorthHrdw	AP	All	F	55
20NorthHrdw	BRP	All	F	75
20NorthHrdw	BRP	All	W	80
20NorthHrdw	MNIAM	All	F	55
20NorthHrdw	NMNDLP	55minus	F	45
20NorthHrdw	NMNDLP	60plus	F	75
20NorthHrdw	NMNOP	All	F	55
20NorthHrdw	NMNOP	All	W	80
20NorthHrdw	NSU	All	F	80
20NorthHrdw	WSU	70minus	F	115
20NorthHrdw	WSU	75plus	F	145
30oak	AP	All	F	55
30oak	BRP	All	F	75
30oak	BRP	All	W	80
30oak	MNIAM	All	F	55
30oak	NMNDLP	55minus	F	45
30oak	NMNDLP	60plus	F	75
30oak	NMNOP	All	F	55
30oak	NMNOP	All	W	80
30oak	NSU	All	F	80
30oak	WSU	70minus	F	115

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
30oak	WSU	75plus	F	145
40CentHrdw	AP	All	F	55
40CentHrdw	BRP	All	F	75
40CentHrdw	BRP	All	W	80
40CentHrdw	MNIAM	All	F	55
40CentHrdw	NMNDLP	55minus	F	45
40CentHrdw	NMNDLP	60plus	F	75
40CentHrdw	NMNOP	All	F	55
40CentHrdw	NSU	All	F	80
40CentHrdw	WSU	70minus	F	115
40CentHrdw	WSU	75plus	F	145
51WhiPinePlt	BRP	50minus	W	65
51WhiPinePlt	BRP	55-60	W	60
51WhiPinePlt	BRP	65plus	W	55
52RedPine	AP	All	F	115
52RedPine	BRP	All	F	110
52RedPine	MNIAM	All	F	110
52RedPine	NMNDLP	All	F	95
52RedPine	NMNOP	All	F	95
52RedPine	NSU	All	F	110
52RedPine	WSU	All	F	115
52RedPinePlt	AP	50minus	F	65
52RedPinePlt	AP	50minus	W	70
52RedPinePlt	AP	55-60	F	60
52RedPinePlt	AP	55-60	W	65
52RedPinePlt	AP	65plus	F	55
52RedPinePlt	AP	65plus	W	60
52RedPinePlt	BRP	50minus	F	65
52RedPinePlt	BRP	50minus	W	70
52RedPinePlt	BRP	55-60	F	60
52RedPinePlt	BRP	55-60	W	65
52RedPinePlt	BRP	65plus	F	55
52RedPinePlt	BRP	65plus	W	60
52RedPinePlt	MNIAM	50minus	F	65
52RedPinePlt	MNIAM	50minus	W	70
52RedPinePlt	MNIAM	55-60	F	60
52RedPinePlt	MNIAM	55-60	W	65

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
52RedPinePlt	MNIAM	65plus	F	55
52RedPinePlt	MNIAM	65plus	W	60
52RedPinePlt	NMNDLP	50minus	F	65
52RedPinePlt	NMNDLP	50minus	W	70
52RedPinePlt	NMNDLP	55-60	F	60
52RedPinePlt	NMNDLP	55-60	W	65
52RedPinePlt	NMNDLP	65plus	F	55
52RedPinePlt	NMNDLP	65plus	W	60
52RedPinePlt	NMNOP	50minus	F	65
52RedPinePlt	NMNOP	50minus	W	70
52RedPinePlt	NMNOP	55-60	F	60
52RedPinePlt	NMNOP	55-60	W	65
52RedPinePlt	NMNOP	65plus	F	55
52RedPinePlt	NMNOP	65plus	W	60
52RedPinePlt	NSU	50minus	F	65
52RedPinePlt	NSU	50minus	W	70
52RedPinePlt	NSU	55-60	F	60
52RedPinePlt	NSU	55-60	W	65
52RedPinePlt	NSU	65plus	F	55
52RedPinePlt	NSU	65plus	W	60
52RedPinePlt	WSU	50minus	F	65
52RedPinePlt	WSU	50minus	W	70
52RedPinePlt	WSU	55-60	F	60
52RedPinePlt	WSU	55-60	W	65
52RedPinePlt	WSU	65plus	F	55
52RedPinePlt	WSU	65plus	W	60
53JacPine	AP	All	F	45
53JacPine	AP	All	W	50
53JacPine	BRP	All	F	55
53JacPine	MNIAM	All	F	30
53JacPine	MNIAM	All	W	40
53JacPine	NMNDLP	All	F	40
53JacPine	NMNDLP	All	W	45
53JacPine	NMNOP	All	F	45
53JacPine	NMNOP	All	W	50
53JacPine	NSU	All	F	55
53JacPine	NSU	All	W	60

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
53JacPine	WSU	All	F	35
53JacPine	WSU	All	W	40
54ScotPine	BRP	All	W	60
54ScotPine	MNIAM	All	W	40
54ScotPine	NMNDLP	All	W	45
54ScotPine	NSU	All	W	60
54ScotPine	WSU	All	W	40
61WhitSprPlt	AP	All	F	45
61WhitSprPlt	AP	All	W	50
61WhitSprPlt	BRP	All	F	45
61WhitSprPlt	BRP	All	W	50
61WhitSprPlt	MNIAM	All	F	45
61WhitSprPlt	MNIAM	All	W	50
61WhitSprPlt	NMNDLP	All	F	45
61WhitSprPlt	NMNOP	All	F	45
61WhitSprPlt	NMNOP	All	W	50
61WhitSprPlt	NSU	All	F	45
61WhitSprPlt	NSU	All	W	50
61WhitSprPlt	WSU	All	F	45
61WhitSprPlt	WSU	All	W	50
62BalFir	AP	All	F	45
62BalFir	AP	All	W	50
62BalFir	BRP	All	F	40
62BalFir	MNIAM	All	F	40
62BalFir	MNIAM	All	W	45
62BalFir	NMNDLP	All	F	40
62BalFir	NMNDLP	All	W	50
62BalFir	NMNOP	All	F	40
62BalFir	NMNOP	All	W	55
62BalFir	NSU	All	F	45
62BalFir	NSU	All	W	55
62BalFir	WSU	All	F	55
62BalFir	WSU	All	W	55
71BlaSprLow	AP	25Minus	F	115
71BlaSprLow	AP	25Minus	W	120
71BlaSprLow	AP	30-35	F	95
71BlaSprLow	AP	30-35	W	100

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
71BlaSprLow	AP	40Plus	F	75
71BlaSprLow	AP	40Plus	W	80
71BlaSprLow	BRP	25Minus	F	115
71BlaSprLow	BRP	30-35	F	95
71BlaSprLow	BRP	40Plus	F	75
71BlaSprLow	MNIAM	25Minus	F	115
71BlaSprLow	MNIAM	25Minus	W	120
71BlaSprLow	MNIAM	30-35	F	95
71BlaSprLow	MNIAM	30-35	W	100
71BlaSprLow	MNIAM	40Plus	F	75
71BlaSprLow	MNIAM	40Plus	W	80
71BlaSprLow	NMNDLP	25Minus	F	115
71BlaSprLow	NMNDLP	25Minus	W	120
71BlaSprLow	NMNDLP	30-35	F	95
71BlaSprLow	NMNDLP	30-35	W	100
71BlaSprLow	NMNDLP	40Plus	F	75
71BlaSprLow	NMNDLP	40Plus	W	80
71BlaSprLow	NMNOP	25Minus	F	115
71BlaSprLow	NMNOP	25Minus	W	120
71BlaSprLow	NMNOP	30-35	F	95
71BlaSprLow	NMNOP	30-35	W	100
71BlaSprLow	NMNOP	40Plus	F	75
71BlaSprLow	NMNOP	40Plus	W	100
71BlaSprLow	NSU	25Minus	F	115
71BlaSprLow	NSU	25Minus	W	120
71BlaSprLow	NSU	30-35	F	95
71BlaSprLow	NSU	30-35	W	100
71BlaSprLow	NSU	40Plus	F	75
71BlaSprLow	NSU	40Plus	W	80
71BlaSprLow	WSU	25Minus	F	115
71BlaSprLow	WSU	25Minus	W	120
71BlaSprLow	WSU	30-35	F	95
71BlaSprLow	WSU	30-35	W	100
71BlaSprLow	WSU	40Plus	F	75
71BlaSprLow	WSU	40Plus	W	80
72TamPine	AP	35Minus	F	95
72TamPine	AP	35Minus	W	100

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
72TamPine	AP	40Plus	F	75
72TamPine	AP	40Plus	W	80
72TamPine	BRP	All	F	80
72TamPine	MNIAM	All	F	80
72TamPine	MNIAM	All	W	85
72TamPine	NMNDLP	35Minus	F	70
72TamPine	NMNDLP	35Minus	W	75
72TamPine	NMNDLP	40Plus	F	60
72TamPine	NMNDLP	40Plus	W	65
72TamPine	NMNOP	35Minus	F	90
72TamPine	NMNOP	35Minus	W	95
72TamPine	NMNOP	40Plus	F	65
72TamPine	NMNOP	40Plus	W	70
72TamPine	NSU	35Minus	F	95
72TamPine	NSU	35Minus	W	100
72TamPine	NSU	40Plus	F	70
72TamPine	NSU	40Plus	W	75
72TamPine	WSU	35Minus	F	95
72TamPine	WSU	35Minus	W	100
72TamPine	WSU	40Plus	F	55
72TamPine	WSU	40Plus	W	60
74BlaSprUpl	AP	All	F	45
74BlaSprUpl	BRP	All	F	30
74BlaSprUpl	MNIAM	All	F	30
74BlaSprUpl	MNIAM	All	W	50
74BlaSprUpl	NMNDLP	All	F	40
74BlaSprUpl	NMNDLP	All	W	50
74BlaSprUpl	NMNOP	All	F	55
74BlaSprUpl	NMNOP	All	W	60
74BlaSprUpl	NSU	All	F	60
74BlaSprUpl	NSU	All	W	65
74BlaSprUpl	WSU	All	F	35
74BlaSprUpl	WSU	All	W	50
79Offoak	BRP	All	W	80

Appendix B: Thin Management Regime

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Thin Number	Minimum Thin Age	Maximum Thin Age
01Ash	All	All	F	Unthinned	40	70
01Ash	All	All	F	Thin 1	55	70
01Ash	All	All	F	Thin 2	70	70
09LowHrdw	All	All	F	Unthinned	40	70
09LowHrdw	All	All	F	Thin 1	55	70
09LowHrdw	All	All	F	Thin 2	70	70
20NorthHrdw	All	60Plus	F	Unthinned	30	70
20NorthHrdw	All	60Plus	F	Thin 1	45	70
20NorthHrdw	All	60Plus	F	Thin 2	60	70
20NorthHrdw	MNIAM	60Plus	W	Unthinned	30	70
20NorthHrdw	MNIAM	60Plus	W	Thin 1	45	70
20NorthHrdw	MNIAM	60Plus	W	Thin 2	60	70
20NorthHrdw	NSU	60Plus	W	Unthinned	30	70
20NorthHrdw	NSU	60Plus	W	Thin 1	45	70
20NorthHrdw	NSU	60Plus	W	Thin 2	60	70
20NorthHrdw	WSU	60Plus	W	Unthinned	30	70
20NorthHrdw	WSU	60Plus	W	Thin 1	45	70
20NorthHrdw	WSU	60Plus	W	Thin 2	60	70
30Oak	All	60Plus	F	Unthinned	30	70
30Oak	All	60Plus	F	Thin 1	45	70
30Oak	All	60Plus	F	Thin 2	60	70
30Oak	MNIAM	60Plus	W	Unthinned	30	70
30Oak	MNIAM	60Plus	W	Thin 1	45	70
30Oak	MNIAM	60Plus	W	Thin 2	60	70
30Oak	NSU	60Plus	W	Unthinned	30	70
30Oak	NSU	60Plus	W	Thin 1	45	70
30Oak	NSU	60Plus	W	Thin 2	60	70
30Oak	WSU	60Plus	W	Unthinned	30	70
30Oak	WSU	60Plus	W	Thin 1	45	70
30Oak	WSU	60Plus	W	Thin 2	60	70
40CentHrdw	All	60Plus	F	Unthinned	30	70
40CentHrdw	All	60Plus	F	Thin 1	45	70
40CentHrdw	All	60Plus	F	Thin 2	60	70
40CentHrdw	MNIAM	60Plus	W	Unthinned	30	70
40CentHrdw	MNIAM	60Plus	W	Thin 1	45	70
40CentHrdw	MNIAM	60Plus	W	Thin 2	60	70

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Thin Number	Minimum Thin Age	Maximum Thin Age
40CentHrdw	NSU	60Plus	W	Unthinned	30	70
40CentHrdw	NSU	60Plus	W	Thin 1	45	70
40CentHrdw	NSU	60Plus	W	Thin 2	60	70
40CentHrdw	WSU	60Plus	W	Unthinned	30	70
40CentHrdw	WSU	60Plus	W	Thin 1	45	70
40CentHrdw	WSU	60Plus	W	Thin 2	60	70
51WhiPinePlt	All	All	F	Unthinned	25	100
51WhiPinePlt	All	All	F	Thin 1	35	100
51WhiPinePlt	All	All	F	Thin 2	45	100
51WhiPinePlt	All	All	F	Thin 3	55	100
51WhiPinePlt	All	All	F	Thin 4	65	100
51WhiPinePlt	All	All	F	Thin 5	75	100
51WhiPinePlt	AP	45Plus	W	Unthinned	25	100
51WhiPinePlt	AP	45Plus	W	Thin 1	35	100
51WhiPinePlt	AP	45Plus	W	Thin 2	45	100
51WhiPinePlt	AP	45Plus	W	Thin 3	55	100
51WhiPinePlt	AP	45Plus	W	Thin 4	65	100
51WhiPinePlt	AP	45Plus	W	Thin 5	75	100
51WhiPinePlt	BRP	45Plus	W	Unthinned	25	100
51WhiPinePlt	BRP	45Plus	W	Thin 1	35	100
51WhiPinePlt	BRP	45Plus	W	Thin 2	45	100
51WhiPinePlt	BRP	45Plus	W	Thin 3	55	100
51WhiPinePlt	BRP	45Plus	W	Thin 4	65	100
51WhiPinePlt	BRP	45Plus	W	Thin 5	75	100
51WhiPinePlt	MNIAM	45Plus	W	Unthinned	25	100
51WhiPinePlt	MNIAM	45Plus	W	Thin 1	35	100
51WhiPinePlt	MNIAM	45Plus	W	Thin 2	45	100
51WhiPinePlt	MNIAM	45Plus	W	Thin 3	55	100
51WhiPinePlt	MNIAM	45Plus	W	Thin 4	65	100
51WhiPinePlt	MNIAM	45Plus	W	Thin 5	75	100
51WhiPinePlt	NMNDLP	45Plus	W	Unthinned	25	100
51WhiPinePlt	NMNDLP	45Plus	W	Thin 1	35	100
51WhiPinePlt	NMNDLP	45Plus	W	Thin 2	45	100
51WhiPinePlt	NMNDLP	45Plus	W	Thin 3	55	100
51WhiPinePlt	NMNDLP	45Plus	W	Thin 4	65	100
51WhiPinePlt	NMNDLP	45Plus	W	Thin 5	75	100
51WhiPinePlt	NSU	45Plus	W	Unthinned	25	100
51WhiPinePlt	NSU	45Plus	W	Thin 1	35	100
51WhiPinePlt	NSU	45Plus	W	Thin 2	45	100

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Thin Number	Minimum Thin Age	Maximum Thin Age
51WhiPinePlt	NSU	45Plus	W	Thin 3	55	100
51WhiPinePlt	NSU	45Plus	W	Thin 4	65	100
51WhiPinePlt	NSU	45Plus	W	Thin 5	75	100
51WhiPinePlt	WSU	45Plus	W	Unthinned	25	100
51WhiPinePlt	WSU	45Plus	W	Thin 1	35	100
51WhiPinePlt	WSU	45Plus	W	Thin 2	45	100
51WhiPinePlt	WSU	45Plus	W	Thin 3	55	100
51WhiPinePlt	WSU	45Plus	W	Thin 4	65	100
51WhiPinePlt	WSU	45Plus	W	Thin 5	75	100
52RedPine	All	All	F	Unthinned	25	100
52RedPine	All	All	F	Thin 1	35	100
52RedPine	All	All	F	Thin 2	45	100
52RedPine	All	All	F	Thin 3	55	100
52RedPine	All	All	F	Thin 4	65	100
52RedPine	All	All	F	Thin 5	75	100
52RedPine	AP	45Plus	W	Unthinned	40	150
52RedPine	AP	45Plus	W	Thin 1	55	150
52RedPine	AP	45Plus	W	Thin 2	70	150
52RedPine	AP	45Plus	W	Thin 3	85	150
52RedPine	AP	45Plus	W	Thin 4	100	150
52RedPine	AP	45Plus	W	Thin 5	115	150
52RedPine	MNIAM	45Plus	W	Unthinned	40	150
52RedPine	MNIAM	45Plus	W	Thin 1	55	150
52RedPine	MNIAM	45Plus	W	Thin 2	70	150
52RedPine	MNIAM	45Plus	W	Thin 3	85	150
52RedPine	MNIAM	45Plus	W	Thin 4	100	150
52RedPine	MNIAM	45Plus	W	Thin 5	115	150
52RedPine	NMNDLP	45Plus	W	Unthinned	40	150
52RedPine	NMNDLP	45Plus	W	Thin 1	55	150
52RedPine	NMNDLP	45Plus	W	Thin 2	70	150
52RedPine	NMNDLP	45Plus	W	Thin 3	85	150
52RedPine	NMNDLP	45Plus	W	Thin 4	100	150
52RedPine	NMNDLP	45Plus	W	Thin 5	115	150
52RedPine	NSU	45Plus	W	Unthinned	40	150
52RedPine	NSU	45Plus	W	Thin 1	55	150
52RedPine	NSU	45Plus	W	Thin 2	70	150
52RedPine	NSU	45Plus	W	Thin 3	85	150
52RedPine	NSU	45Plus	W	Thin 4	100	150
52RedPine	NSU	45Plus	W	Thin 5	115	150

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Thin Number	Minimum Thin Age	Maximum Thin Age
52RedPine	WSU	45Plus	W	Unthinned	40	150
52RedPine	WSU	45Plus	W	Thin 1	55	150
52RedPine	WSU	45Plus	W	Thin 2	70	150
52RedPine	WSU	45Plus	W	Thin 3	85	150
52RedPine	WSU	45Plus	W	Thin 4	100	150
52RedPine	WSU	45Plus	W	Thin 5	115	150
52RedPinePlt	All	All	F	Unthinned	25	100
52RedPinePlt	All	All	F	Thin 1	35	100
52RedPinePlt	All	All	F	Thin 2	45	100
52RedPinePlt	All	All	F	Thin 3	55	100
52RedPinePlt	All	All	F	Thin 4	65	100
52RedPinePlt	All	All	F	Thin 5	75	100
52RedPinePlt	AP	45Plus	W	Unthinned	25	100
52RedPinePlt	AP	45Plus	W	Thin 1	35	100
52RedPinePlt	AP	45Plus	W	Thin 2	45	100
52RedPinePlt	AP	45Plus	W	Thin 3	55	100
52RedPinePlt	AP	45Plus	W	Thin 4	65	100
52RedPinePlt	AP	45Plus	W	Thin 5	75	100
52RedPinePlt	BRP	45Plus	W	Unthinned	25	100
52RedPinePlt	BRP	45Plus	W	Thin 1	35	100
52RedPinePlt	BRP	45Plus	W	Thin 2	45	100
52RedPinePlt	BRP	45Plus	W	Thin 3	55	100
52RedPinePlt	BRP	45Plus	W	Thin 4	65	100
52RedPinePlt	BRP	45Plus	W	Thin 5	75	100
52RedPinePlt	MNIAM	45Plus	W	Unthinned	25	100
52RedPinePlt	MNIAM	45Plus	W	Thin 1	35	100
52RedPinePlt	MNIAM	45Plus	W	Thin 2	45	100
52RedPinePlt	MNIAM	45Plus	W	Thin 3	55	100
52RedPinePlt	MNIAM	45Plus	W	Thin 4	65	100
52RedPinePlt	MNIAM	45Plus	W	Thin 5	75	100
52RedPinePlt	NMNDLP	45Plus	W	Unthinned	25	100
52RedPinePlt	NMNDLP	45Plus	W	Thin 1	35	100
52RedPinePlt	NMNDLP	45Plus	W	Thin 2	45	100
52RedPinePlt	NMNDLP	45Plus	W	Thin 3	55	100
52RedPinePlt	NMNDLP	45Plus	W	Thin 4	65	100
52RedPinePlt	NMNDLP	45Plus	W	Thin 5	75	100
52RedPinePlt	NMNOP	45Plus	W	Unthinned	25	100
52RedPinePlt	NMNOP	45Plus	W	Thin 1	35	100
52RedPinePlt	NMNOP	45Plus	W	Thin 2	45	100

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Thin Number	Minimum Thin Age	Maximum Thin Age
52RedPinePlt	NMNOP	45Plus	W	Thin 3	55	100
52RedPinePlt	NMNOP	45Plus	W	Thin 4	65	100
52RedPinePlt	NMNOP	45Plus	W	Thin 5	75	100
52RedPinePlt	NSU	45Plus	W	Unthinned	25	100
52RedPinePlt	NSU	45Plus	W	Thin 1	35	100
52RedPinePlt	NSU	45Plus	W	Thin 2	45	100
52RedPinePlt	NSU	45Plus	W	Thin 3	55	100
52RedPinePlt	NSU	45Plus	W	Thin 4	65	100
52RedPinePlt	NSU	45Plus	W	Thin 5	75	100
52RedPinePlt	WSU	45Plus	W	Unthinned	25	100
52RedPinePlt	WSU	45Plus	W	Thin 1	35	100
52RedPinePlt	WSU	45Plus	W	Thin 2	45	100
52RedPinePlt	WSU	45Plus	W	Thin 3	55	100
52RedPinePlt	WSU	45Plus	W	Thin 4	65	100
52RedPinePlt	WSU	45Plus	W	Thin 5	75	100
53JacPine	NMNDLP	All	W	Unthinned	25	100
53JacPine	NMNDLP	All	W	Thin 1	35	100
54ScotPine	BRP	All	W	Unthinned	25	100
54ScotPine	BRP	All	W	Thin 1	35	100
61WhitSprPlt	All	All	F	Unthinned	25	80
61WhitSprPlt	All	All	F	Thin 1	35	80
61WhitSprPlt	All	All	F	Thin 2	45	80
61WhitSprPlt	AP	All	W	Unthinned	25	80
61WhitSprPlt	AP	All	W	Thin 1	35	80
61WhitSprPlt	AP	All	W	Thin 2	45	80
61WhitSprPlt	BRP	All	W	Unthinned	25	80
61WhitSprPlt	BRP	All	W	Thin 1	35	80
61WhitSprPlt	BRP	All	W	Thin 2	45	80
61WhitSprPlt	MNIAM	All	W	Unthinned	25	80
61WhitSprPlt	MNIAM	All	W	Thin 1	35	80
61WhitSprPlt	MNIAM	All	W	Thin 2	45	80
61WhitSprPlt	NMNDLP	All	W	Unthinned	25	80
61WhitSprPlt	NMNDLP	All	W	Thin 1	35	80
61WhitSprPlt	NMNDLP	All	W	Thin 2	45	80
61WhitSprPlt	NMNOP	All	W	Unthinned	25	80
61WhitSprPlt	NMNOP	All	W	Thin 1	35	80
61WhitSprPlt	NMNOP	All	W	Thin 2	45	80
61WhitSprPlt	NSU	All	W	Unthinned	25	80
61WhitSprPlt	NSU	All	W	Thin 1	35	80

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Thin Number	Minimum Thin Age	Maximum Thin Age
61WhitSprPlt	NSU	All	W	Thin 2	45	80
61WhitSprPlt	WSU	All	W	Unthinned	25	80
61WhitSprPlt	WSU	All	W	Thin 1	35	80
61WhitSprPlt	WSU	All	W	Thin 2	45	80
79OffOak	BRP	All	W	Unthinned	30	70
79OffOak	BRP	All	W	Thin 1	45	70
79OffOak	BRP	All	W	Thin 2	60	70

Appendix C: Partial Harvest Management Regime

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age	Maximum Rotation Age
12Aspen	AP	60minus	W	45	60
12Aspen	AP	65plus	W	35	50
12Aspen	MNIAM	60minus	W	50	70
12Aspen	MNIAM	65plus	W	40	70
12Aspen	NMNDLP	60minus	W	50	80
12Aspen	NMNDLP	65plus	W	50	80
12Aspen	NMNOP	60minus	W	60	90
12Aspen	NMNOP	65plus	W	60	90
12Aspen	NSU	60minus	W	60	90
12Aspen	NSU	65plus	W	55	90
12Aspen	WSU	60minus	W	50	60
12Aspen	WSU	65plus	W	45	65
13Birch	AP	All	W	45	55
13Birch	MNIAM	All	W	45	70
13Birch	NMNDLP	All	W	50	80
13Birch	NMNOP	All	W	50	80
13Birch	NSU	55minus	W	55	90
13Birch	NSU	60plus	W	60	100
13Birch	WSU	All	W	50	60
14BlmGil	AP	60minus	W	45	60
14BlmGil	AP	65plus	W	35	50
14BlmGil	MNIAM	60minus	W	50	70
14BlmGil	MNIAM	65plus	W	40	70
14BlmGil	NMNDLP	60minus	W	50	80
14BlmGil	NMNDLP	65plus	W	50	80
14BlmGil	NMNOP	60minus	W	60	90
14BlmGil	NMNOP	65plus	W	60	90
14BlmGil	NSU	60minus	W	60	90
14BlmGil	NSU	65plus	W	55	90
14BlmGil	WSU	60minus	W	50	60
14BlmGil	WSU	65plus	W	45	65
20NorthHrdw	AP	All	W	60	180
20NorthHrdw	MNIAM	All	W	80	200
20NorthHrdw	NMNDLP	55minus	W	80	180
20NorthHrdw	NMNDLP	60plus	W	80	180
20NorthHrdw	NSU	All	W	120	240

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age	Maximum Rotation Age
20NorthHrdw	WSU	70minus	W	120	175
20NorthHrdw	WSU	75plus	W	150	200
30oak	AP	All	W	60	180
30oak	MNIAM	All	W	80	200
30oak	NMNDLP	55minus	W	80	180
30oak	NMNDLP	60plus	W	80	180
30oak	NSU	All	W	120	240
30oak	WSU	70minus	W	120	175
30oak	WSU	75plus	W	150	200
40CentHrdw	AP	All	W	60	180
40CentHrdw	MNIAM	All	W	80	200
40CentHrdw	NMNDLP	55minus	W	80	180
40CentHrdw	NMNDLP	60plus	W	80	180
40CentHrdw	NSU	All	W	120	240
40CentHrdw	WSU	70minus	W	120	175
40CentHrdw	WSU	75plus	W	150	200
53JacPine	MNIAM	All	W	40	60
53JacPine	NMNDLP	All	W	45	65
53JacPine	NSU	All	W	60	90
53JacPine	WSU	All	W	40	65
61WhitSprPlt	AP	All	W	50	80
61WhitSprPlt	NMNDLP	All	W	50	80
61WhitSprPlt	NSU	All	W	50	80
61WhitSprPlt	WSU	All	W	50	80
62BalFir	AP	All	W	50	60
62BalFir	MNIAM	All	W	45	60
62BalFir	NMNDLP	All	W	50	70
62BalFir	NMNOP	All	W	55	70
62BalFir	NSU	All	W	55	70
62BalFir	WSU	All	W	55	70
71BlaSprLow	AP	25Minus	W	120	200
71BlaSprLow	AP	30-35	W	100	200
71BlaSprLow	AP	40Plus	W	80	175
71BlaSprLow	MNIAM	25Minus	W	120	170
71BlaSprLow	MNIAM	30-35	W	100	145
71BlaSprLow	MNIAM	40Plus	W	80	130
71BlaSprLow	NMNDLP	25Minus	W	120	200
71BlaSprLow	NMNDLP	30-35	W	100	200
71BlaSprLow	NMNDLP	40Plus	W	80	175

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age	Maximum Rotation Age
71BlaSprLow	NMNOP	25Minus	W	120	200
71BlaSprLow	NMNOP	30-35	W	100	200
71BlaSprLow	NMNOP	40Plus	W	100	200
71BlaSprLow	NSU	25Minus	W	120	200
71BlaSprLow	NSU	30-35	W	100	200
71BlaSprLow	NSU	40Plus	W	80	175
71BlaSprLow	WSU	25Minus	W	120	180
71BlaSprLow	WSU	30-35	W	100	150
71BlaSprLow	WSU	40Plus	W	80	130
74BlaSprUpl	NMNDLP	All	W	50	80
74BlaSprUpl	NSU	All	W	65	100

Appendix D: Uneven Age Management Regime

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Age	Minimum Basal Area	Minimum Inventory Volume
01Ash	All	All	F	70	None	None
01Ash	All Except BRP	45plus	W	None	90	15
09LowHrdw	All	All	F	70	None	None
09LowHrdw	All Except BRP	45plus	W	None	90	21
20NorthHrdw	All	All	F	30	110	None
20NorthHrdw	All	All	W	30	110	None
30oak	All	55minus	F	80	None	None
30oak	All	55minus	W	80	None	None
30oak	All	60plus	F	50	None	None
30oak	All	60plus	W	50	None	None
40CentHrdw	All Except BRP	All	F	30	100	None
40CentHrdw	BRP	All	W	30	100	None
40CentHrdw	MNIAM	All	W	30	100	None
40CentHrdw	NMNDLP	All	W	30	100	None
40CentHrdw	NSU	All	W	30	100	None
40CentHrdw	WSU	All	W	30	100	None
51WhiPine	All	All	F	45	None	None
51WhiPine	All	All	F	45	None	None
51WhiPine	All Except BRP	All	W	45	None	None
51WhiPine	All Except BRP	All	W	45	None	None
51WhiPinePlt	All	All	F	30	None	None
51WhiPinePlt	All Except BRP	All	W	30	None	None
61WhitSpr	All	All	F	80	None	None
61WhitSpr	All	All	F	80	None	None
61WhitSpr	All Except BRP	All	W	35	None	None
61WhitSpr	All Except BRP	All	W	35	None	None
73WhiCed	All	All	F	80	None	None
73WhiCed	All	All	F	80	None	None

Appendix E: Regulated Uneven-Age Management Regime

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Age	First Planning Period
01Ash	All	All	F	90	None
01Ash	All Except BRP	All	W	None	5
09LowHrdw	All	All	F	90	None
09LowHrdw	All Except BRP	All	W	None	5
20NorthHrdw	All	All	F	50	None
20NorthHrdw	All	All	W	50	None
30oak	All	55minus	F	100	None
30oak	All	55minus	W	100	None
30oak	All	60plus	F	70	None
30oak	All	60plus	W	70	None
40CentHrdw	All Except BRP	All	F	50	None
40CentHrdw	BRP	All	W	50	None
40CentHrdw	MNIAM	All	W	50	None
40CentHrdw	NMNDLP	All	W	50	None
40CentHrdw	NSU	All	W	50	None
40CentHrdw	WSU	All	W	50	None
51WhiPine	All	All	F	65	None
51WhiPine	All Except BRP	All	W	150	None
51WhiPinePlt	All	All	F	50	None
51WhiPinePlt	All Except BRP	All	W	150	None
61WhitSpr	All	All	F	100	None
61WhitSpr	All Except BRP	All	W	80	None
73WhiCed	All	All	F	100	None

Appendix F: Aspen Conversion Management Regime

Cover Type	Planning Area	Site Index	Forestry or Wildlife Land	Minimum Rotation Age
12Aspen	MNIAM	60minus	F	45
12Aspen	MNIAM	60minus	W	50
12Aspen	MNIAM	65plus	F	35
12Aspen	MNIAM	65plus	W	40
12Aspen	NMNDLP	60minus	F	45
12Aspen	NMNDLP	60minus	W	50
12Aspen	NMNDLP	65plus	F	35
12Aspen	NMNDLP	65plus	W	50
12Aspen	NMNOP	60minus	F	45
12Aspen	NMNOP	60minus	W	60
12Aspen	NMNOP	65plus	F	35
12Aspen	NMNOP	65plus	W	60
12Aspen	NSU	60minus	F	45
12Aspen	NSU	60minus	W	60
12Aspen	NSU	65plus	F	35
12Aspen	NSU	65plus	W	55
12Aspen	WSU	60minus	F	45
12Aspen	WSU	60minus	W	50
12Aspen	WSU	65plus	F	35
12Aspen	WSU	65plus	W	45

Appendix G: Inventory Summary Supplementary Tables (NMOP, MDLP, NSU, WSU)

Table 22. NMOP Area (acres) by age class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
NMOP	01Ash	517.7	354.8	457.7	429.6	622.0	1,084.0	769.0	933.7	843.2	1,051.8	760.2	710.2
	09LHD		9.5	26.1	15.2	6.6			114.3	14.2	17.3	40.4	30.0
	12Asp	56,789.2	41,067.4	34,643.1	36,410.2	31,446.8	31,293.7	22,016.2	17,024.9	15,127.5	12,234.6	7,858.3	8,023.7
	13Bir	483.2	396.8	104.4	41.3	100.0	141.8	198.0	205.9	374.1	935.4	865.0	194.3
	14BGL	3,460.9	3,489.7	1,668.8	1,669.3	751.2	970.6	1,079.6	1,313.1	896.7	970.0	743.0	916.7
	20NHH			33.5	32.6	89.7	9.1	32.7	82.6	64.6	24.0	19.7	122.4
	30Oak			12.7	14.6	45.9	13.2	12.2			6.9		4.3
	51WPN	20.8	7.8	1.2	30.3	13.4			7.9		4.4	18.1	39.4
	51WPP		67.5	32.0	138.6	142.2		38.0				25.8	29.8
	52RPN	91.3	26.4	50.1			73.0	35.9	52.6	94.2	188.7	95.6	21.0
	52RPP	1,099.7	870.3	623.2	361.1	491.2	1,258.8	2,453.0	1,336.4	1,671.9	1,966.6	1,591.9	1,190.0
	53JPN	7,969.0	5,220.8	4,100.7	3,695.6	4,070.8	5,205.0	5,140.1	1,854.7	1,751.0	1,720.3	1,405.2	831.1
	61WSP	409.1	487.5	515.2	531.1	346.0	1,730.0	2,725.7	1,391.0	844.0	1,257.0	1,155.6	809.7
	62BFR	2,345.6	864.1	461.8	446.9	385.3	440.5	624.3	1,073.6	2,304.9	2,022.6	2,219.9	1,157.3
	71BSL	23,382.2	12,384.2	10,256.4	12,721.9	10,173.4	8,414.5	8,815.4	11,675.8	12,781.4	12,393.3	12,430.3	8,472.9
	72TPN	12,005.6	9,161.0	8,867.9	5,818.5	4,223.7	8,956.6	9,036.4	9,510.7	17,987.0	18,328.2	17,012.9	13,123.9
	73WCD	384.5	74.9	202.8	227.4	203.3	516.5	580.3	373.6	1,055.2	1,623.1	1,306.8	1,008.4
	74BSU	101.0	48.7	41.4	45.8	130.2	114.8	152.3	34.8	10.0	63.4	74.2	24.9
NMOP Total		109,059.6	74,531.1	62,098.9	62,629.9	53,241.9	60,222.1	53,709.0	46,985.8	55,820.0	54,807.8	47,622.9	36,709.9

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
NMOP	01Ash	901.5	1,208.4	1,630.1	2,139.3	2,007.8	2,955.8	2,979.6	3,064.8	3,335.7	2,866.2	2,469.1	2,549.6	13,734.3
	09LHD	64.3	64.4	76.2	460.5	265.6	361.1	406.5	185.3	126.8	651.2	144.8	251.9	1,472.6
	12Asp	7,336.9	6,647.9	4,561.6	3,832.4	2,658.8	1,426.5	765.5	372.7	326.2	187.1	69.4	75.7	63.0
	13Bir	177.2	315.0	376.5	313.4	273.6	254.7	58.5	78.7	35.5	60.6	28.7	96.9	6.4
	14BGL	948.9	781.7	818.2	576.9	608.2	242.1	81.6	86.5	8.0	13.8	15.5	4.4	22.9
	20NHH	104.4	75.0	335.7	109.3	162.6	315.3	231.7	89.4	95.2	11.4	93.2	42.7	127.6
	30Oak	20.3		41.5	9.2	19.4	94.0	5.3	14.9	14.7		26.0		11.3
	51WPN	7.7	10.3	61.7		3.2			21.4	33.4		17.5	17.2	108.1
	51WPP		20.8	56.3	13.5	17.5							5.2	
	52RPN	25.1	107.0	87.1	113.2	135.4	171.2	297.5	109.1	133.8	229.0	45.6	49.2	75.8
	52RPP	316.1	251.1	568.2	477.2	135.4	78.2	17.7		4.4		15.6		9.4
	53JPN	682.7	372.5	232.5	81.7	96.0	106.9	74.1	15.5					6.2
	61WSP	452.4	393.2	248.3	222.3	154.2	144.2	80.2	35.7	22.3	30.3	38.9	25.4	75.1
	62BFR	1,055.7	740.9	686.5	621.9	517.4	654.6	554.8	168.7	352.5	72.9	78.1	47.8	84.5
	71BSL	8,213.8	9,445.9	7,192.2	9,489.0	9,468.8	8,405.3	8,976.1	7,613.5	8,886.2	10,239.3	9,205.0	7,969.4	44,272.7
	72TPN	10,318.8	5,312.2	5,777.9	4,065.7	5,836.7	6,910.3	10,526.6	9,903.9	6,346.2	7,303.0	4,848.5	4,617.6	35,222.7
	73WCD	2,056.1	1,052.3	979.6	1,087.9	2,118.9	1,596.1	1,723.2	3,447.0	3,864.0	4,111.8	4,991.8	6,002.2	58,391.8
	74BSU	56.1	80.1	39.0	69.7	255.3	66.6	93.6	25.0	31.4		18.5		33.9
NMOP Total		32,737.9	26,878.7	23,768.9	23,683.3	24,734.8	23,782.7	26,872.3	25,232.2	23,616.3	25,776.6	22,106.2	21,755.3	153,718.5

Table 23. NMOP volume (cords) by age class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
NMOP	01Ash	384.4	597.2	1,461.8	2,075.1	3,764.4	1.0	5,834.5	7,746.1	7,859.5	10,023.2	8,421.3	7,801.3
	09LHD		29.2	60.1	57.1	36.1			701.7	118.4	103.5	499.2	372.4
	12Asp	22,436.4	58,106.3	109,990.0	198,890.0	249,146.6	1.0	276,593.1	259,949.1	258,558.0	232,402.2	168,647.1	185,532.5
	13Bir	809.2	1,223.5	488.3	254.0	723.6	1.0	1,957.3	2,077.5	4,465.5	11,527.3	12,205.6	2,762.2
	14BGL	1,459.3	4,267.7	4,987.7	9,962.3	5,956.9	1.0	10,301.9	14,342.8	11,594.6	12,557.8	11,334.2	13,245.4
	20NHH			290.4	287.2	1,063.9	1.0	423.9	1,101.6	936.2	333.4	310.8	1,993.5
	30Oak			128.5	148.9	511.3	1.0	155.2			103.0		66.5
	51WPN	147.5	78.2	13.9	406.6	199.5			142.6		87.5	373.0	827.8
	51WPP		665.9	378.8	1,876.4	2,101.7		645.9				526.1	641.3
	52RPN	468.4	235.8	546.9			1.0	830.1	1,191.6	2,333.4	4,906.5	2,406.8	595.6
	52RPP	2,422.4	4,427.5	5,211.9	3,760.9	7,041.0	1.0	49,270.3	33,206.7	48,267.1	63,865.7	56,744.5	46,690.9
	53JPN	5,749.8	11,392.1	16,173.3	22,220.9	32,492.1	1.0	68,994.1	29,577.9	30,590.9	34,829.3	30,117.2	18,921.6
	61WSP	362.2	838.8	1,445.4	2,715.6	2,631.3	2.0	36,792.8	21,976.3	16,001.2	26,114.3	24,432.7	16,353.0
	62BFR	614.6	1,094.3	1,116.1	1,607.6	2,355.4	1.0	4,798.5	10,471.1	23,341.6	18,136.9	23,855.5	11,658.2
	71BSL	1,479.0	3,931.0	7,951.4	17,689.6	21,135.7	1.0	36,336.1	59,855.5	70,984.1	87,880.3	89,510.6	81,367.0
	72TPN	3,581.5	8,488.1	14,974.3	12,649.6	12,324.8	1.0	47,569.1	60,820.7	121,514.1	171,467.1	157,337.2	141,481.7
	73WCD	359.3	185.6	581.0	1,289.6	1,362.5	1.0	4,992.5	3,718.0	11,145.7	19,199.5	17,556.5	16,315.9
	74BSU	54.1	88.6	181.2	245.7	562.4	1.0	1,388.7	432.9	127.3	833.9	1,008.5	345.8
NMOP Total		40,328.1	95,649.5	165,981.0	276,137.1	343,409.1	16.0	546,884.0	507,312.0	607,837.8	694,371.5	605,286.9	546,972.4

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
NMOP	01Ash	10,656.7	14,763.0	21,137.9	29,341.4	28,469.1	44,218.5	44,035.6	46,216.9	49,619.8	41,220.7	35,753.2	39,271.6	163,292.1
	09LHD	925.9	1,026.8	1,188.4	7,780.3	4,681.8	5,280.5	6,762.6	2,888.2	2,001.2	10,058.2	2,614.6	3,797.2	21,158.3
	12Asp	176,204.5	174,344.0	112,575.5	93,795.1	65,002.4	34,307.8	19,370.6	7,834.7	7,562.8	3,532.8	1,340.5	571.2	340.4
	13Bir	2,877.6	5,366.9	6,206.6	5,397.3	4,832.5	4,045.0	983.1	1,247.2	559.3	792.6	394.8	1,321.1	
	14BGL	15,165.2	12,488.3	13,393.3	10,098.9	8,516.0	3,658.6	1,057.2	808.7	27.3	41.4	46.6	13.3	44.1
	20NHH	1,828.5	1,142.8	6,118.0	2,237.3	3,304.0	6,844.6	4,926.3	1,751.3	2,009.4	240.9	2,099.3	941.5	995.7
	30Oak	311.8		630.3	155.6	292.9	1,549.0	80.5	230.1	235.0		400.0		110.3
	51WPN	169.6	229.9	1,418.1		74.2			537.3	840.7		447.6	441.0	2,772.5
	51WPP		467.5	1,307.0	318.1	412.7							133.3	
	52RPN	806.9	3,255.9	2,604.9	3,702.6	4,252.5	5,816.4	9,545.8	3,584.8	4,588.7	7,896.3	1,352.4	1,635.8	2,447.0
	52RPP	12,967.2	9,725.1	25,140.3	21,281.1	6,143.9	4,288.4	798.5		212.1		718.2		633.6
	53JPN	15,780.6	8,201.2	5,065.0	1,869.6	2,011.8	1,701.6	836.6	61.9					
	61WSP	9,727.0	7,215.5	4,238.6	4,217.2	2,913.2	2,414.0	1,067.0	363.8	199.2	147.5	155.4	101.8	300.2
	62BFR	7,143.6	2,963.5	2,746.0	2,487.6	2,069.8	2,618.4	2,219.3	674.9	1,409.9	291.5	312.3	191.1	242.3
	71BSL	88,417.0	121,955.9	101,846.2	138,543.6	155,843.3	145,398.7	145,870.4	132,683.1	142,702.5	159,282.0	145,516.2	116,695.9	578,539.5
	72TPN	114,002.9	63,579.4	72,862.2	50,635.8	69,783.2	80,688.5	117,273.2	102,761.2	72,827.9	73,371.6	49,576.5	45,218.5	334,962.4
	73WCD	35,792.1	18,464.8	17,346.5	21,349.6	41,960.7	33,326.5	35,902.6	72,504.0	81,841.5	85,497.9	109,595.5	127,756.3	1,214,923.6
	74BSU	1,072.4	1,379.4	692.6	1,198.3	4,115.2	899.9	817.7	99.8	125.4		73.8		135.6
NMOP Total		493,849.4	446,569.9	396,517.2	394,409.1	404,679.2	377,056.1	391,547.0	374,247.9	366,762.9	382,373.4	350,397.1	338,089.6	2,320,897.6

Table 24. MDLP Area (Acres) by Age Class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
MDLP	01Ash	136.6	135.0	93.4	89.0	204.9	1,046.0	547.7	442.5	508.1	406.4	384.6	443.3
	09LHD	6.2			3.7	26.0	4.5		21.8		29.0	39.1	62.2
	12Asp	44,196.1	30,847.5	26,435.2	26,108.3	25,130.3	31,080.1	33,823.6	21,231.2	18,319.3	11,864.7	6,417.8	4,735.5
	13Bir	1,173.3	1,318.4	429.7	389.0	388.3	631.7	290.8	261.5	130.4	165.9	325.2	635.9
	14BGL	269.4	263.3	275.7	340.7	185.0	205.2	206.6	211.8	188.7	155.3	113.8	114.6
	20NHH	1,282.0	1,115.4	720.7	766.9	608.3	1,262.0	1,515.1	590.6	463.4	686.0	889.8	1,015.1
	30Oak	1,038.1	462.9	216.7	185.7	162.6	544.6	702.1	452.4	245.3	254.8	364.4	676.2
	51WPN	38.5	34.0	15.1	33.6	24.3	32.0	16.6	6.5	10.8		98.7	63.9
	51WPP	63.0	143.7	131.6	445.6	74.6	40.1	46.0	19.5	3.4	43.5	62.7	32.8
	52RPN	373.5	193.6	30.8	108.2	22.4	70.6	264.5	121.3	144.4	217.1	226.4	344.5
	52RPP	1,355.5	2,081.9	2,654.2	1,465.6	2,170.0	3,052.9	6,425.1	4,849.8	2,021.4	3,642.6	3,979.3	1,531.5
	53JPN	3,367.8	3,369.6	1,305.7	922.0	999.7	1,006.0	1,647.5	1,000.7	658.5	337.9	609.0	360.3
	61WSP	285.2	431.1	957.2	548.2	377.6	1,077.2	1,864.6	1,124.2	757.7	752.2	821.8	381.0
	62BFR	761.7	202.8	189.1	255.0	319.0	254.3	302.1	316.8	190.4	328.0	550.8	697.0
	71BSL	4,014.2	1,974.3	1,616.2	1,878.0	1,703.8	1,370.7	781.9	1,299.7	2,661.2	2,763.3	2,121.4	2,743.8
	72TPN	5,857.7	4,099.2	3,040.6	2,101.8	1,310.7	1,373.6	1,315.2	2,783.7	3,702.0	4,051.2	4,448.9	4,470.3
	73WCD	147.3	5.5		129.2	7.5	57.8	42.9	106.8	96.5	42.1	61.6	127.0
	74BSU	44.0	52.7	77.0	14.1	9.2	9.9	66.3	21.3			34.4	
MDLP Total		64,410.3	46,731.0	38,188.9	35,784.7	33,724.2	43,119.4	49,858.5	34,862.0	30,101.5	25,740.2	21,549.7	18,435.0

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
MDLP	01Ash	817.2	811.4	1,029.1	2,413.3	2,525.1	2,457.9	3,357.8	2,790.3	2,394.9	2,509.0	1,854.4	1,741.4	6,542.1
	09LHD	43.2	69.4	182.4	295.5	846.5	641.0	469.4	588.4	401.6	573.2	357.8	391.1	648.7
	12Asp	4,225.0	3,760.8	3,921.8	3,272.7	1,811.6	1,582.7	784.1	244.0	54.9	192.1	22.6	23.2	57.4
	13Bir	362.1	769.7	655.9	934.0	840.6	593.1	482.1	176.2	201.9	109.0	30.8	42.8	27.1
	14BGL	91.9	52.3	61.4	150.7	211.7	27.5	90.5	17.4	16.4	10.1	19.5	5.5	
	20NHH	1,924.3	2,111.2	2,697.1	4,212.3	3,951.3	3,470.8	2,753.3	1,820.7	1,208.9	737.7	643.5	258.5	750.3
	30Oak	836.8	1,229.3	1,906.5	3,416.3	3,428.1	3,049.3	2,055.1	1,594.3	547.7	646.8	164.6	182.0	457.4
	51WPN	239.7	74.8	54.1	72.2	139.9	51.6	58.8	40.7	22.4	63.2	59.0	139.4	404.4
	51WPP	80.8	132.8	31.3	37.9					13.2	23.8			30.8
	52RPN	208.1	214.9	158.4	516.0	356.2	628.9	334.0	908.4	1,098.5	1,191.7	1,091.1	815.5	1,110.0
	52RPP	868.1	447.9	514.1	370.7	124.6	140.8	27.9	71.6	59.8	42.9	30.7		30.5
	53JPN	450.8	141.2	213.6	68.2	48.7	23.3	15.0	21.6	38.0	5.6	8.3		
	61WSP	142.9	56.7	28.9	47.5	10.5		48.0			2.6	19.2		
	62BFR	333.4	515.9	250.7	491.6	548.6	250.7	180.9	86.1	60.4	96.7	17.8	29.6	8.6
	71BSL	1,981.8	1,660.0	2,085.9	1,779.1	2,131.1	2,335.9	3,293.4	3,009.2	2,274.4	2,229.8	2,542.6	1,996.7	8,975.8
	72TPN	3,037.0	4,903.7	3,678.9	4,068.4	3,417.0	3,459.1	4,284.2	3,749.2	3,879.5	3,782.8	3,805.8	3,175.1	10,794.6
	73WCD	467.8	209.2	144.0	410.2	337.3	657.5	792.4	1,607.2	1,560.5	1,845.5	2,321.6	2,586.9	14,147.1
	74BSU	29.3					10.2			7.7				
MDLP Total		16,140.1	17,161.1	17,614.1	22,556.6	20,728.8	19,380.5	19,027.0	16,725.4	13,840.8	14,062.6	12,989.5	11,387.7	43,984.7

Table 25. MDLP Volume (Cords) by Age Class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
MDLP	01Ash	97	262	343	388	1,456	1	5,455	4,145	5,074	4,364	4,620	5,281
	09LHD	1			16	142	1		192		536	679	948
	12Asp	19,714	46,122	84,414	136,794	191,069	1	436,212	323,125	329,208	244,533	146,051	112,035
	13Bir	1,255	3,240	1,637	2,375	2,957	1	3,082	3,132	1,817	2,440	5,734	10,442
	14BGL	130	416	887	1,689	1,207	1	2,050	2,460	2,237	2,196	1,975	2,048
	20NHH	2,707	4,820	3,988	7,272	6,448	1	20,071	9,411	7,238	11,751	15,657	19,181
	30Oak	3,277	2,412	1,510	1,482	1,736	1	9,342	6,009	3,576	3,765	5,710	11,416
	51WPN	461	449	208	474	358	1	249	99	172		1,541	1,029
	51WPP	787	1,894	1,814	6,299	1,085	1	683	297	52	700	1,003	524
	52RPN	2,707	1,683	307	1,220	270	1	3,547	1,691	2,122	3,215	3,511	5,462
	52RPP	5,199	14,497	26,720	19,441	35,176	1	142,037	120,786	53,425	105,955	122,620	49,935
	53JPN	1,809	5,827	4,624	5,178	7,591	1	20,848	15,242	10,742	5,956	11,974	7,171
	61WSP	271	1,462	6,925	5,636	5,223	1	35,410	25,767	17,461	19,800	24,300	10,394
	62BFR	457	364	577	1,195	2,160	1	3,033	3,224	2,254	3,736	6,215	7,354
	71BSL	237	662	1,126	2,094	3,743	1	3,367	5,354	11,866	15,472	15,550	22,055
	72TPN	2,307	4,542	5,669	5,633	5,211	1	7,902	18,469	27,000	34,402	43,963	48,348
	73WCD	427	34		1,348	74	1	845	1,561	1,306	543	797	2,054
	74BSU	20	104	163	61	49	1	601	288			501	
MDLP Total		41,864	88,791	140,913	198,593	265,956	18	694,734	541,251	475,550	459,365	412,400	315,678

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
MDLP	01Ash	11,241	11,215	15,072	37,399	39,895	39,152	54,969	45,736	39,574	40,496	29,919	28,544	83,837
	09LHD	702	1,000	3,436	5,698	16,822	12,229	8,727	10,636	8,326	10,212	6,197	6,887	10,187
	12Asp	101,653	95,169	104,829	89,185	48,501	42,768	19,453	5,941	1,190	3,373	287	336	122
	13Bir	6,950	15,621	14,646	20,277	18,135	12,729	10,013	3,785	4,000	2,077	611	715	136
	14BGL	1,643	1,060	1,219	2,803	3,876	529	1,656	332	263	145	189	69	
	20NHH	38,687	44,565	58,697	92,457	93,109	81,807	62,759	43,274	28,367	18,322	15,615	6,327	18,643
	30Oak	14,934	23,050	36,151	68,052	70,143	63,722	42,151	32,318	11,509	13,878	3,507	3,735	8,943
	51WPN	3,875	1,230	884	1,162	2,276	853	957	670	376	1,042	987	2,322	6,567
	51WPP	1,305	2,136	515	618					222	365			508
	52RPN	3,335	3,557	2,682	8,862	6,202	10,934	5,901	16,250	19,767	21,397	19,774	14,902	20,021
	52RPP	29,179	15,455	19,071	13,747	4,405	5,135	1,042	2,823	2,382	1,670	1,204		1,182
	53JPN	8,838	2,845	4,668	1,225	962	281	127	-	-	-	-		
	61WSP	3,482	1,521	714	1,405	139		620			13	-		
	62BFR	2,569	-	-	-	-	-	-	-	-	-	-	-	-
	71BSL	18,523	19,086	23,953	23,973	31,945	33,396	44,825	42,027	35,422	30,406	35,822	27,215	104,512
	72TPN	32,083	57,425	43,905	45,822	42,830	45,421	45,604	46,873	48,377	41,699	40,350	37,292	118,000
	73WCD	6,477	3,512	2,823	7,051	5,763	11,152	13,439	28,027	25,900	29,978	36,726	40,630	232,129
	74BSU	498					106			-				
MDLP Total		285,976	298,448	333,264	419,735	385,004	360,214	312,243	278,691	225,674	215,072	191,188	168,973	604,786

Table 26. NSU Area (Acres) by Age Class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
⊟NSU	01Ash	44.1	104.1	50.8	79.8	188.4	398.9	230.3	110.5	103.3	103.4	105.7	176.5
	09LHD			17.3						7.7			25.6
	12Asp	24,590.5	15,226.9	20,456.9	16,198.9	22,403.1	24,326.9	14,381.6	11,029.9	10,686.5	6,461.9	4,669.9	3,262.1
	13Bir	4,938.8	1,280.6	558.9	231.3	255.8	244.6	332.3	201.3	280.1	343.5	599.0	719.6
	14BGL	324.3	256.2	531.2	627.1	464.6	296.6	127.2	288.0	471.9	91.2	34.7	35.3
	20NHH	383.4	512.6	549.2	388.7	275.1	338.7	381.4	285.4	147.6	246.9	247.4	514.4
	30Oak		12.6	15.7	10.4		13.5			22.4	17.6		
	51WPN	378.0	149.7	104.3	151.3	148.6	183.9	225.3	66.3	73.7	11.6	57.1	143.9
	51WPP	396.3	564.3	203.3	766.4	666.9	209.8	61.6	62.1				
	52RPN	150.1		2.4	50.1	38.2	77.6	28.0	15.2	46.2	73.1	23.0	168.5
	52RPP	2,778.3	3,823.9	3,343.9	3,087.6	2,793.8	2,939.4	3,148.3	2,292.2	1,254.2	1,393.0	1,195.8	509.4
	53JPN	1,843.8	2,668.6	1,807.0	2,079.6	1,806.9	2,352.5	2,406.0	2,478.0	1,625.7	1,123.8	266.3	651.4
	61WSP	485.2	1,893.7	2,472.6	1,622.6	1,547.3	1,920.4	3,235.7	2,532.6	1,569.8	1,798.3	1,029.0	401.3
	62BFR	1,045.6	660.8	443.7	819.8	472.4	881.7	1,549.9	1,216.1	1,003.1	898.0	916.0	1,065.0
	71BSL	4,386.6	2,900.8	2,944.9	1,977.7	1,779.7	1,313.5	1,099.9	1,461.3	948.2	2,189.5	2,214.5	1,742.7
	72TPN	764.4	460.0	488.1	268.5	378.9	332.0	172.9	432.6	320.8	528.8	223.5	550.9
	73WCD	60.1	1.8	25.4	102.9	95.5	268.2	95.4	88.5	106.6	22.8	289.4	106.6
	74BSU	784.3	187.4	77.4	248.9	65.1	120.9	144.6	118.6	397.2	204.3	179.2	196.2
NSU Total		43,353.7	30,703.9	34,093.0	28,711.7	33,380.3	36,219.2	27,620.1	22,678.5	19,065.1	15,507.8	12,050.4	10,269.5

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
⊟NSU	01Ash	207.4	255.0	361.6	476.5	412.3	1,013.6	1,124.4	1,410.8	1,248.5	996.8	698.0	801.0	4,970.5
	09LHD	43.8	60.7	28.0	47.4	121.4	127.1	29.0	28.9	13.9	134.3	34.1	12.9	241.5
	12Asp	2,877.6	2,827.5	3,658.3	3,315.4	3,187.8	2,430.8	2,250.3	702.0	638.6	195.2	240.8	48.5	160.6
	13Bir	951.9	1,680.7	1,635.4	2,209.1	2,541.7	2,200.1	986.6	1,371.1	1,087.6	285.4	99.2	192.7	531.3
	14BGL	54.8		60.5	137.1	158.3	152.2	44.0	17.7	8.2	84.4			13.8
	20NHH	653.0	503.6	1,112.6	1,431.4	925.5	864.4	941.5	390.9	500.6	466.9	932.4	306.6	374.4
	30Oak			92.2			57.8		36.8	142.4	4.7	9.0		
	51WPN	57.6	227.1	26.1	177.6	202.7	259.5	466.7	197.5	246.3	623.1	355.1	374.8	1,283.3
	51WPP			50.9	67.7	141.2	7.2	25.9				52.5	5.5	96.9
	52RPN	122.5	132.7	77.3	189.2	214.8	165.7	317.4	301.1	398.6	407.9	450.0	624.6	741.8
	52RPP	143.5	88.8	58.2	270.1	275.1	159.5	218.9	68.3	49.5	33.9	16.7	23.3	37.3
	53JPN	401.8	514.9	433.5	185.5	288.0	331.5	249.8	181.0	113.9	175.9	56.7	94.9	58.2
	61WSP	214.7	243.5	205.5	255.1	173.4	334.5	158.4	71.1	18.9	29.3		52.2	261.5
	62BFR	795.4	302.5	665.3	867.1	605.2	541.9	317.2	442.2	231.7	101.4	5.5	11.2	175.7
	71BSL	1,783.6	2,276.7	2,186.2	2,720.2	2,933.7	3,232.8	2,933.4	2,495.8	3,064.6	2,107.2	2,048.7	2,026.2	7,017.5
	72TPN	330.7	392.2	307.3	560.6	581.3	438.0	767.6	514.5	450.0	421.4	186.8	157.2	1,020.5
	73WCD	227.7	365.3	305.4	273.9	640.2	587.0	571.1	1,364.1	975.8	1,309.0	1,780.4	1,752.9	20,650.4
	74BSU	412.3	301.8	292.8	452.0	322.0	254.9	221.1	130.2	182.4	156.5	88.4	39.1	140.1
NSU Total		9,278.4	10,173.0	11,557.0	13,636.2	13,724.7	13,158.5	11,623.4	9,723.9	9,371.6	7,533.4	7,054.1	6,523.6	37,775.3

Table 27. NSU Volume (Cords) by Age Class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
NSU	01Ash	31	219	151	376	1,046	1	1,798	776	1,005	1,048	1,294	1,910
	09LHD			77						57			387
	12Asp	14,312	30,057	78,857	91,035	177,899	1	178,614	163,329	175,088	119,456	90,307	63,301
	13Bir	10,067	5,287	3,264	1,664	2,451	1	4,669	2,403	3,693	4,967	9,131	11,189
	14BGL	107	322	1,832	3,277	3,581	1	1,469	3,742	7,691	1,536	585	626
	20NHH	471	1,537	2,560	2,591	2,102	1	4,295	3,304	1,934	3,430	2,916	8,244
	30Oak		45	88	83		1			327	252		
	51WPN	1,117	733	694	1,185	1,390	1	2,548	801	952	159	799	2,069
	51WPP	1,128	2,825	1,355	6,175	6,187	1	692	810				
	52RPN	316		14	454	426	1	453	224	1,006	1,299	556	3,559
	52RPP	3,286	12,748	18,771	25,892	32,881	1	56,585	49,473	28,980	36,485	36,844	16,655
	53JPN	1,470	5,870	7,011	12,723	13,878	1	26,866	30,771	22,453	16,031	4,207	10,942
	61WSP	82	1,987	6,144	6,828	11,217	2	40,383	35,857	21,835	27,928	18,398	7,128
	62BFR	650	1,115	1,447	3,476	2,425	1	11,143	9,127	8,648	8,015	8,365	8,288
	71BSL	739	1,888	3,944	4,399	5,176	1	5,462	7,505	6,928	16,088	20,907	21,025
	72TPN	203	401	734	645	1,297	1	1,093	2,666	2,362	4,471	1,819	5,939
	73WCD	141	6	131	852	998	1	883	1,136	1,688	361	3,770	1,751
	74BSU	406	333	196	1,017	395	1	1,065	1,297	4,254	3,097	2,592	2,112
NSU Total		34,526	65,373	127,271	162,672	263,347	18	338,020	313,221	288,901	244,622	202,492	165,126

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
NSU	01Ash	2,698	3,331	4,840	5,785	5,803	13,160	15,236	19,021	17,142	13,445	10,115	11,344	57,892
	09LHD	572	873	477	664	1,893	2,106	550	427	178	2,198	530	194	3,255
	12Asp	56,734	59,524	83,138	75,888	73,963	58,908	51,222	14,825	11,995	3,557	3,998	652	458
	13Bir	16,012	28,828	30,088	42,841	50,011	39,816	17,969	24,284	18,267	4,416	1,459	2,251	2,224
	14BGL	764		762	3,065	2,307	2,243	696	233	42	253			41
	20NHH	10,360	9,201	21,022	26,521	19,058	17,815	19,408	8,770	11,074	11,158	21,593	6,927	8,635
	30Oak			1,996			1,232		829	3,266	94	233		
	51WPN	883	3,584	418	3,034	3,602	4,545	8,256	3,622	4,576	11,694	6,661	7,207	24,791
	51WPP			864	1,189	2,584	127	467				1,063	112	1,971
	52RPN	3,006	2,915	2,003	5,241	5,508	4,682	9,258	9,247	12,096	12,550	13,438	17,879	22,780
	52RPP	5,558	3,366	2,669	12,366	12,548	8,157	12,053	3,030	1,429	1,454	695	1,096	1,827
	53JPN	7,100	9,331	7,504	2,996	4,326	4,341	1,815	724	456	704	227	379	227
	61WSP	3,347	3,601	3,305	3,454	2,578	4,231	1,919	660	125	106		209	968
	62BFR	4,382	1,210	2,661	3,469	2,421	2,168	1,269	1,769	927	406	22	45	703
	71BSL	20,024	28,200	31,641	38,315	46,053	56,099	47,825	40,425	48,867	31,577	31,361	30,605	89,000
	72TPN	2,588	5,530	2,902	5,858	5,330	4,771	8,672	6,455	4,428	4,413	2,031	1,643	9,946
	73WCD	4,508	7,259	6,653	5,346	12,351	12,262	11,709	29,936	18,954	27,016	38,315	35,545	415,857
	74BSU	5,698	4,341	3,800	5,818	3,780	2,250	1,169	521	730	626	354	156	561
NSU Total		144,234	171,093	206,742	241,848	254,116	238,914	209,493	164,779	154,551	125,667	132,094	116,245	641,135

Table 28. WSU area (acres) by age class.

Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
WSU	01Ash	18.8	88.7	70.8	21.5	35.6	110.8	51.1	111.7	132.0	216.9	278.2	259.8
	09LHD			6.9				9.7	67.5			3.6	
	12Asp	16,957.3	13,196.2	9,872.4	10,456.6	10,817.0	7,539.1	7,517.9	7,267.2	4,610.4	3,051.2	2,172.7	1,674.0
	13Bir	1,510.1	1,295.4	403.7	15.0	172.6	74.3	40.5	68.2	13.5	14.7	81.7	150.3
	14BGL		20.7		18.1				6.9			21.9	3.2
	20NHH	2,175.6	2,062.2	699.1	540.8	462.8	457.9	568.8	633.3	450.8	351.0	964.7	1,611.3
	30Oak	551.1	556.3	58.7	12.3	116.5	422.8	139.7	82.0	250.0	323.1	518.3	653.8
	40CHR									9.9			
	51WPN	13.2	15.7		22.6	5.1							14.1
	51WPP	9.8	76.2	86.5	54.0	35.0	2.6		3.4	14.0	2.0	21.5	
	52RPN	175.8	42.5		3.2	53.1	6.7	96.5	5.1	8.6	21.1	23.5	81.5
	52RPP	762.4	676.8	280.0	209.4	291.0	302.1	624.1	532.6	411.4	420.2	1,286.8	738.7
	53JPN	18.7	283.4	161.5	73.8	89.8	119.5	59.3	82.8	78.9	29.1	21.8	14.5
	61WSP		49.2	28.4	153.8	54.4	185.0	125.0	262.0	313.1	416.4	222.1	163.7
	62BFR	140.7		35.3	2.0	283.9	56.0		55.8	9.8	17.1	70.9	90.8
	71BSL	416.6	47.5		64.7		54.8	133.7	194.1	558.8	757.2	472.8	247.2
	72TPN	218.1	54.0	341.4	75.8	29.0	160.1	138.5	131.1	690.2	336.5	424.0	192.1
	73WCD							16.4					
	74BSU							3.3	4.8			8.6	6.6
WSU Total		22,968.3	18,464.9	12,044.7	11,723.5	12,445.8	9,491.8	9,524.6	9,508.5	7,551.5	5,956.6	6,593.1	5,901.7

Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
WSU	01Ash	200.8	288.5	701.4	814.9	571.1	990.9	1,698.1	1,386.5	1,913.6	1,628.6	1,182.6	1,194.7	4,600.9
	09LHD		19.5	20.1	25.5	78.6	36.6	18.0	33.6	100.2	12.4		66.6	146.3
	12Asp	1,573.8	1,776.8	1,810.0	900.9	530.3	289.4	8.9	87.3	56.9	41.0			
	13Bir	129.4	379.6	308.3	201.2	652.0	154.8	21.6	180.7		4.4	3.1		8.4
	14BGL					5.0	1.1							
	20NHH	2,020.6	2,805.9	3,076.2	3,856.1	3,614.1	3,532.2	3,021.7	1,488.3	787.4	834.7	367.0	187.4	687.6
	30Oak	1,745.9	2,577.4	3,767.5	4,299.4	6,663.5	4,501.0	2,708.6	2,101.7	720.9	71.9	33.9	50.5	56.0
	40CHR													
	51WPN	14.3		3.4			4.6	36.8	3.7	12.0	45.3			106.9
	51WPP	10.8	6.6		12.7									
	52RPN	103.6	4.0	6.8	20.7	13.1	9.7	27.9	10.6	16.5	28.2	6.6		
	52RPP	257.2	93.4	119.6	80.3		26.4							
	53JPN	6.3	2.9	4.1	10.2		14.6							
	61WSP	30.6	122.1	18.6	29.5		8.7	59.6	51.8					37.9
	62BFR	54.3	76.0	164.1	217.7	133.6	29.5	15.9	15.7	8.0	19.5			
	71BSL	378.7	500.4	689.3	546.3	440.4	430.5	680.4	855.9	380.0	412.0	251.1	504.1	1,206.9
	72TPN	284.6	544.1	665.0	1,032.7	927.5	613.4	383.6	507.4	213.1	367.8	185.7	248.1	1,189.4
	73WCD				18.0		15.9	28.9	18.7	30.9	72.7		29.2	198.1
	74BSU	15.5	19.2			7.7	2.1		2.9	6.6		4.7		
WSU Total		6,826.6	9,216.4	11,354.6	12,066.0	13,636.8	10,661.5	8,710.0	6,744.9	4,246.4	3,538.6	2,034.7	2,280.4	8,238.4

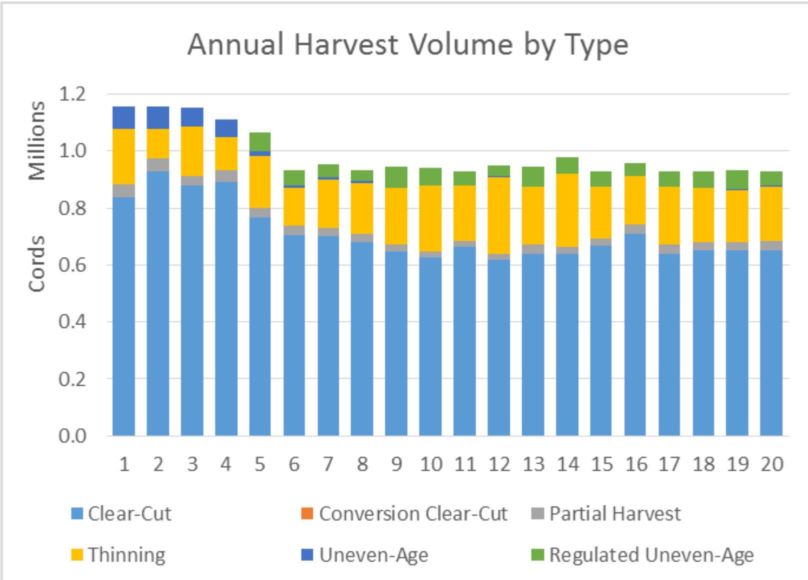
Table 29. WSU volume (cords) by age class.

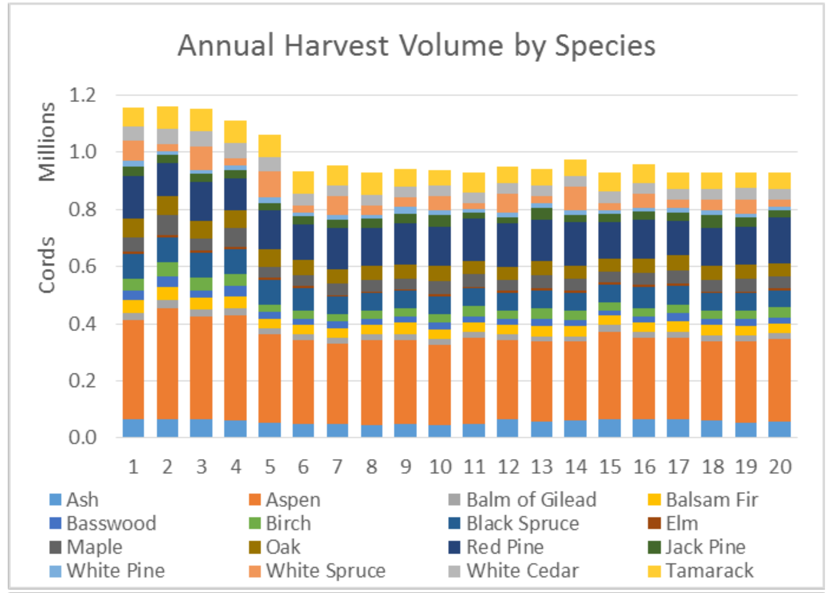
Planning_area	Cover Type	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60
WSU	01Ash	3	165	259	159	263	1	432	904	1,238	2,631	3,259	3,343
	09LHD			20				94	315			49	
	12Asp	15,971	36,672	51,524	87,805	117,103	1	119,083	135,822	94,113	68,069	51,518	40,865
	13Bir	2,240	3,655	1,845	87	1,477	1	491	902	151	228	1,950	3,424
	14BGL		0		113				66			250	37
	20NHH	5,847	9,125	4,706	5,497	5,469	1	8,476	10,778	8,057	6,881	19,070	33,503
	30Oak	3,479	5,263	688	176	1,831	1	2,555	1,554	4,631	6,688	11,000	14,045
	40CHR									171			
	51WPN	6	17		122	23							204
	51WPP	5	72	236	358	299	1		42	372	63	866	
	52RPN	382	205		38	761	1	1,797	123	203	648	822	2,496
	52RPP	2,892	5,507	3,182	3,071	5,816	1	17,310	18,133	15,560	17,844	55,863	34,158
	53JPN	15	578	603	421	662	1	876	1,478	1,436	717	595	341
	61WSP		73	194	1,441	695	1	2,356	5,964	6,799	10,649	5,703	4,580
	62BFR	153		110	7	2,682	1		499	66	203	1,074	1,201
	71BSL	15	19		74		1	381	671	2,359	3,385	2,367	1,662
	72TPN	150	83	630	248	290	1	580	671	3,649	2,546	2,981	2,267
	73WCD							58					
	74BSU							26	26			163	52
WSU Total		31,157	61,434	63,997	99,618	137,372	13	154,516	177,948	138,804	120,550	157,529	142,178

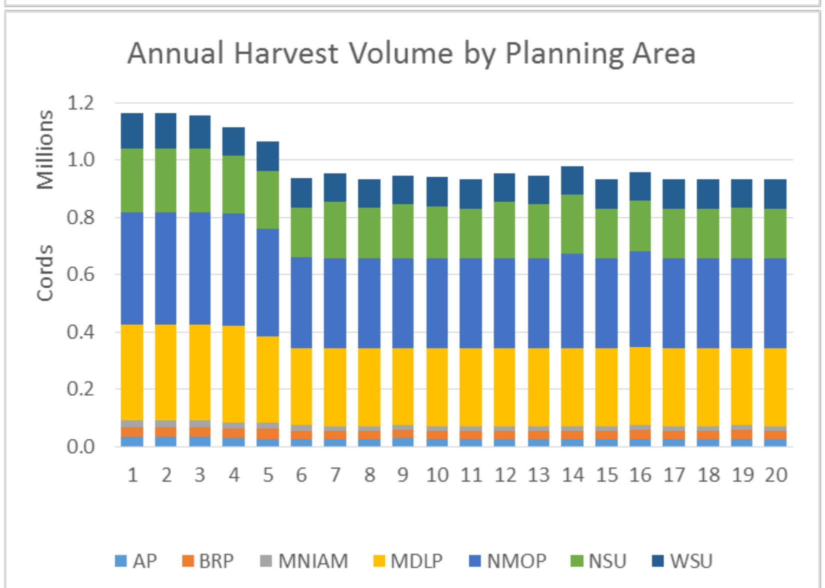
Planning_area	Cover Type	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85	86 to 90	91 to 95	96 to 100	101 to 105	106 to 110	111 to 115	116 to 120	120+
WSU	01Ash	2,833	3,995	10,231	12,094	8,933	15,744	24,721	20,642	27,107	25,281	17,832	18,281	59,327
	09LHD		357	375	517	1,507	725	293	576	1,859	246		1,116	3,231
	12Asp	42,712	47,183	48,620	24,853	14,192	7,479	235	2,698	1,234	740			
	13Bir	2,532	8,327	7,517	4,528	15,158	3,455	507	3,742		87	56		26
	14BGL					62	11							
	20NHH	43,061	64,628	74,488	96,197	90,472	90,708	79,185	38,342	19,840	23,338	9,870	5,279	13,610
	30Oak	40,019	60,149	90,058	104,582	166,088	112,426	68,169	53,278	18,015	1,914	859	1,349	1,387
	40CHR													
	51WPN	373		85			44	1,401	56	256	900			2,533
	51WPP	283	235		424									
	52RPN	3,792	142	241	719	503	410	1,278	452	753	1,229	256		
	52RPP	11,498	4,244	5,208	4,046		1,506							
	53JPN	143	88	148	252		240							
	61WSP	804	3,033	370	668		142	863	681					-
	62BFR	430	-	-	-	-	-	-	-	-	-			
	71BSL	3,454	4,820	6,323	7,996	5,260	8,003	9,105	12,320	6,013	3,974	3,992	4,761	12,293
	72TPN	2,985	7,544	7,070	11,682	10,460	8,134	4,209	5,701	2,264	3,877	1,927	1,834	10,301
	73WCD				660		367	937	375	639	1,384		387	2,979
	74BSU	393	296			92	23		-	-		-		
WSU Total		155,313	205,041	250,735	269,217	312,728	249,418	190,904	138,862	77,979	62,970	34,793	33,007	105,688

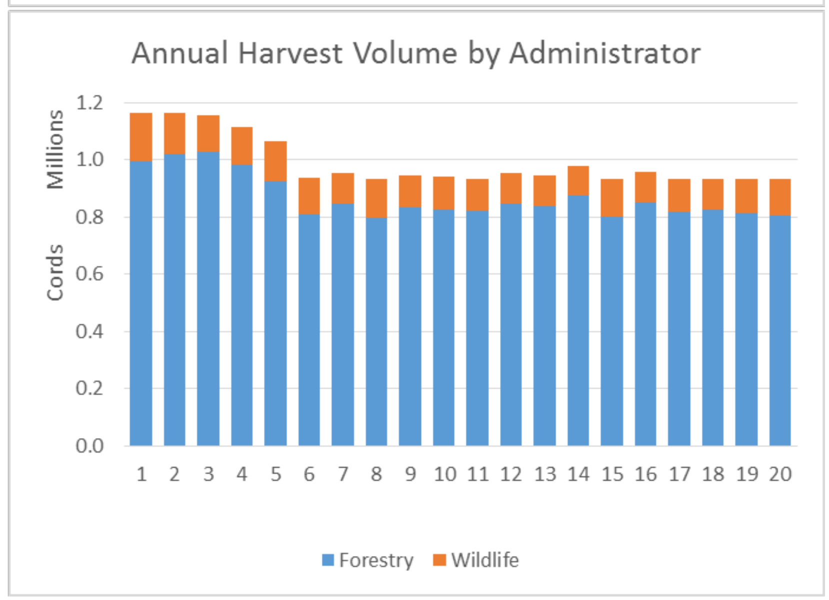
Appendix H: Detailed Scenario Results

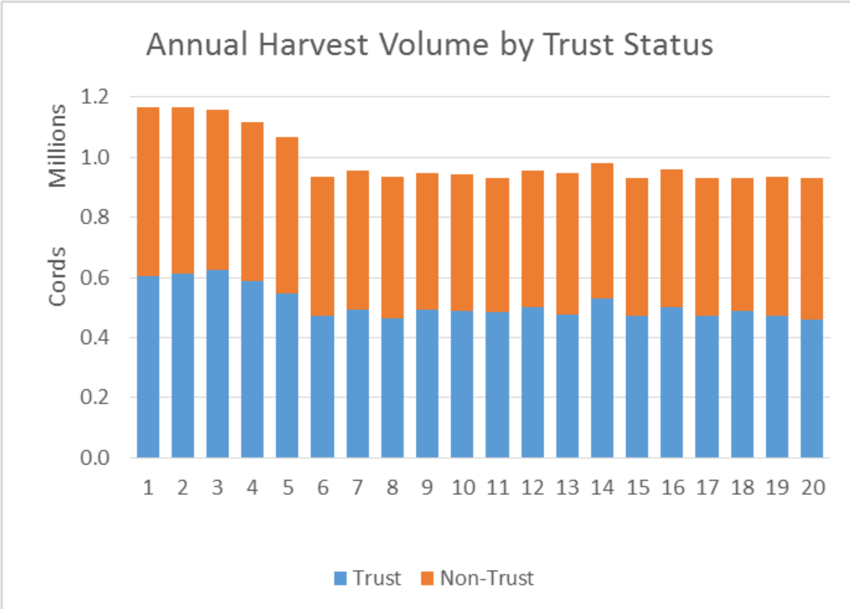
Scenario 1.1.1



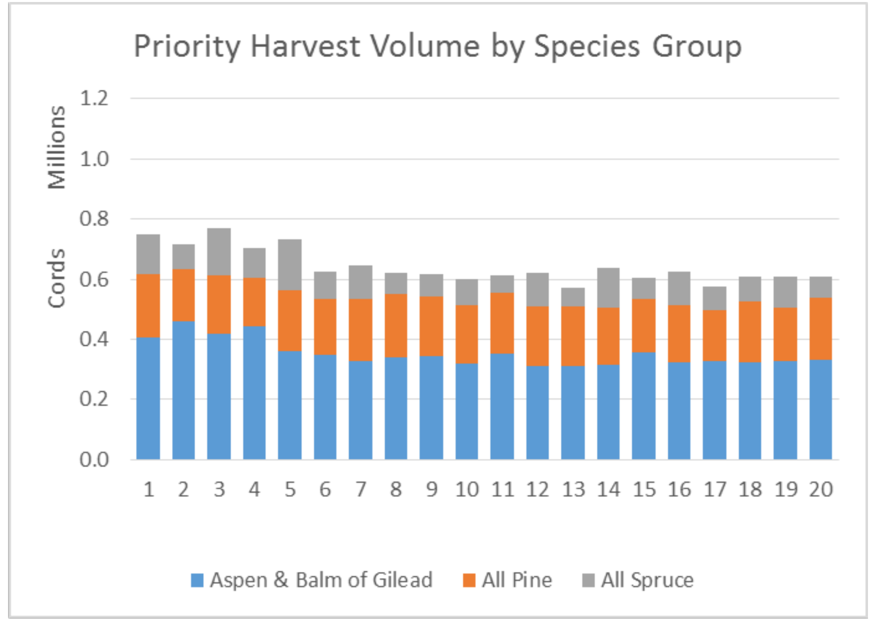




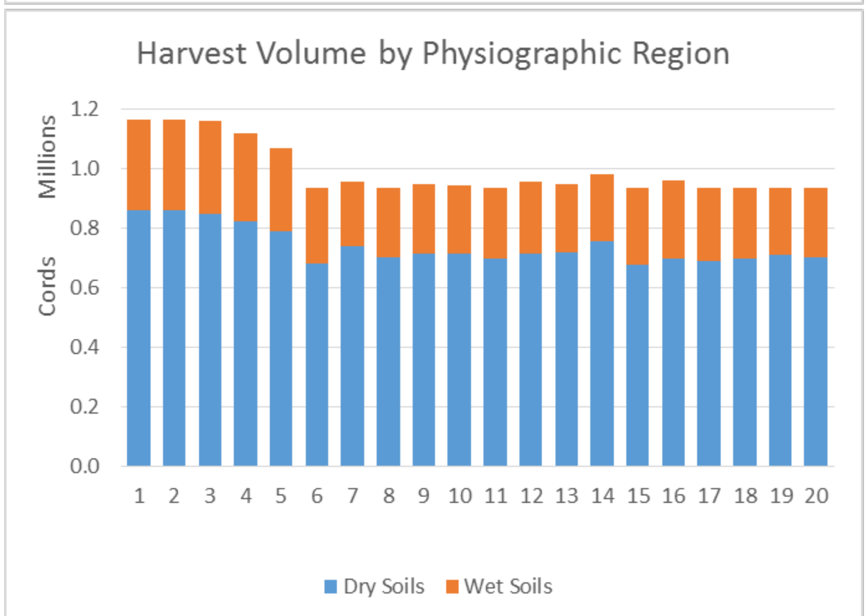




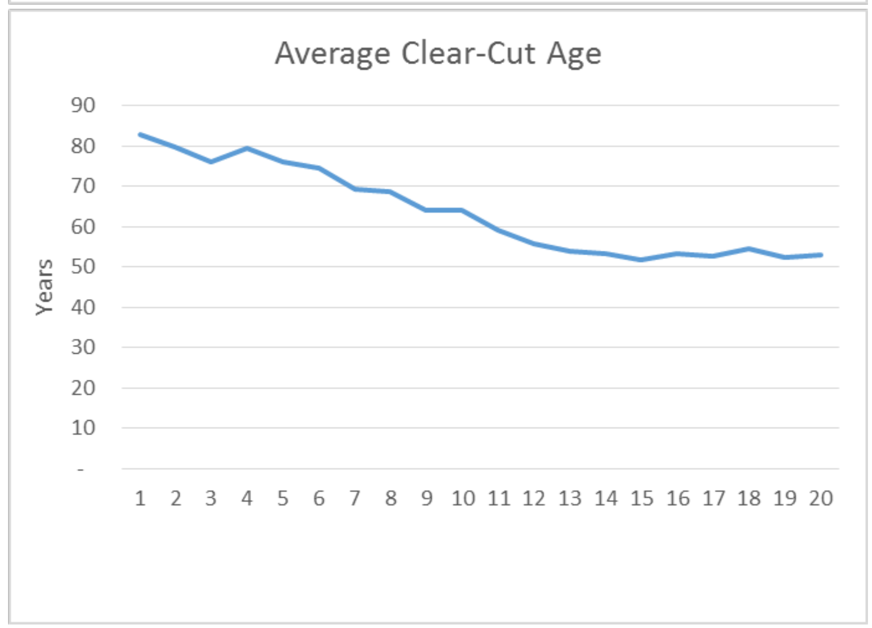
Annual Harvest Volume by Trust Status
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust



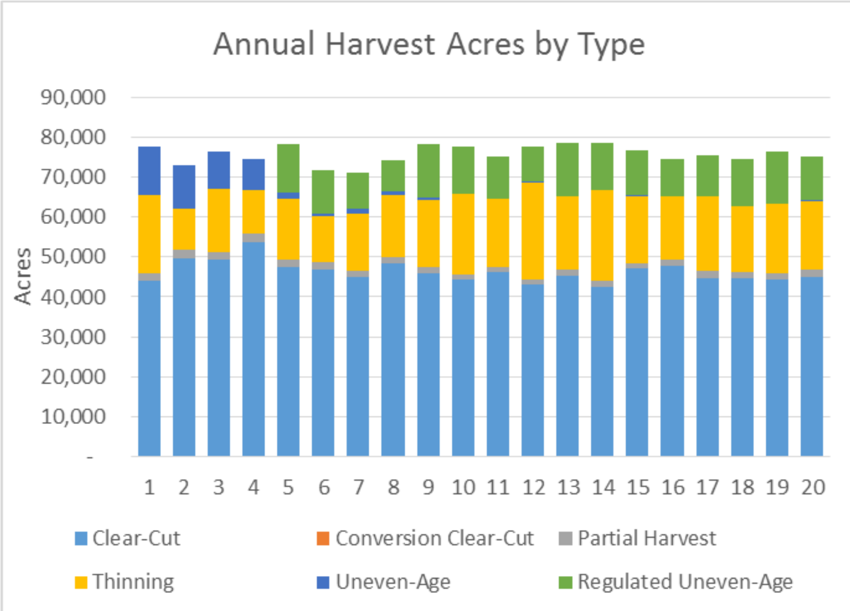
Priority Harvest Volume by Species Group
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

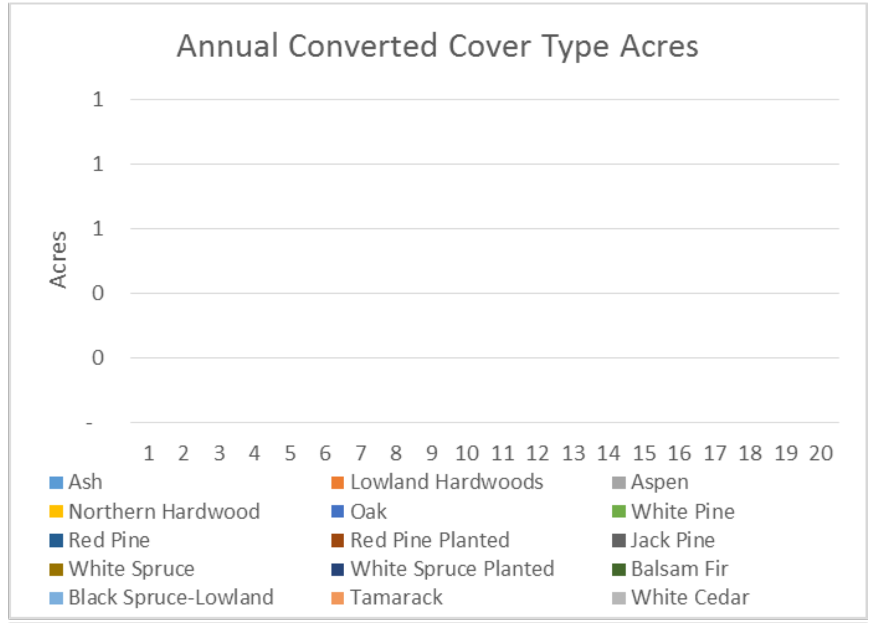


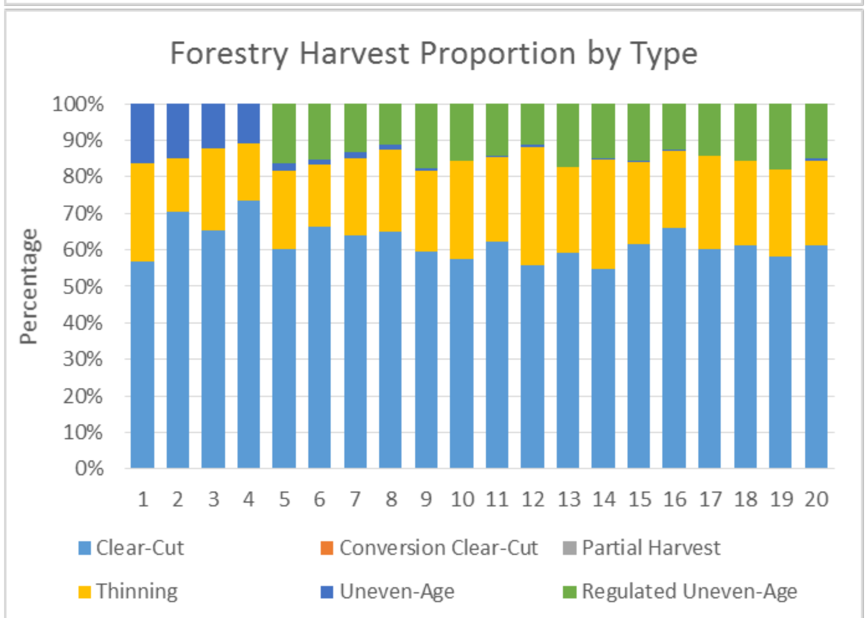
Harvest Volume by Physiographic Region
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

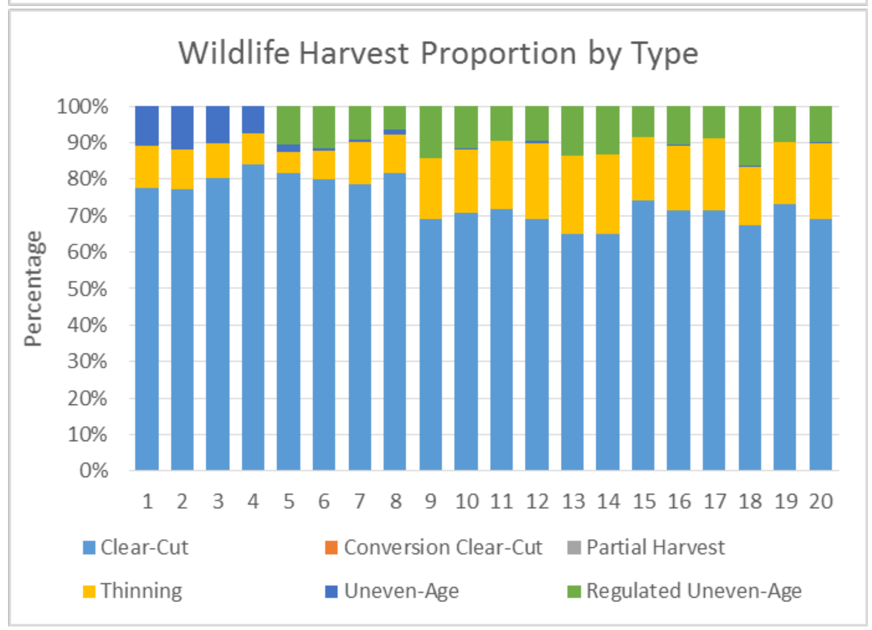


Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

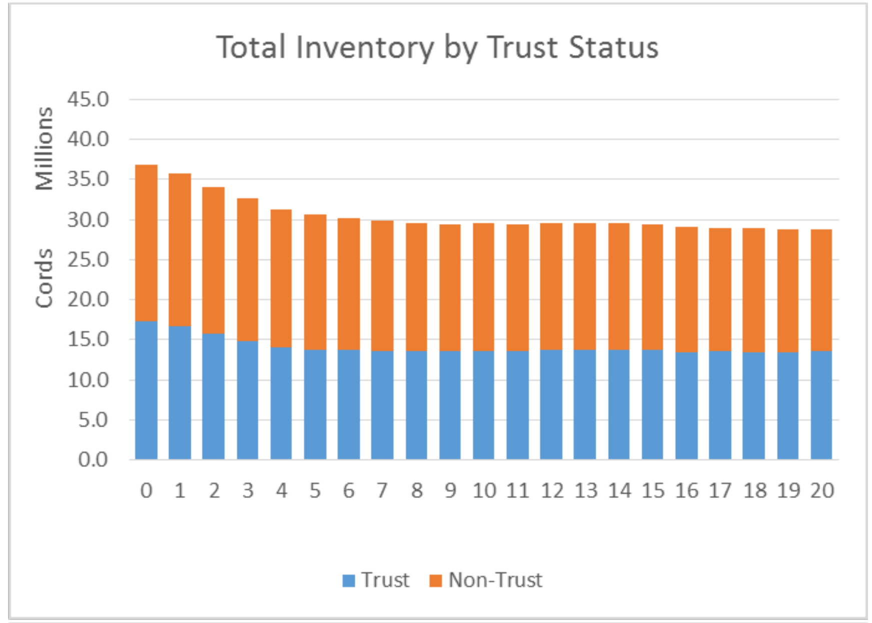

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

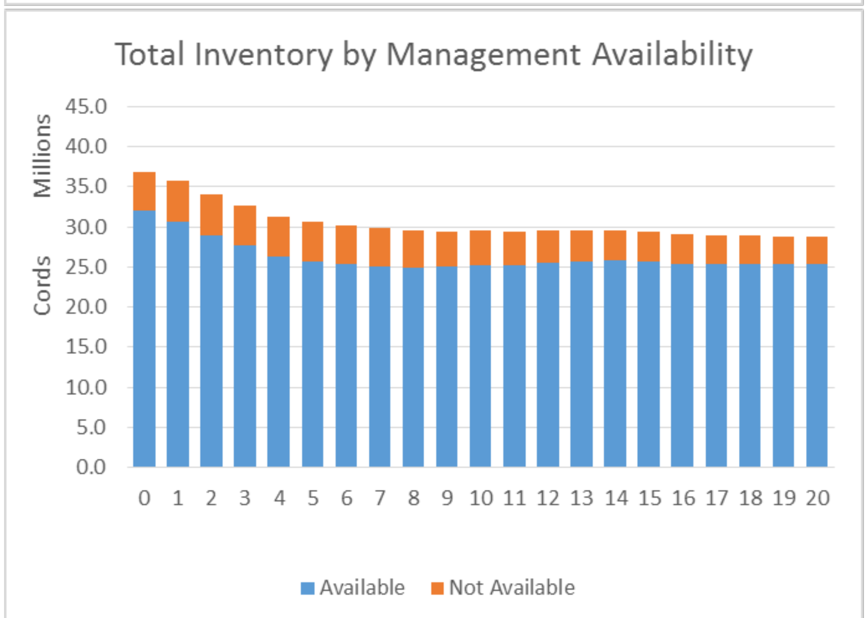

Annual Converted Cover Type Acres
1
1
1
0
0
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

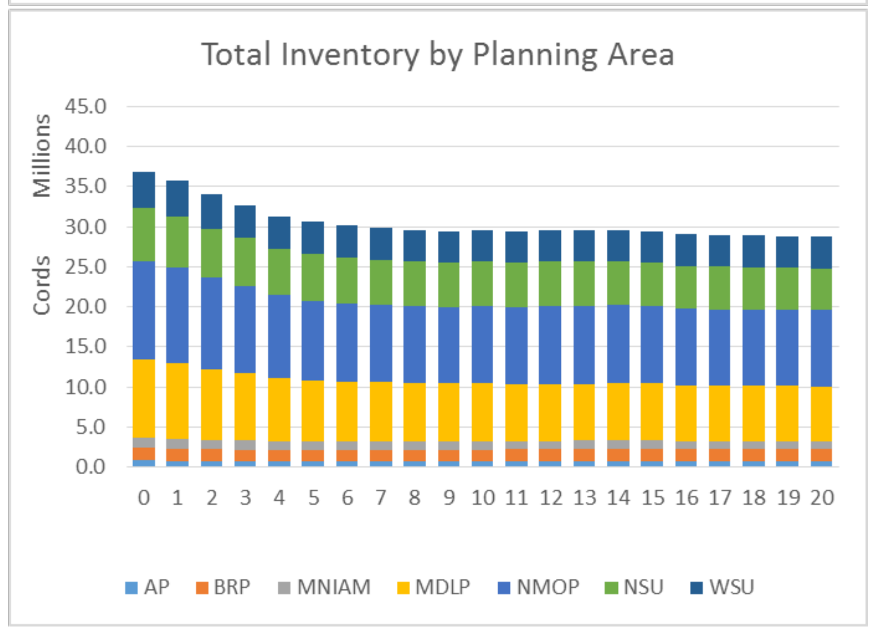

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

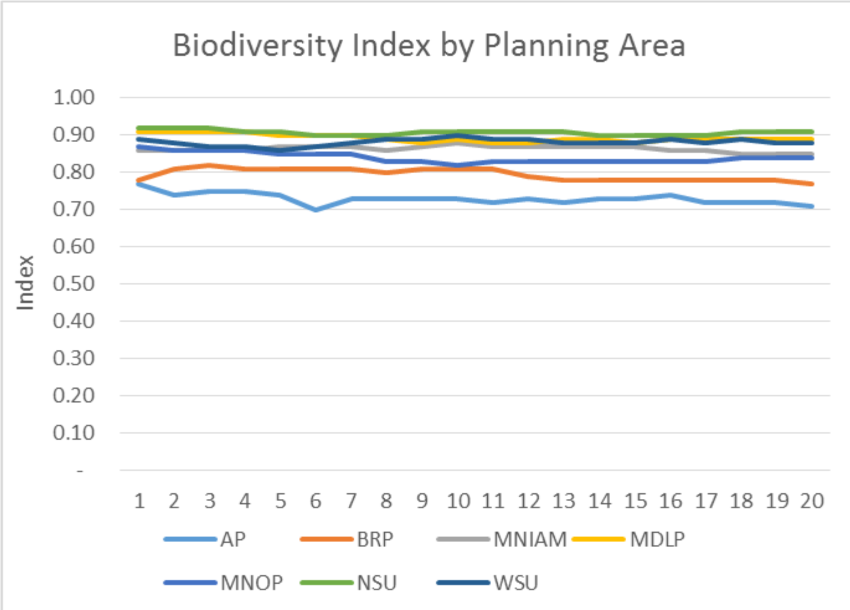

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

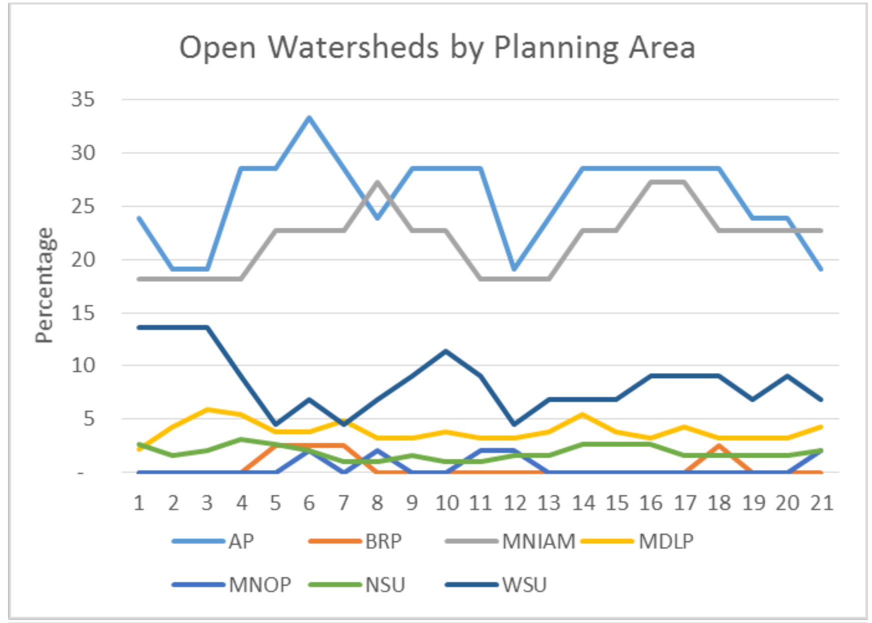

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

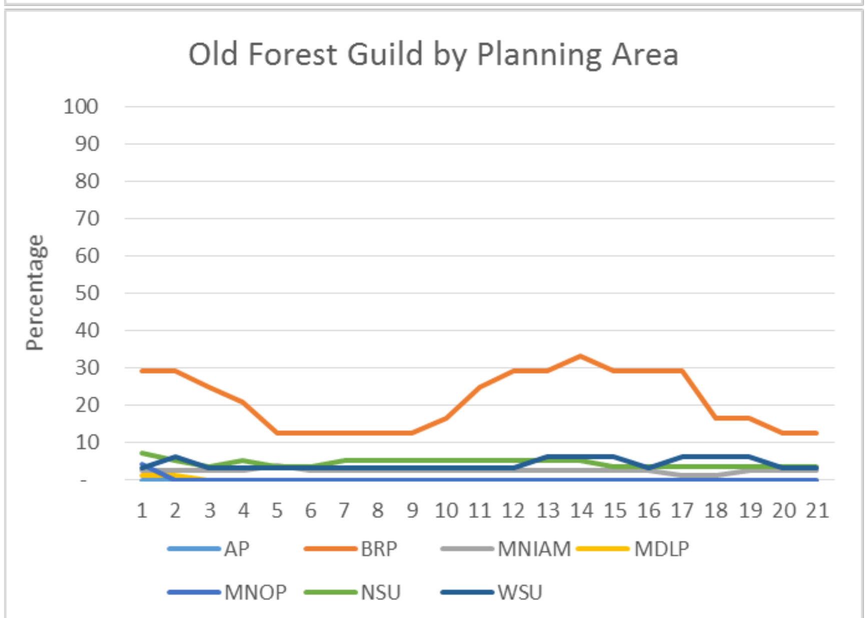

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

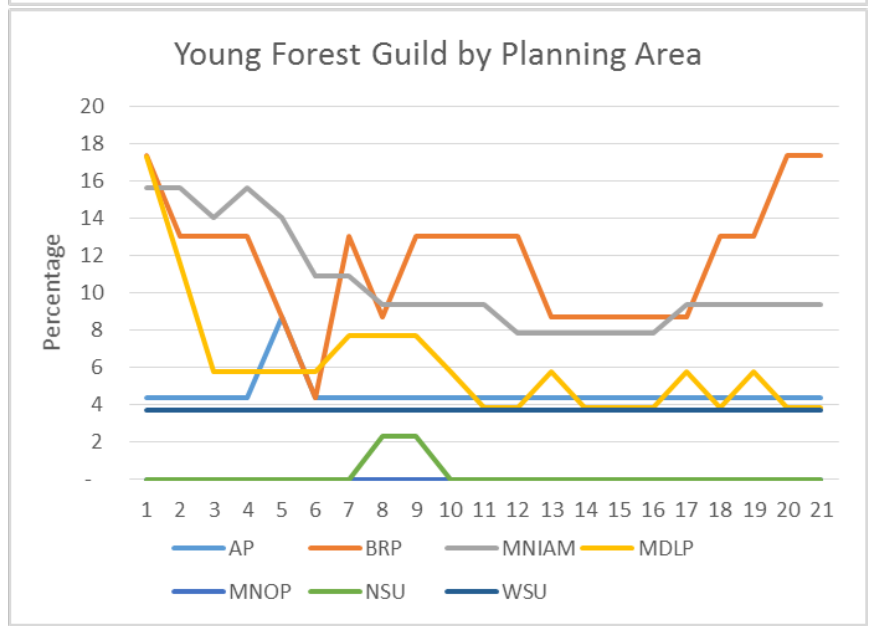

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

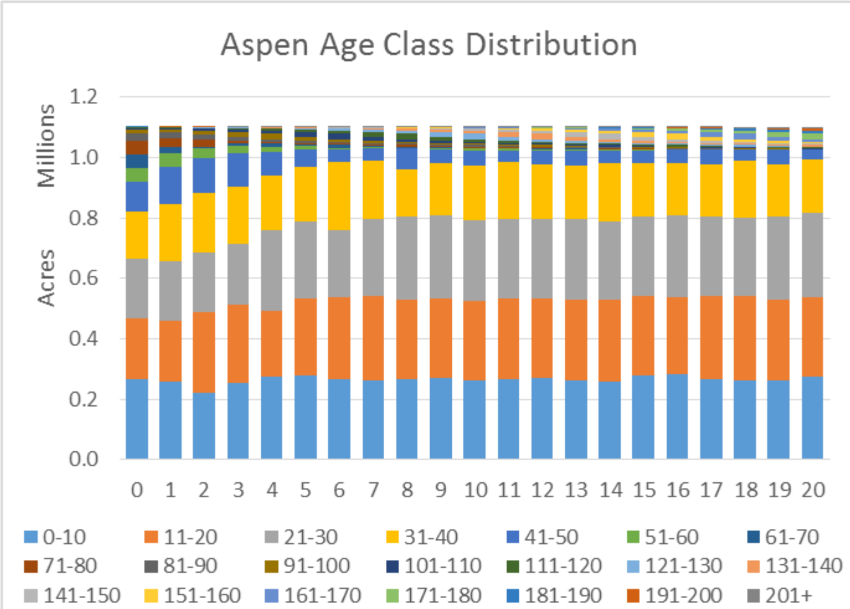

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

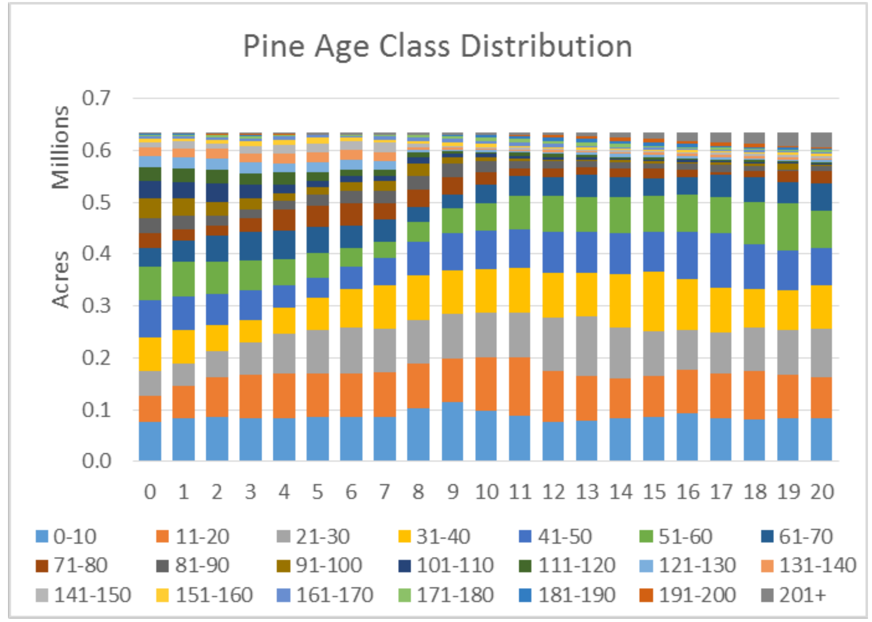

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

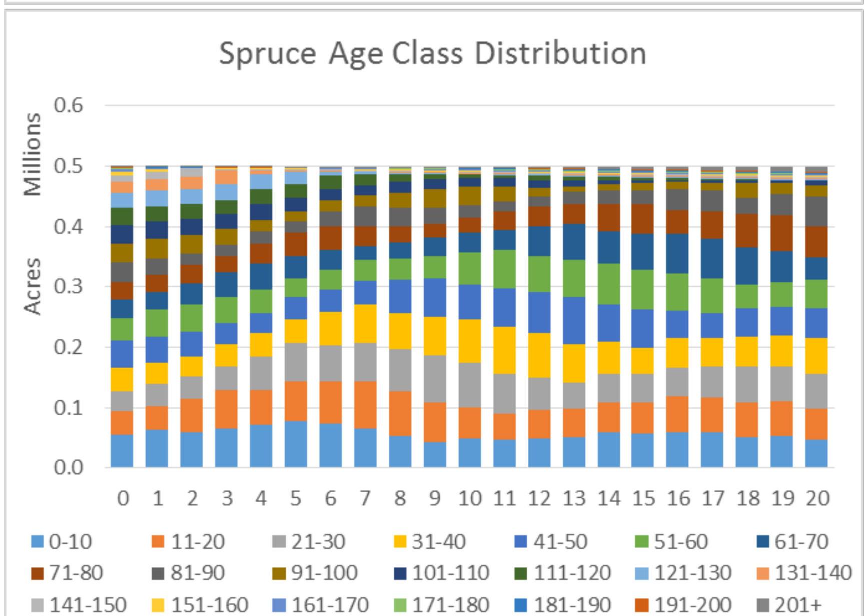

Open Watersheds by Planning Area
Percentage
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

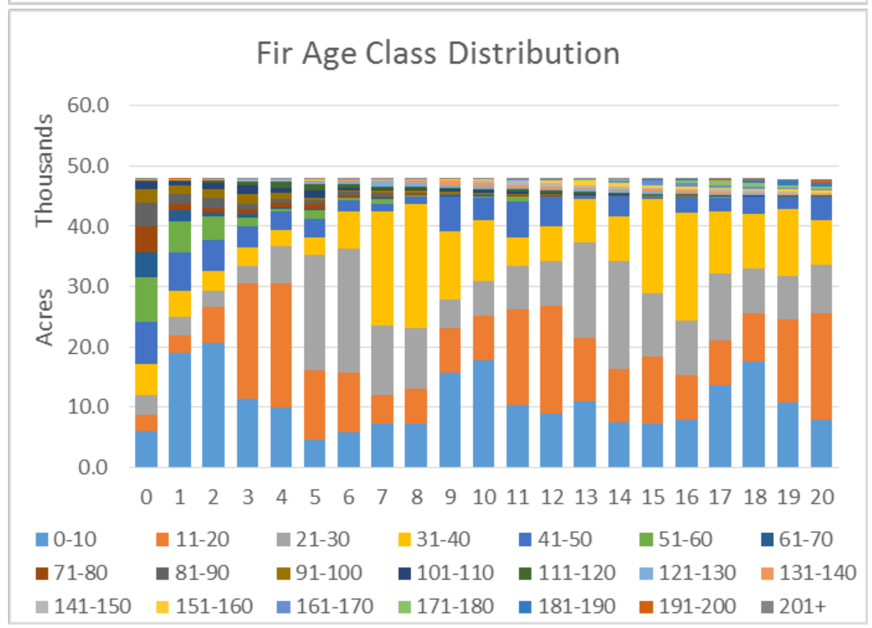

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

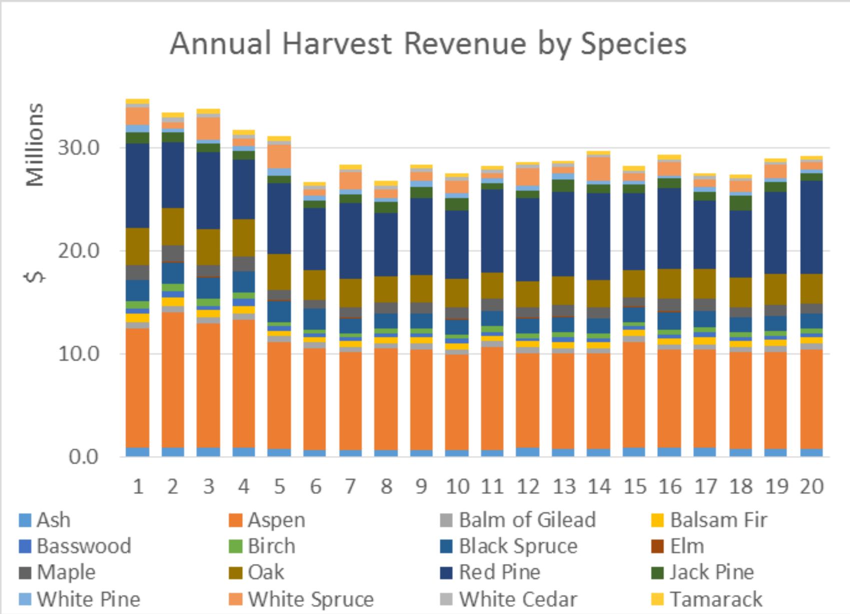

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Acres
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

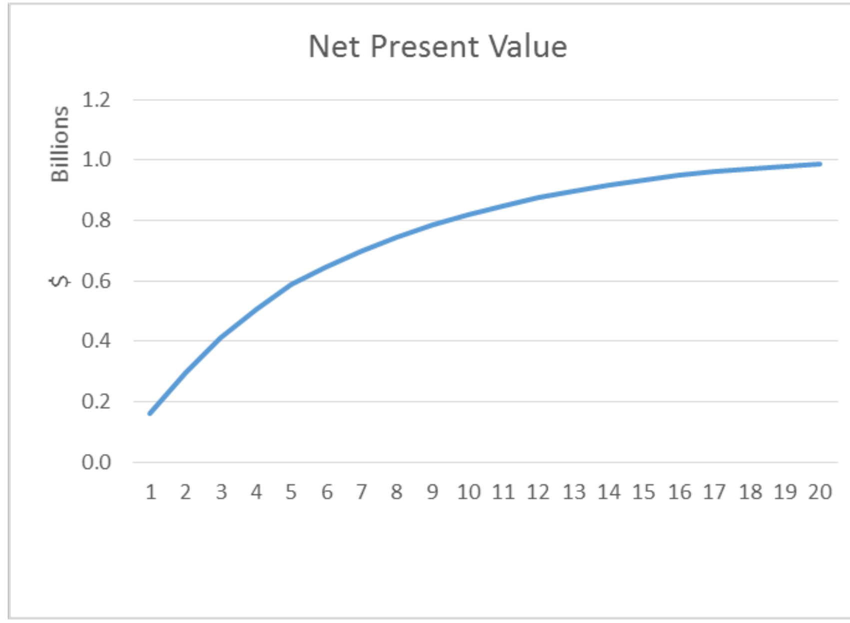

Pine Age Class Distribution
Acres
Millions
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Acres
Millions
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Acres
Thousands
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

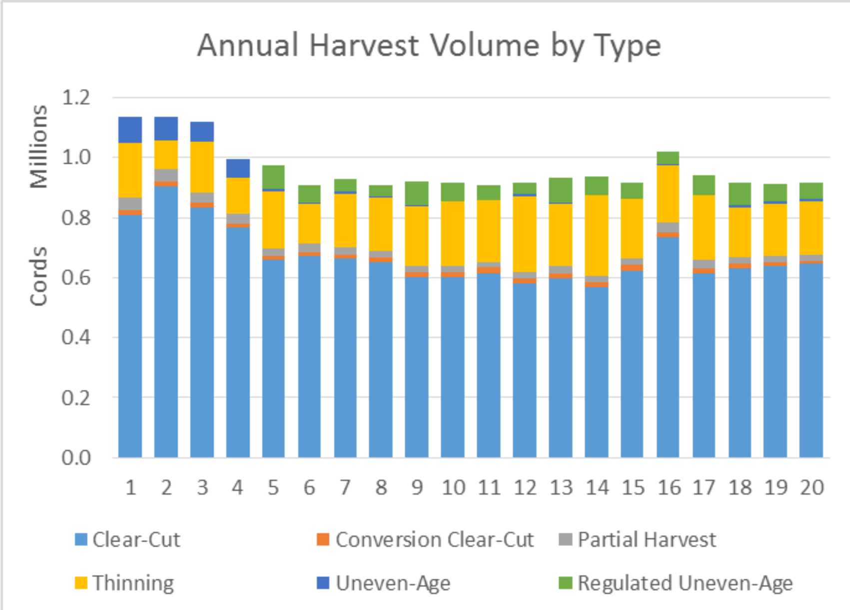


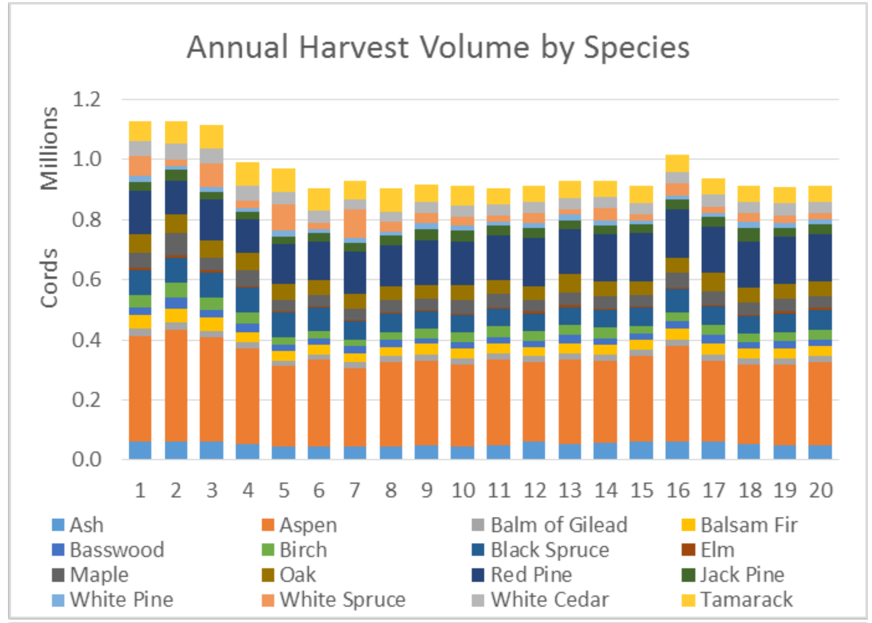
Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

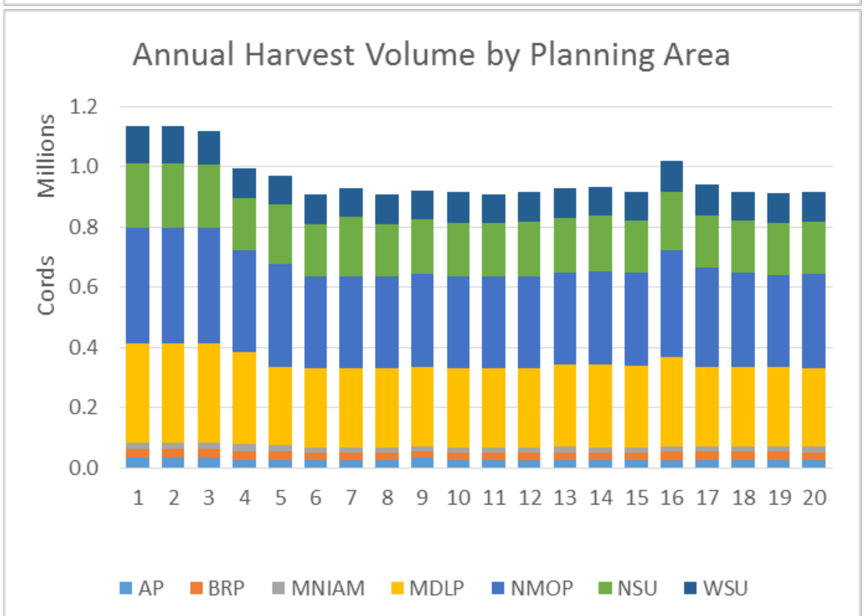


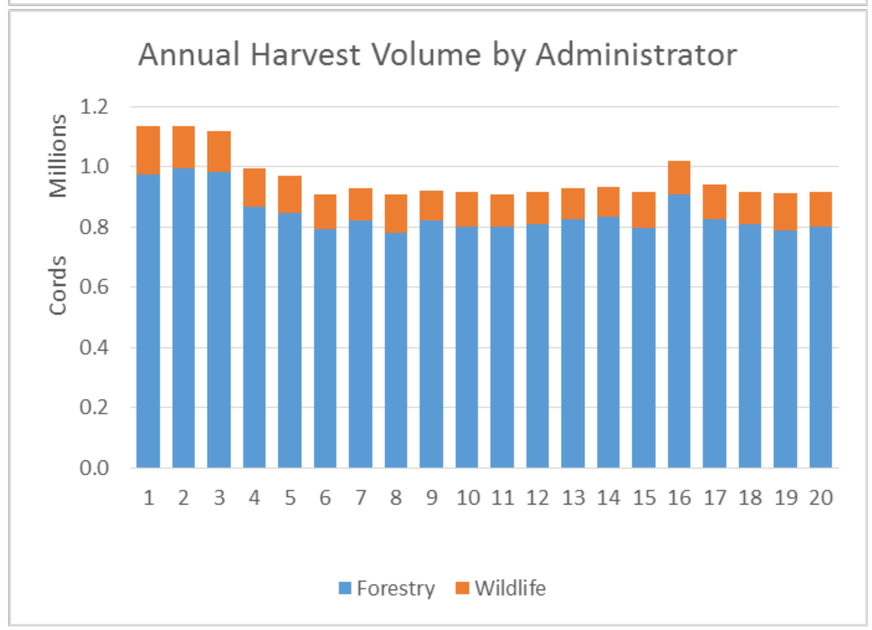
Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

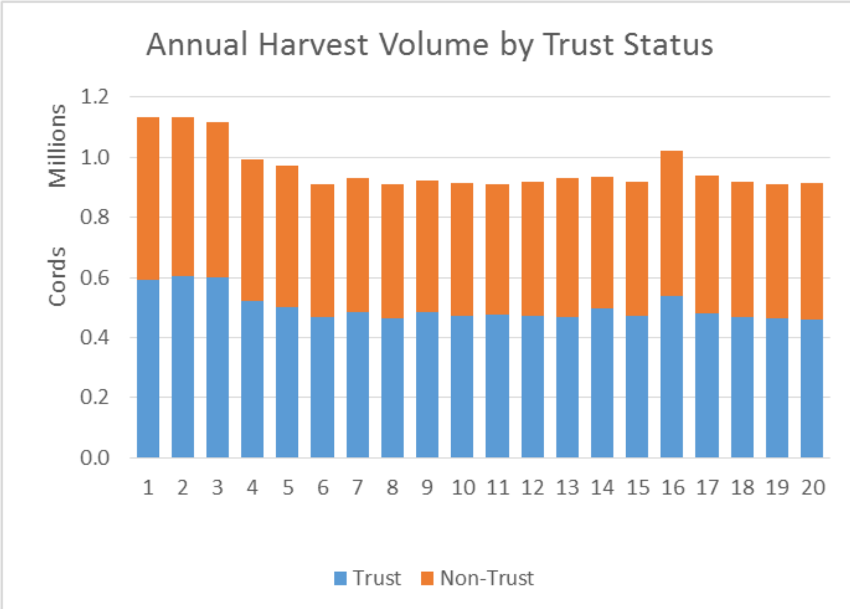
Scenario 1.1.2

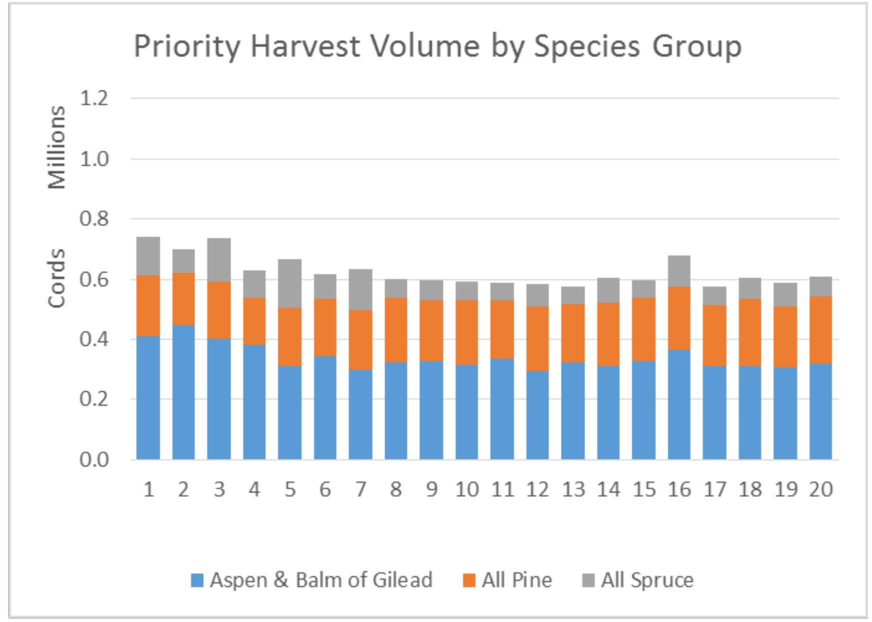


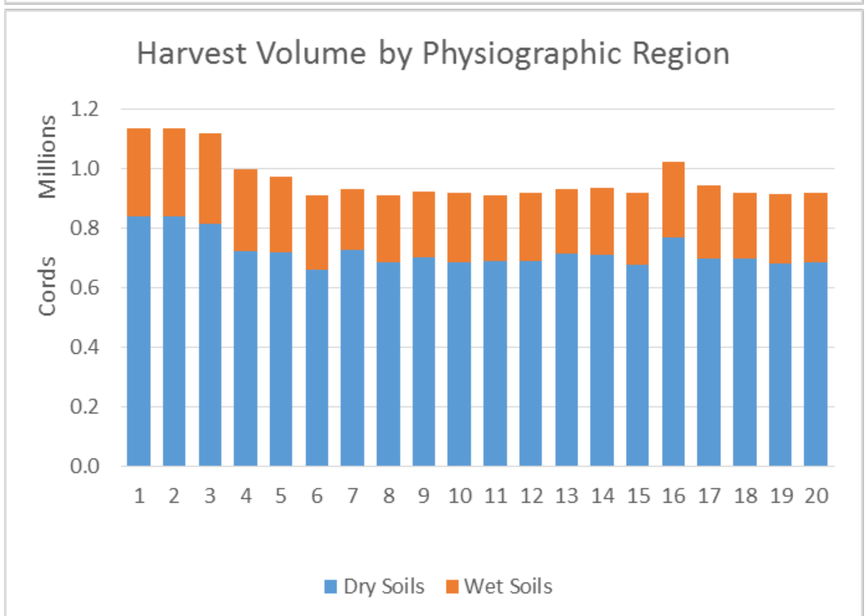


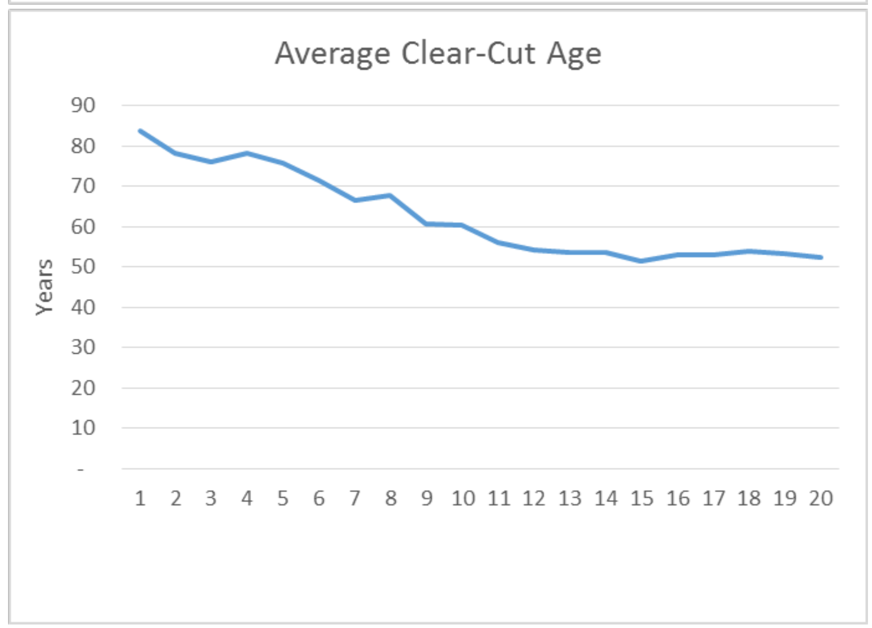


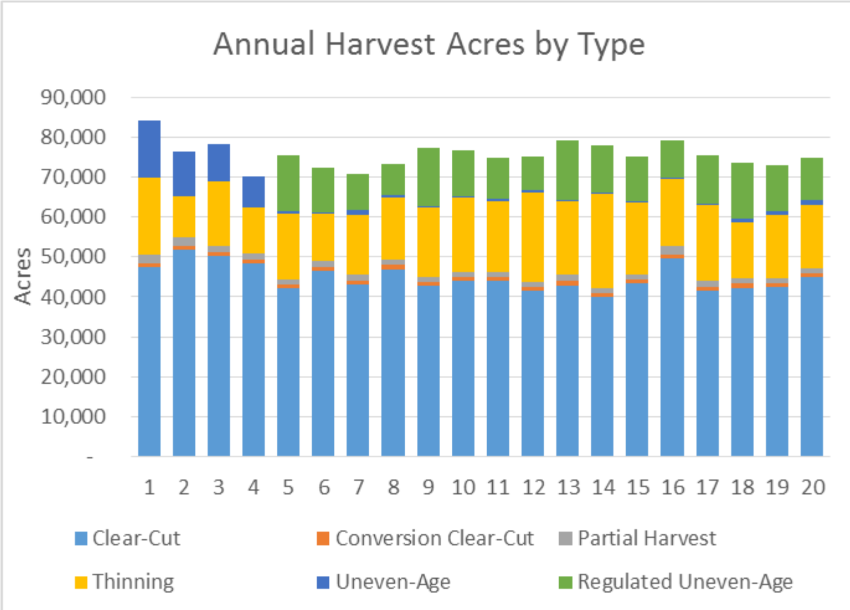



Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

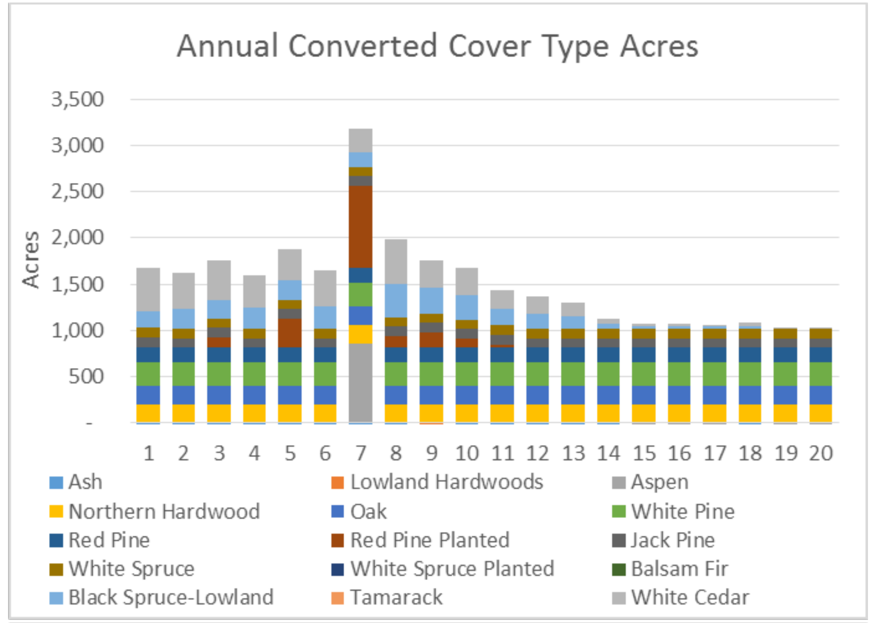

Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce


Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

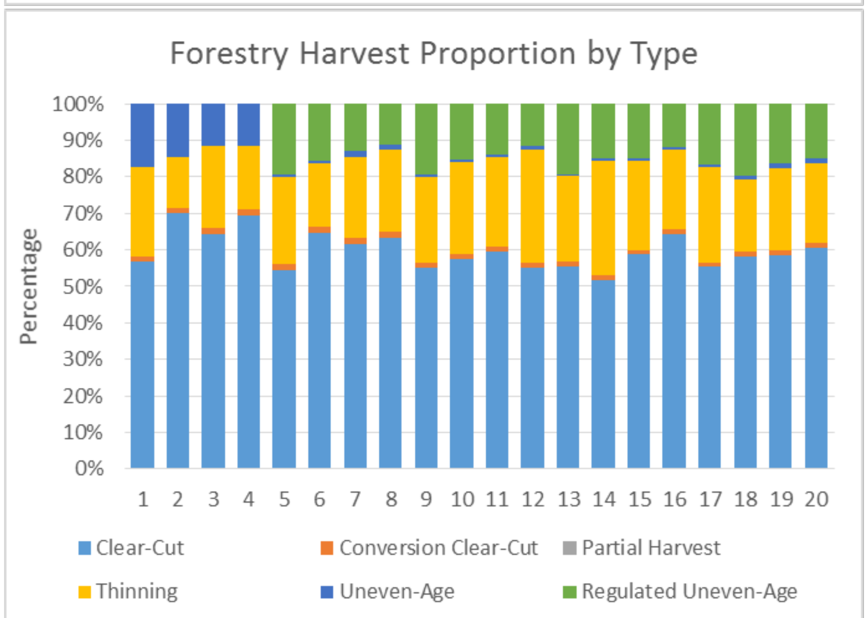

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



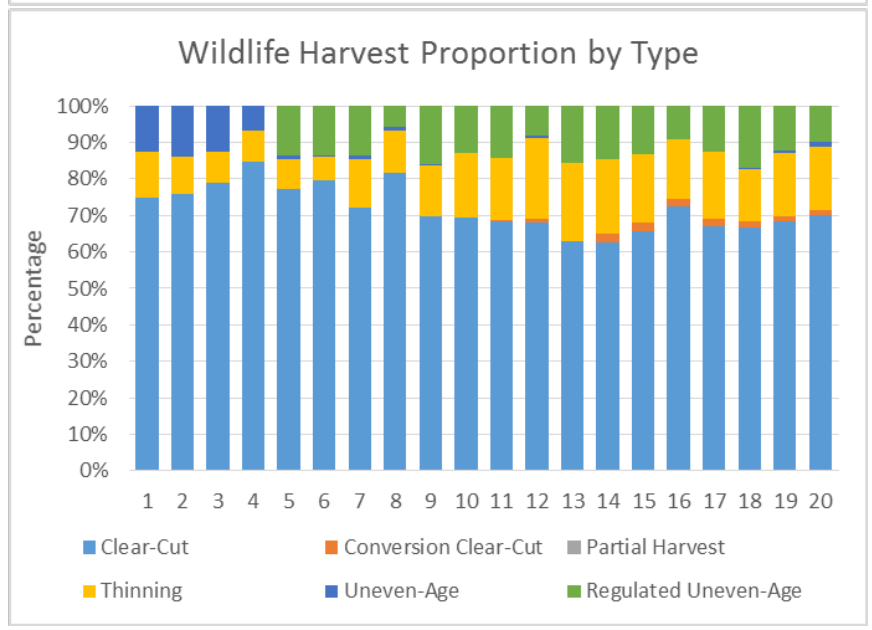
Annual Harvest Acres by Type
Acres
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age



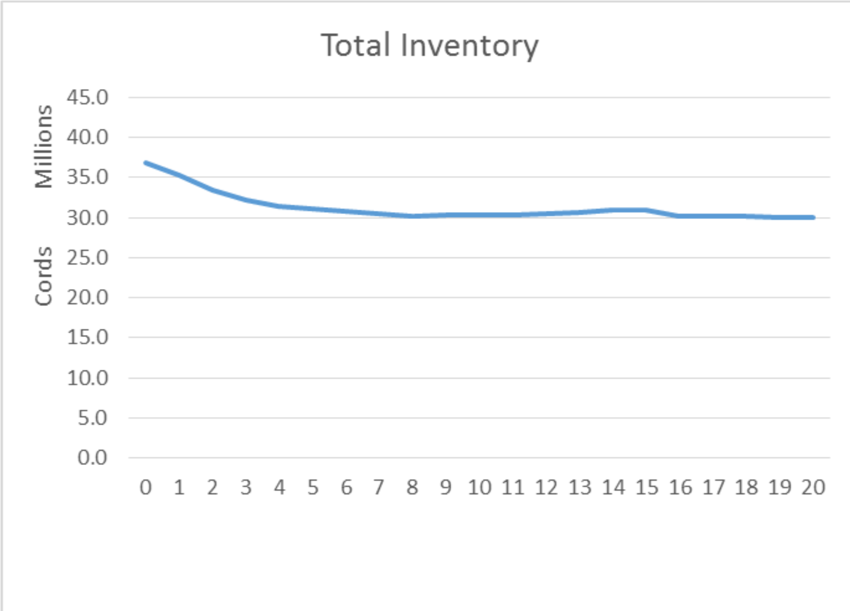
Annual Converted Cover Type Acres
Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

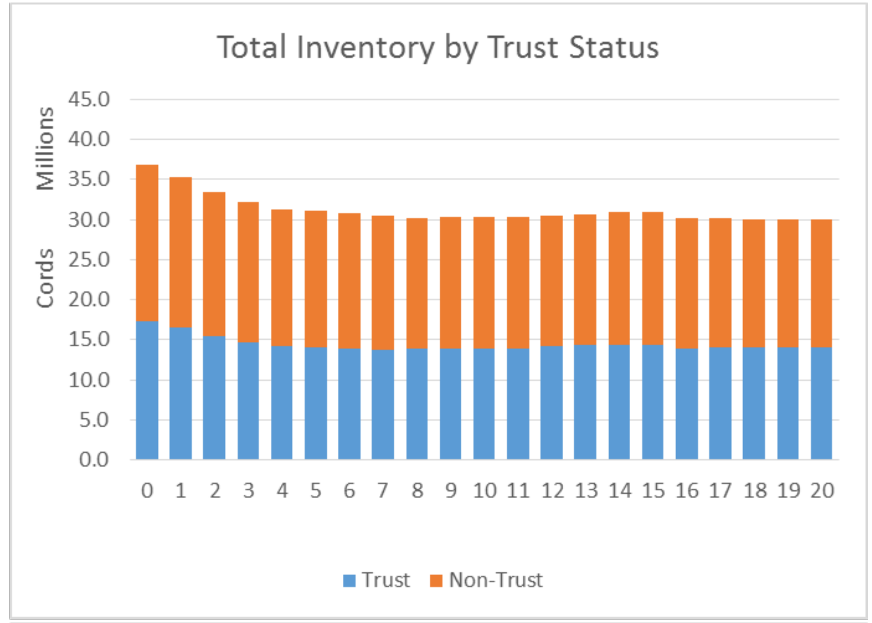


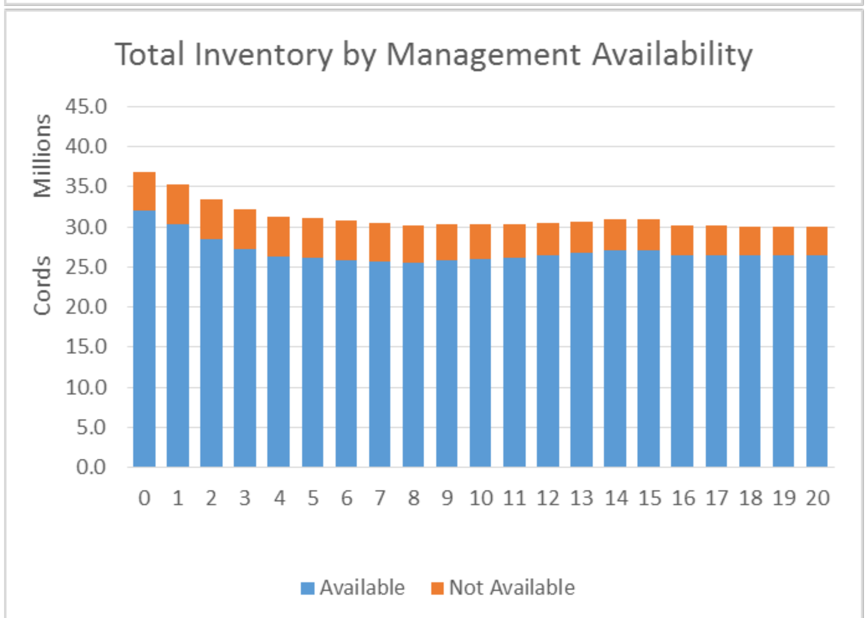
Forestry Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

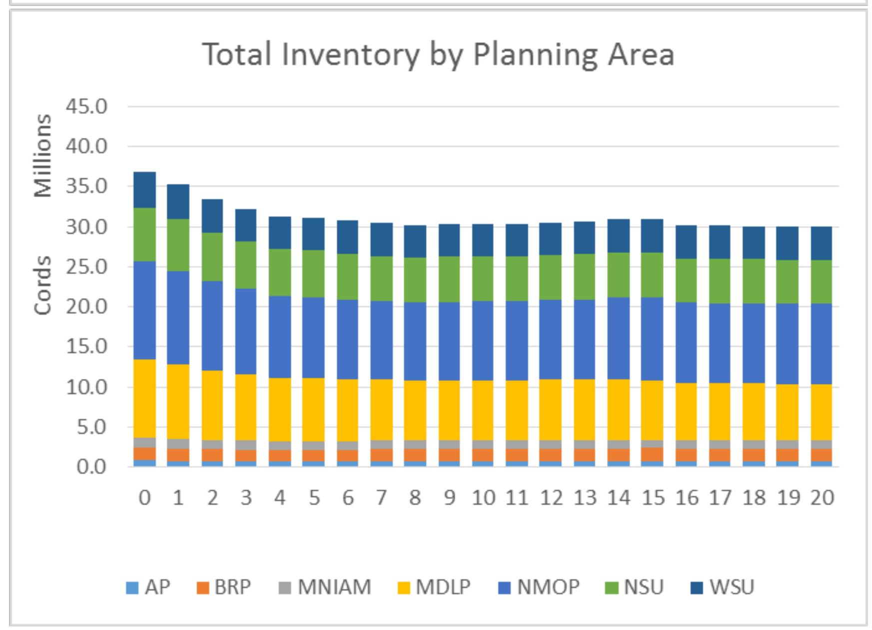


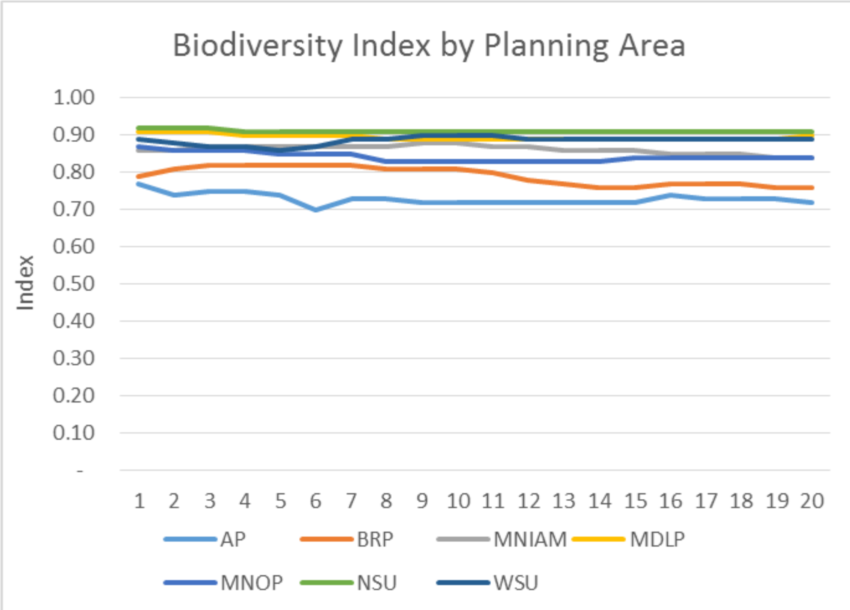
Wildlife Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

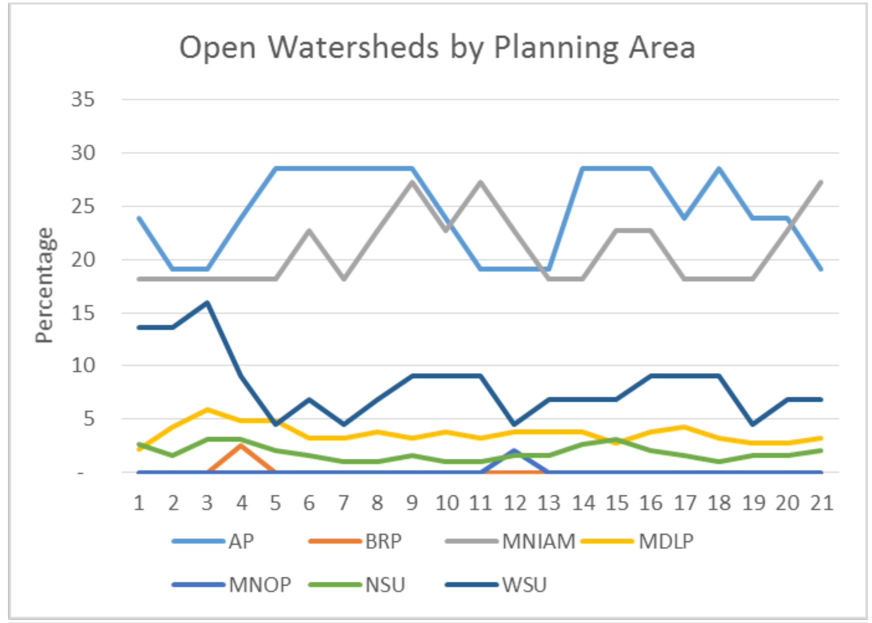

Total Inventory
Cords
Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

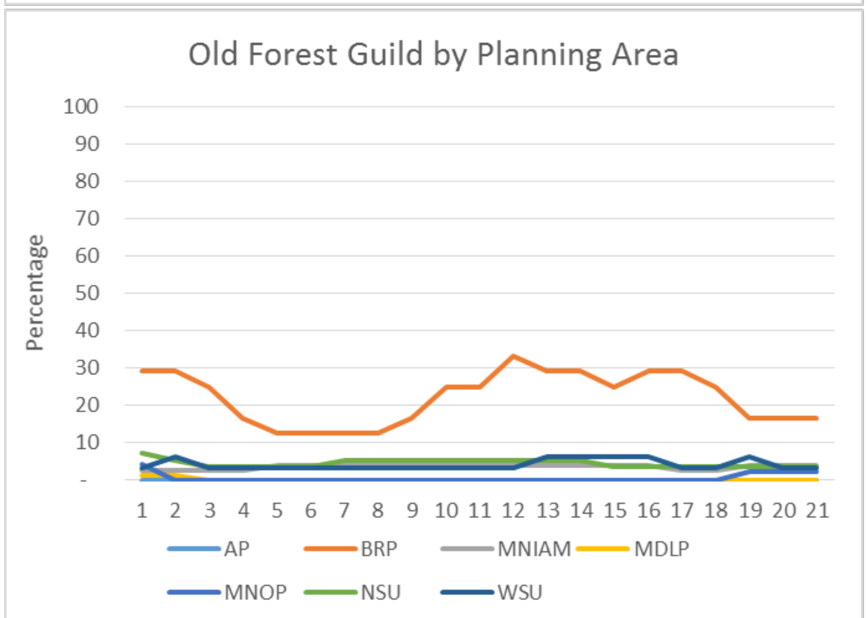

Total Inventory by Trust Status
Cords
Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

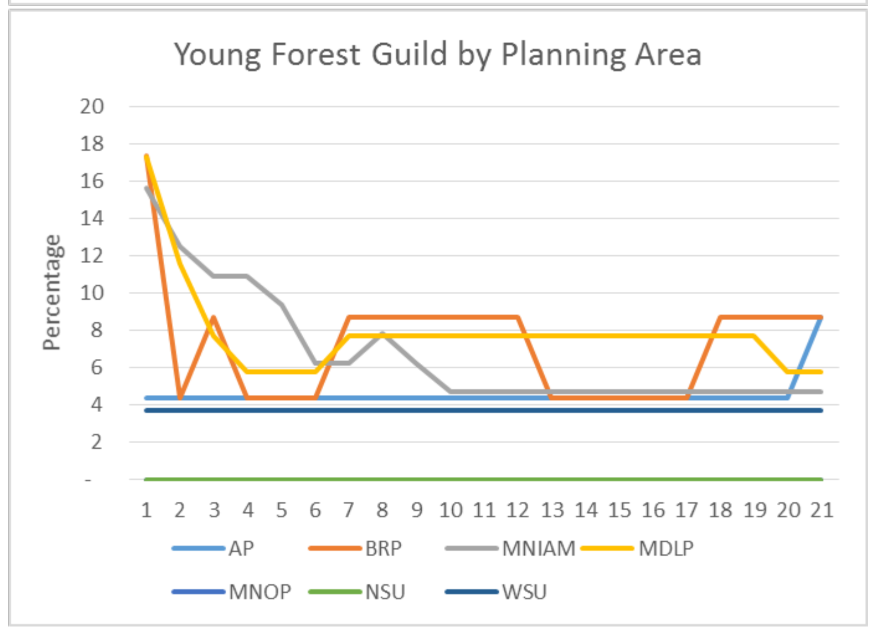

Total Inventory by Management Availability
Cords
Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

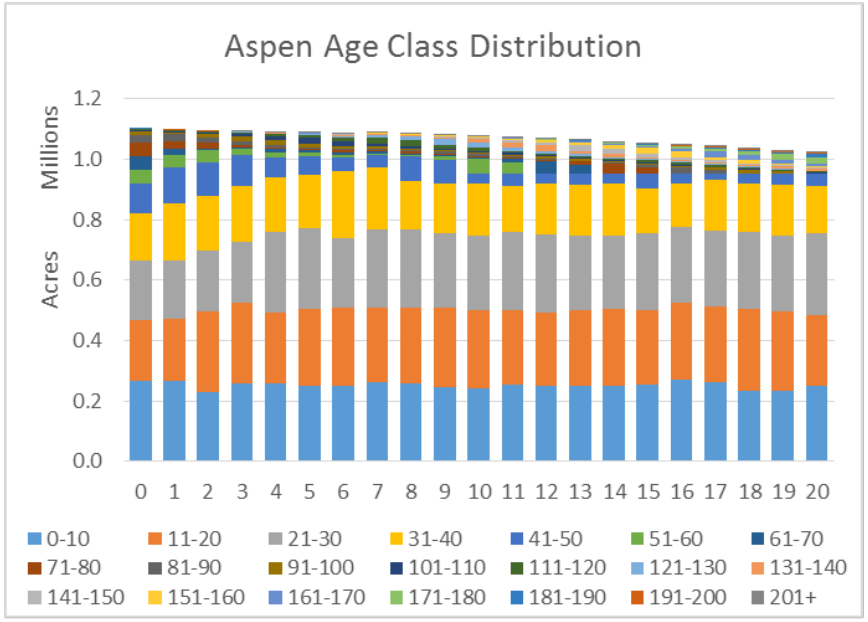

Total Inventory by Planning Area
Cords
Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

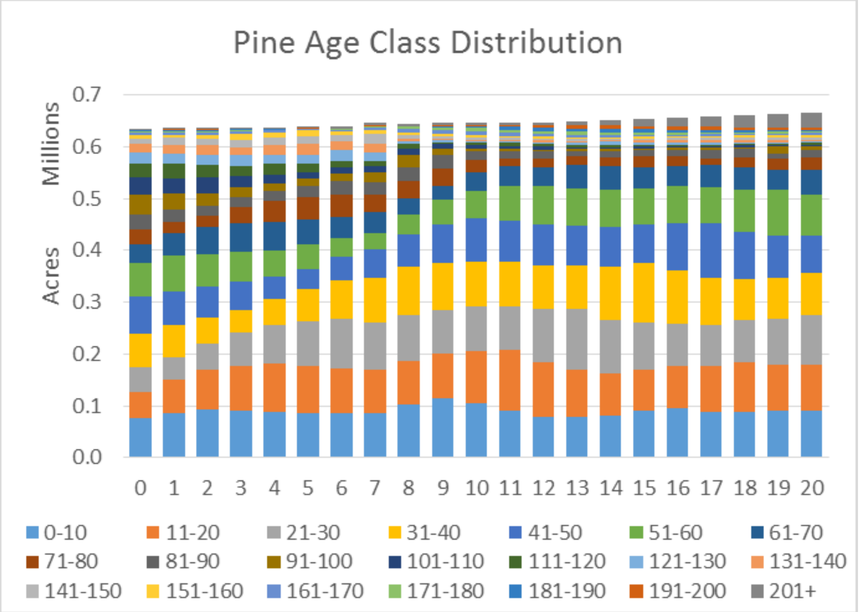

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

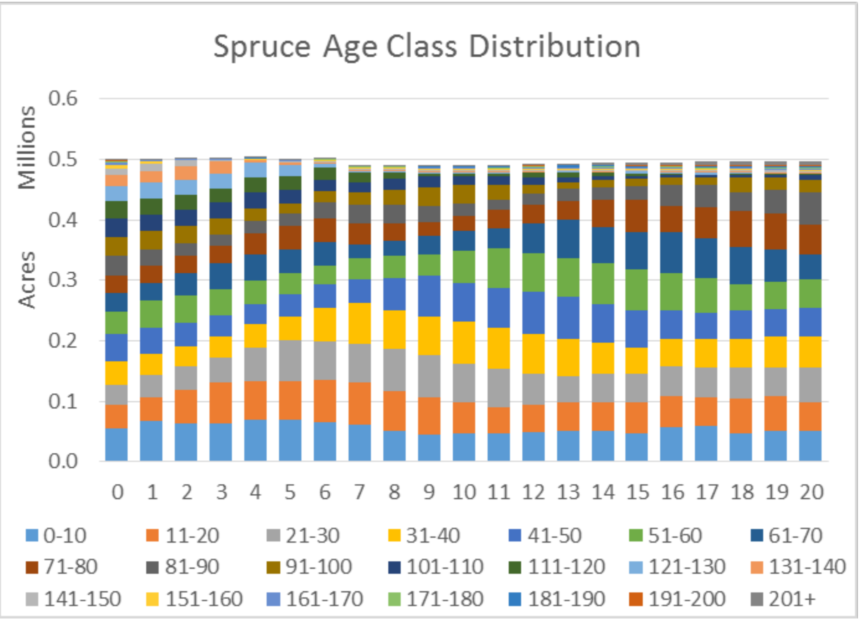

Open Watersheds by Planning Area
Percentage
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

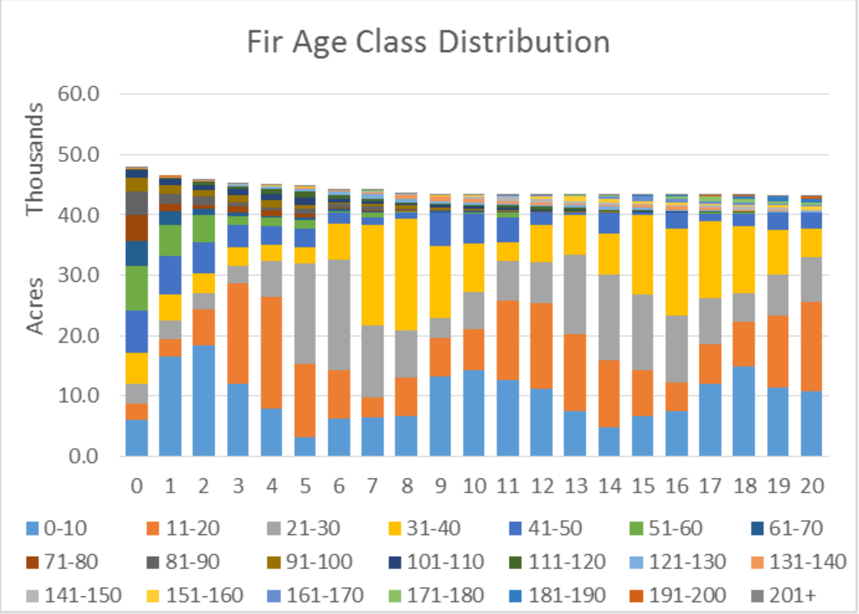

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

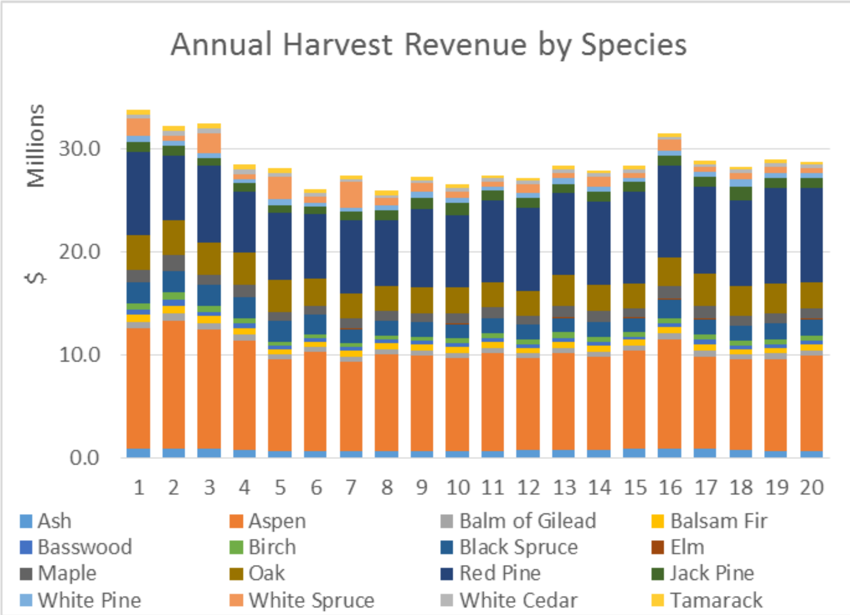

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

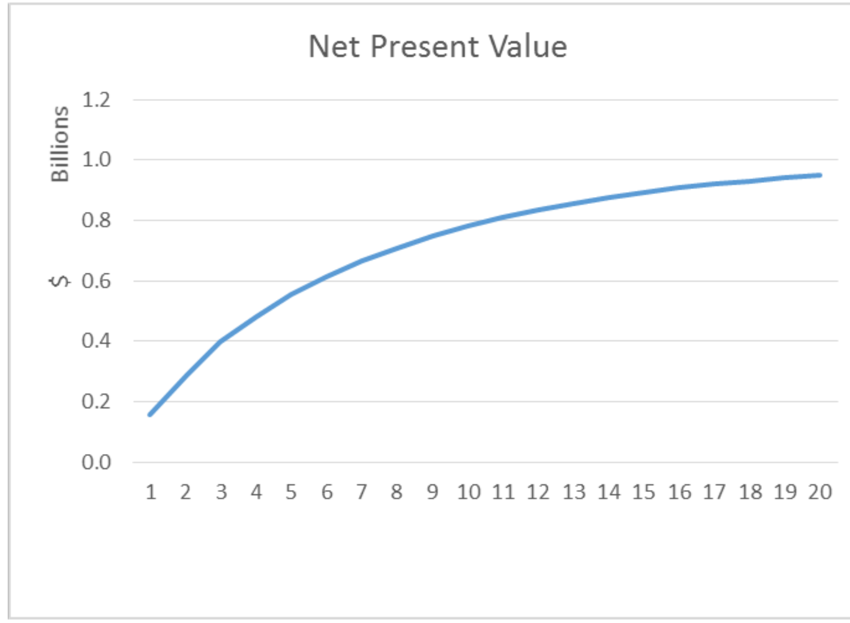

Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Millions
Acres
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

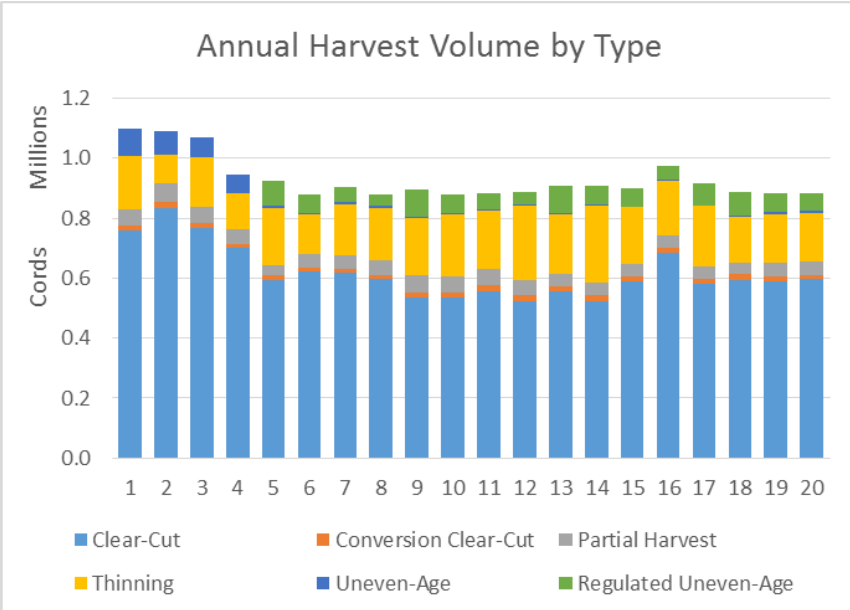

Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

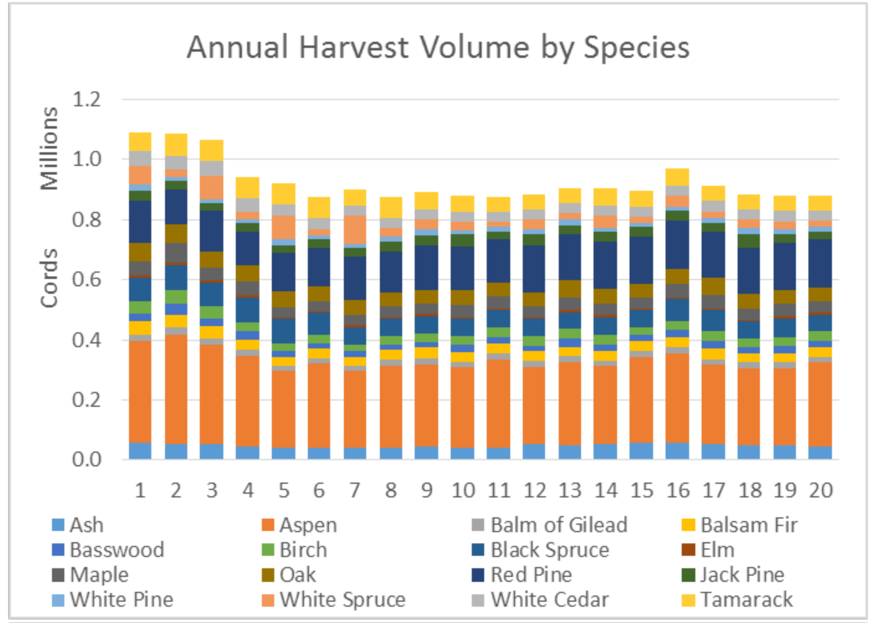

Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

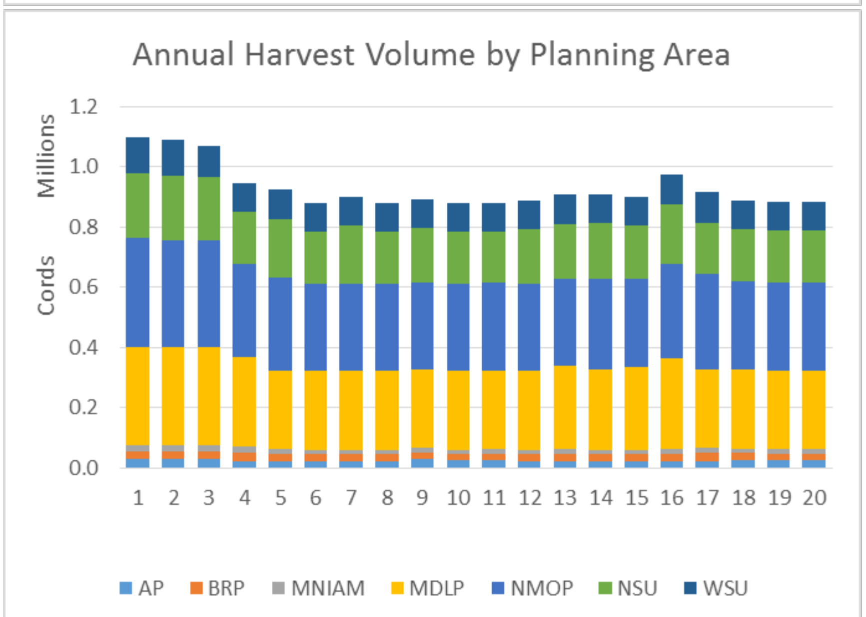

Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

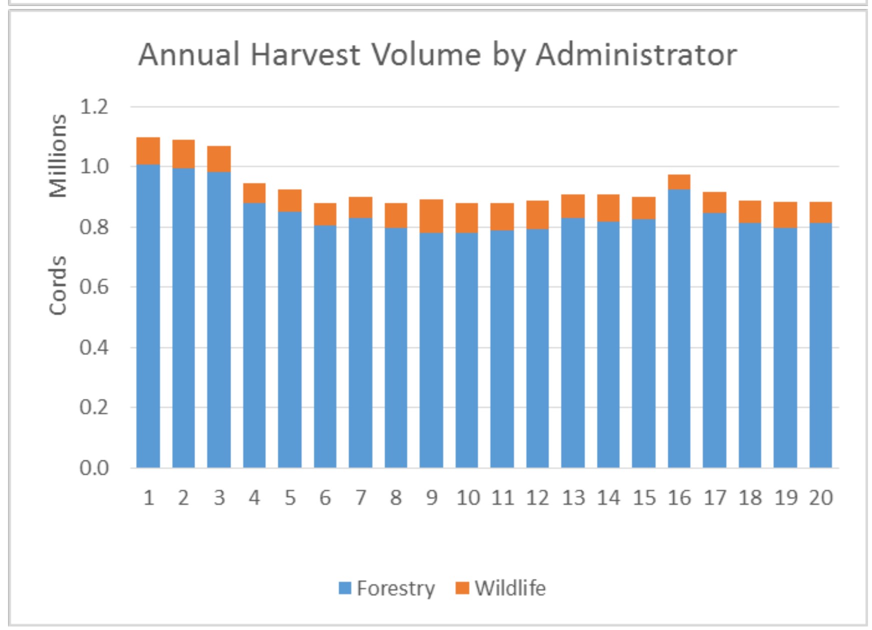

Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

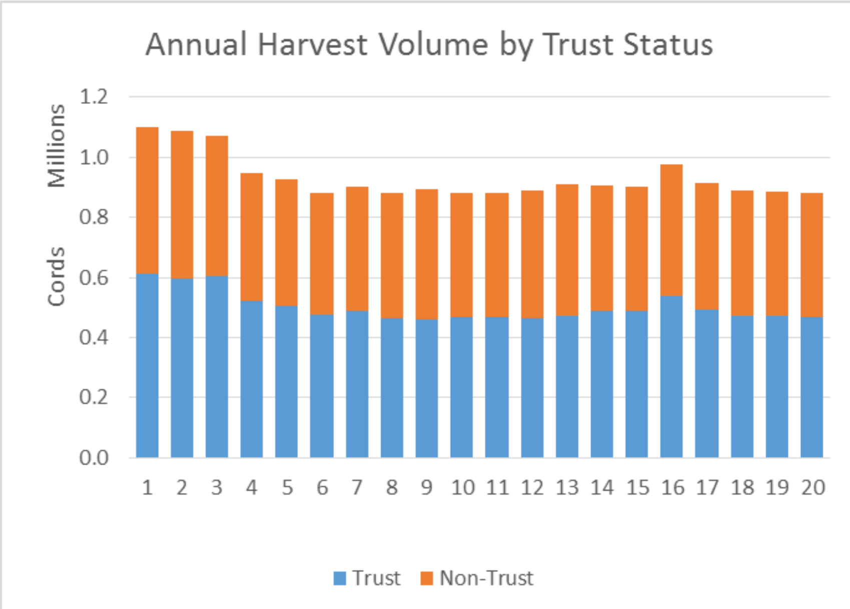
Scenario 1.2.2

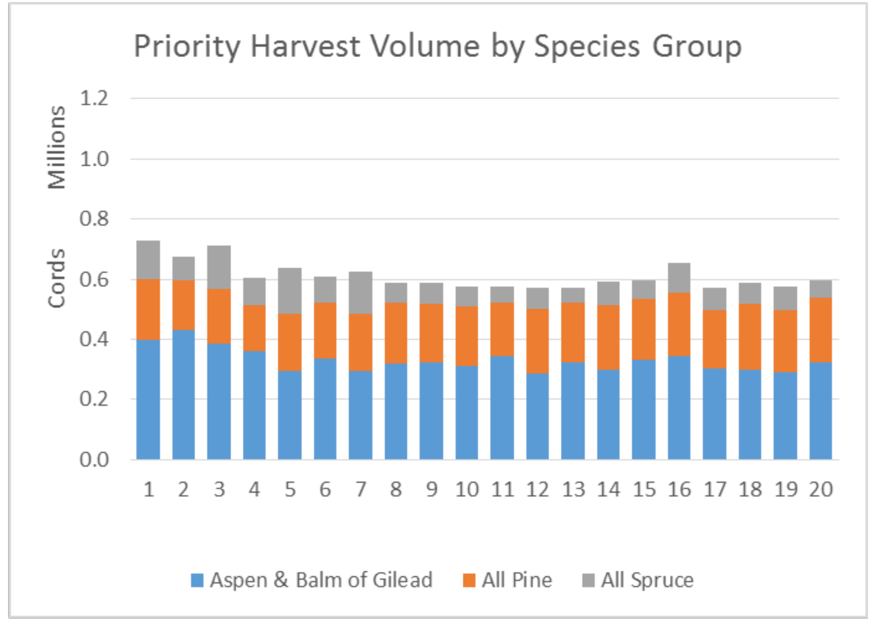


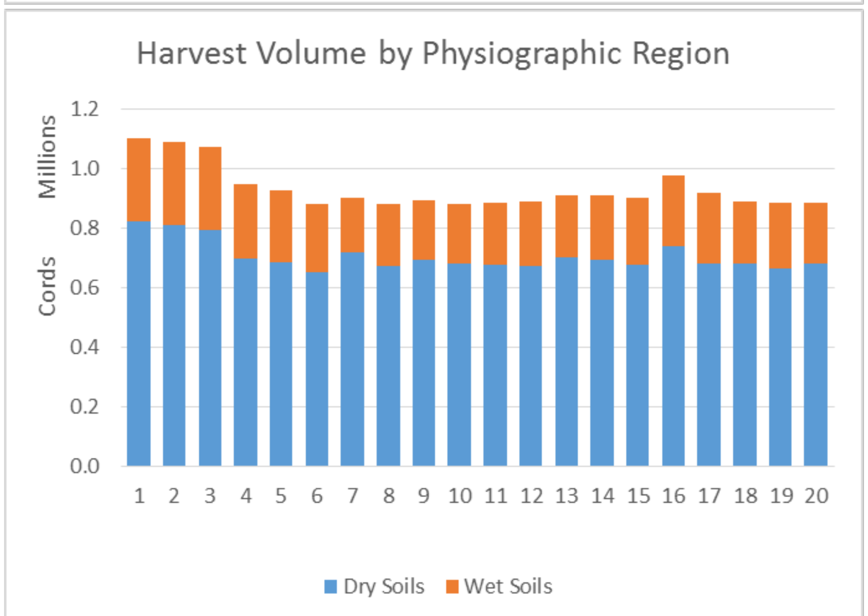


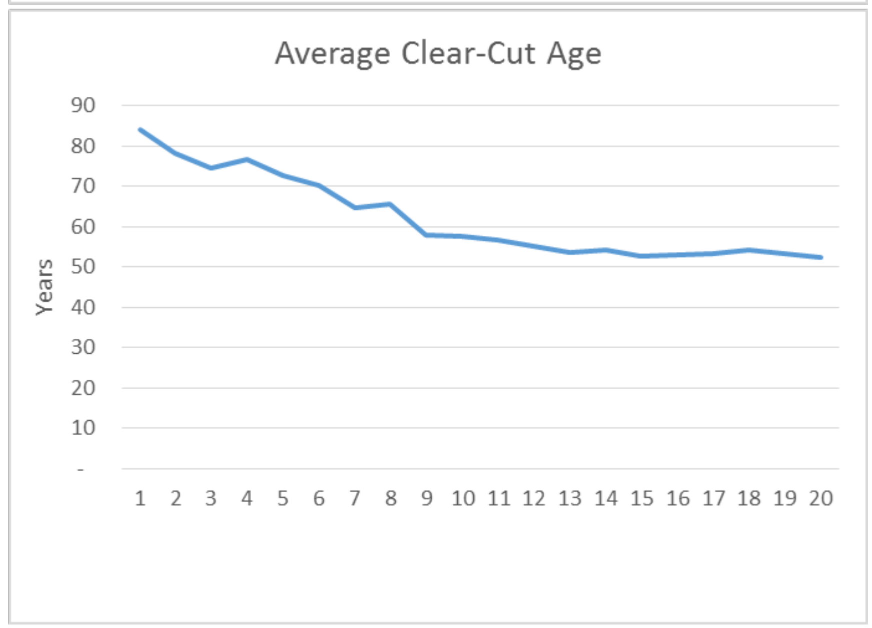


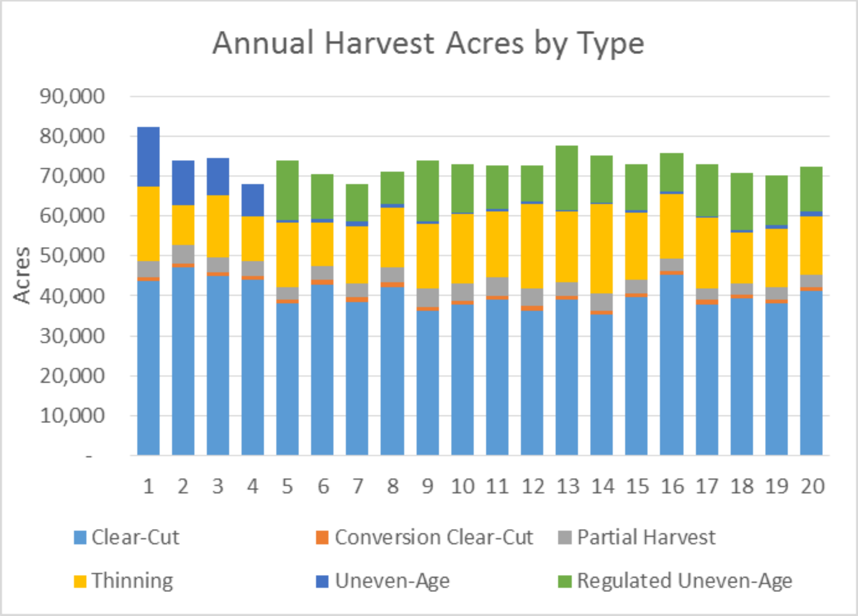


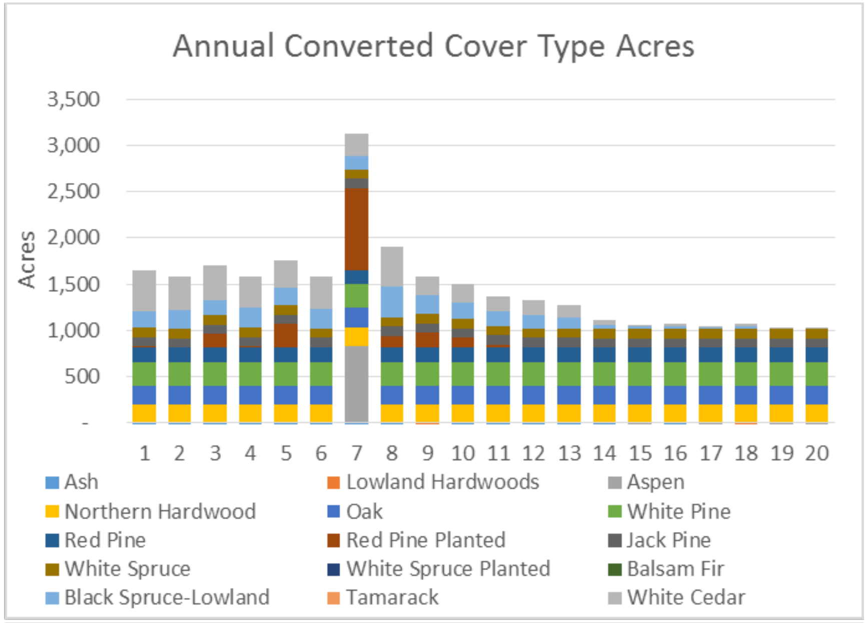

Annual Harvest Volume by Trust Status
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

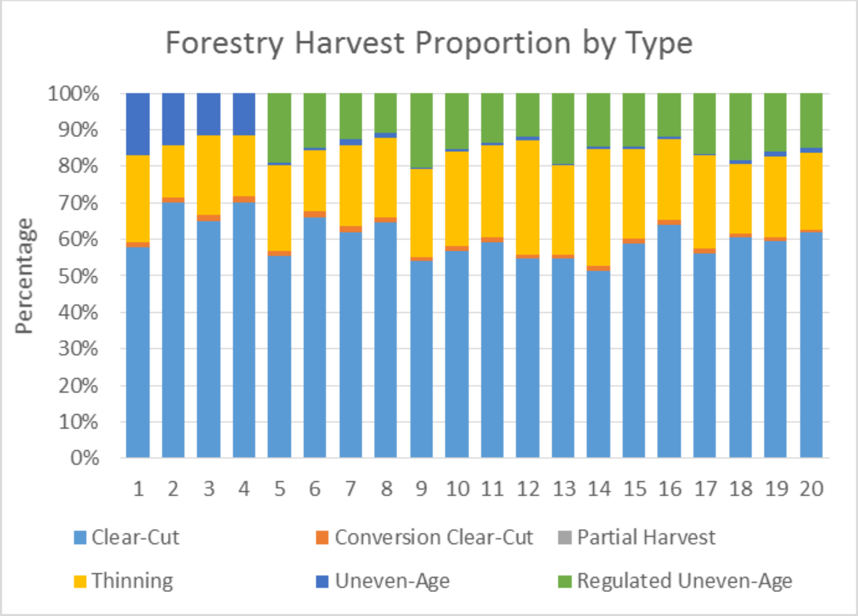

Priority Harvest Volume by Species Group
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

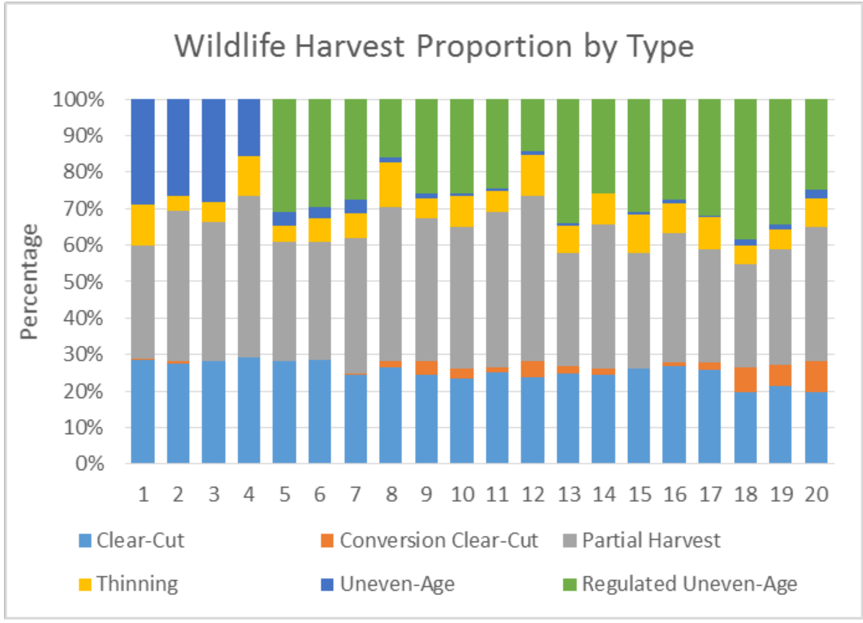

Harvest Volume by Physiographic Region
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

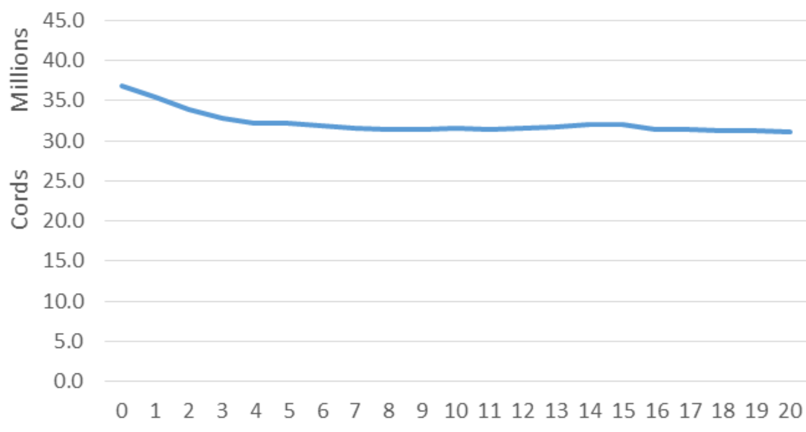

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age


Annual Converted Cover Type Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

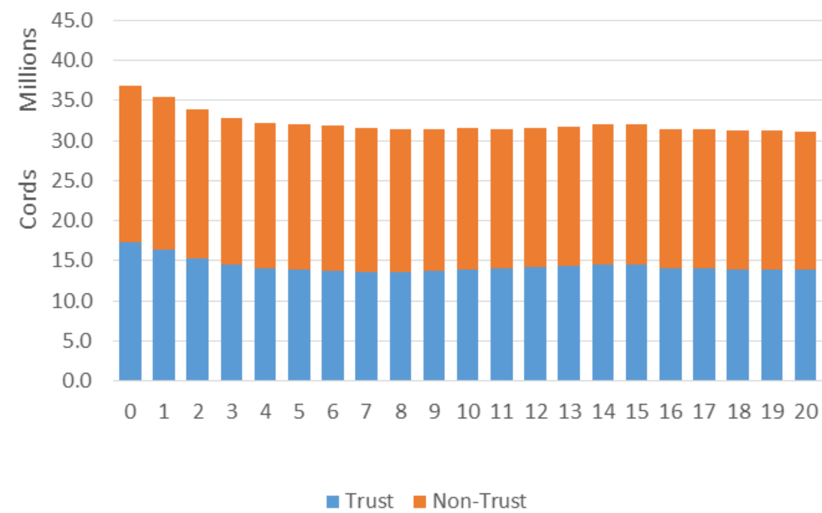

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age


Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

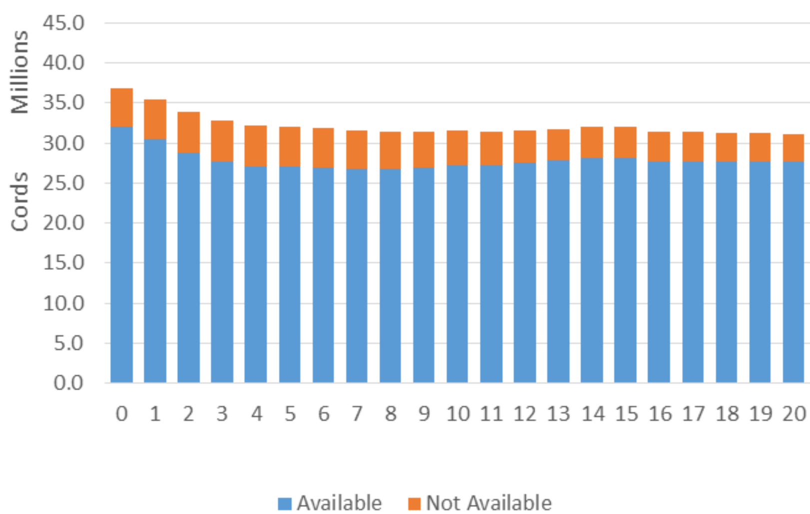
Total Inventory



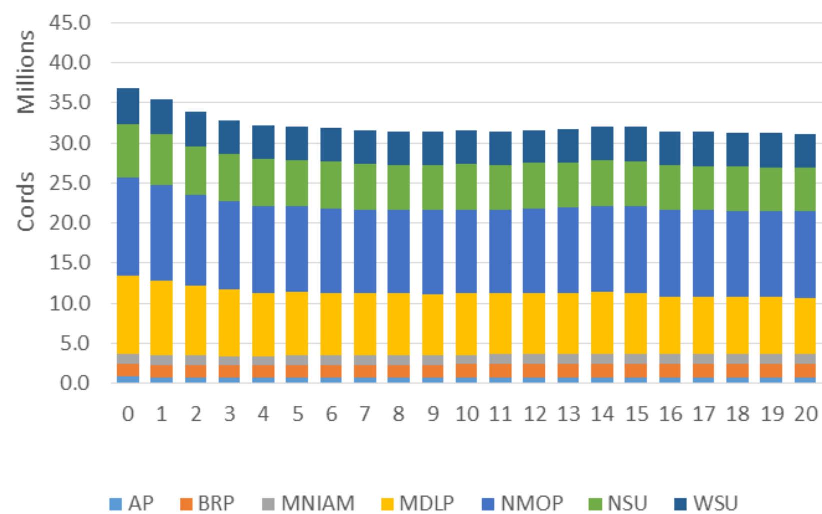
Total Inventory by Trust Status

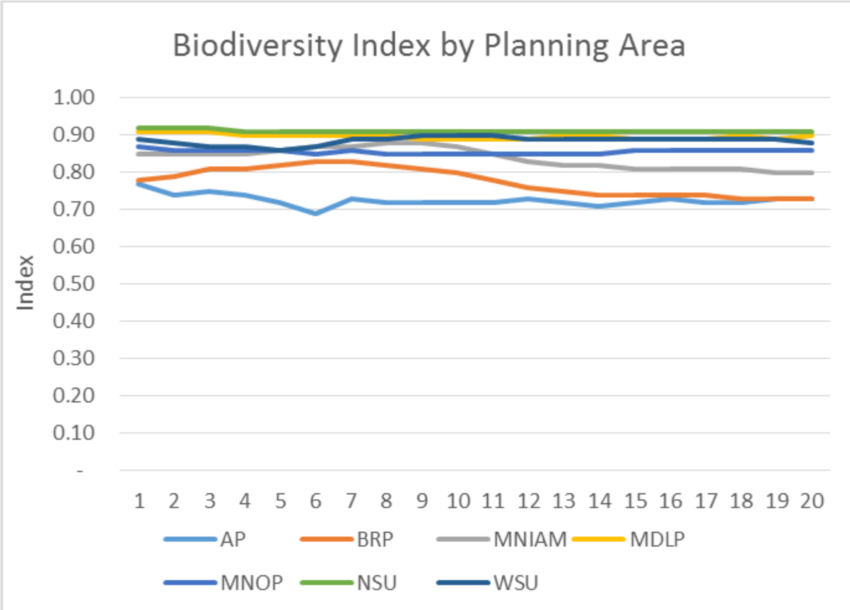


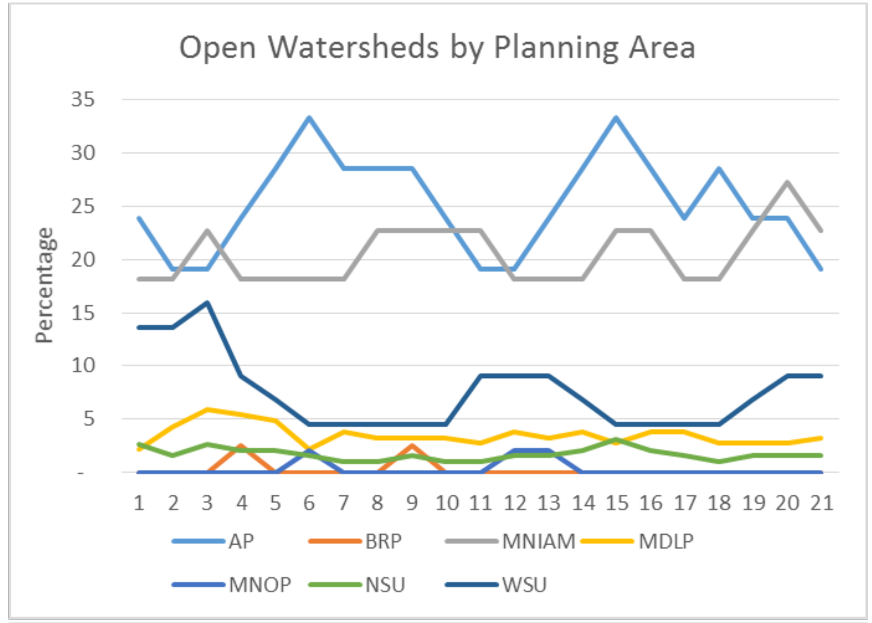
Total Inventory by Management Availability

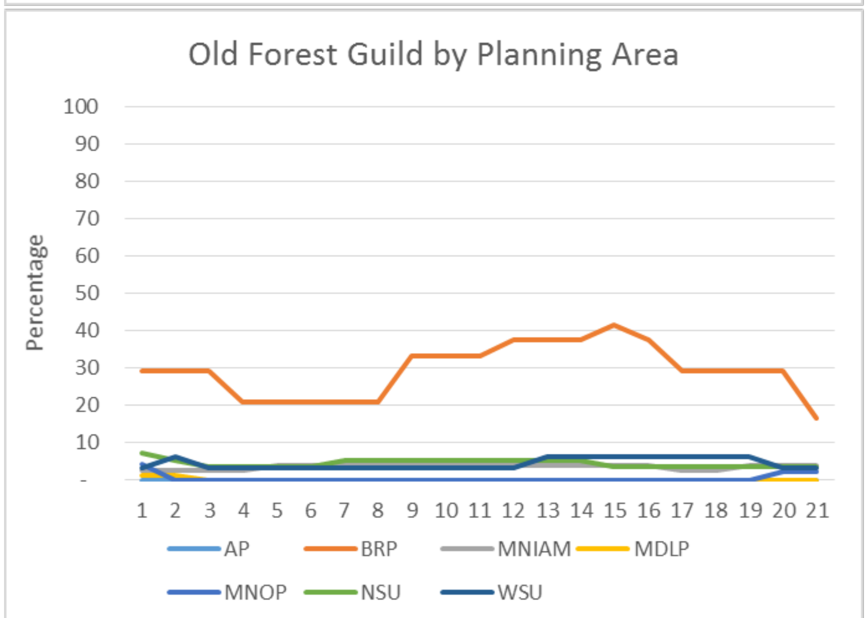


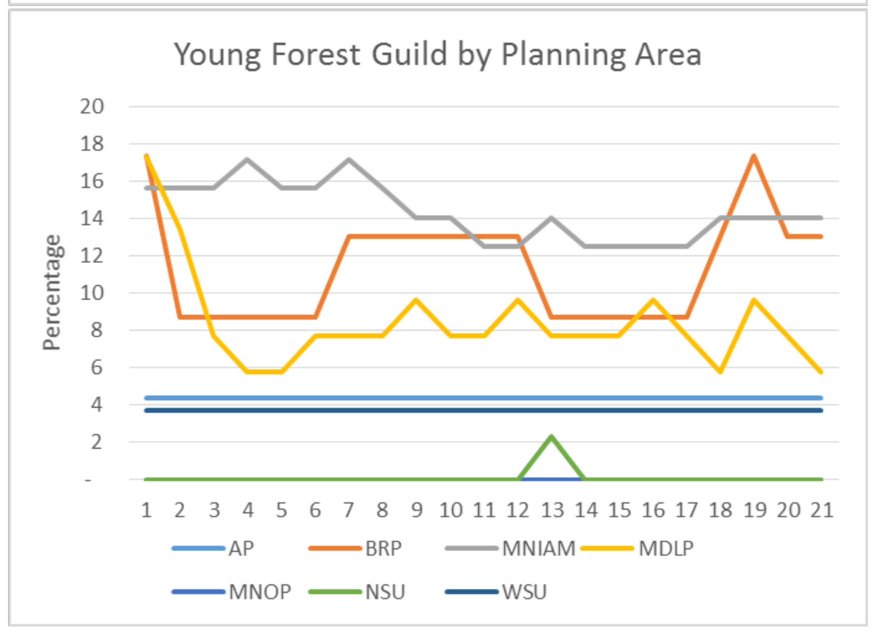
Total Inventory by Planning Area

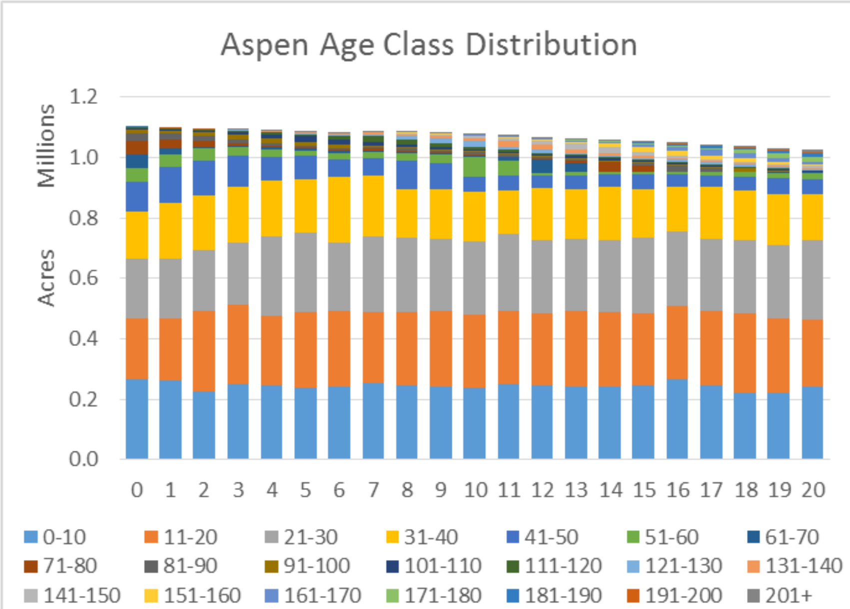


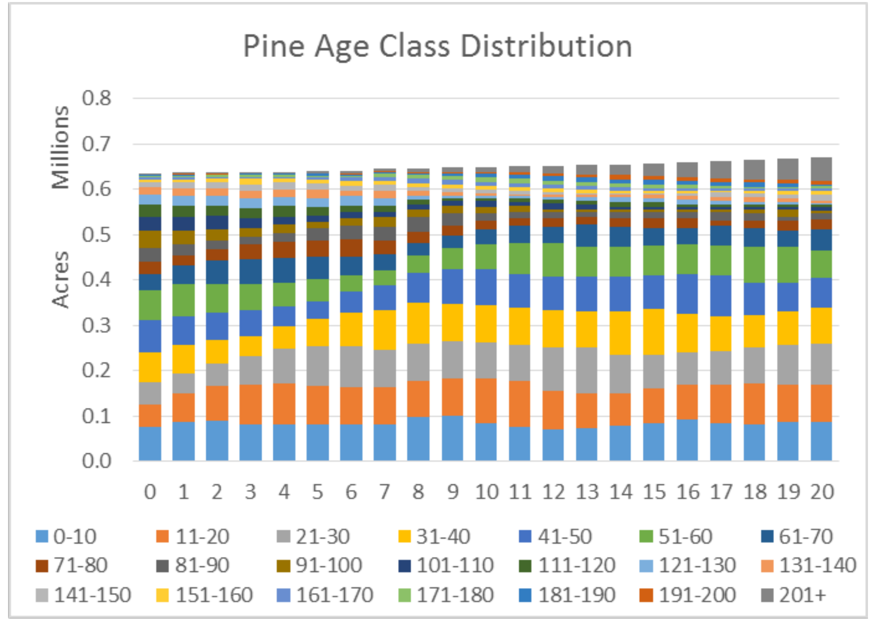

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

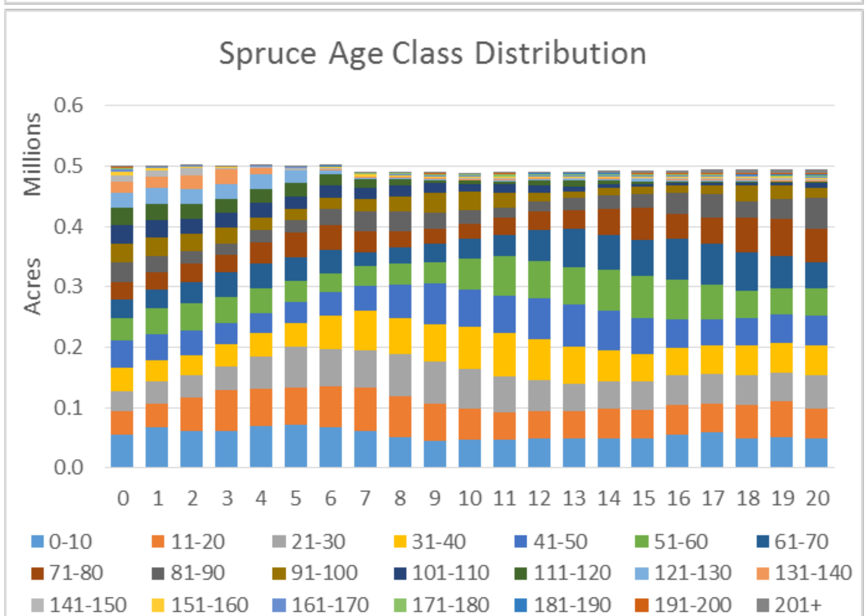

Open Watersheds by Planning Area
Percentage
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

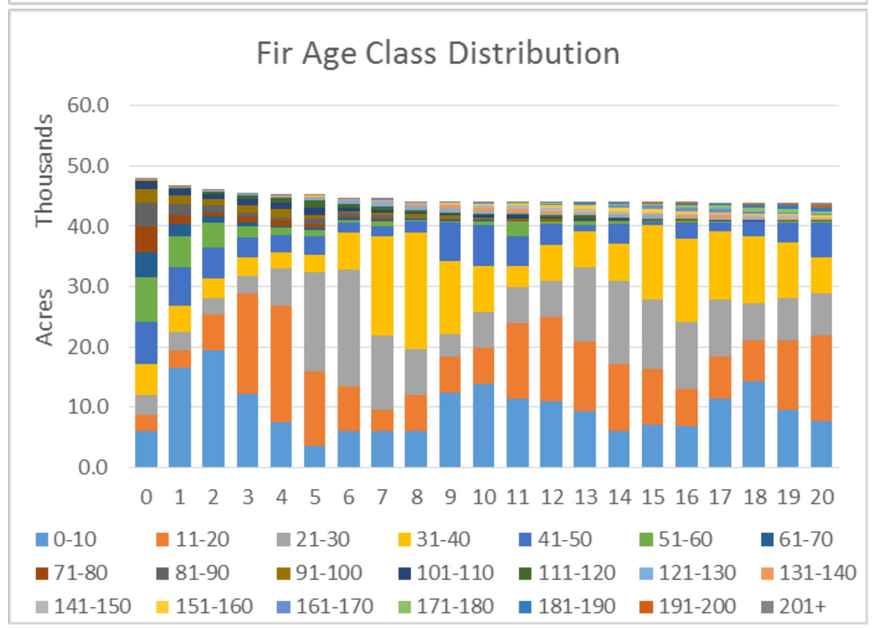

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

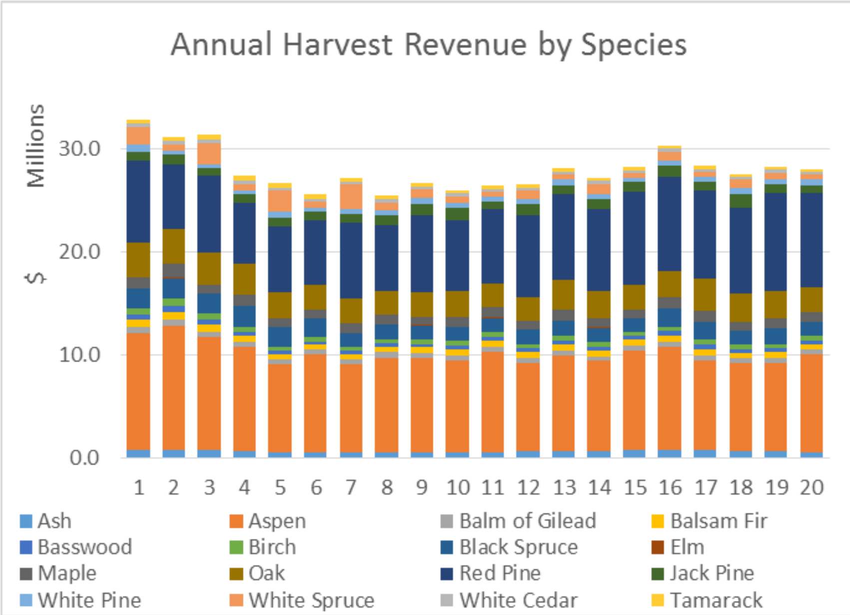

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

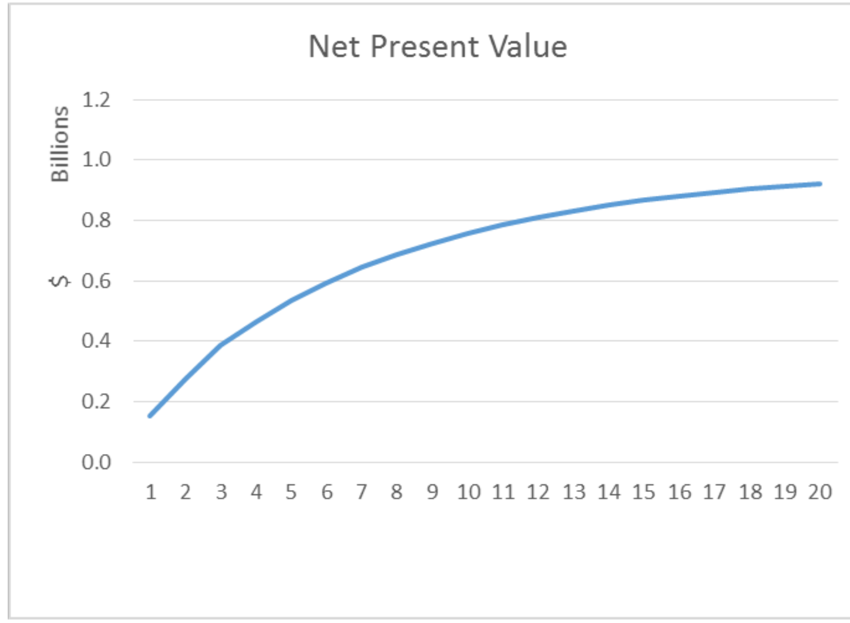

Pine Age Class Distribution
Millions
Acres
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
0.0
10.0
20.0
30.0
40.0
50.0
60.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

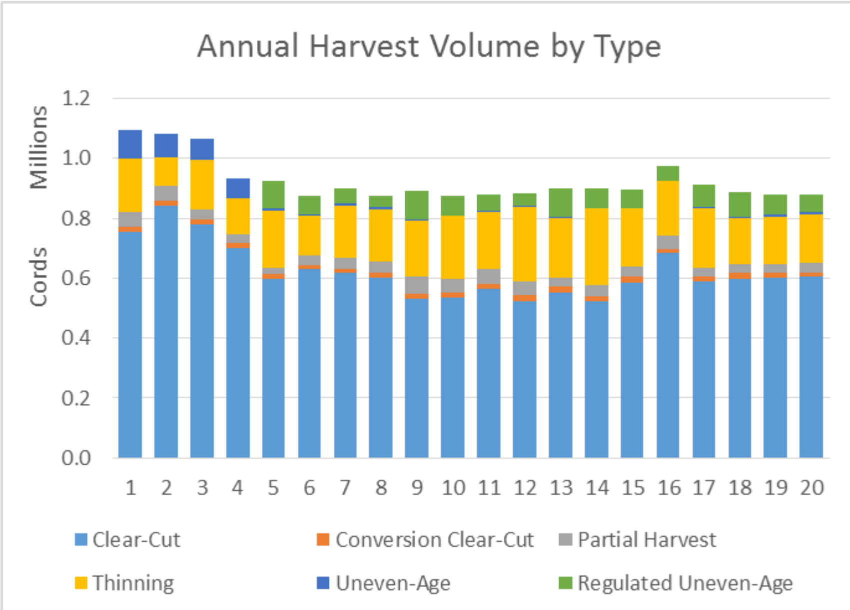


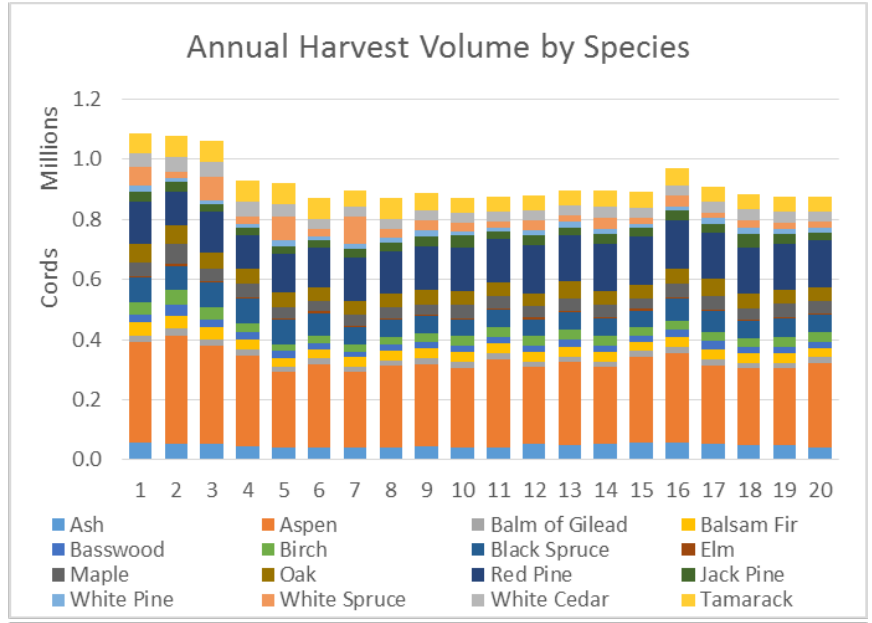
Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

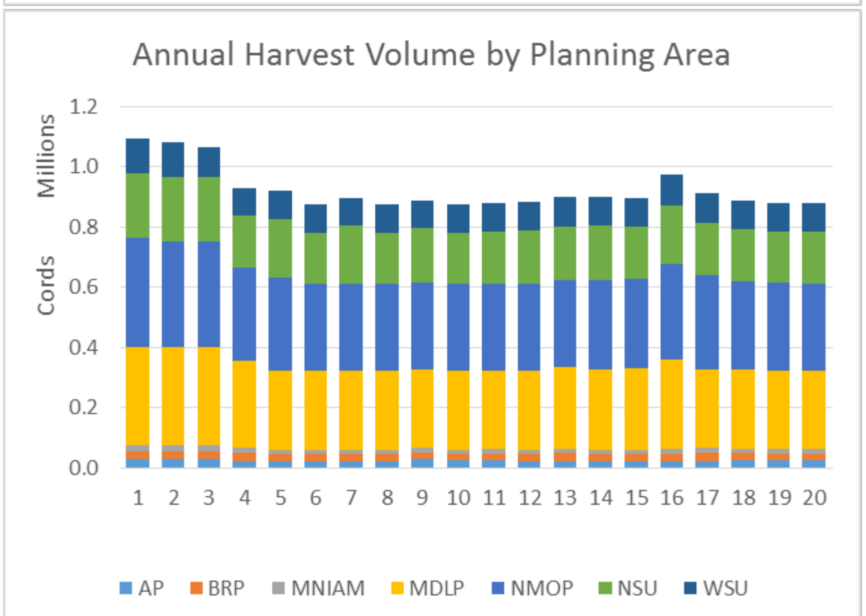


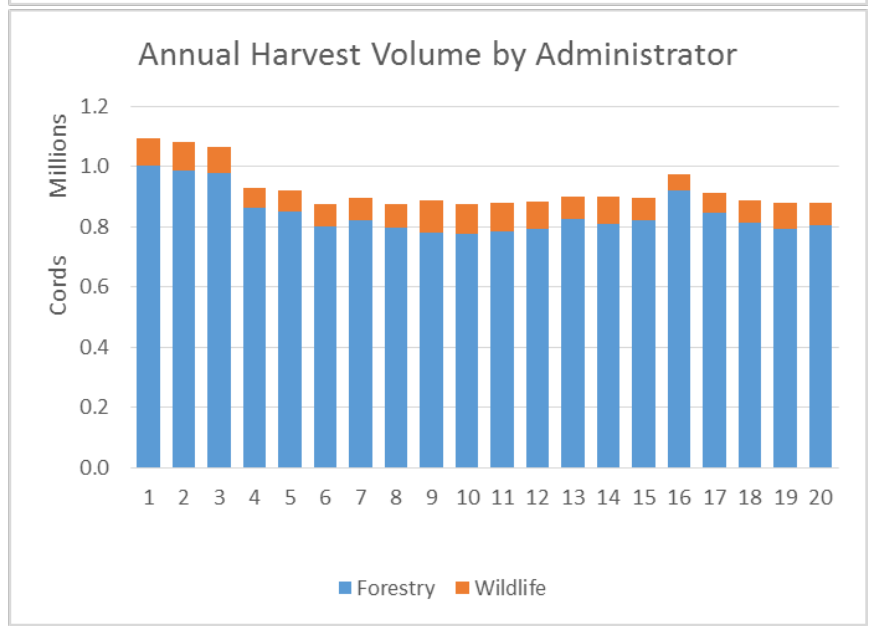
Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

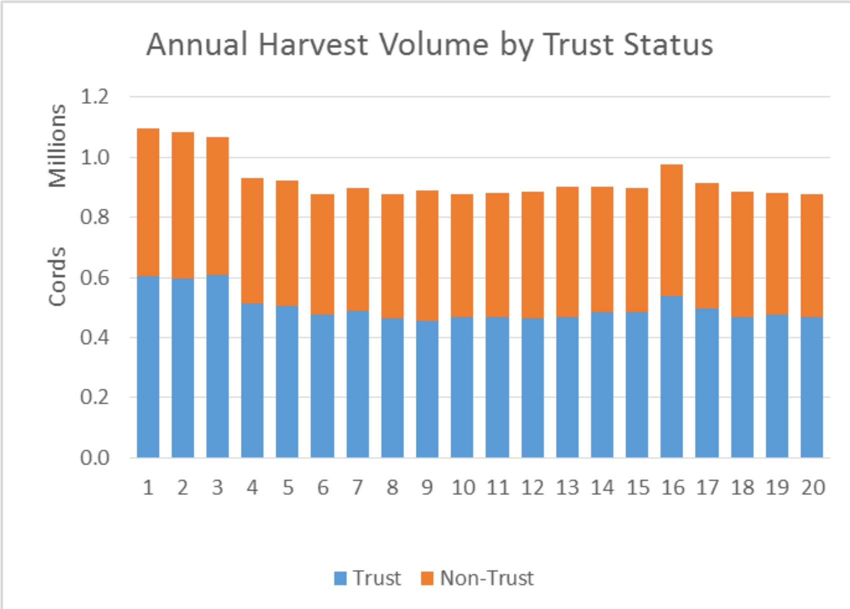
Scenario 1.2.3

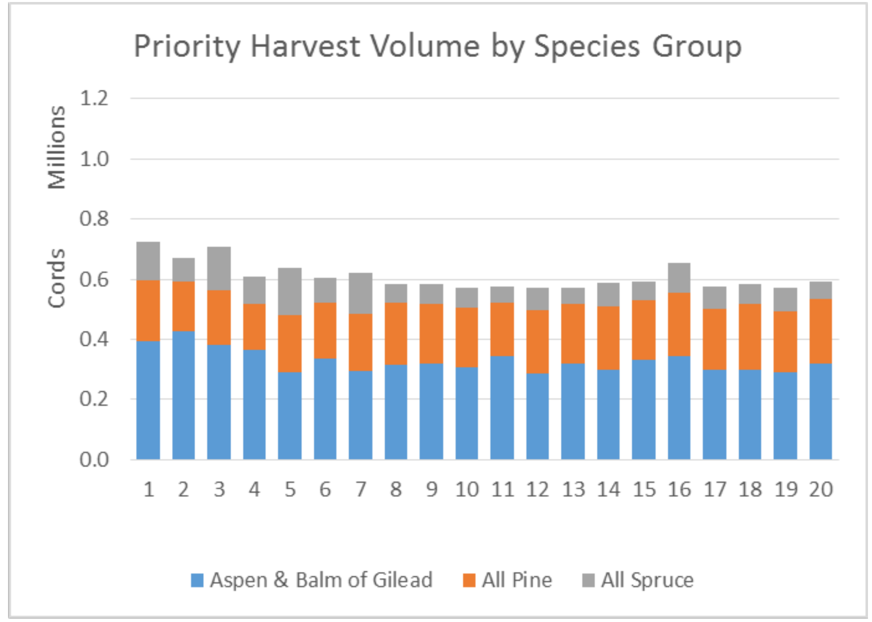


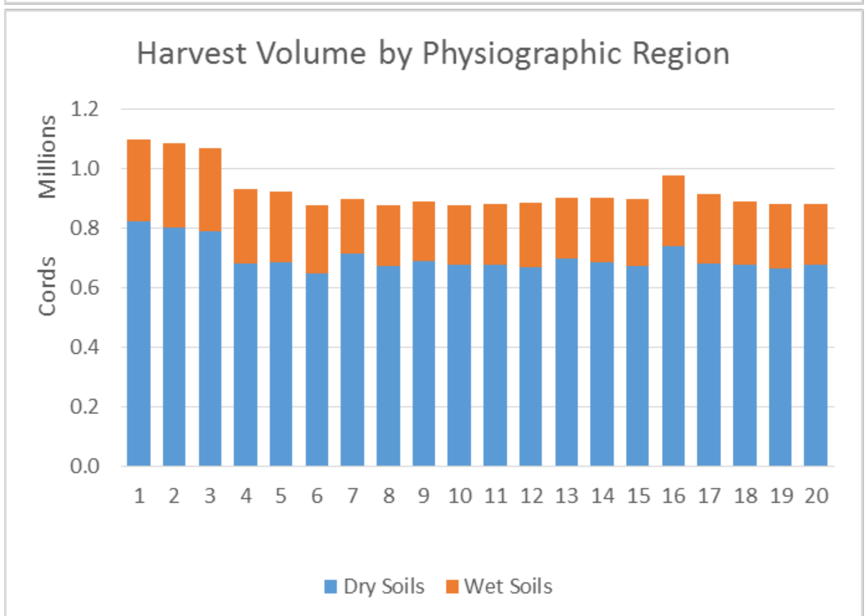


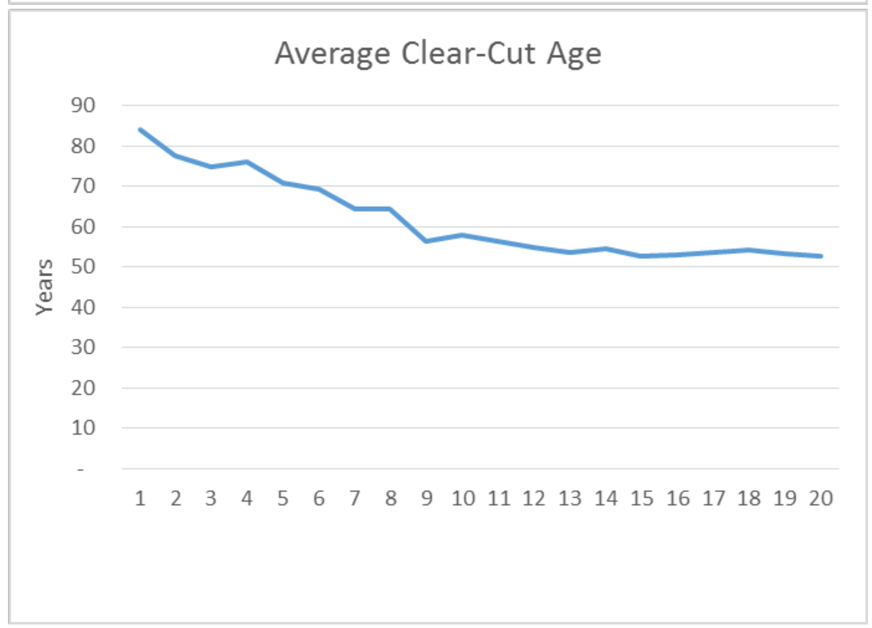


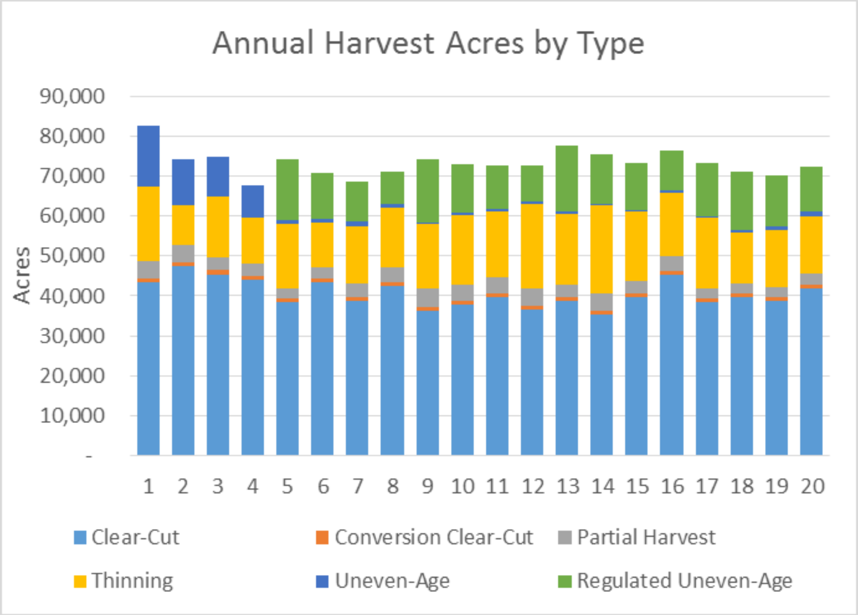


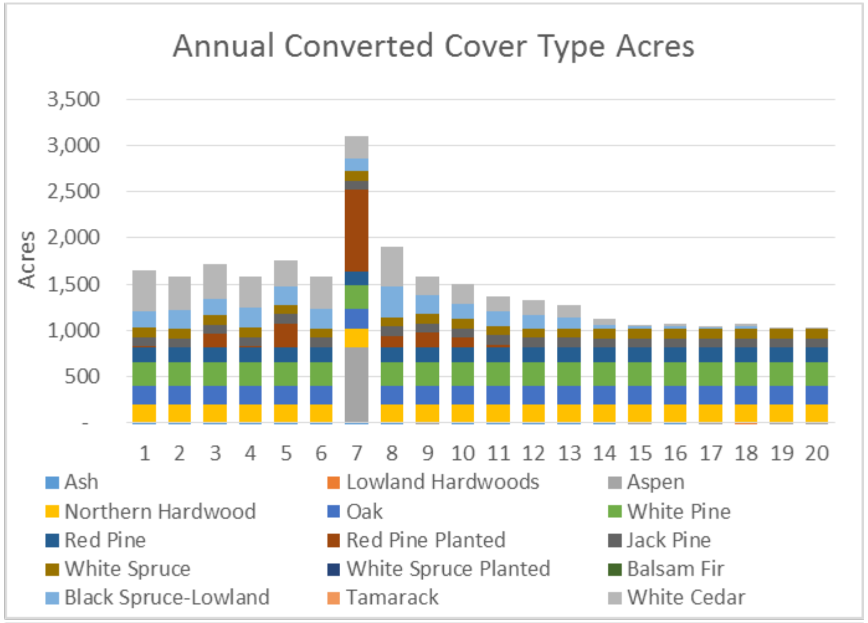

Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

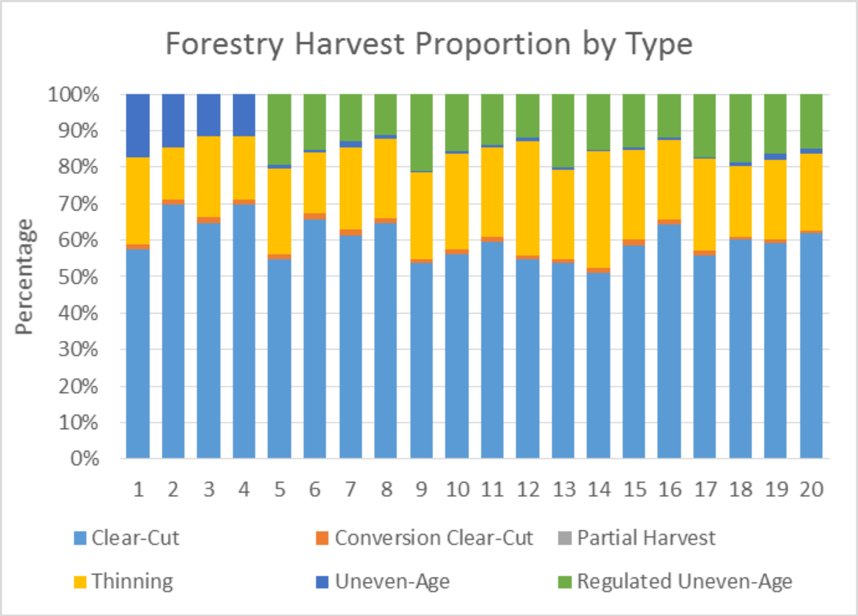

Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

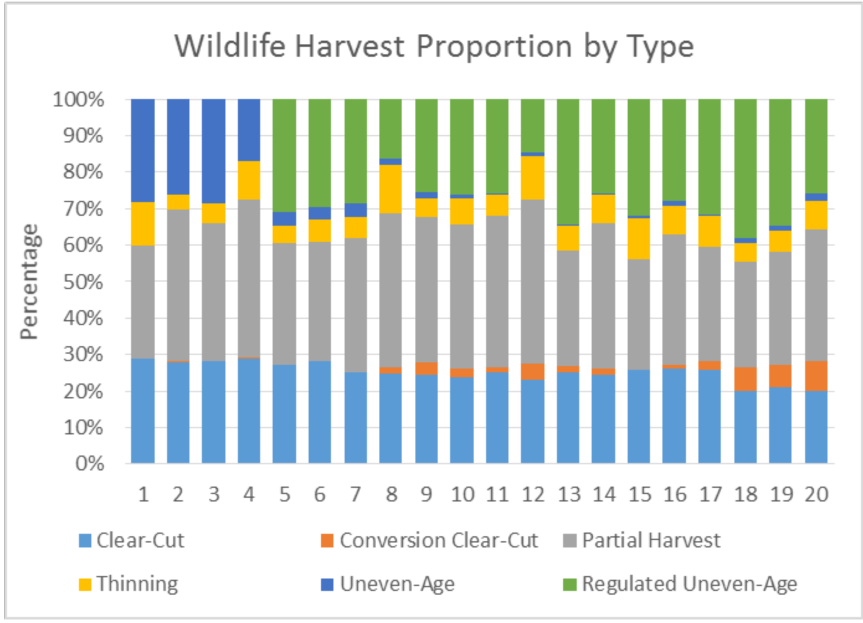

Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

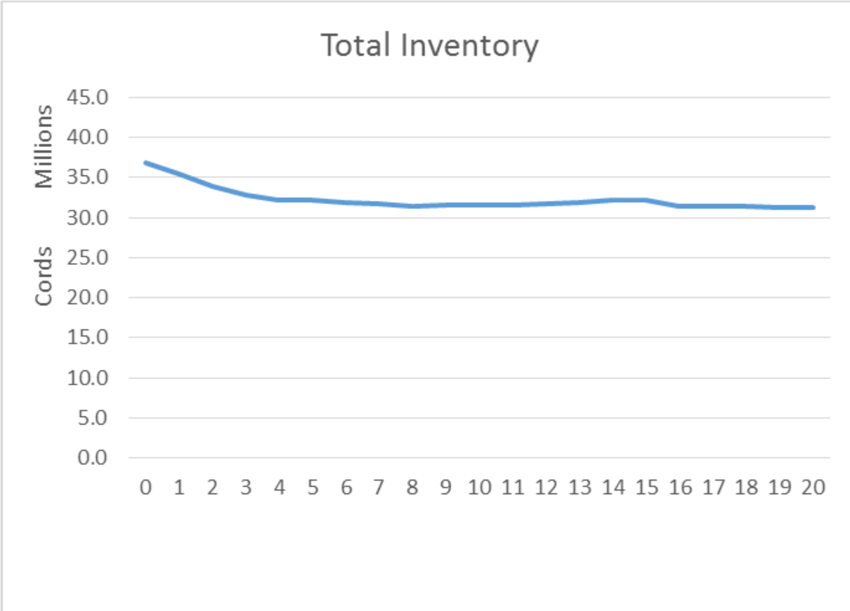

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

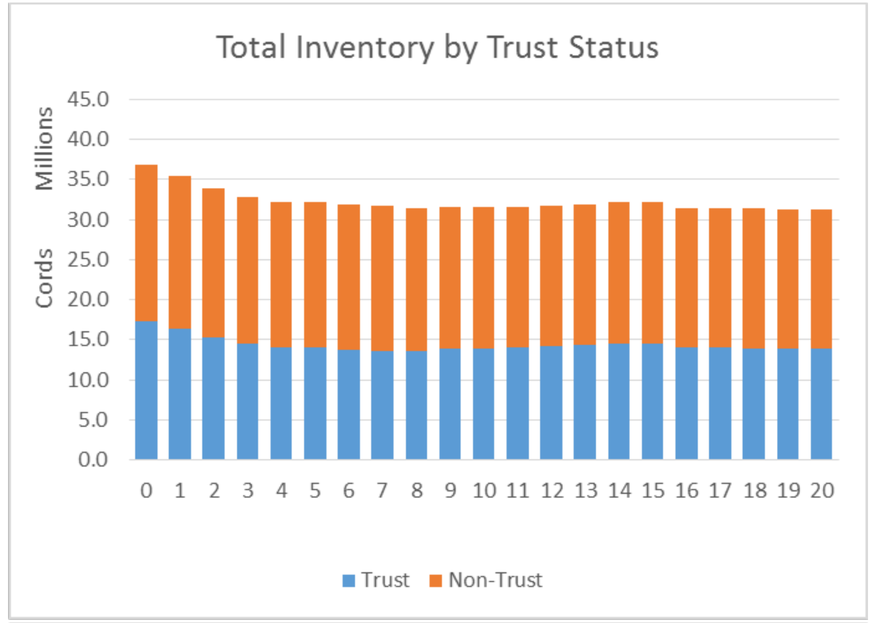

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

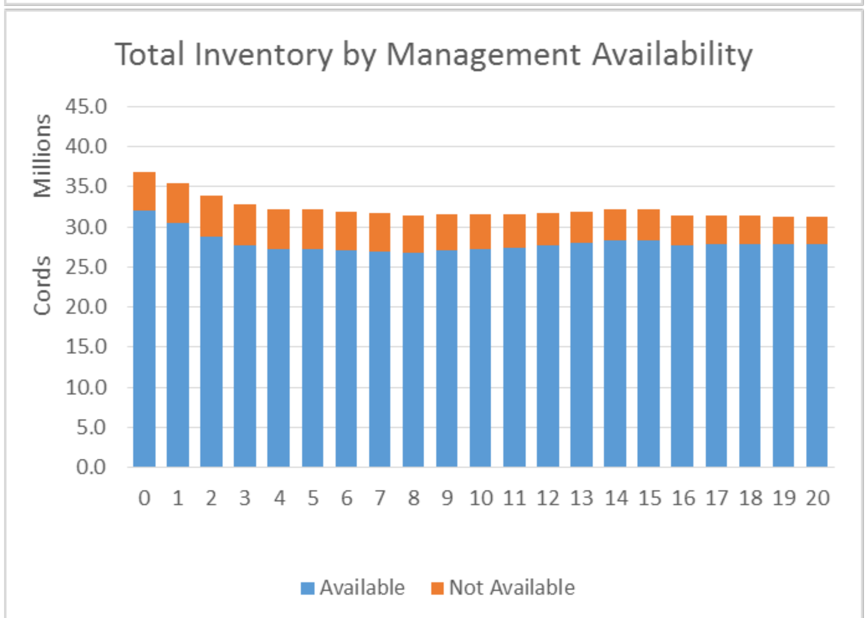

Annual Converted Cover Type Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

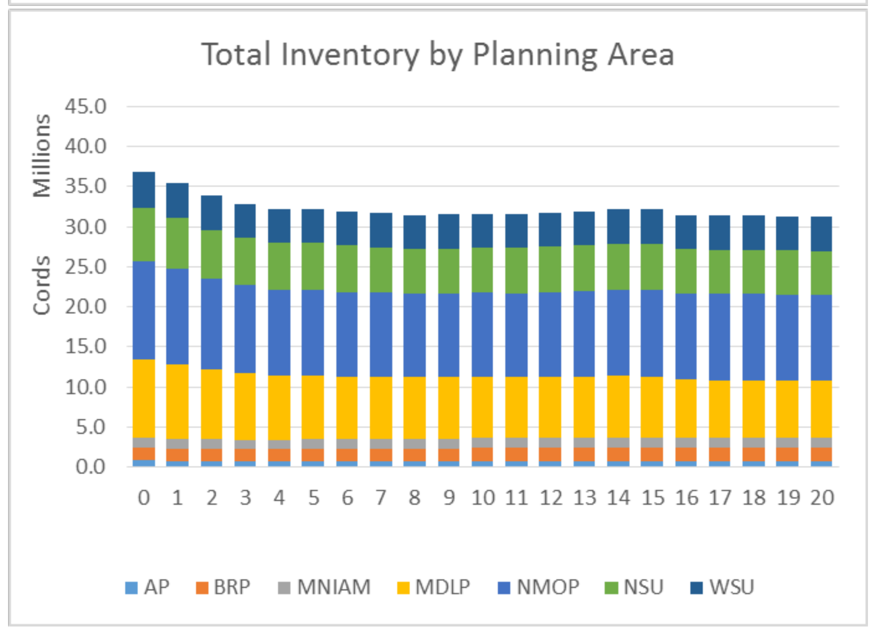

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

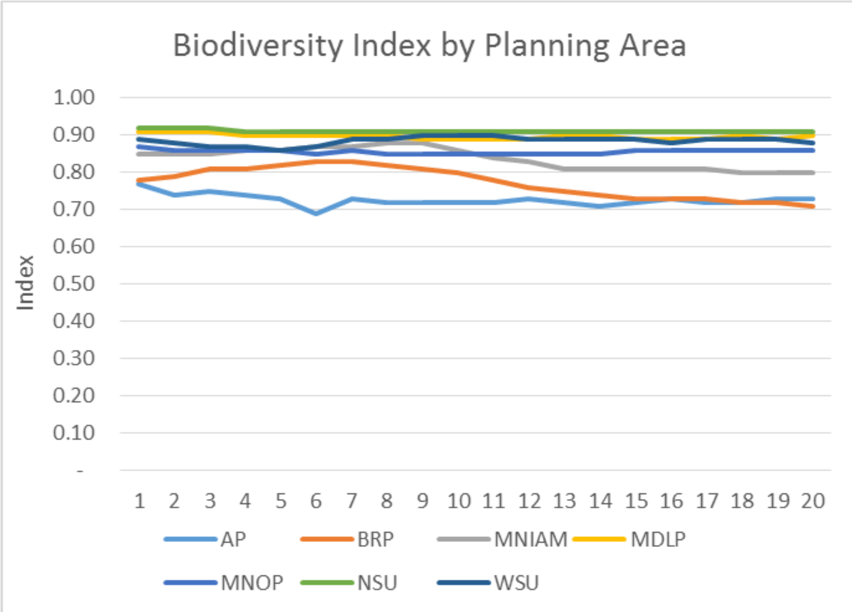

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

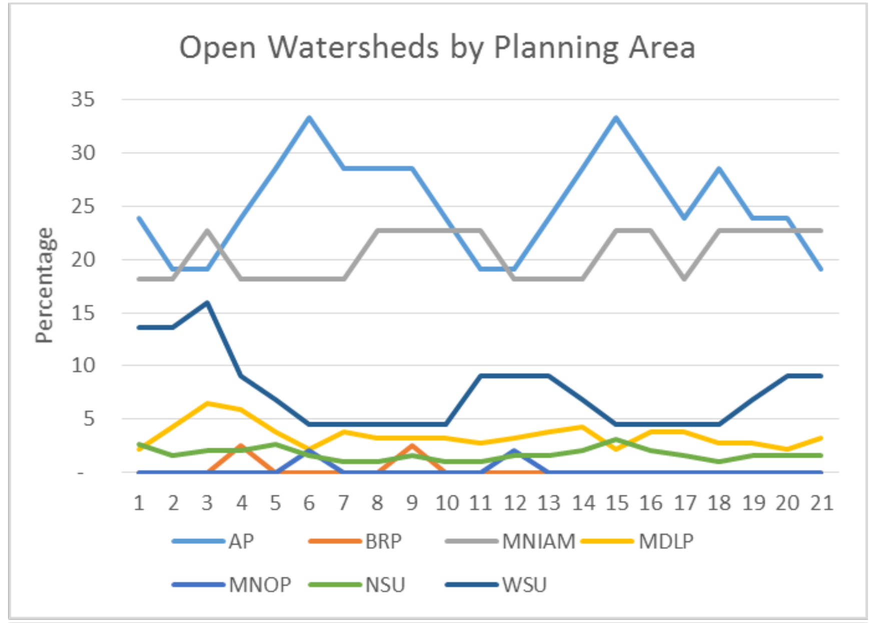

Total Inventory
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

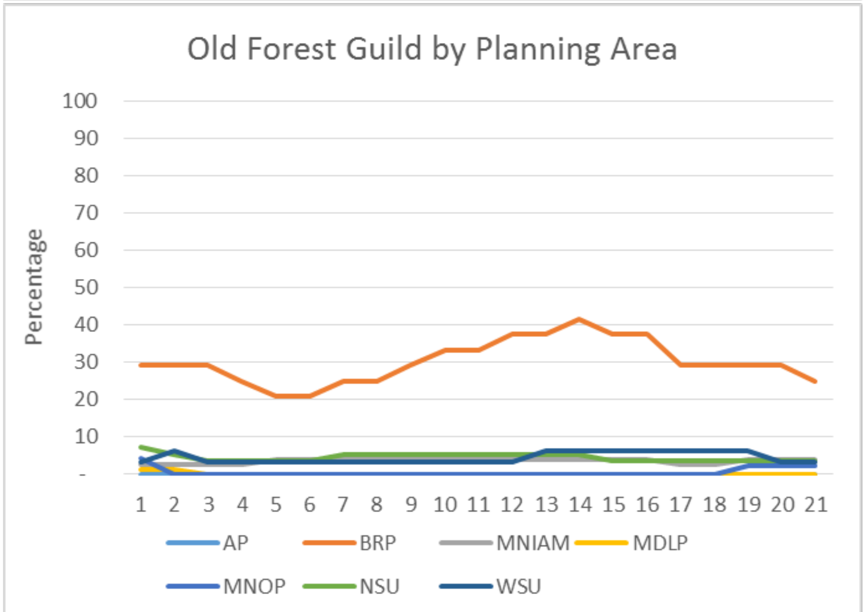

Total Inventory by Trust Status
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

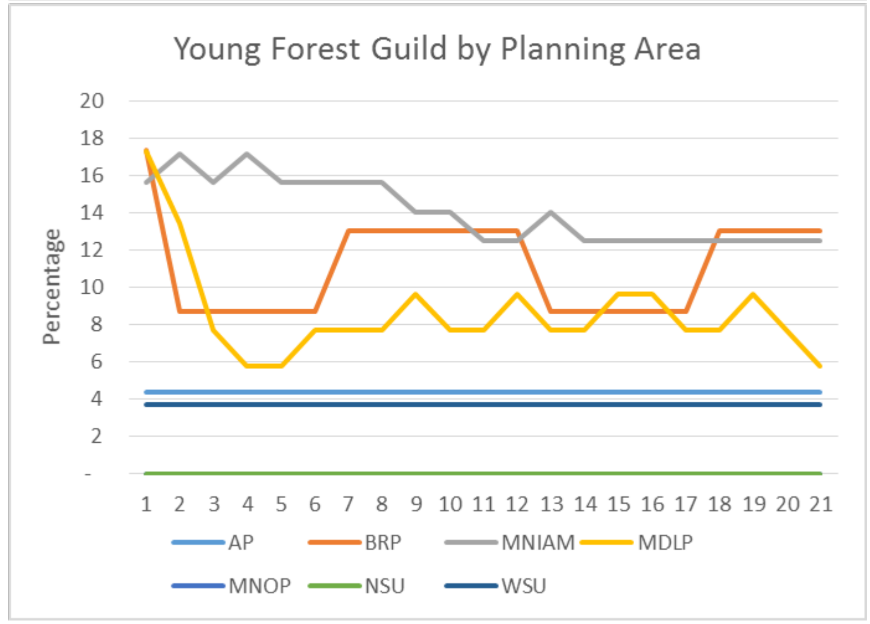

Total Inventory by Management Availability
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

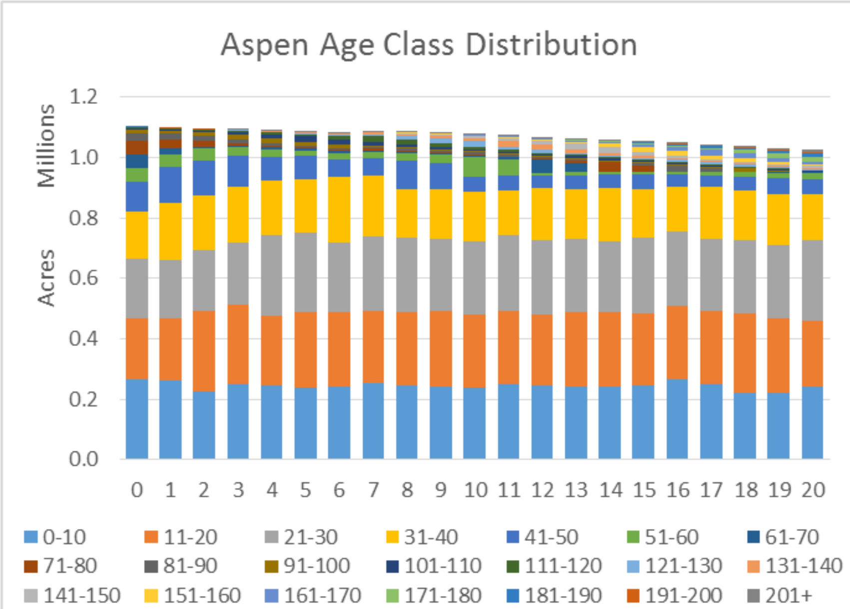

Total Inventory by Planning Area
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

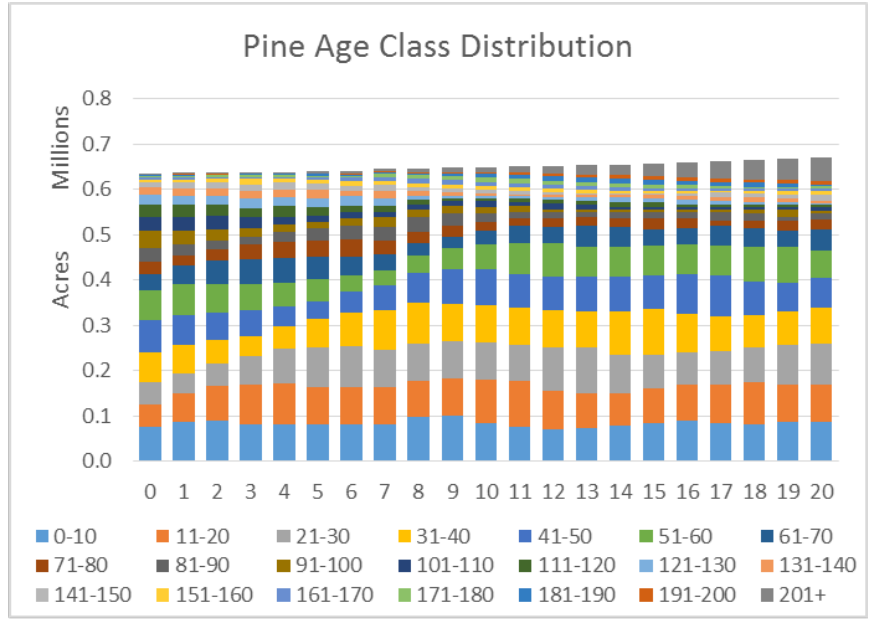

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

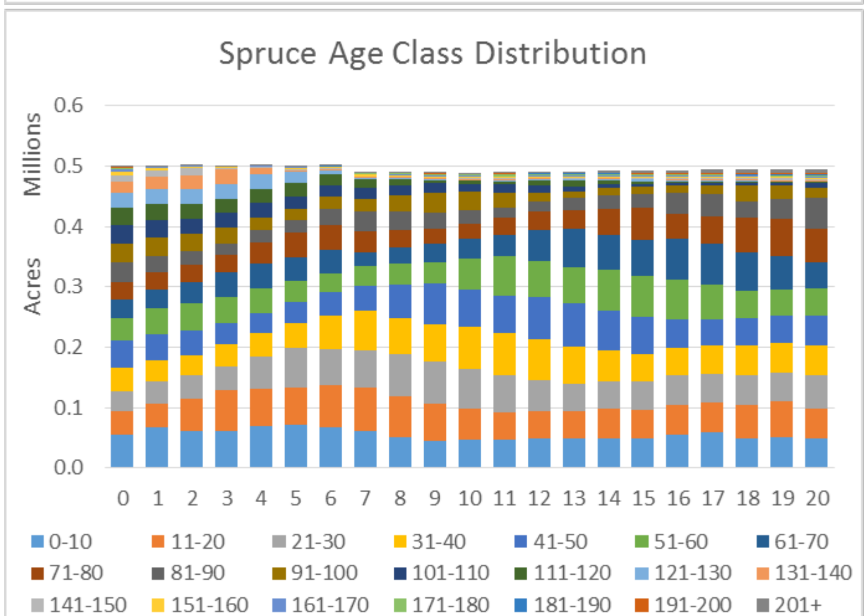

Open Watersheds by Planning Area
Percentage
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

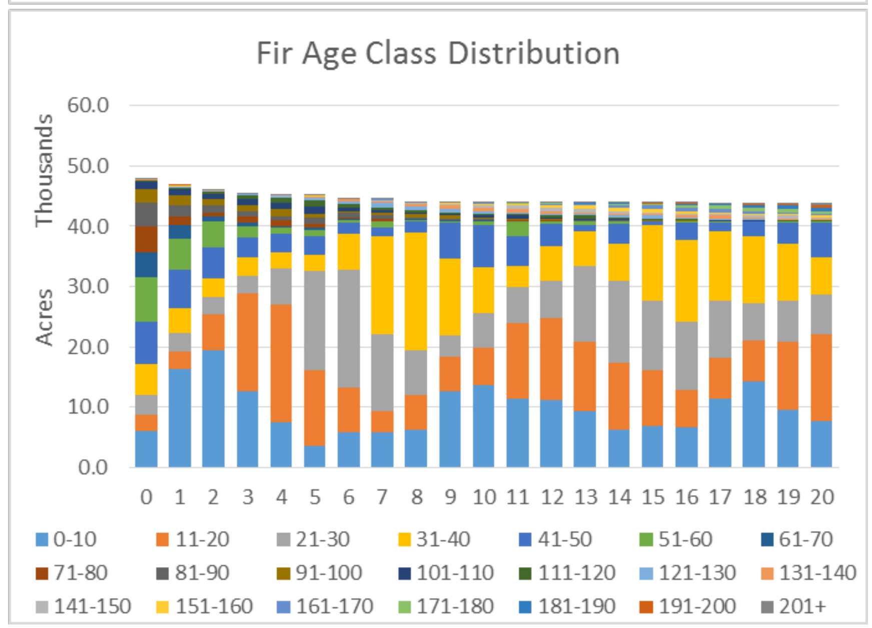

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

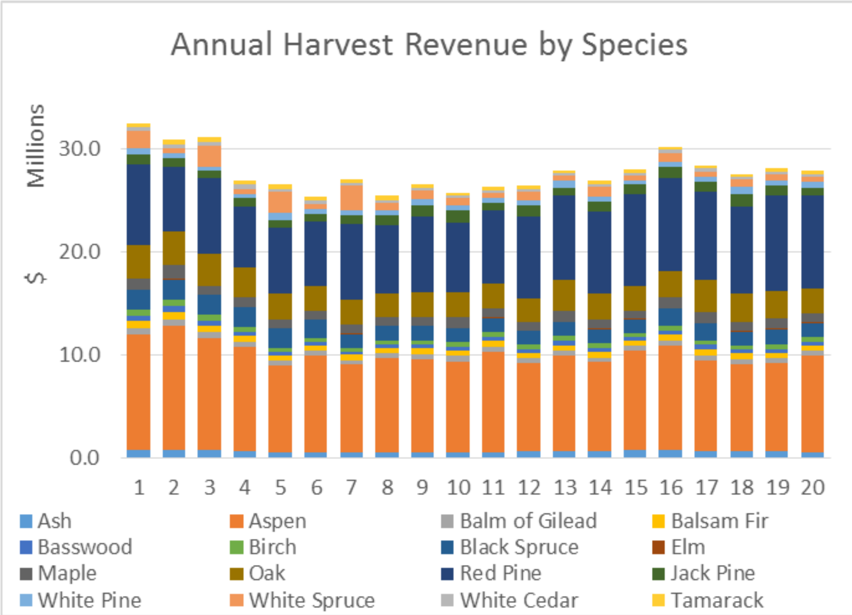

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

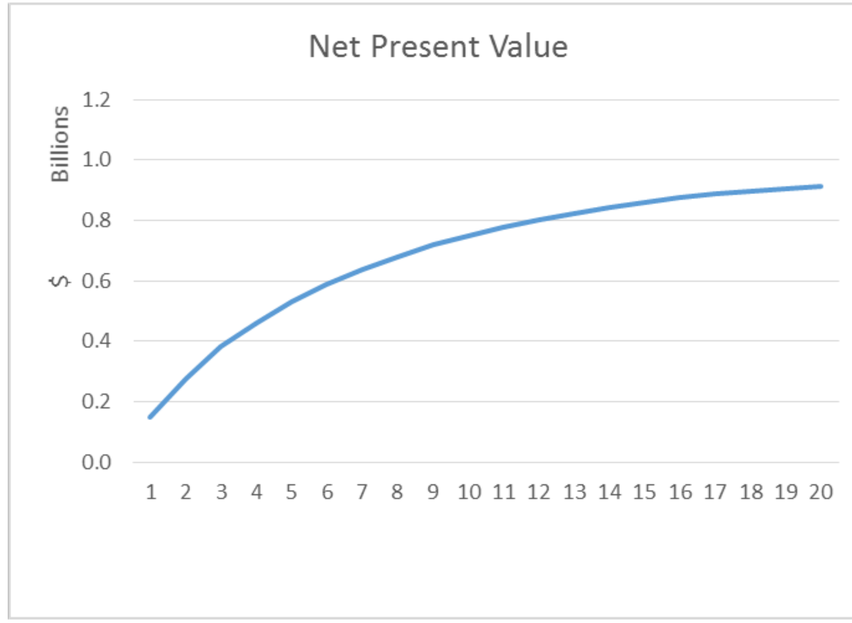

Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

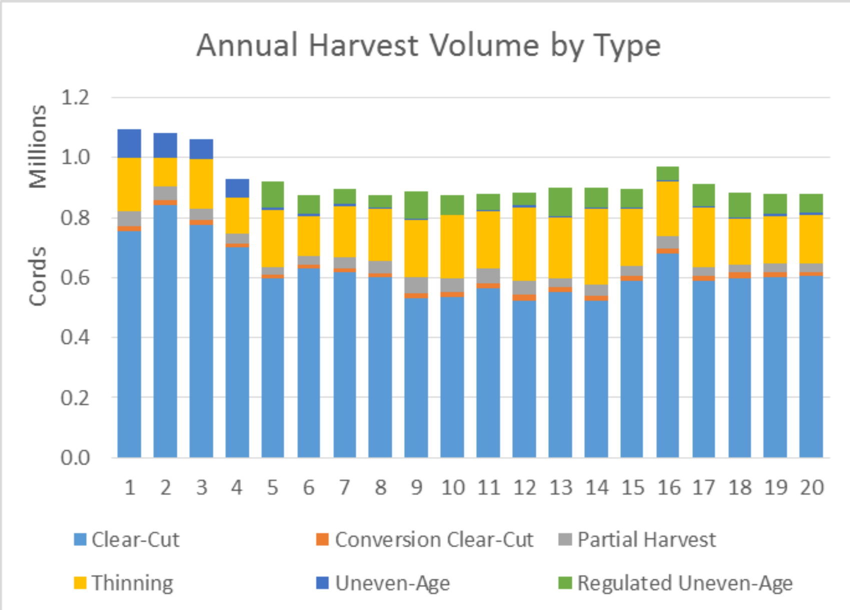

Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

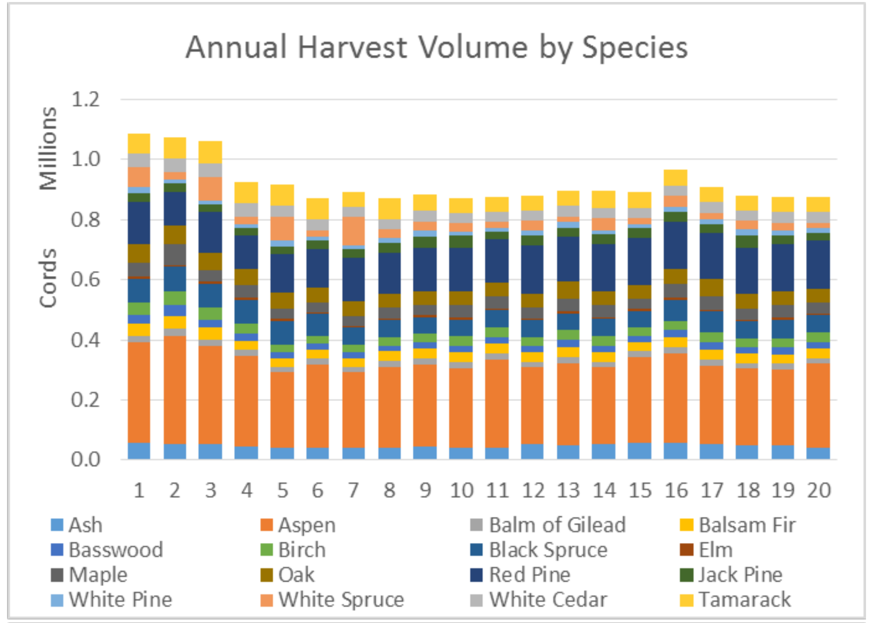

Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

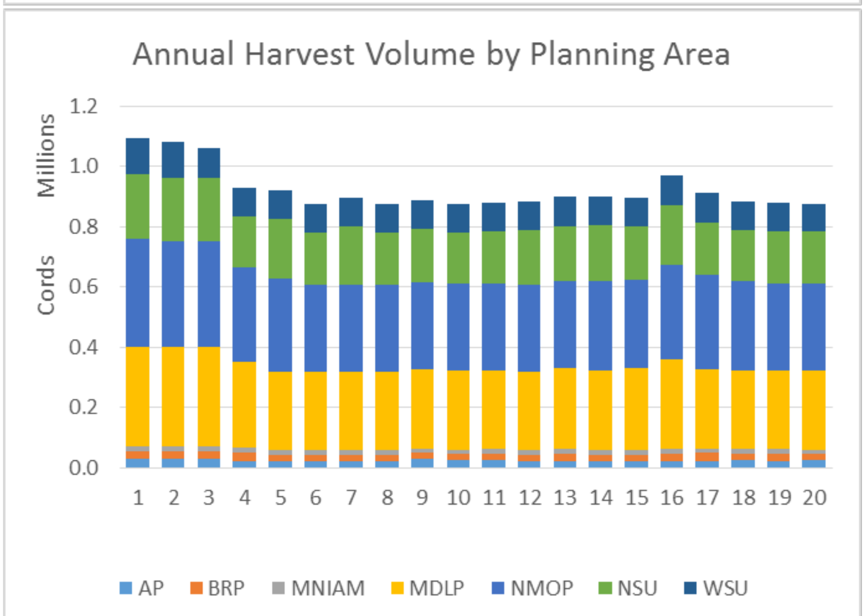

Annual Harvest Revenue by Species
$
Millions
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

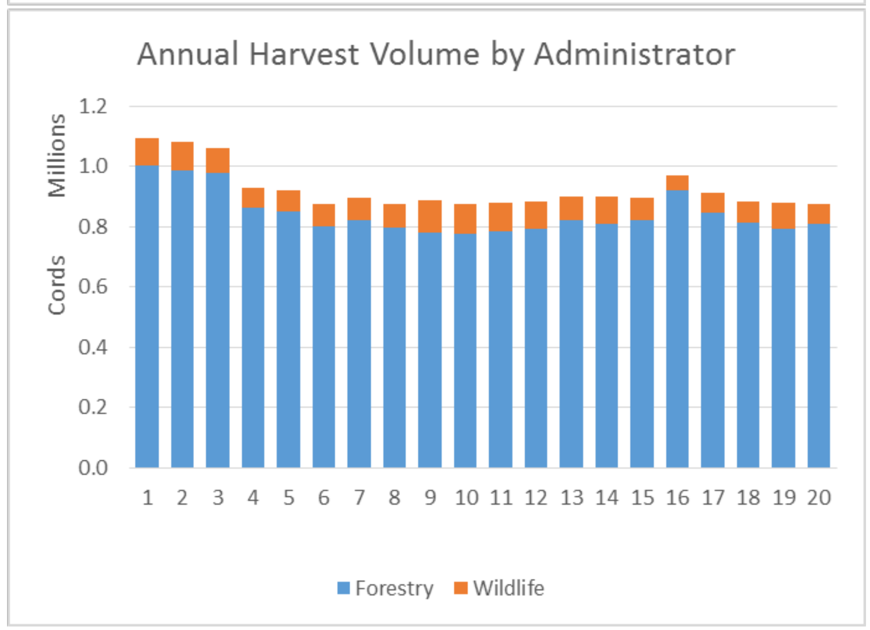

Net Present Value
$
Billions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

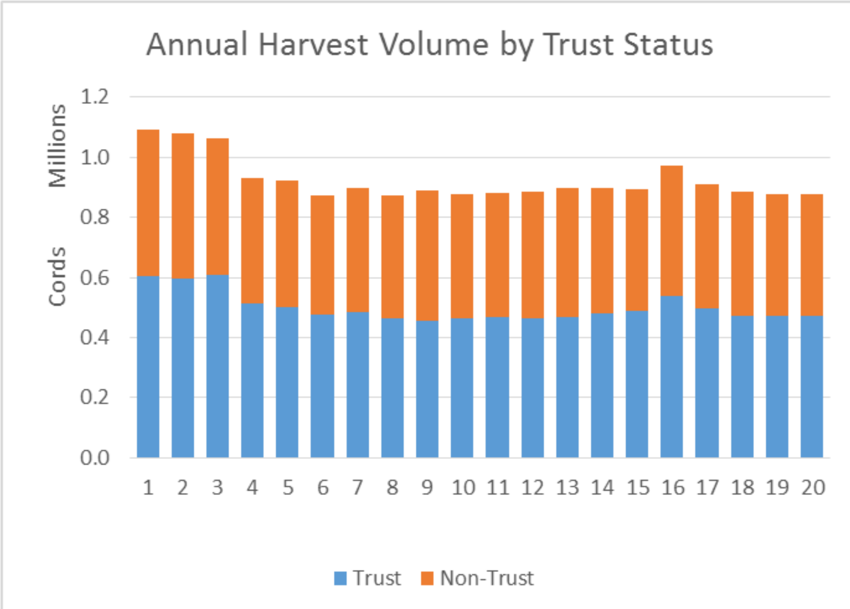
Scenario 1.2.4.1

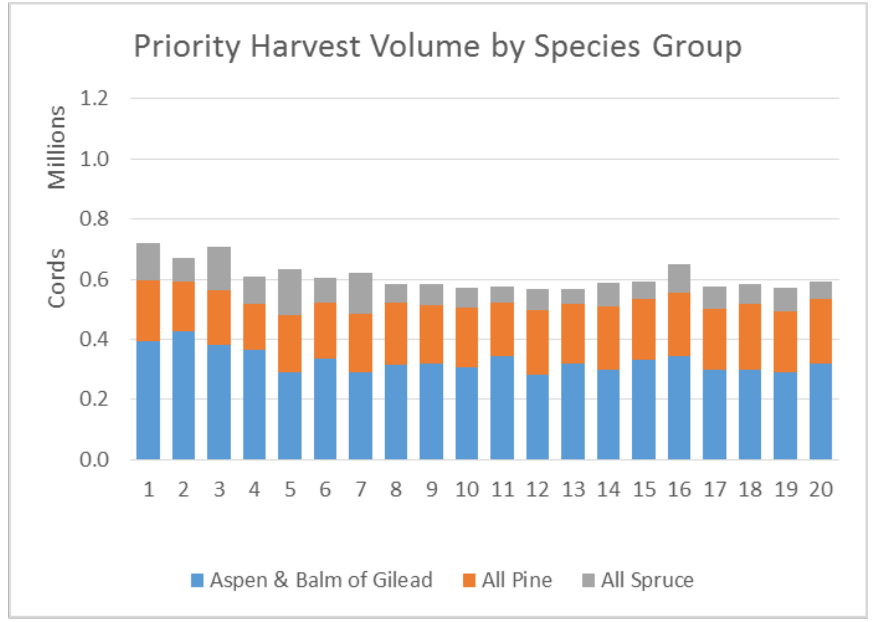


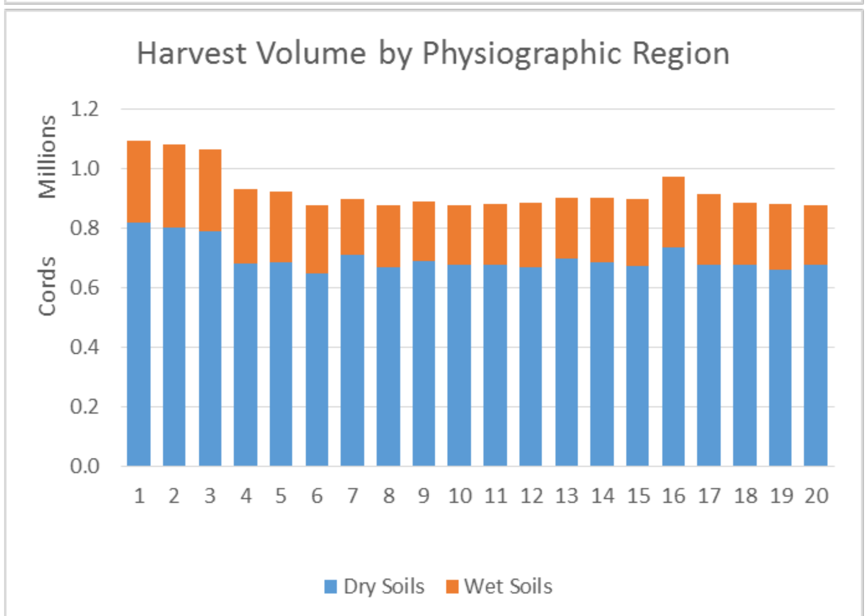


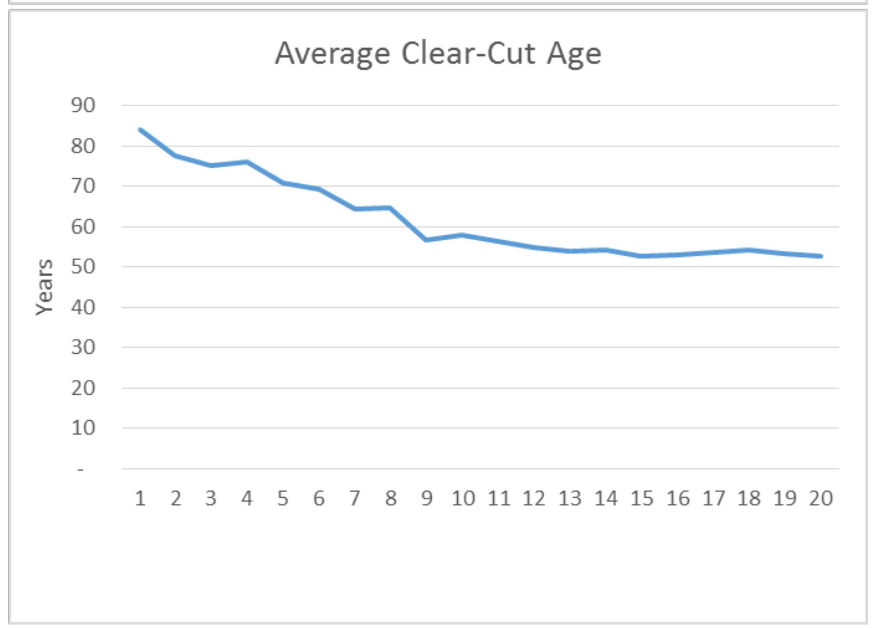


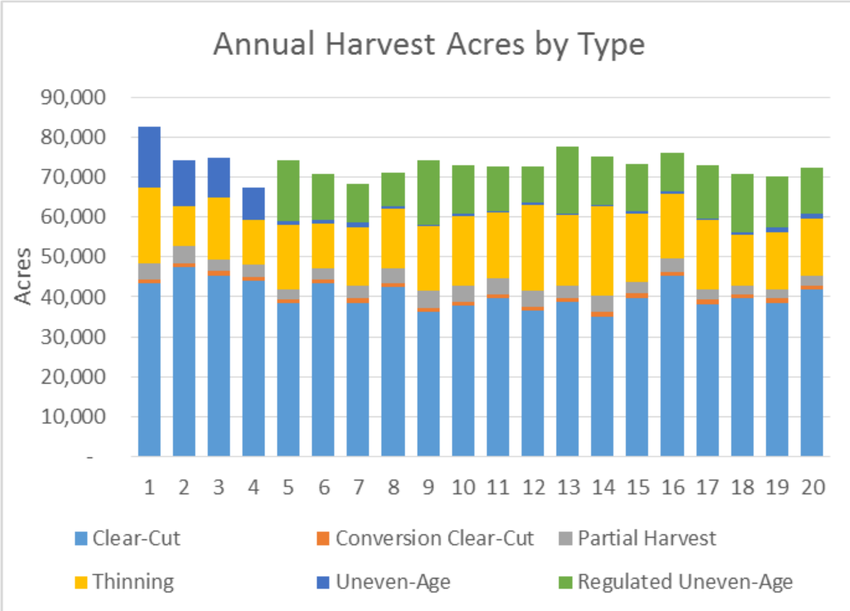


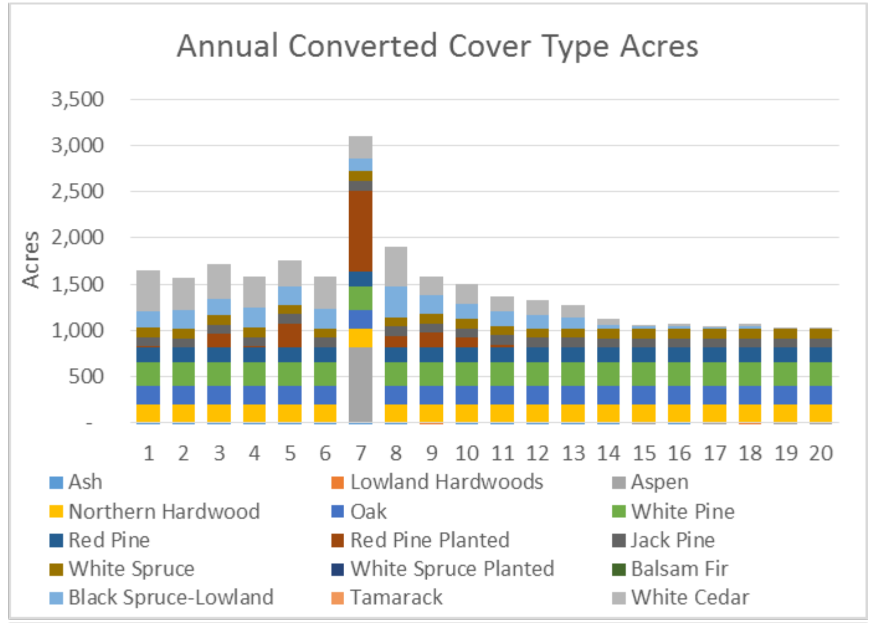

Annual Harvest Volume by Trust Status
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

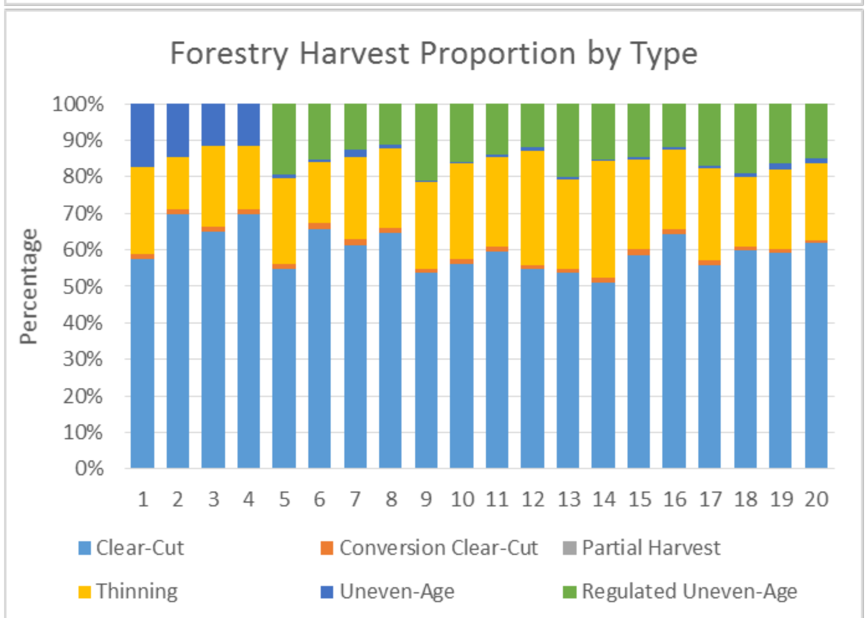

Priority Harvest Volume by Species Group
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

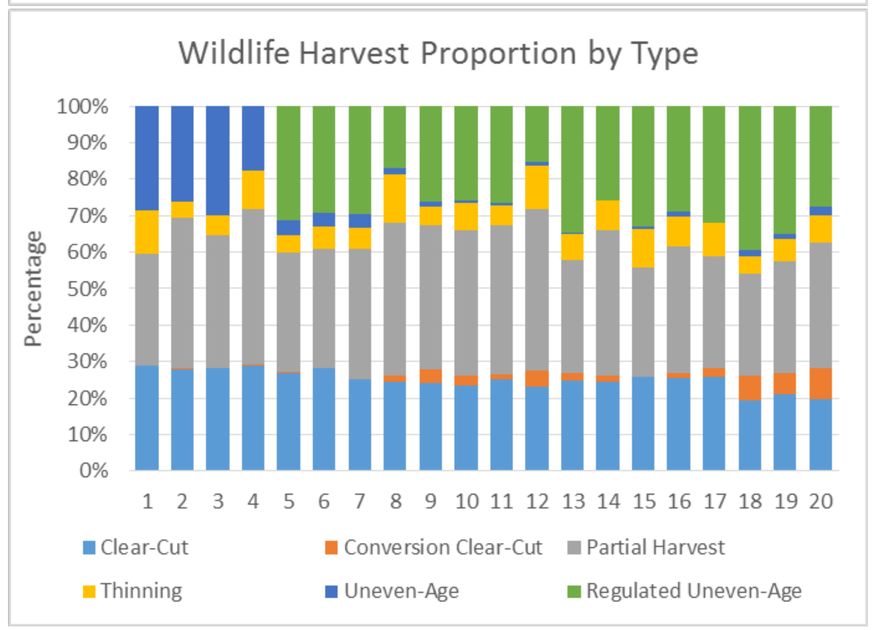

Harvest Volume by Physiographic Region
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

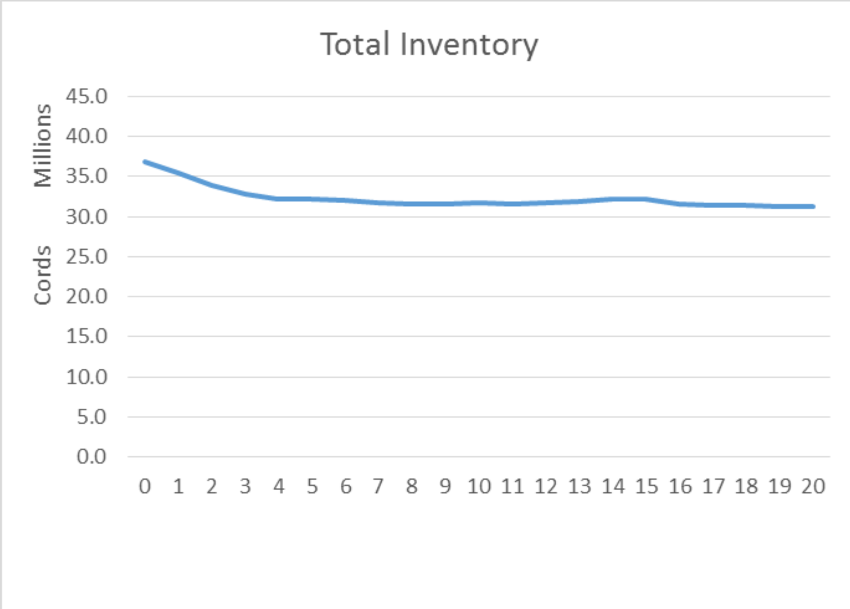

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

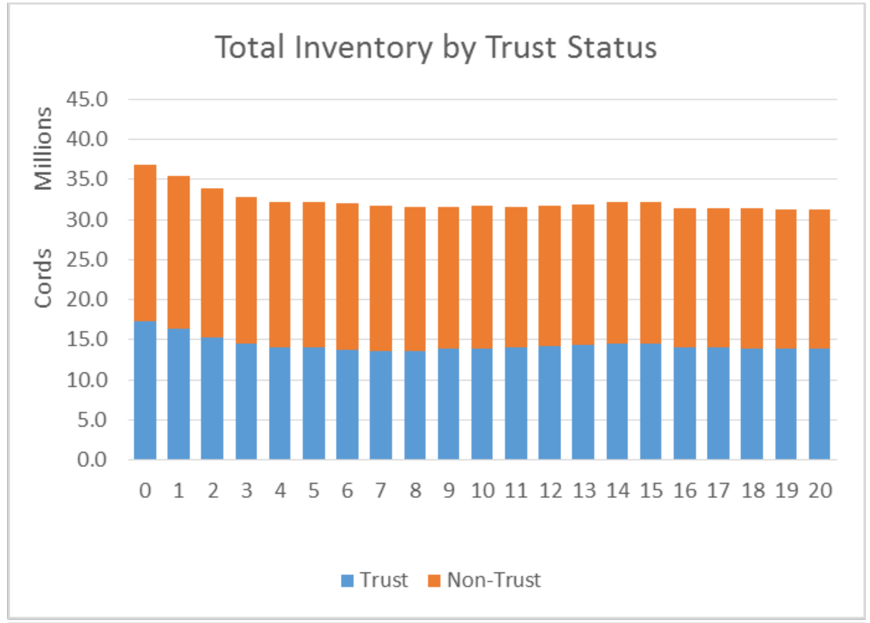

Annual Harvest Acres by Type
Acres
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

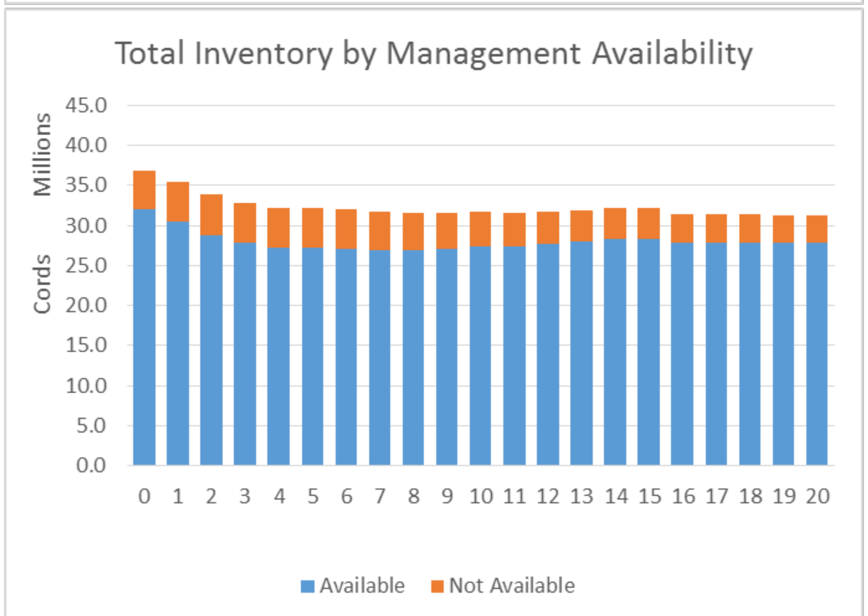

Annual Converted Cover Type Acres
Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

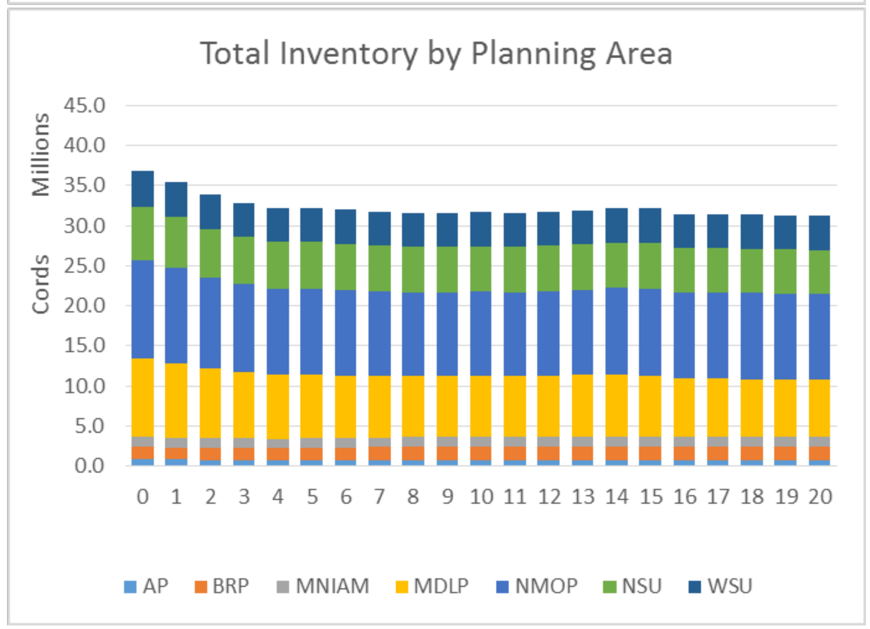

Forestry Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

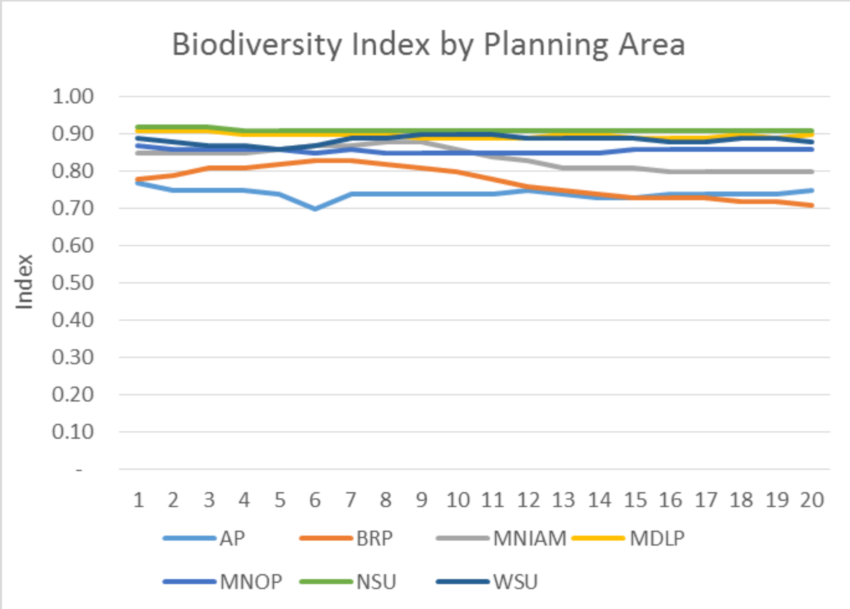

Wildlife Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age


Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

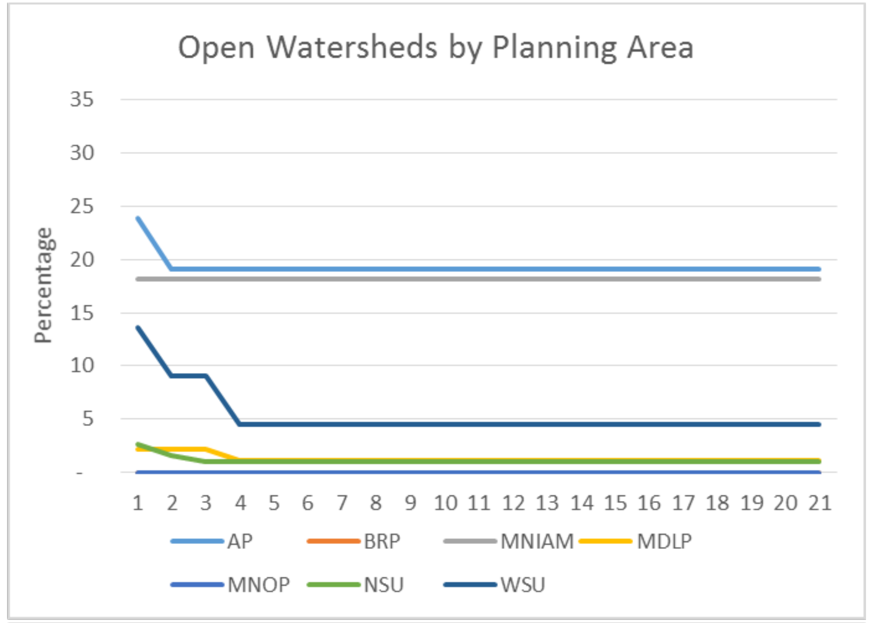

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust


Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

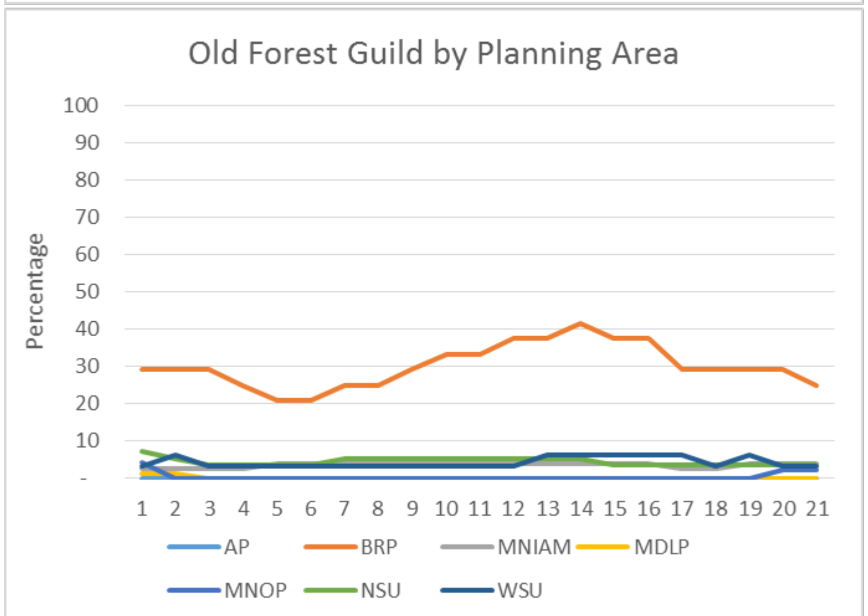

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU



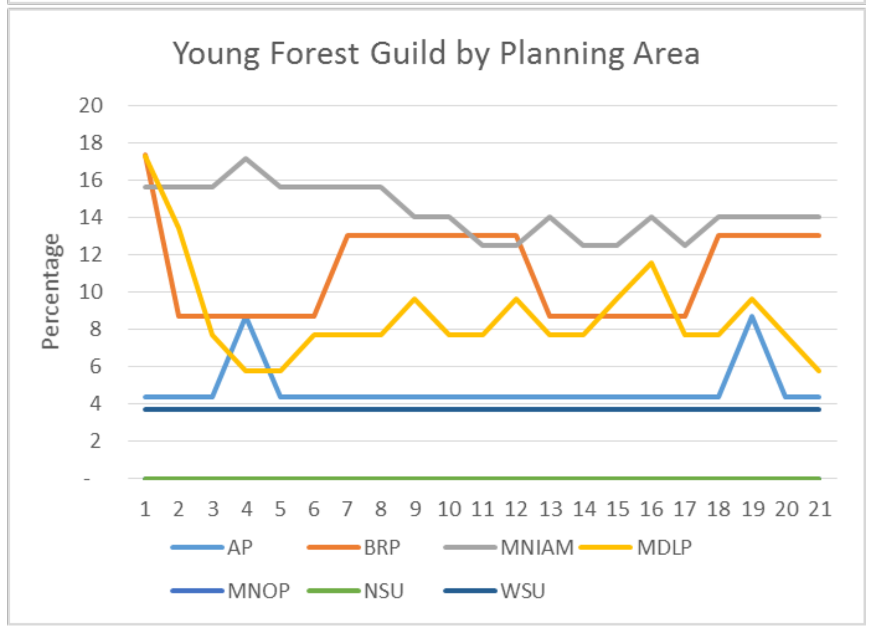
Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU



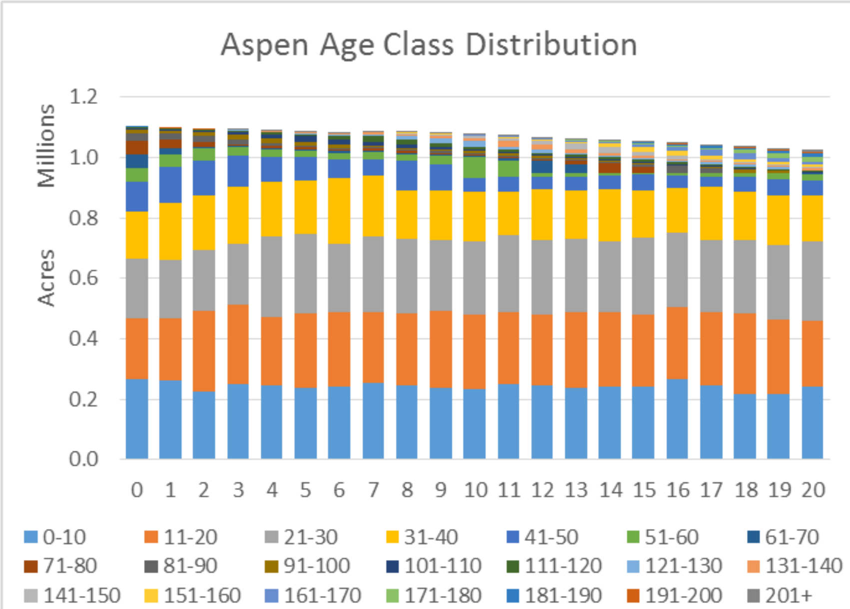
Open Watersheds by Planning Area
Percentage
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

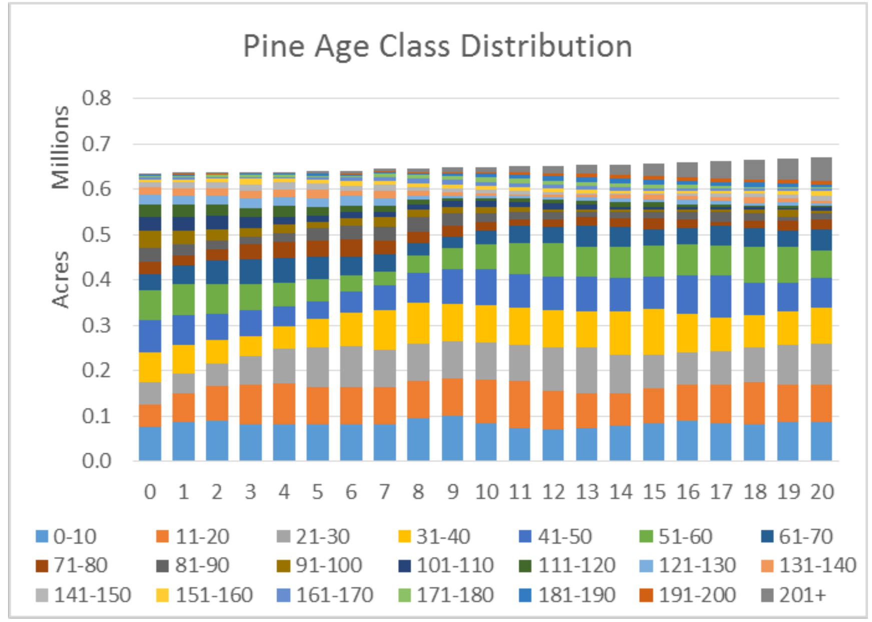


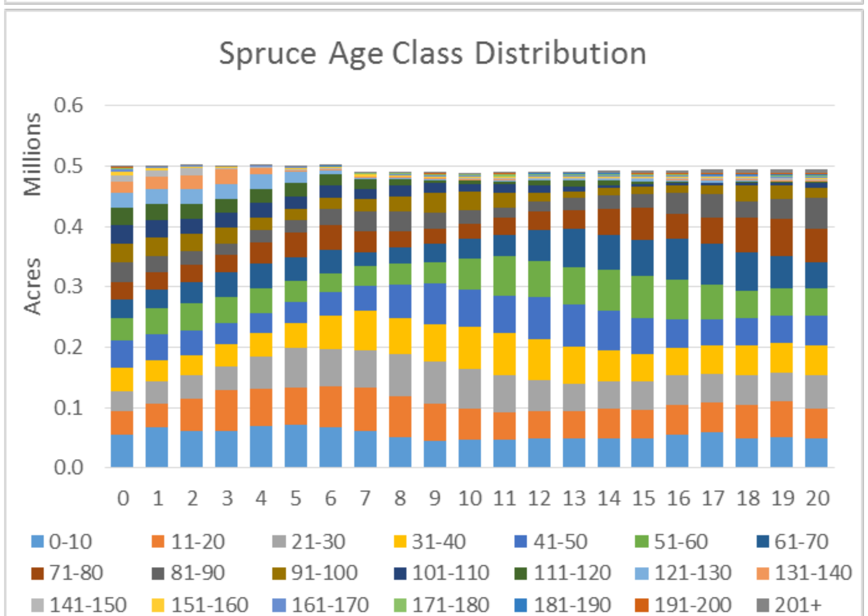
Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

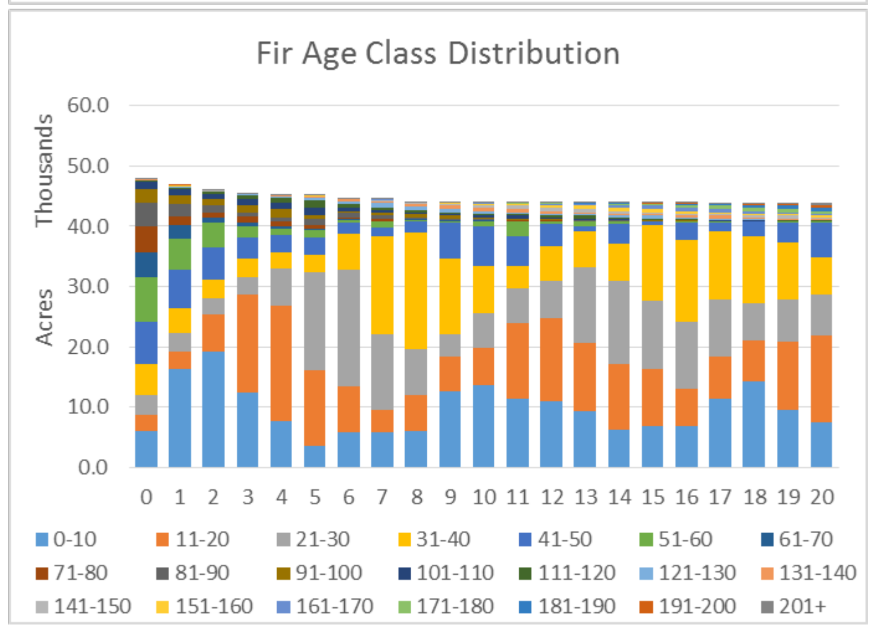


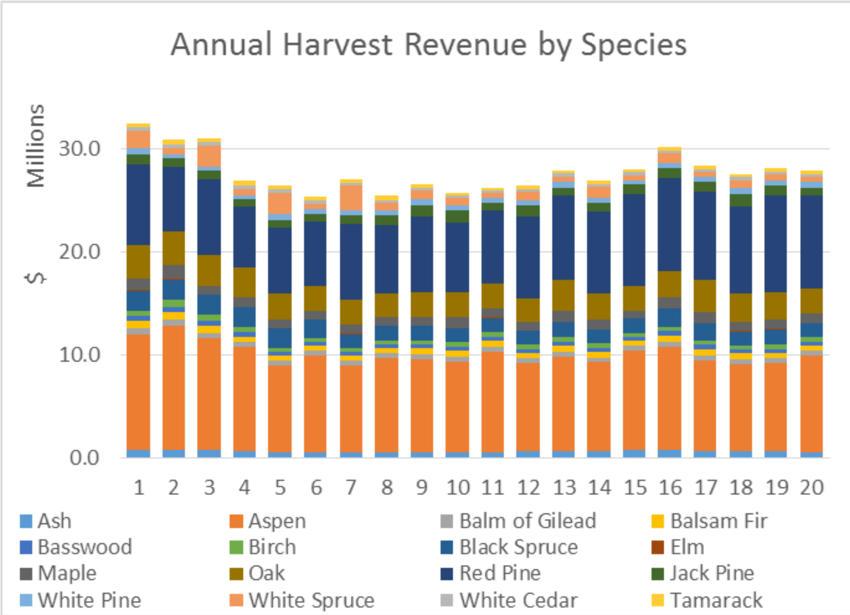
Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

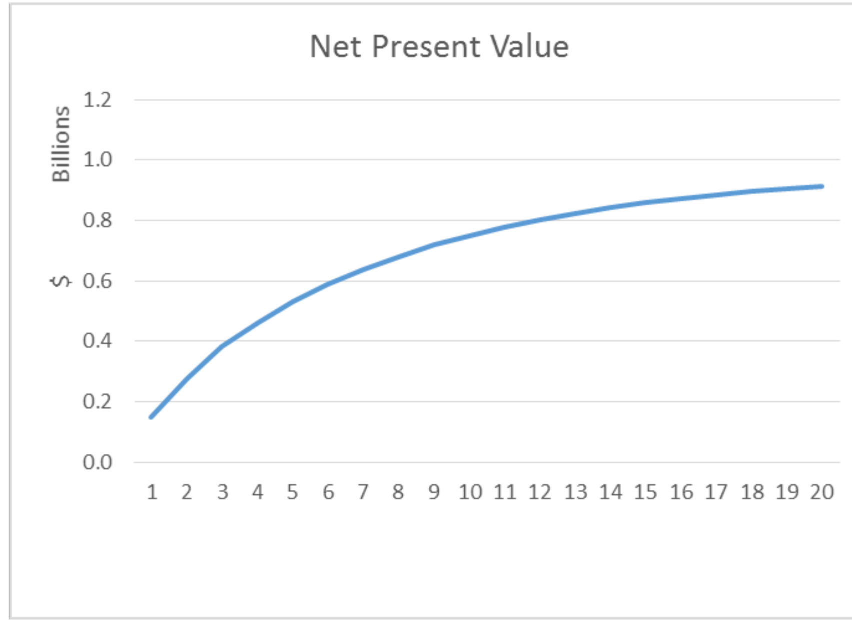

Aspen Age Class Distribution
Acres
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Acres
Millions
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

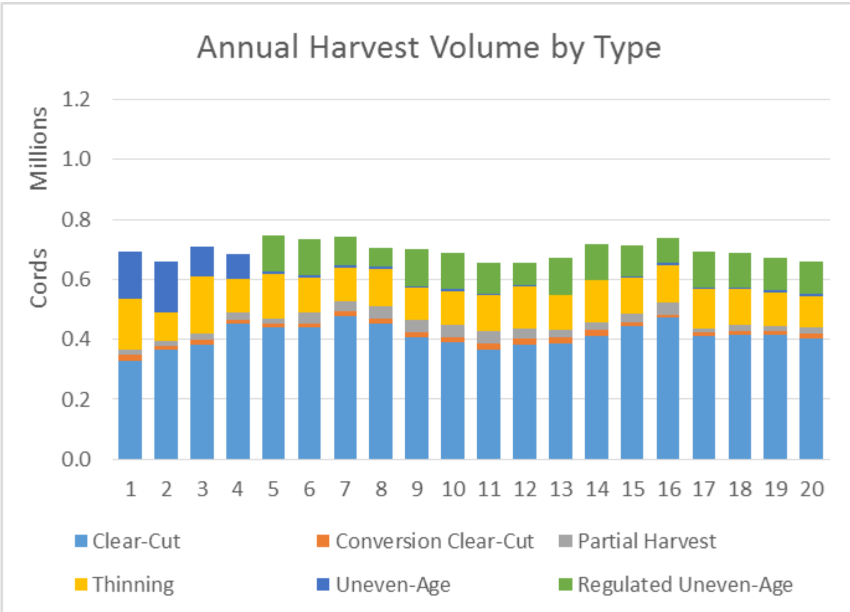

Spruce Age Class Distribution
Acres
Millions
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

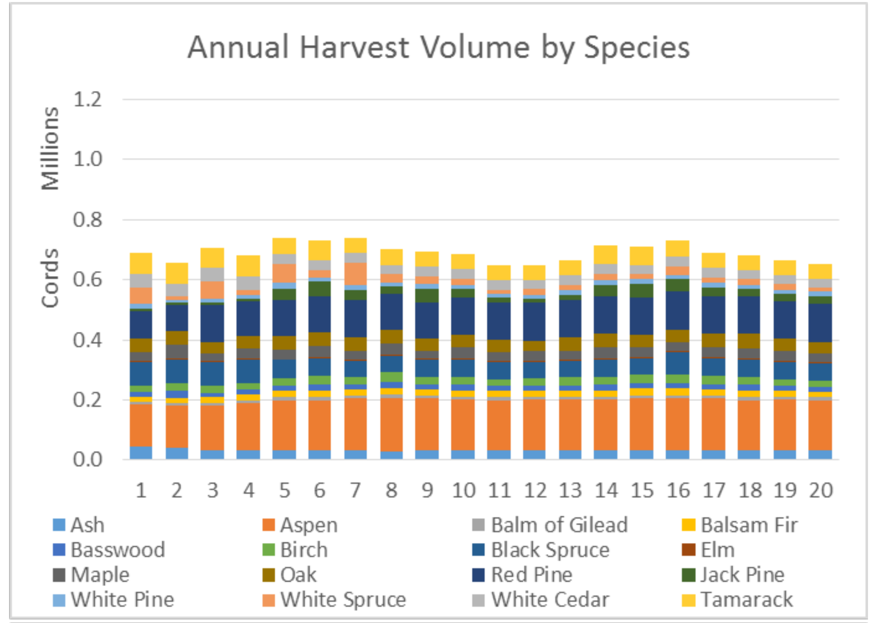

Fir Age Class Distribution
Acres
Thousands
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

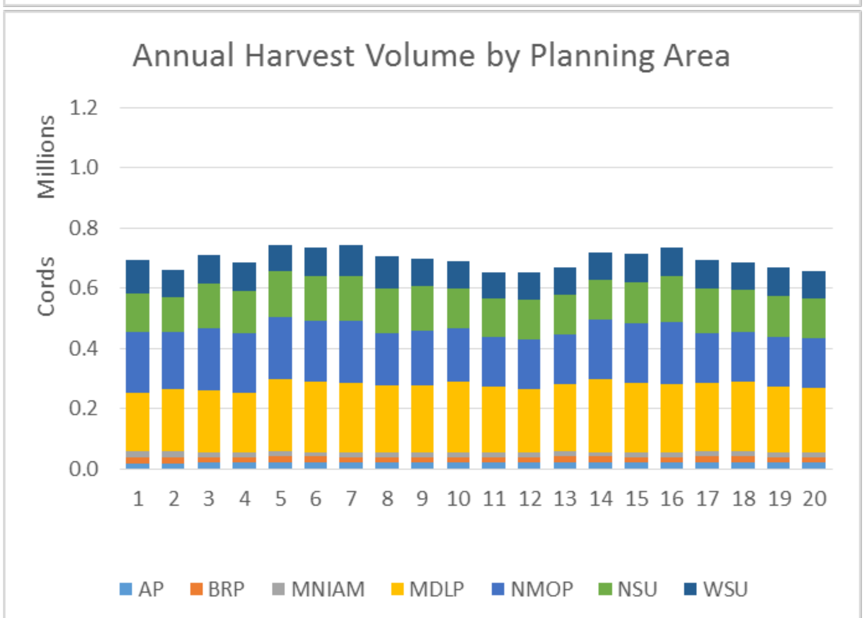

Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

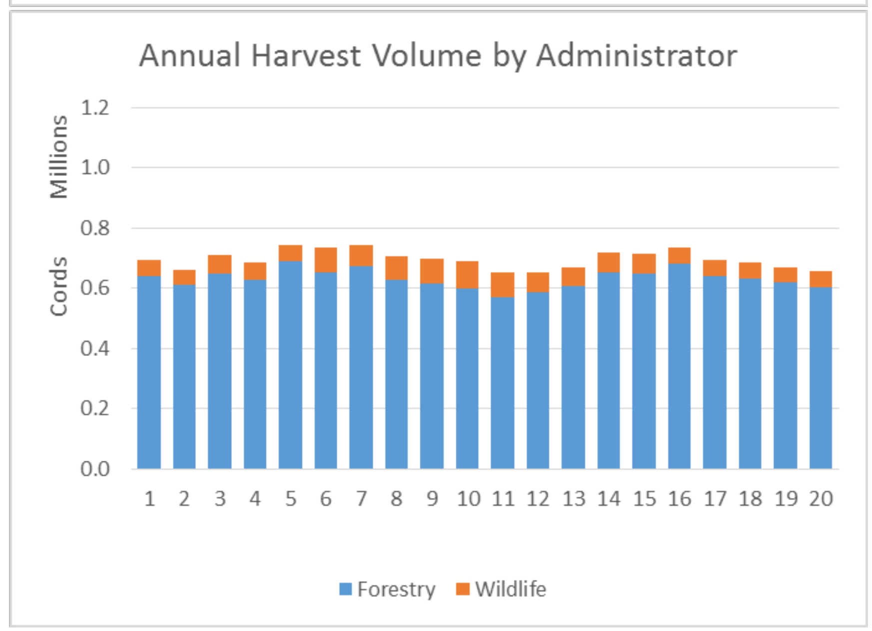

Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

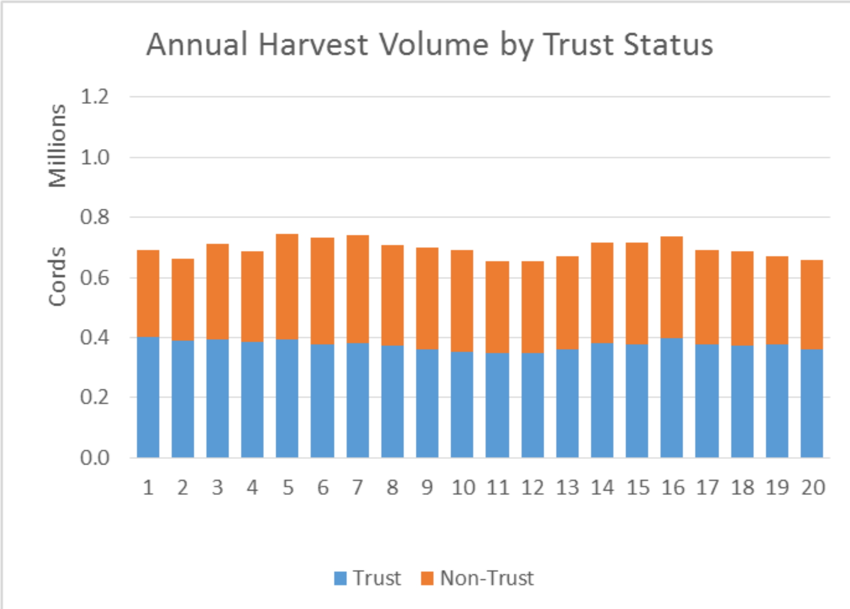
Scenario 1.2.4.2

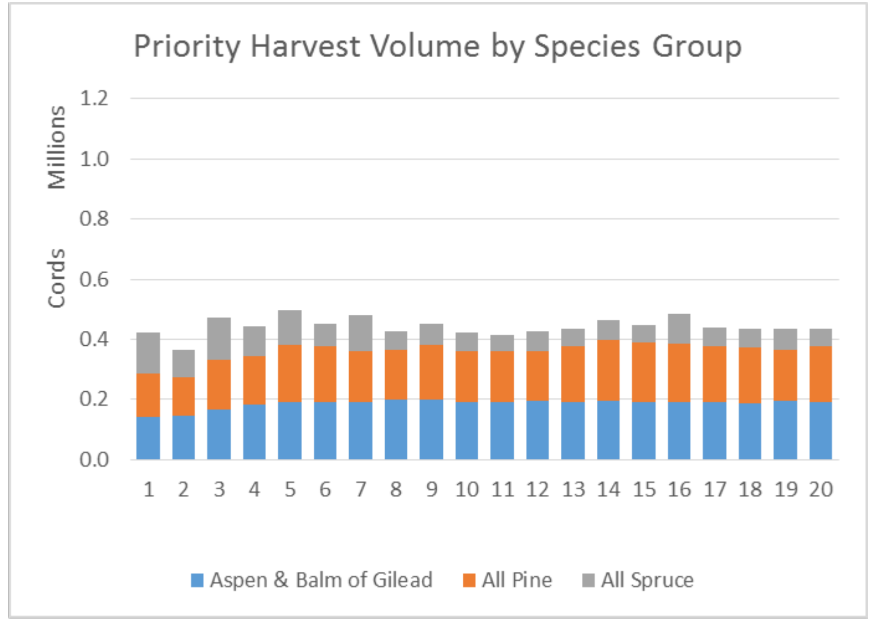


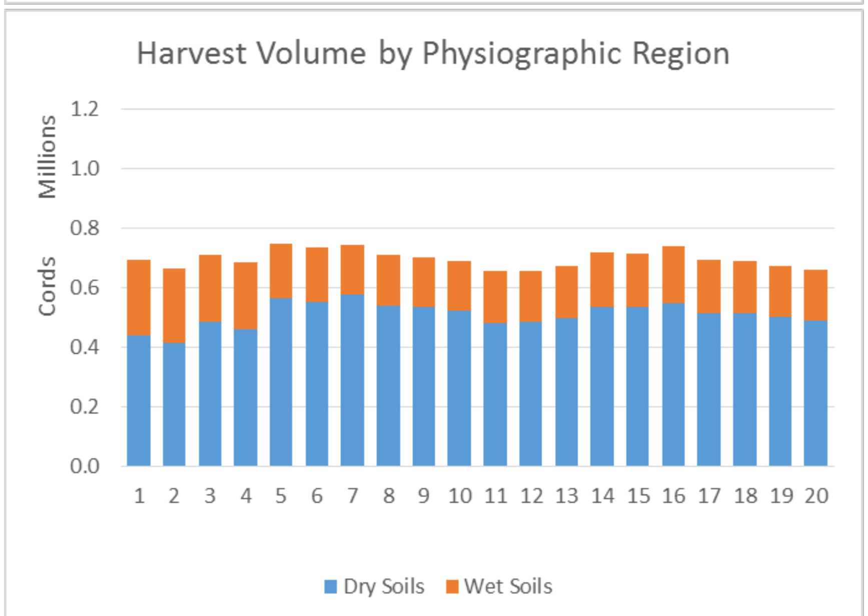


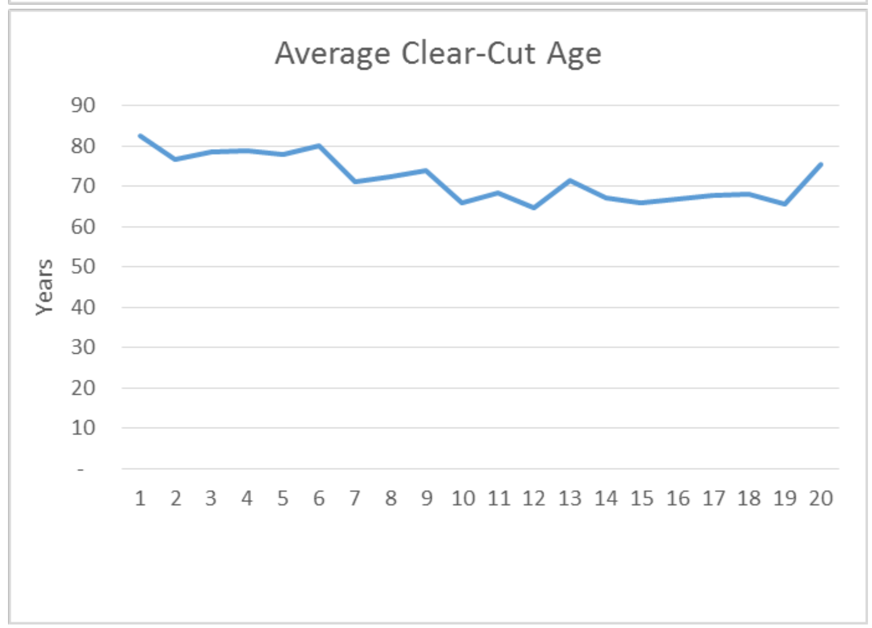


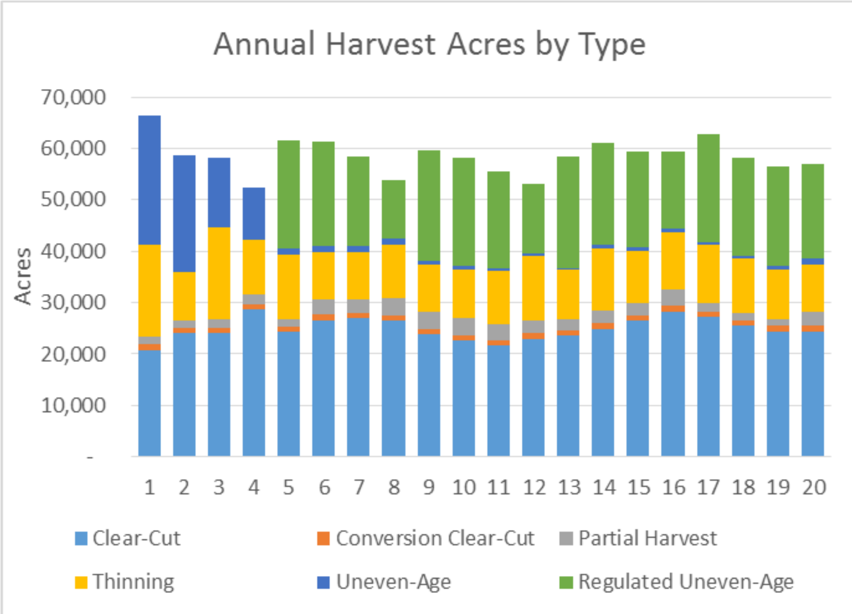


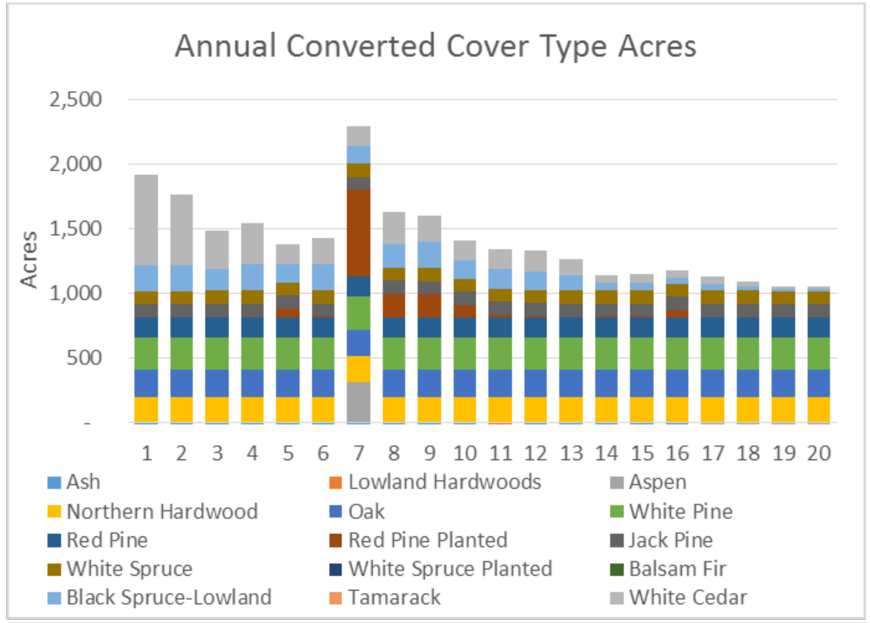

Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

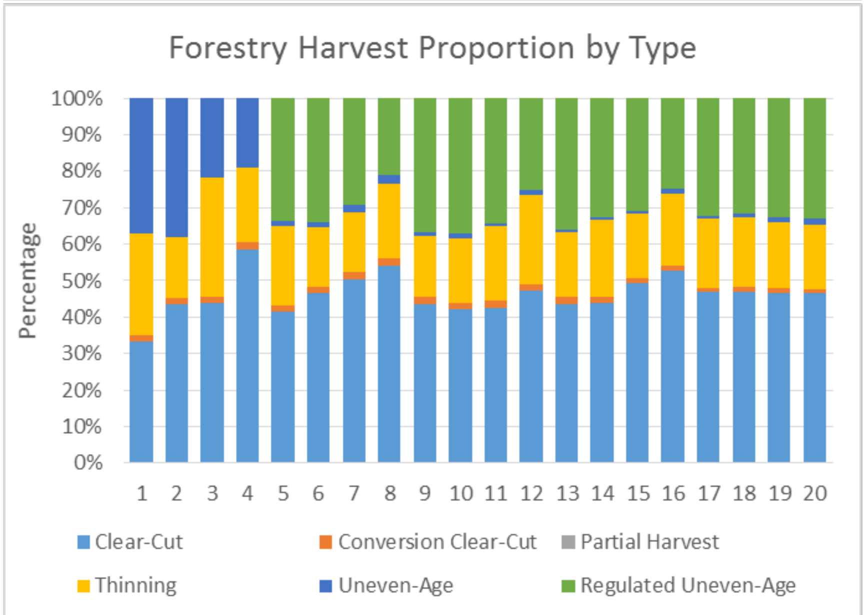

Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

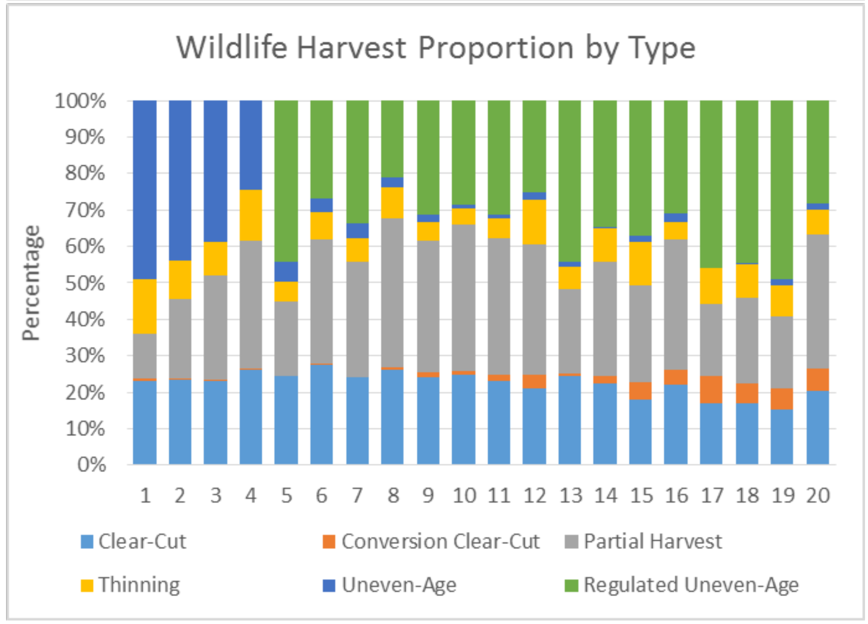

Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

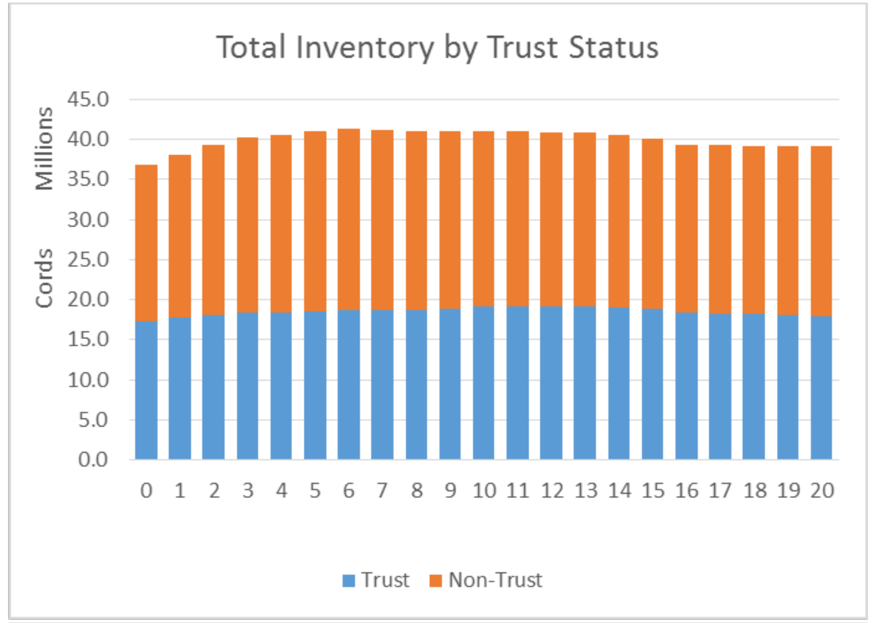

Annual Harvest Acres by Type
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

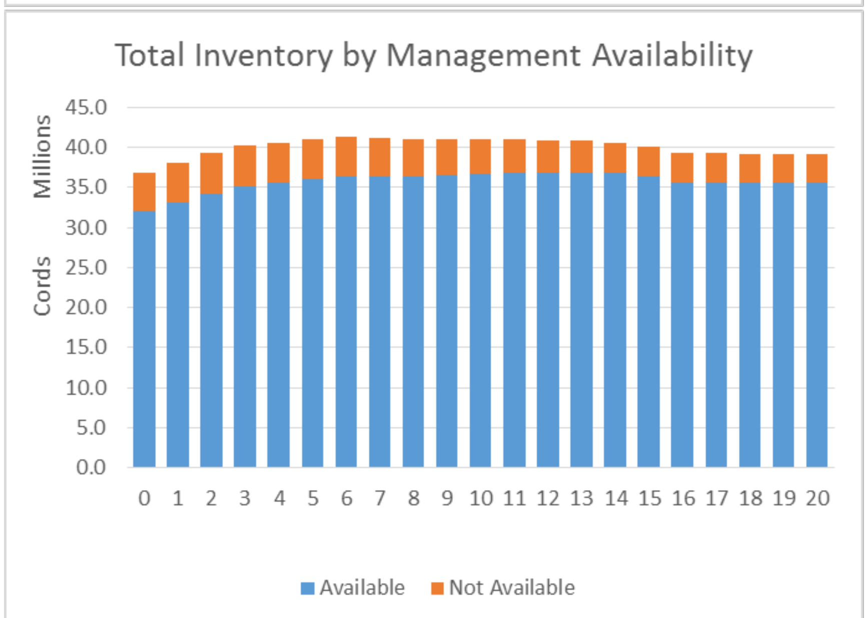

Annual Converted Cover Type Acres
2,500
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

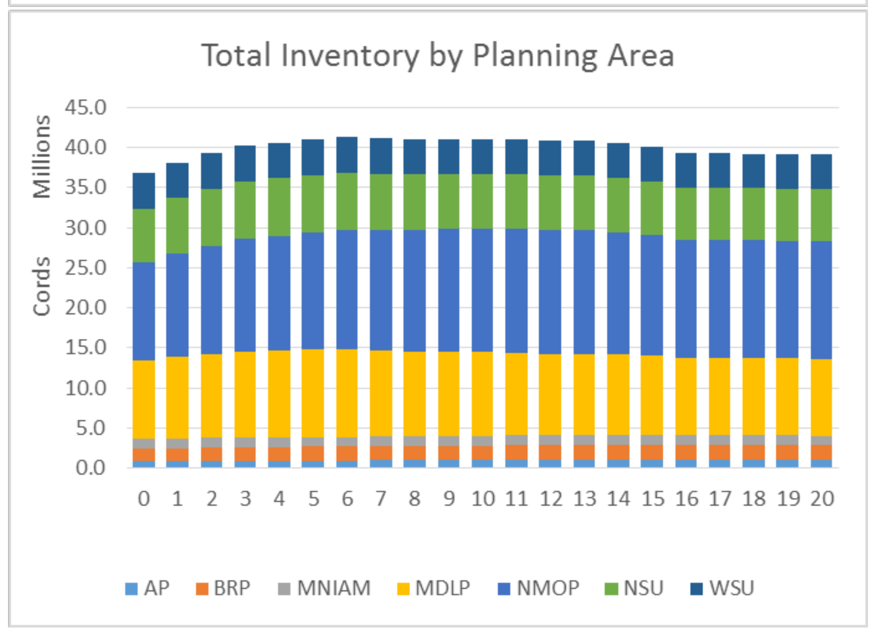

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

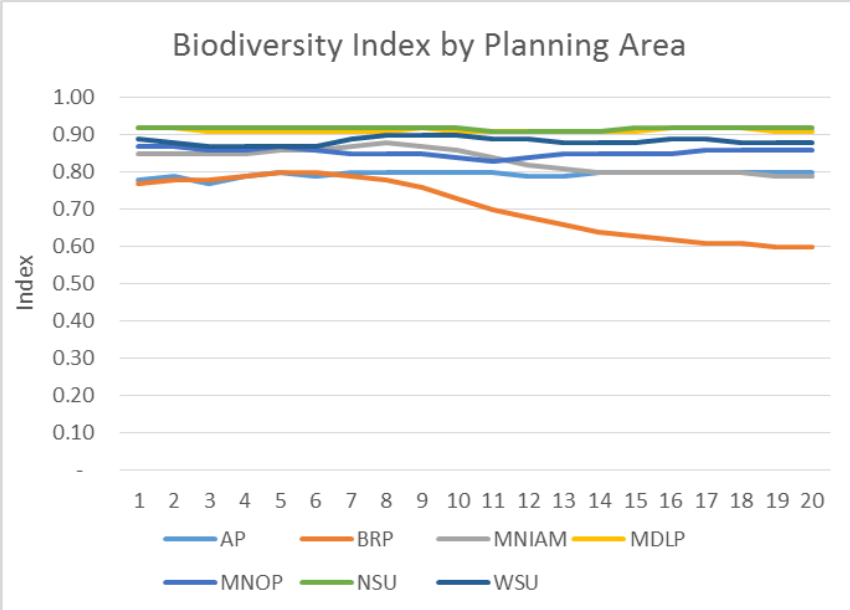

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

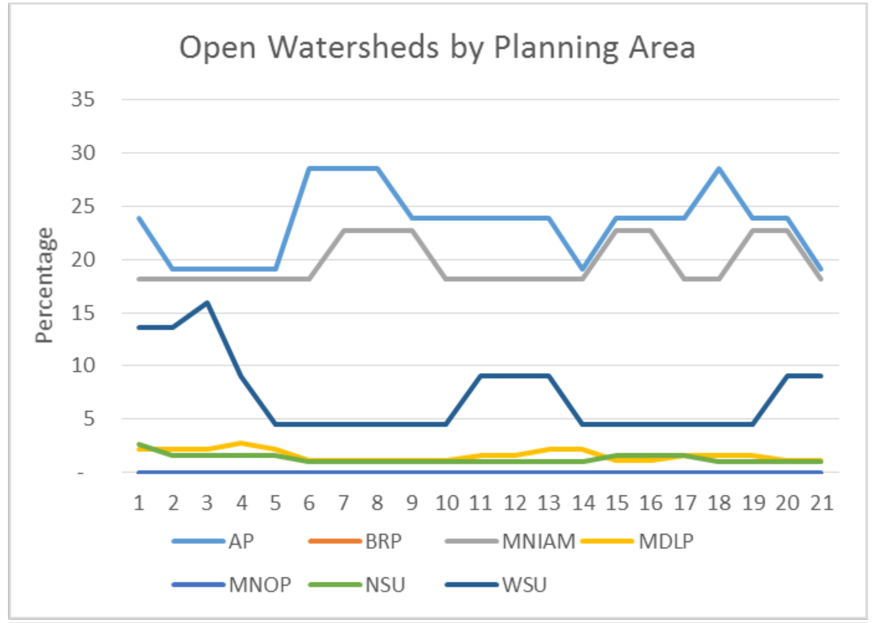

Total Inventory
Cords Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

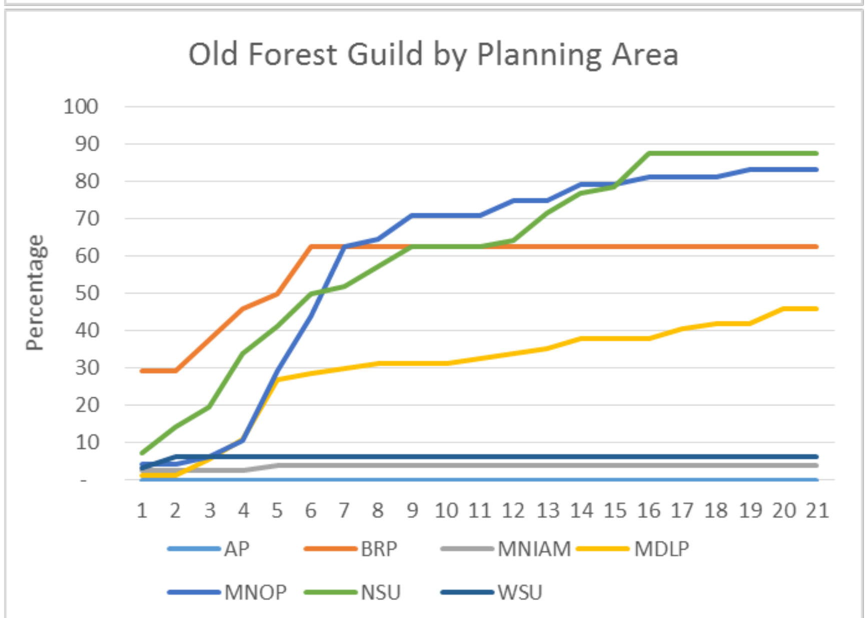

Total Inventory by Trust Status
Cords Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

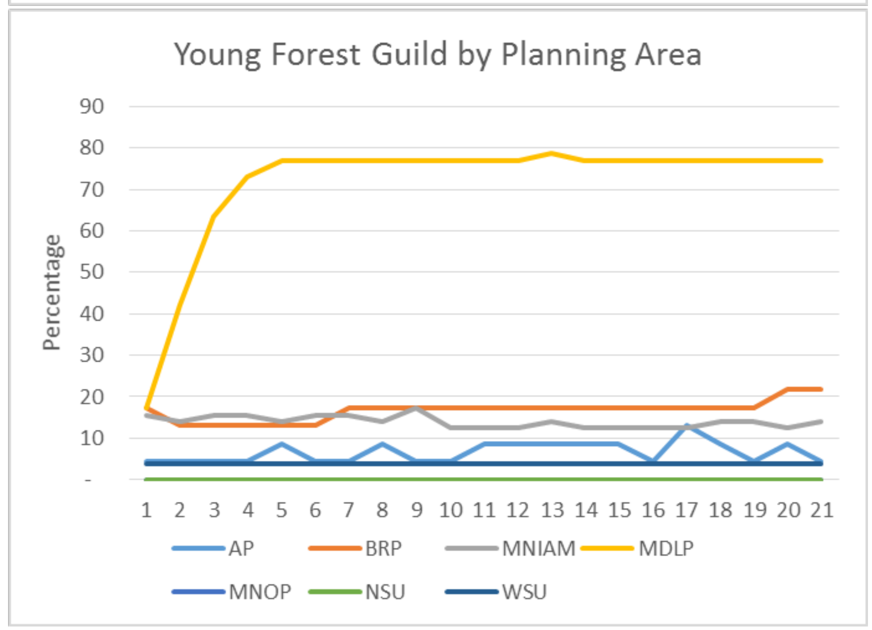

Total Inventory by Management Availability
Cords Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

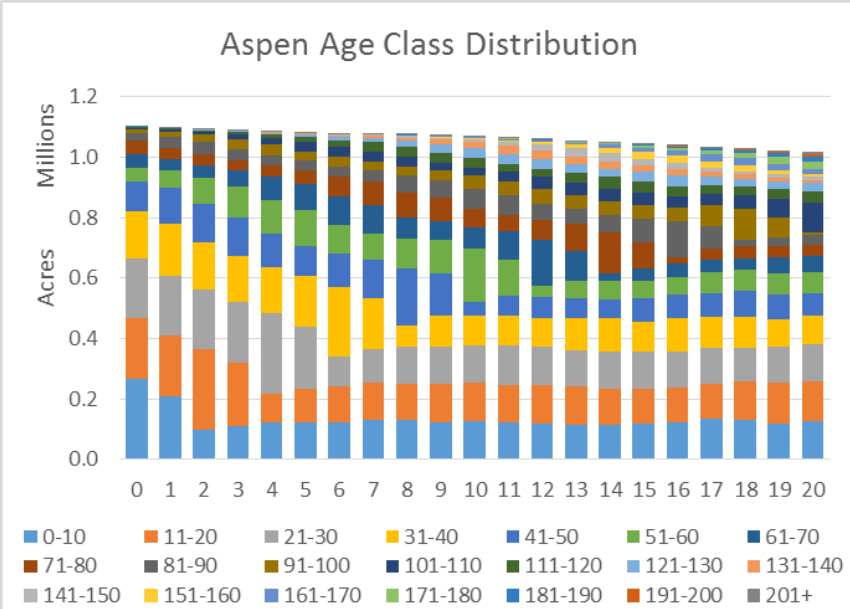

Total Inventory by Planning Area
Cords Millions
45.0 40.0 35.0 30.0 25.0 20.0 15.0 10.0 5.0 0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

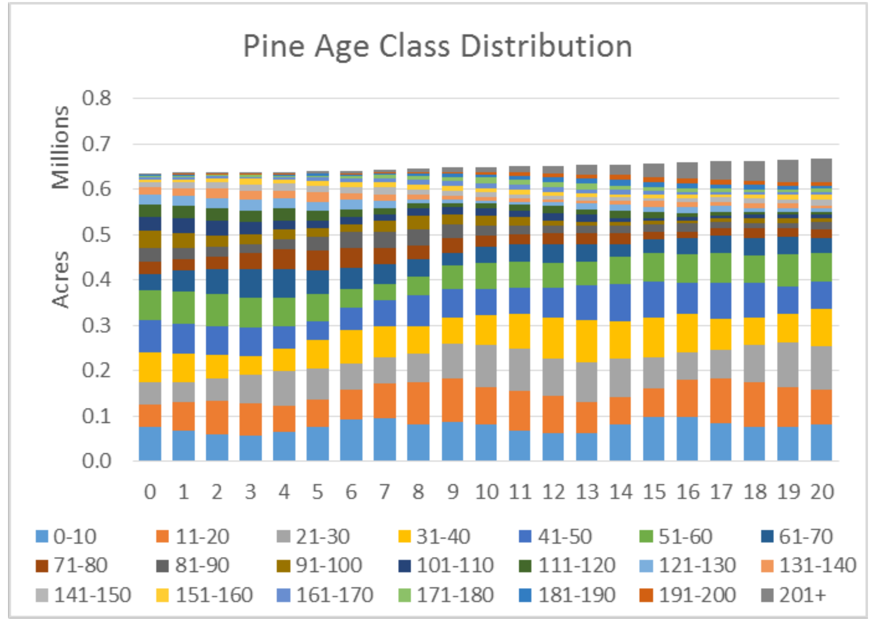

Biodiversity Index by Planning Area
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
Index
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

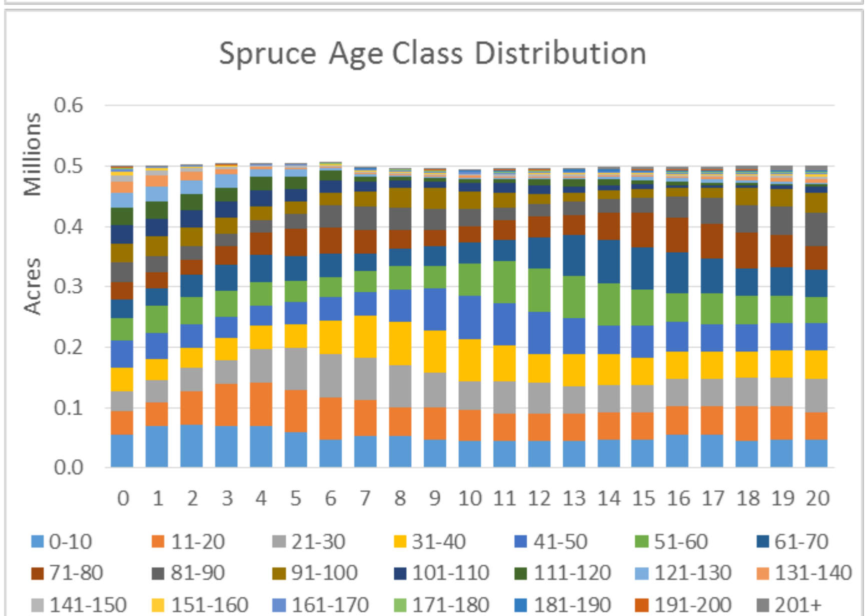

Open Watersheds by Planning Area
35
30
25
20
15
10
5
-
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

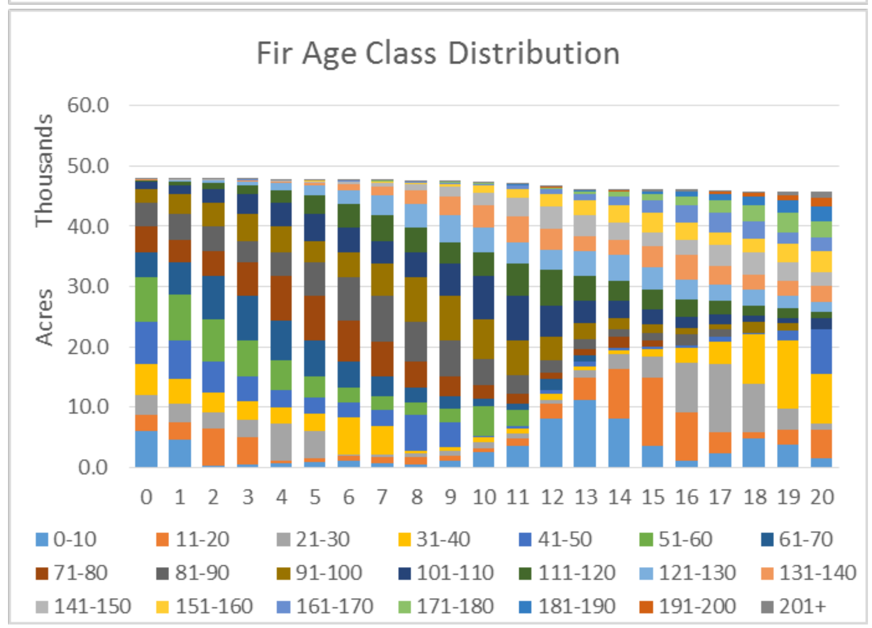

Old Forest Guild by Planning Area
100
90
80
70
60
50
40
30
20
10
-
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

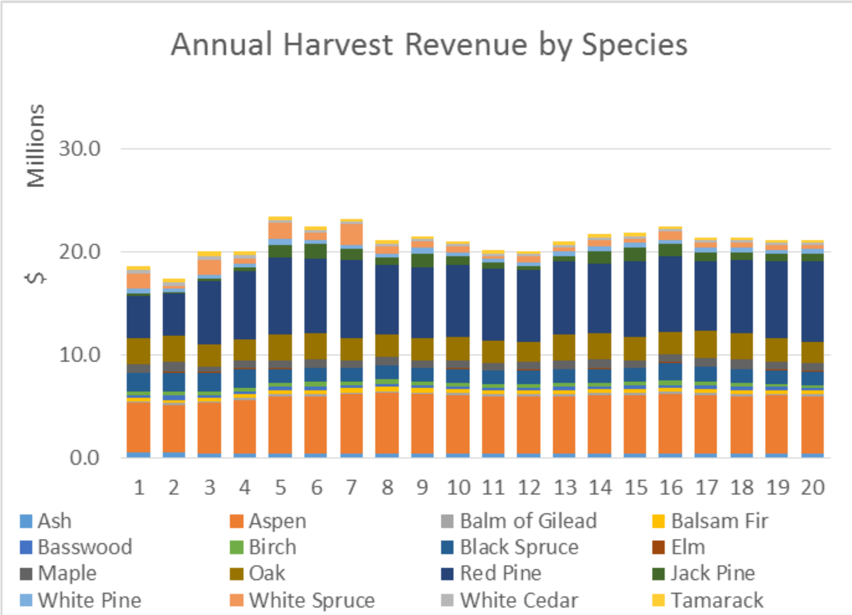

Young Forest Guild by Planning Area
90
80
70
60
50
40
30
20
10
-
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

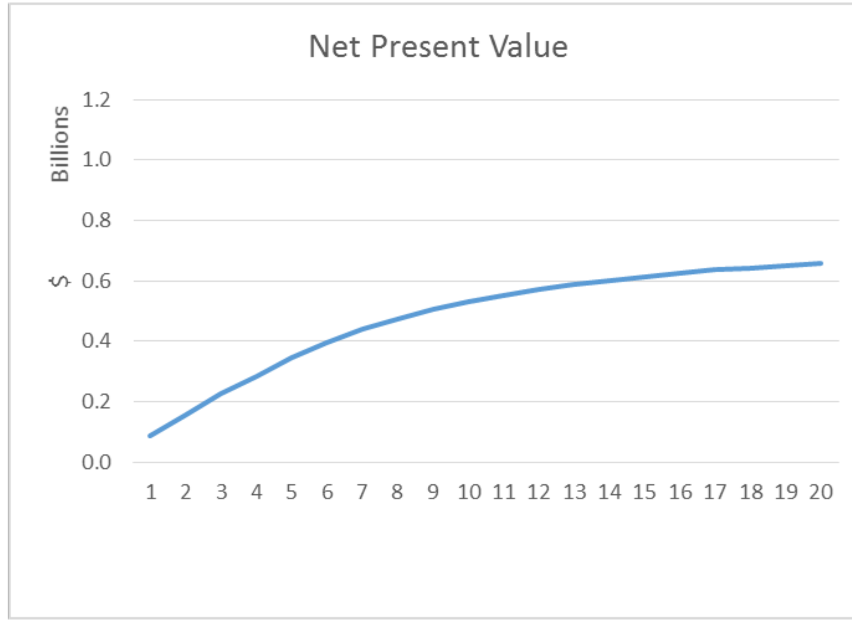

Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

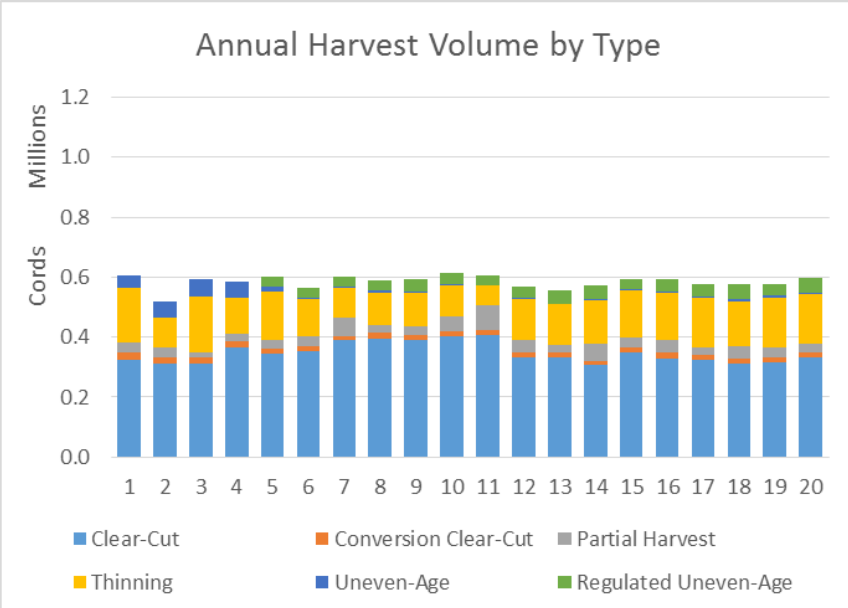


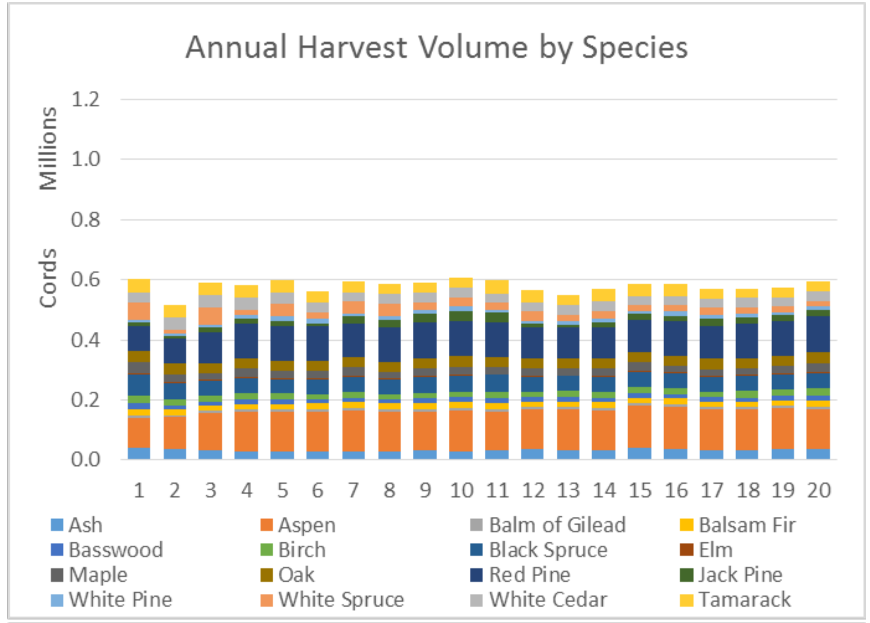
Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

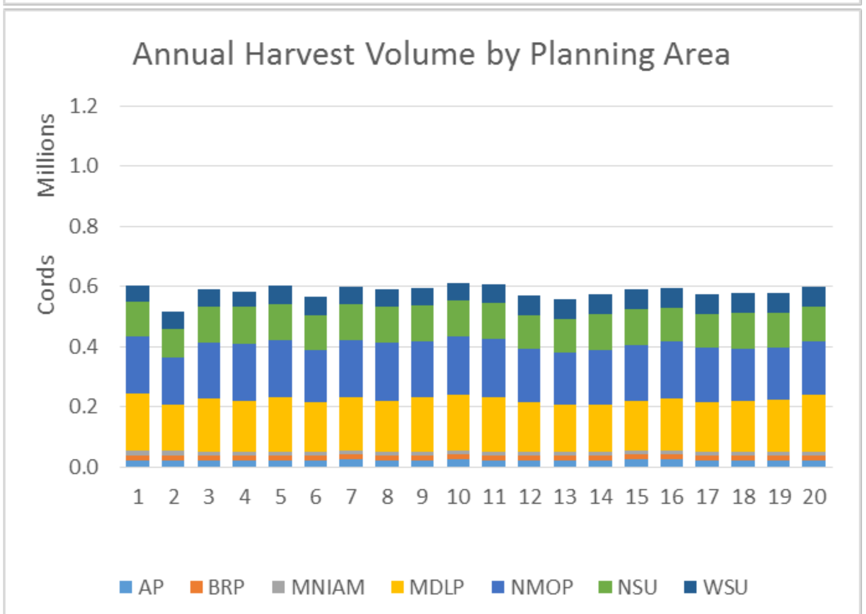


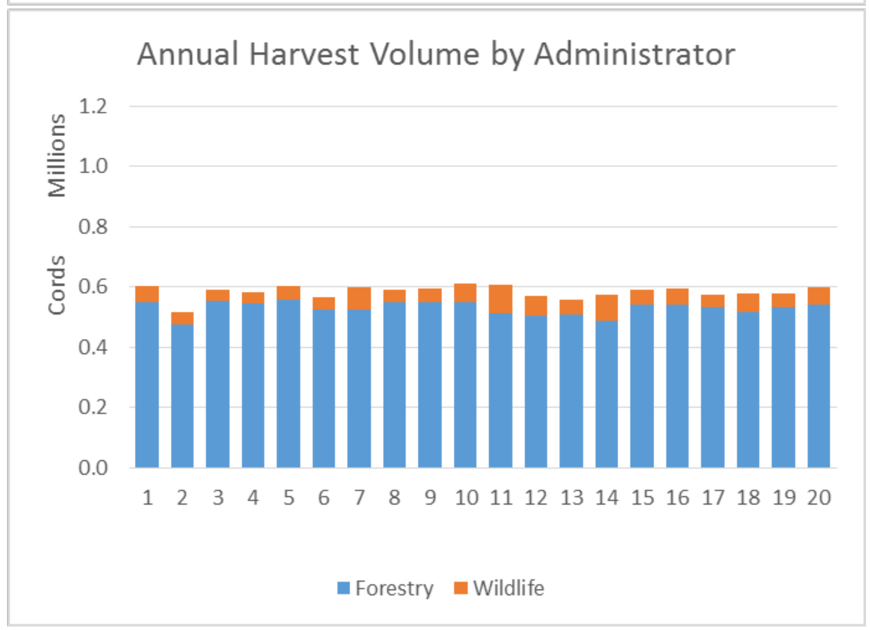
Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

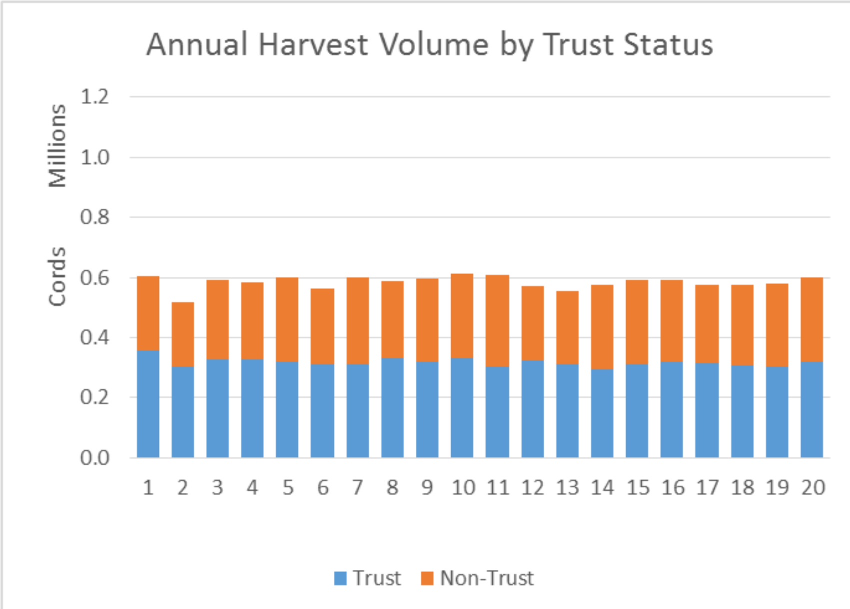
Scenario 1.2.4.3

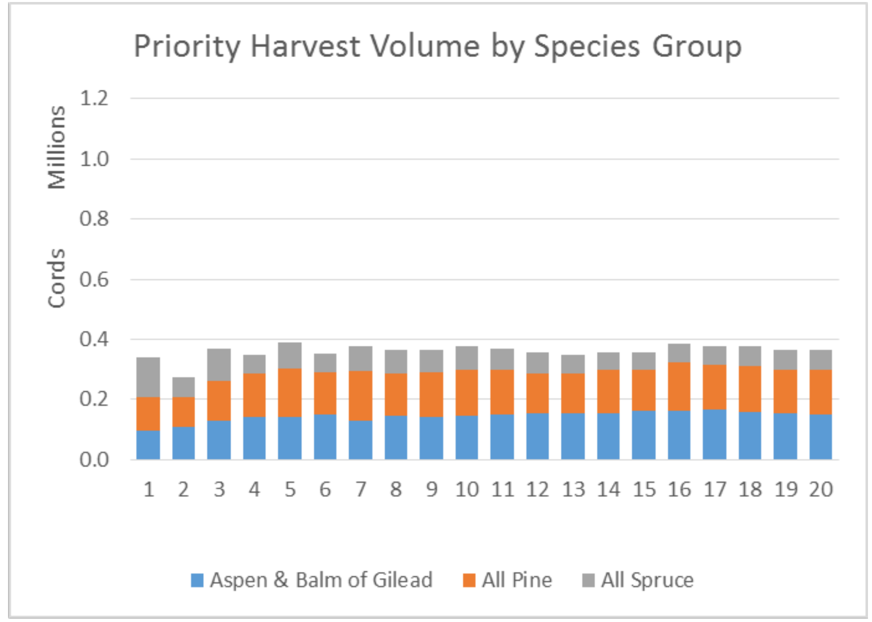


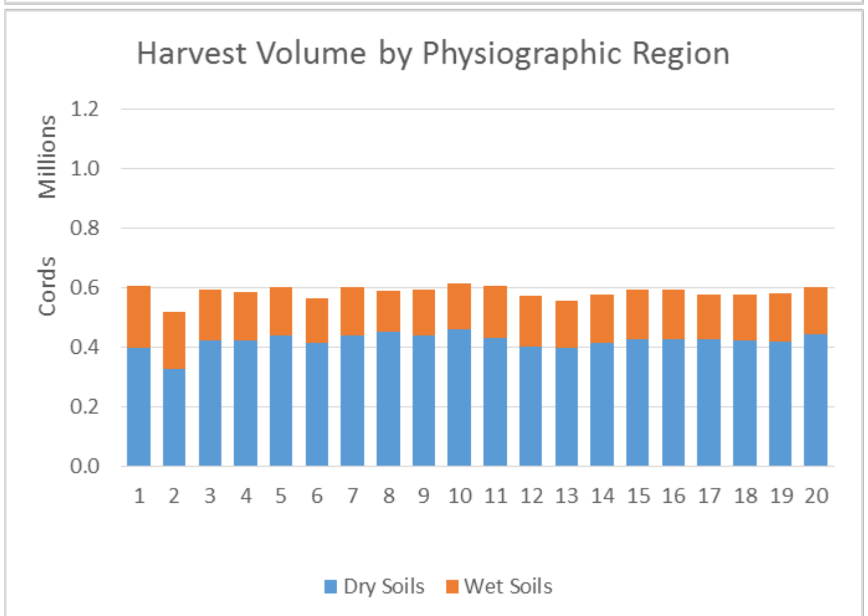


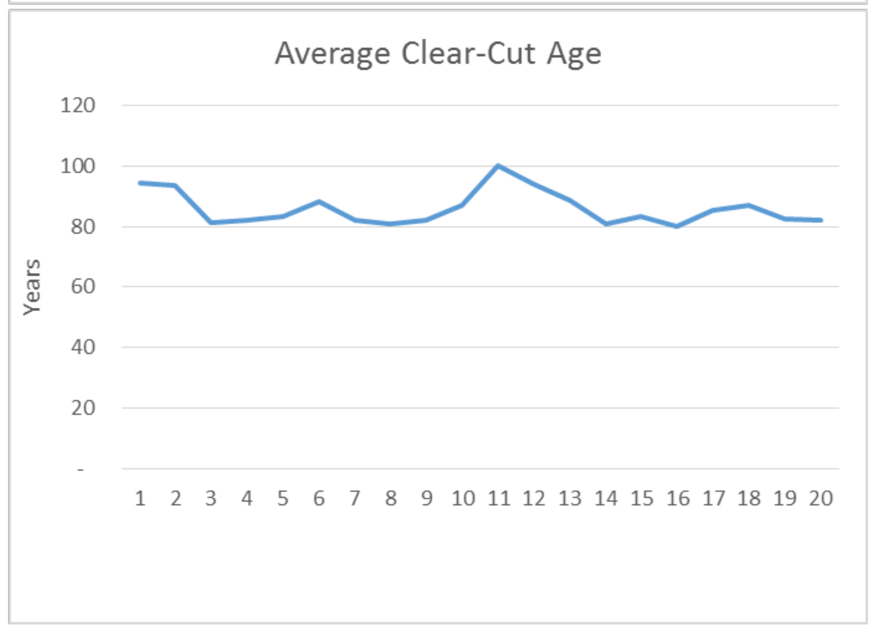


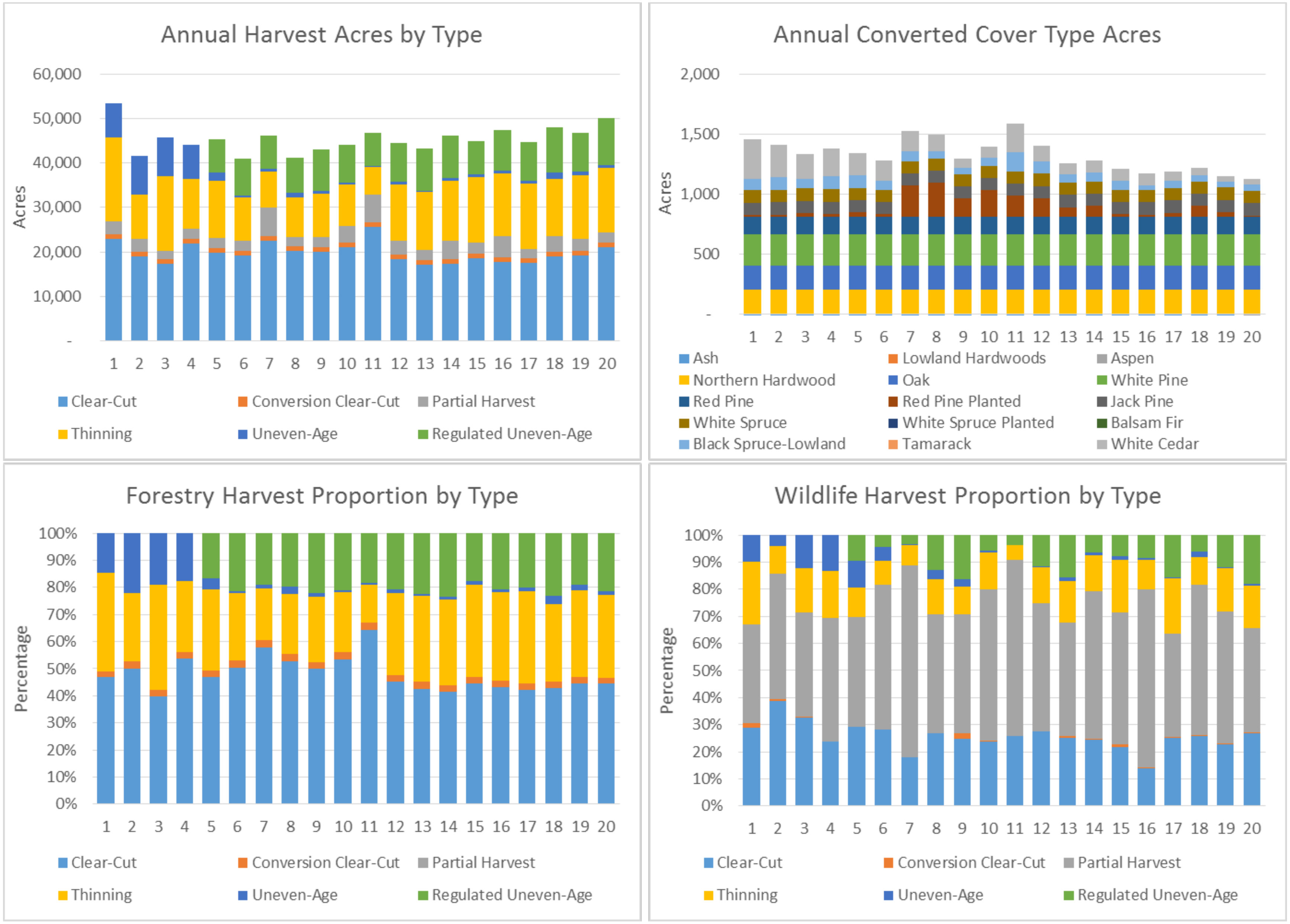



Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

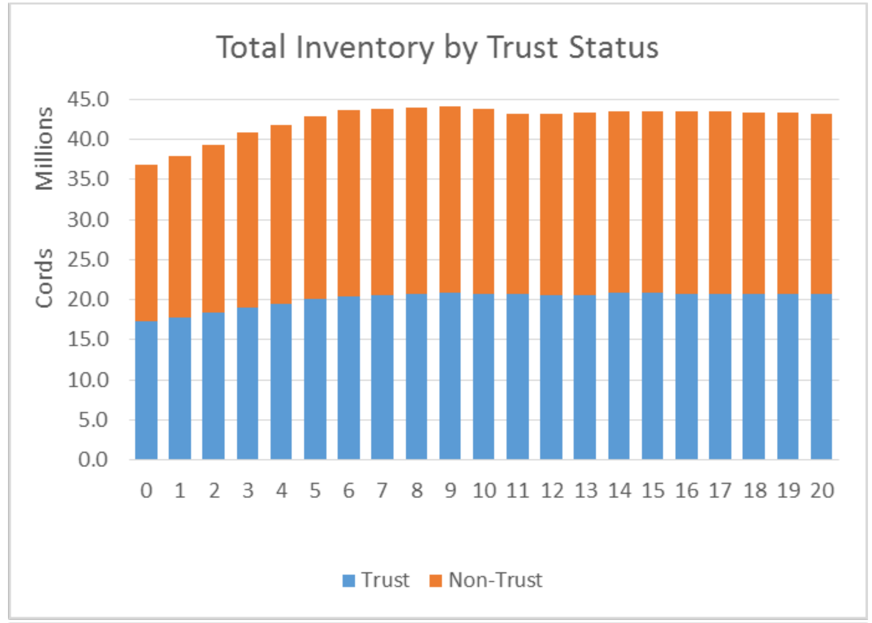

Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

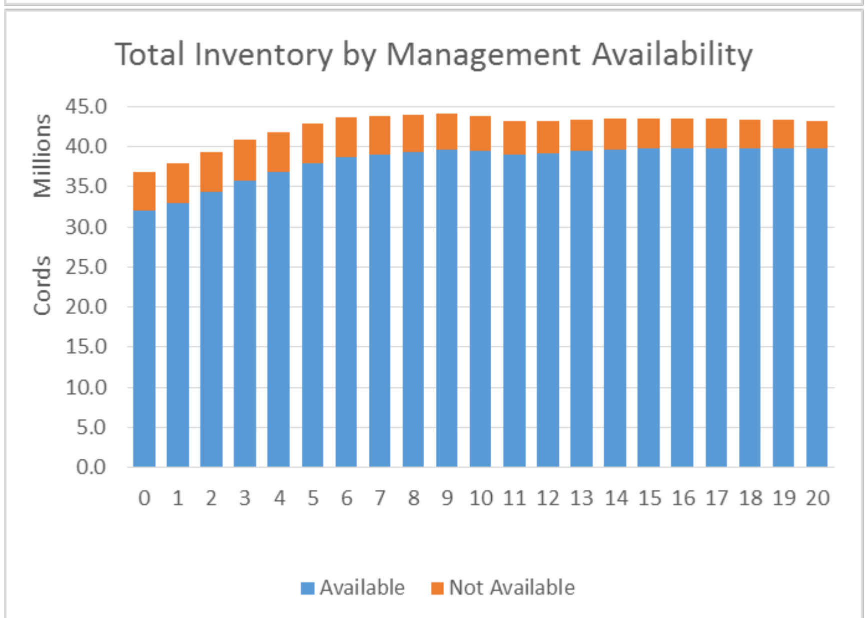

Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

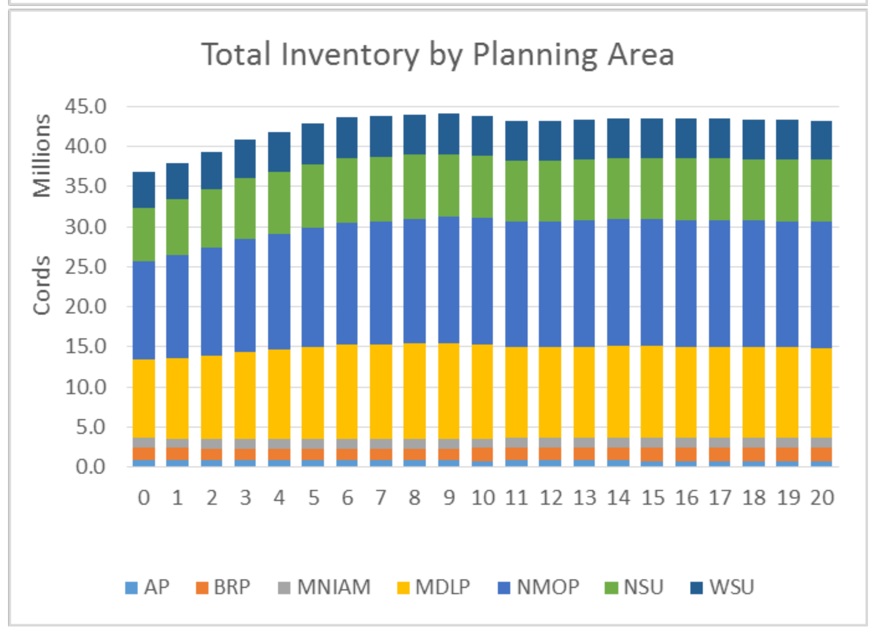

Average Clear-Cut Age
Years
120
100
80
60
40
20
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

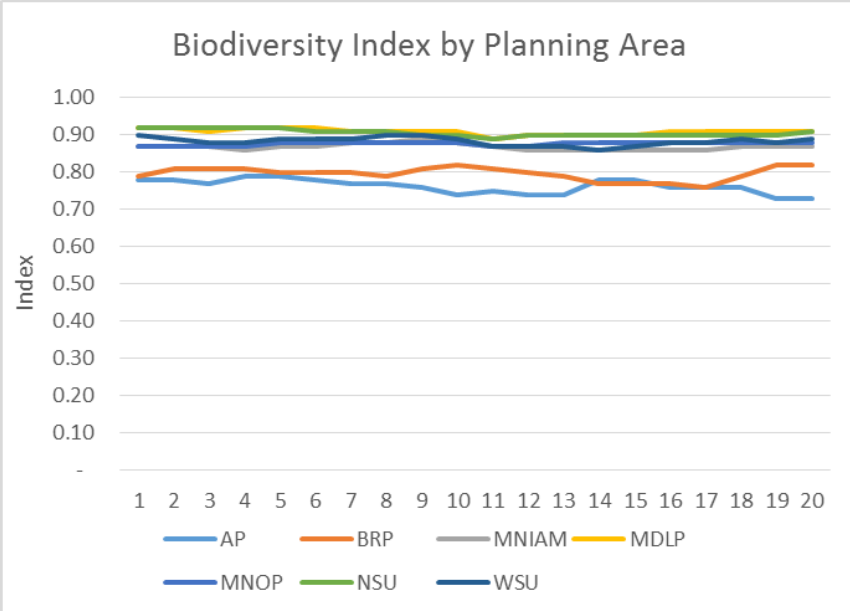

Annual Harvest Acres by Type
Acres
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age
Annual Converted Cover Type Acres
Acres
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar
Forestry Harvest Proportion by Type
Percentage
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age
Wildlife Harvest Proportion by Type
Percentage
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

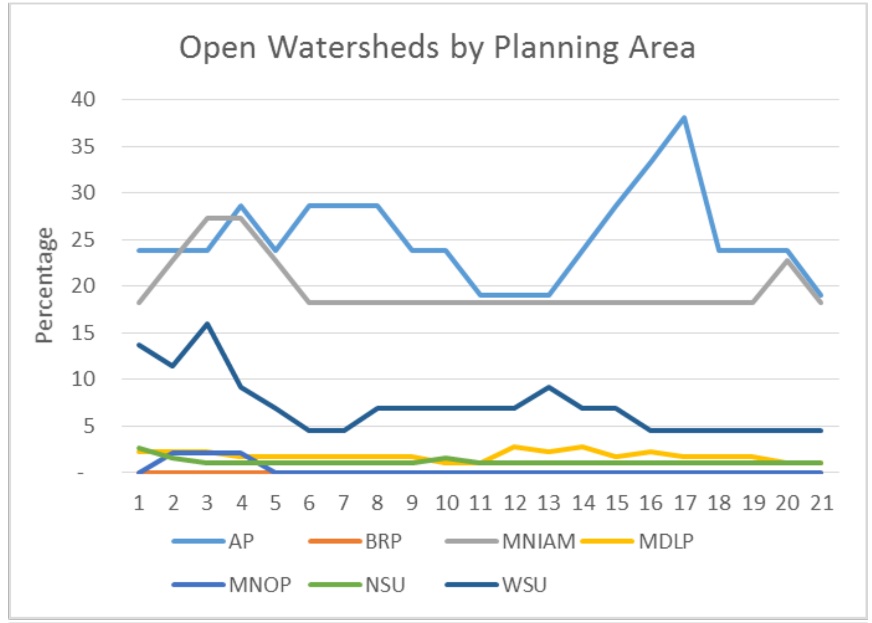

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

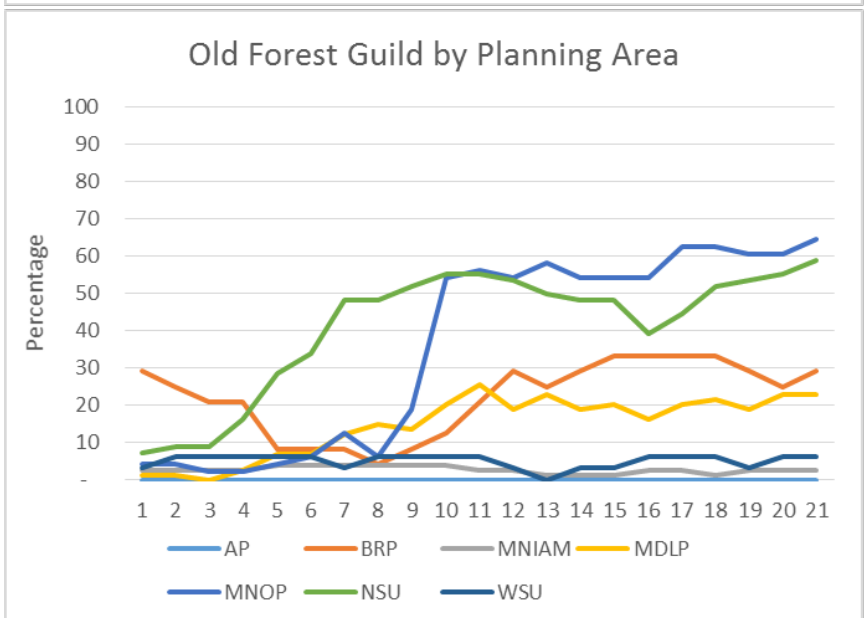

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

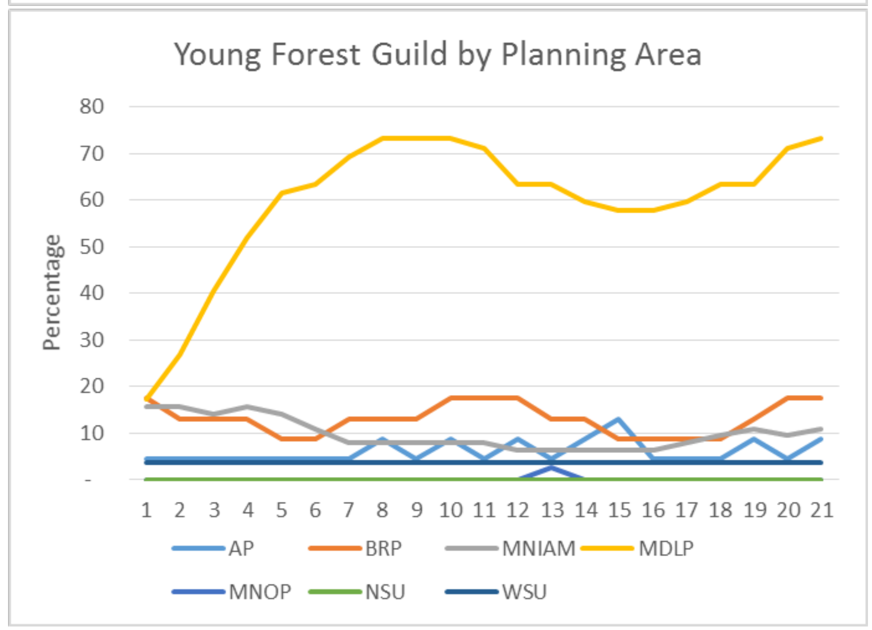

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

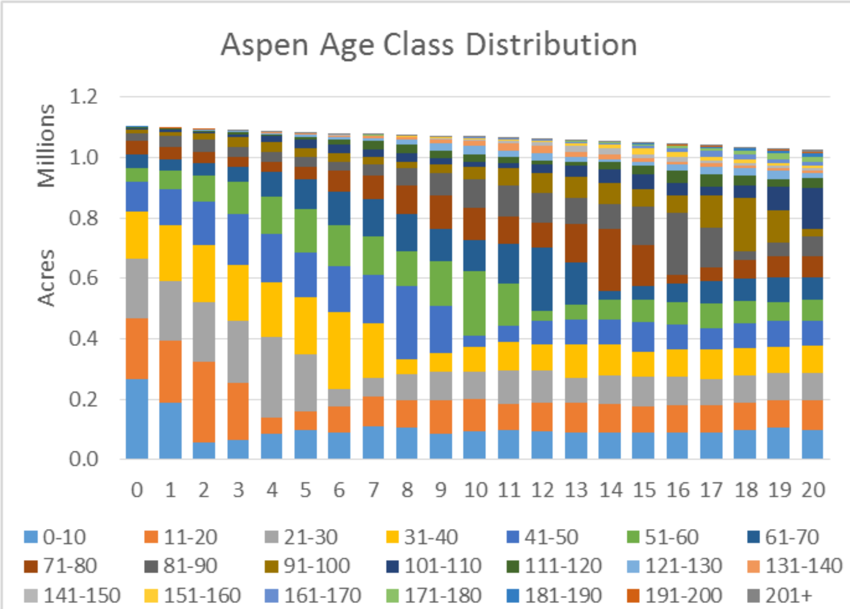

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

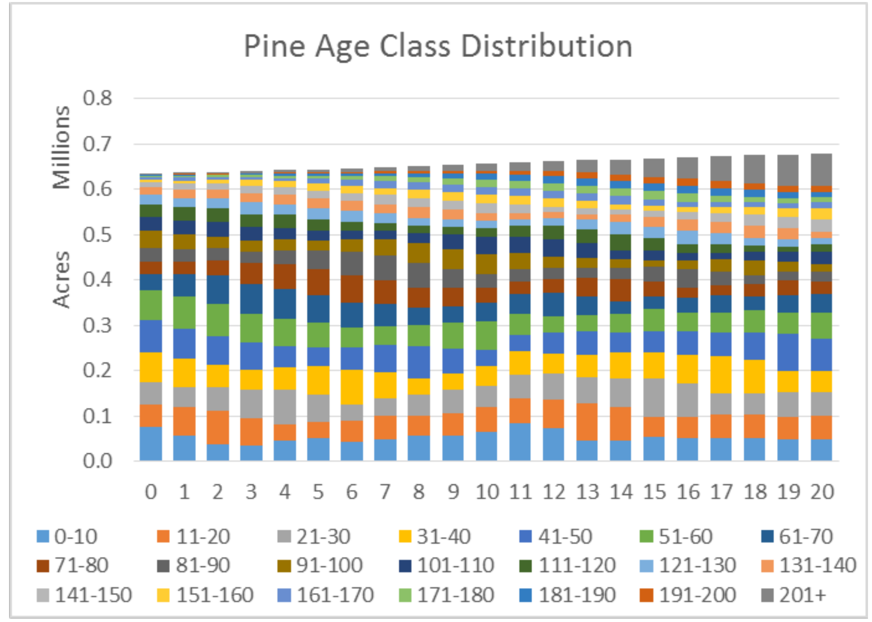

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

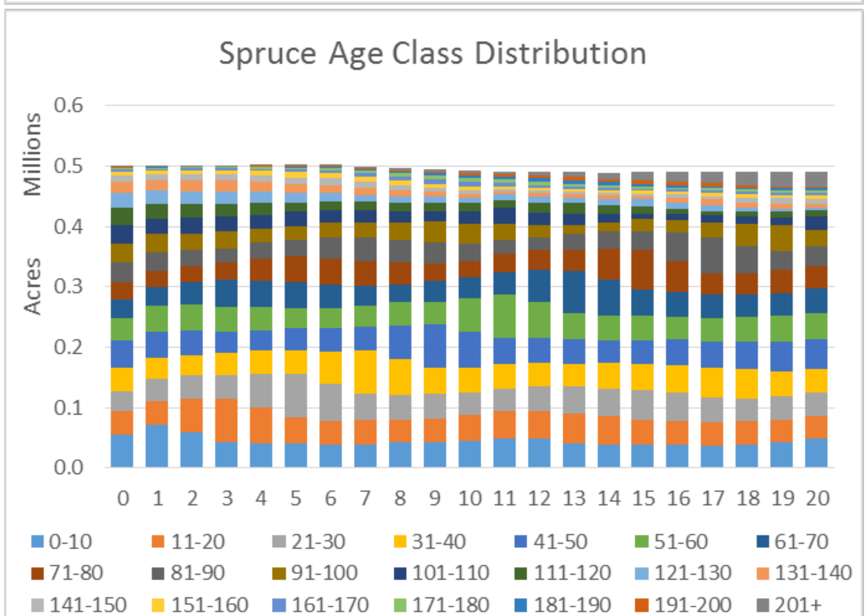

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

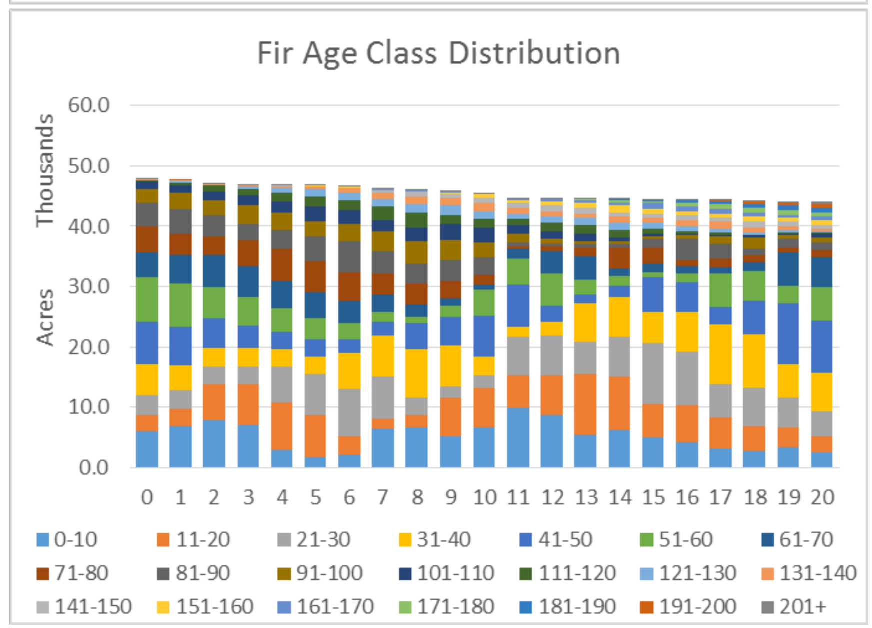

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

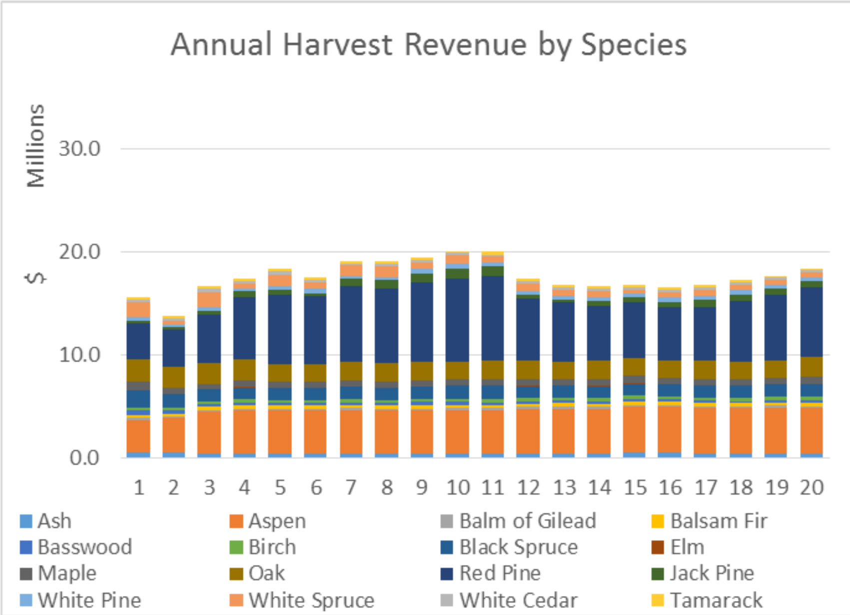

Young Forest Guild by Planning Area
Percentage
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

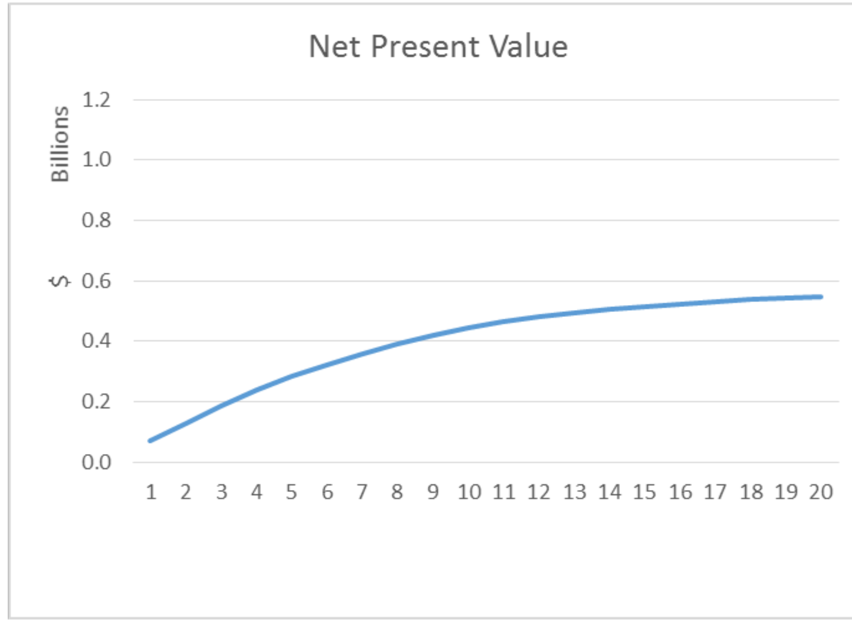

Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

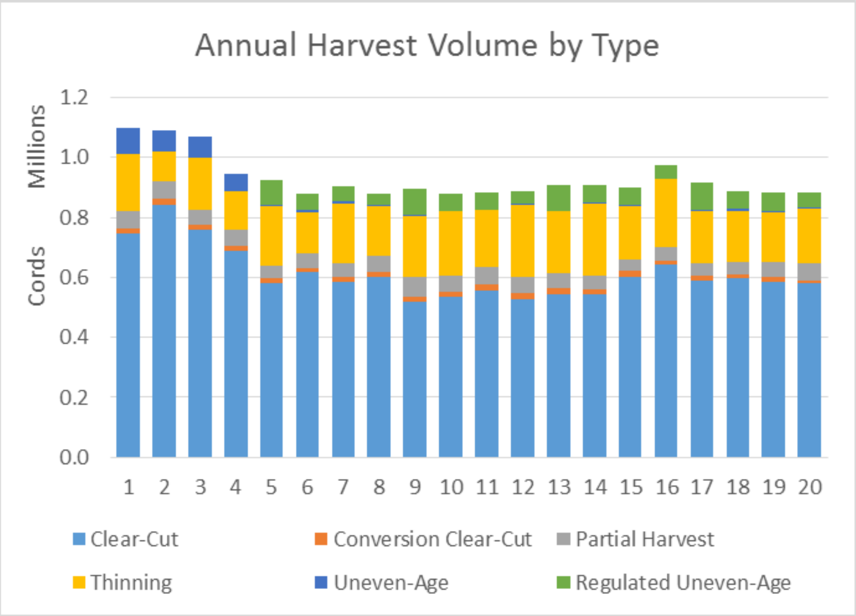

Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

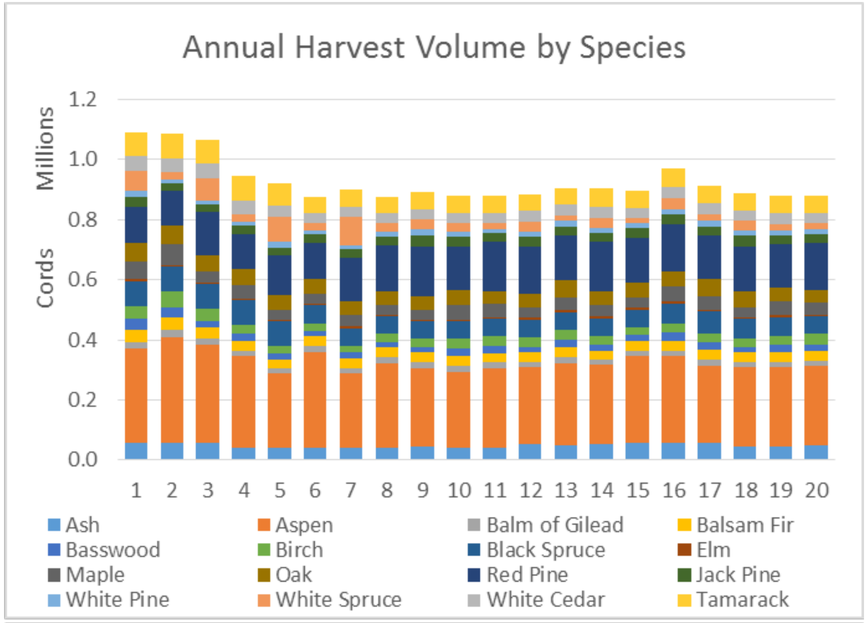

Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack


Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

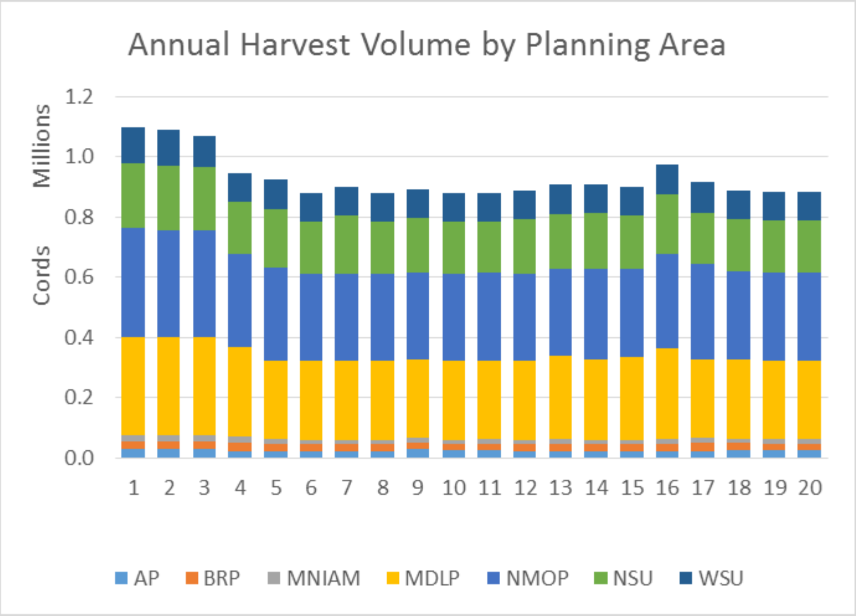
Scenario 2.1



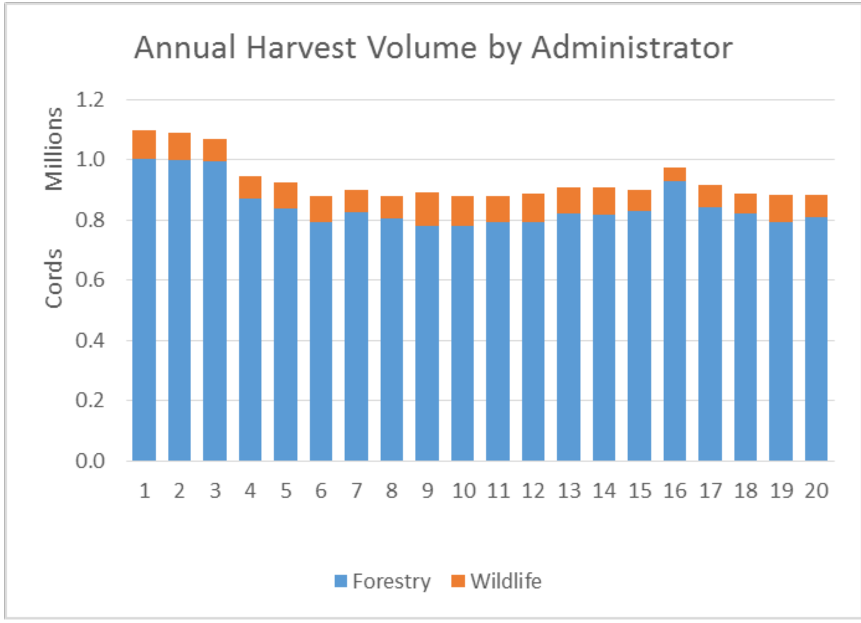
Annual Harvest Volume by Type
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age



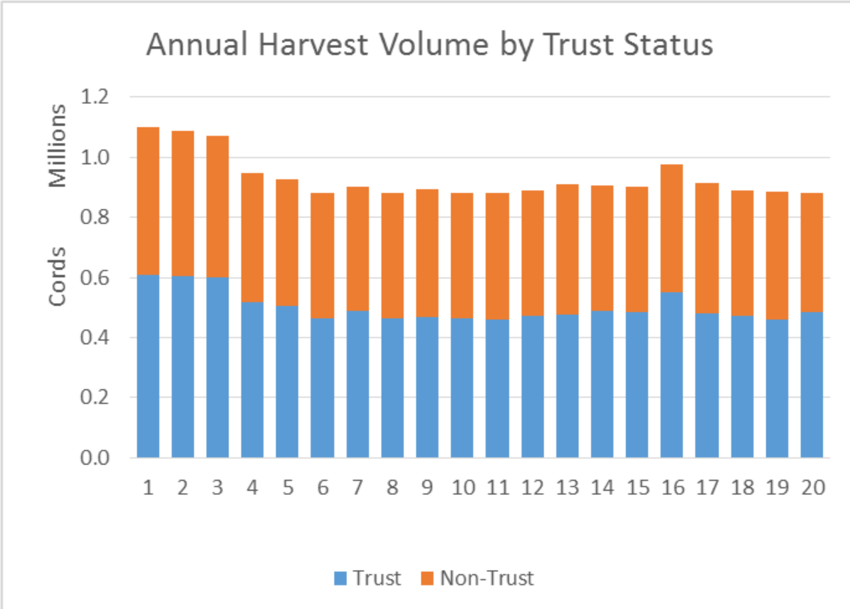
Annual Harvest Volume by Species
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

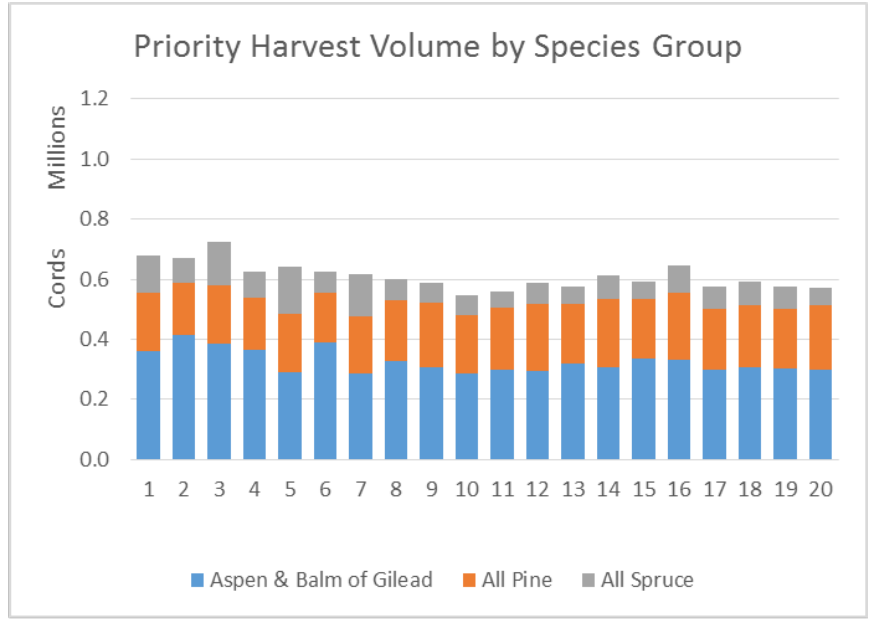


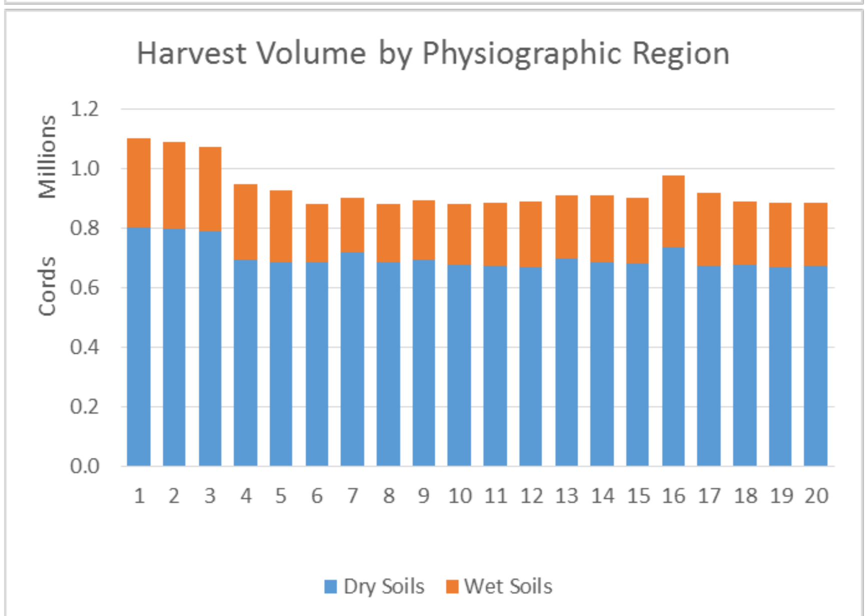
Annual Harvest Volume by Planning Area
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

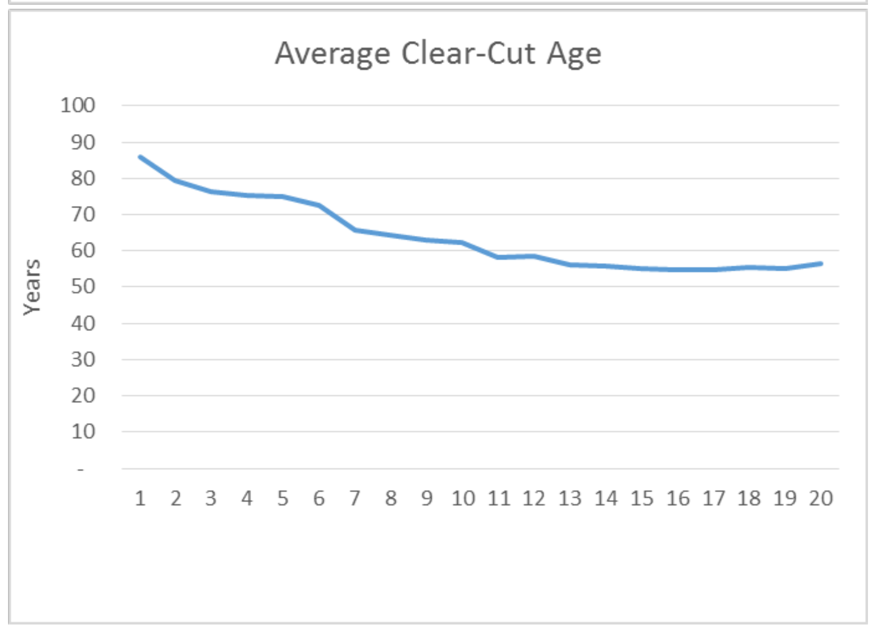


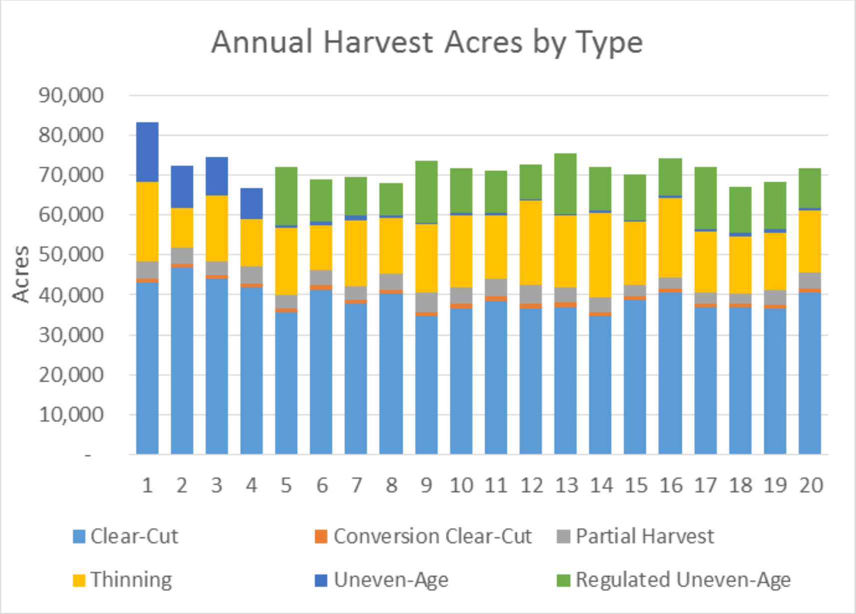
Annual Harvest Volume by Administrator
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Forestry
Wildlife

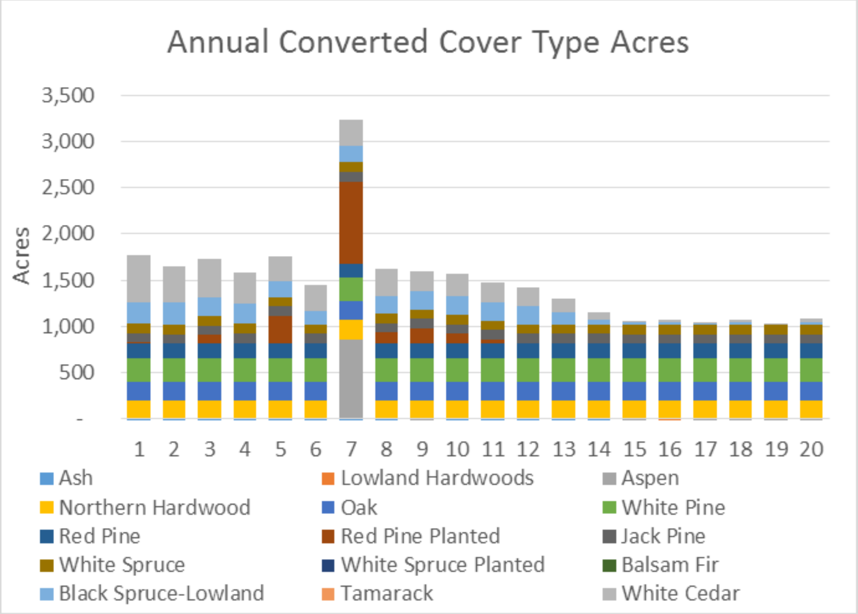

Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

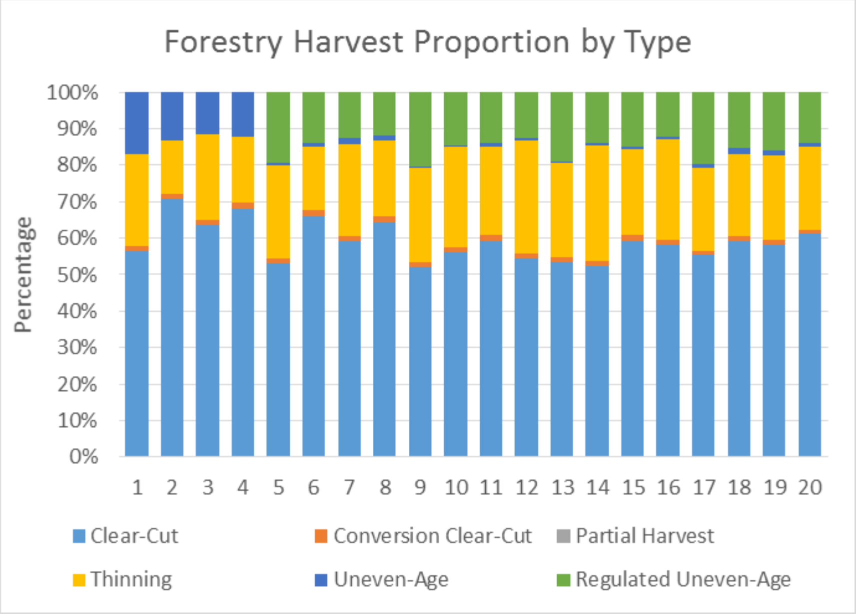

Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

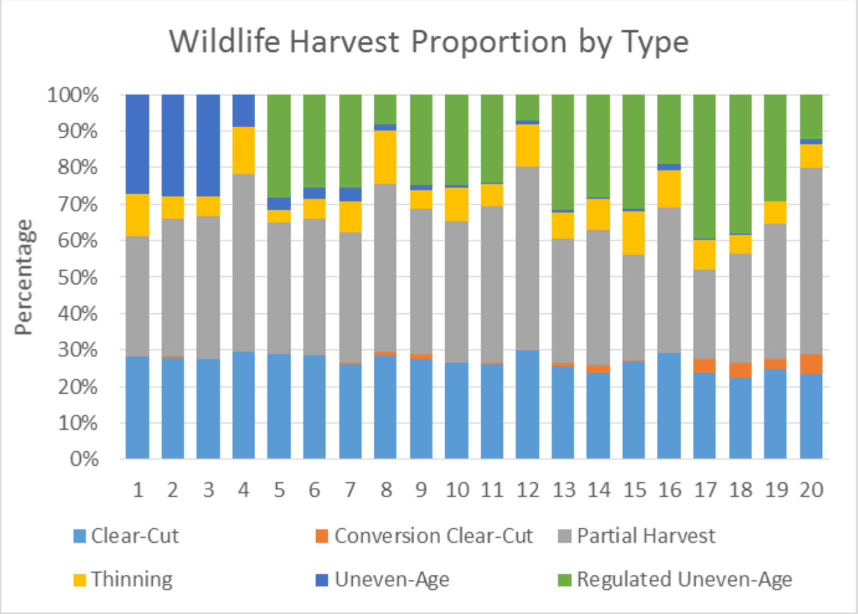

Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

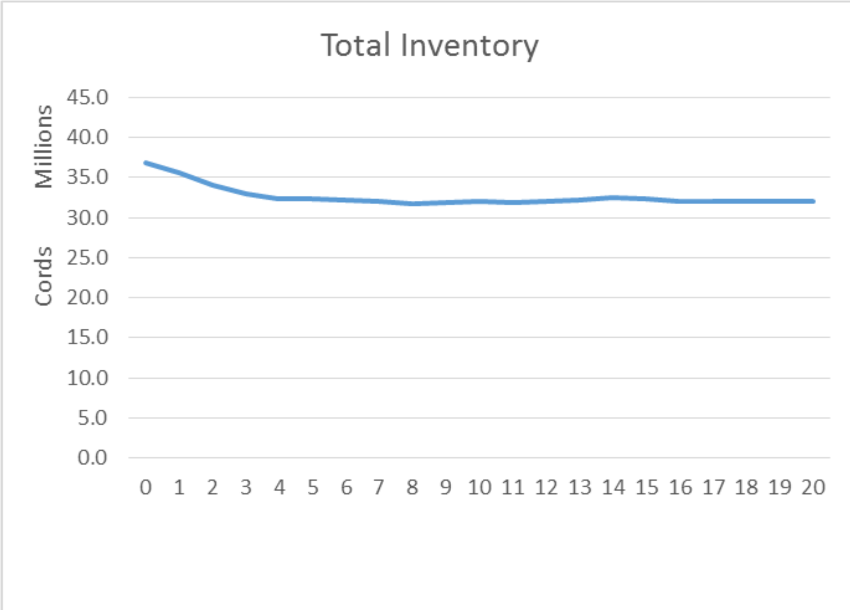

Average Clear-Cut Age
Years
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

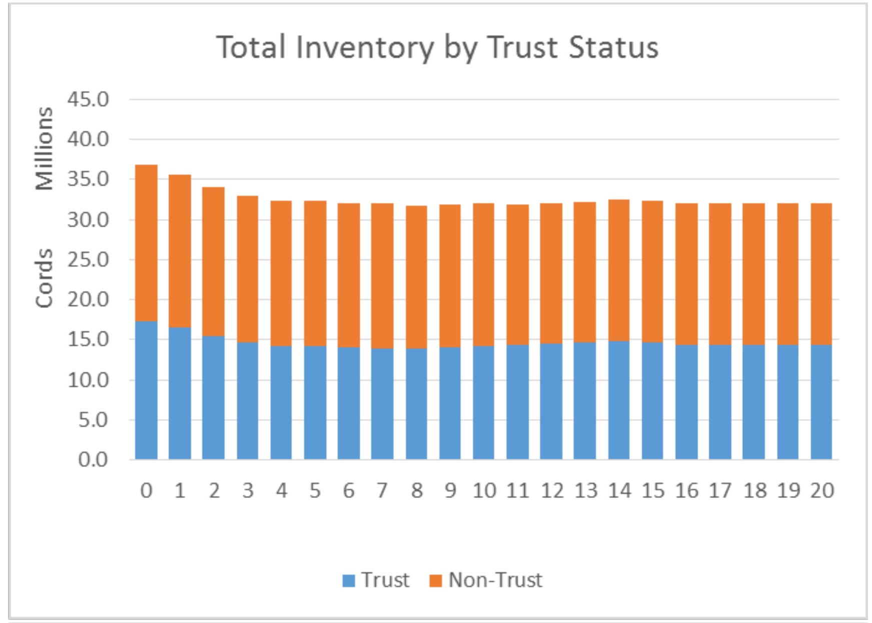

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

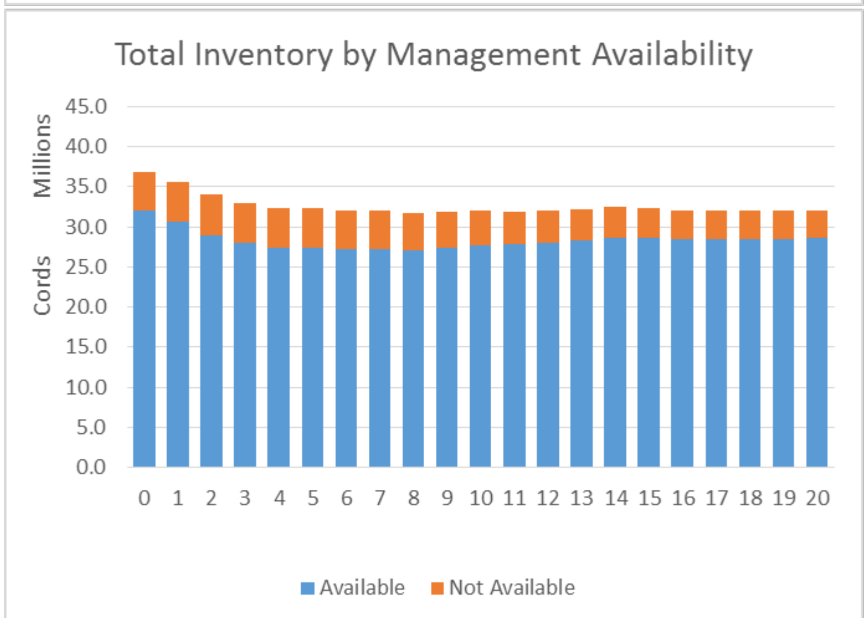

Annual Converted Cover Type Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

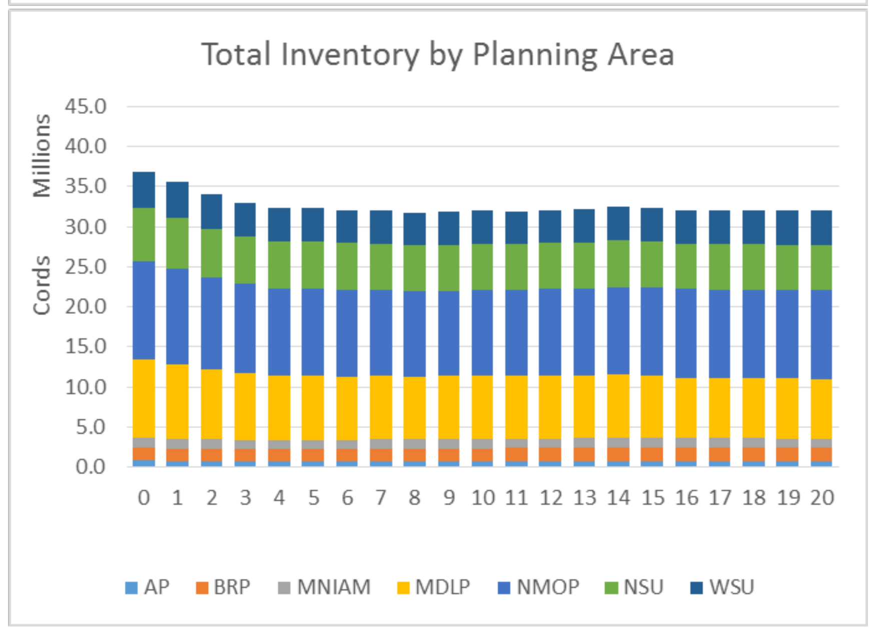

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

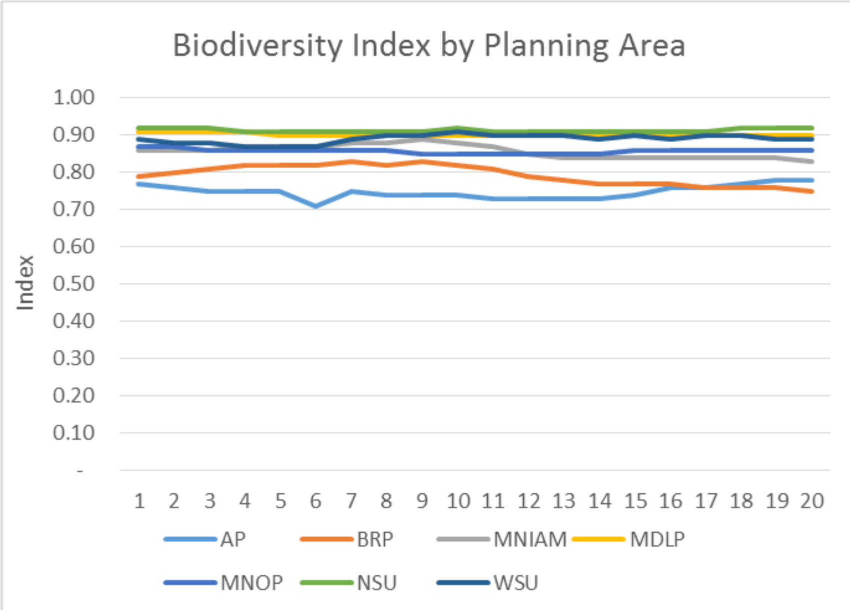

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age


Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

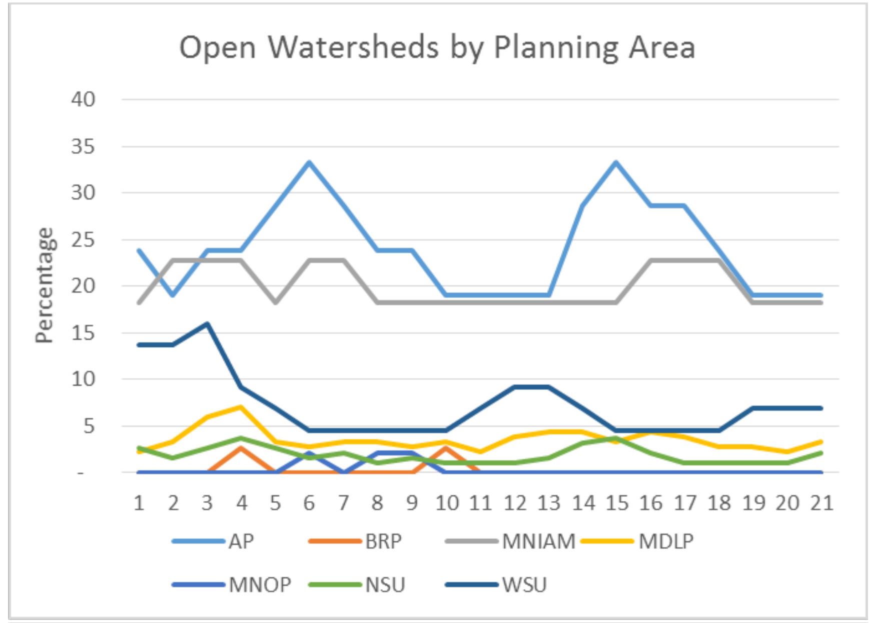

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust


Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

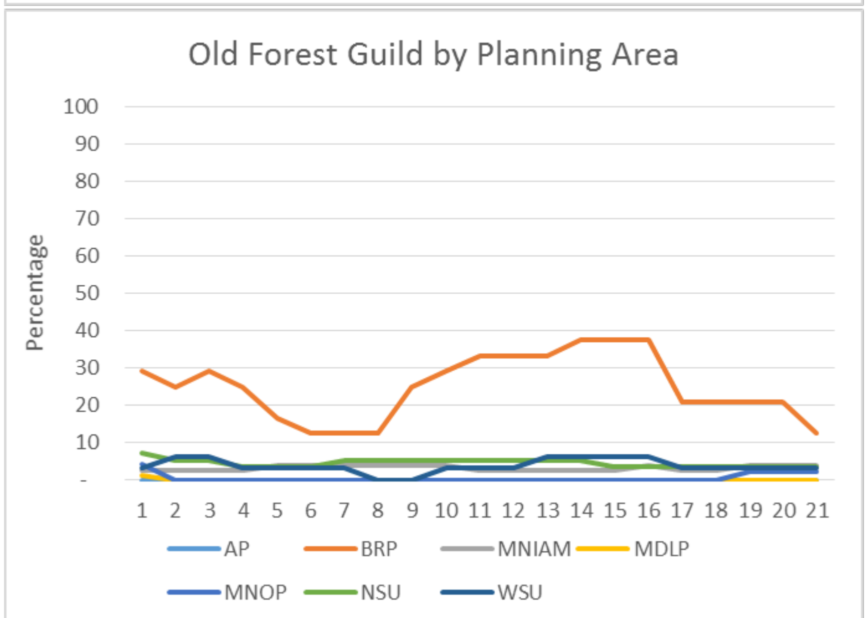

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU



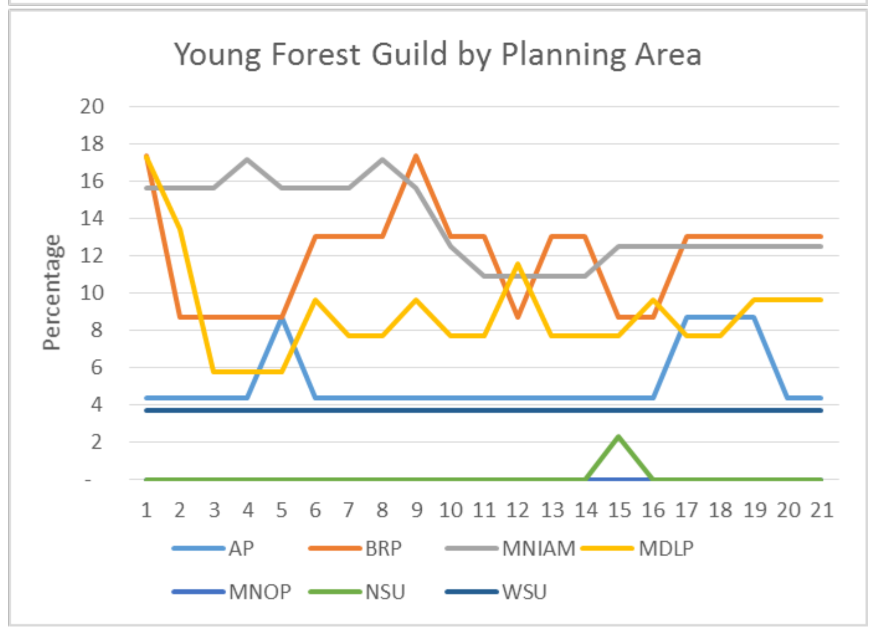
Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU



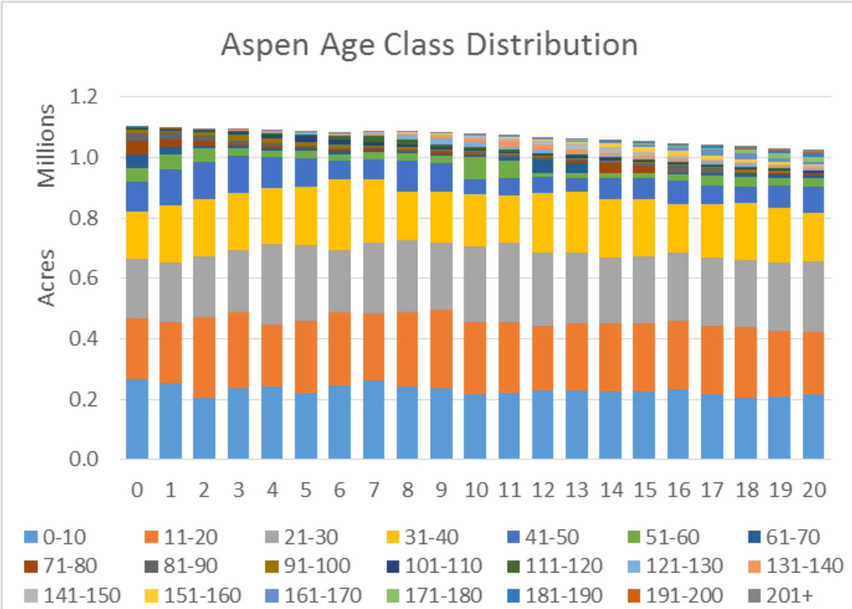
Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

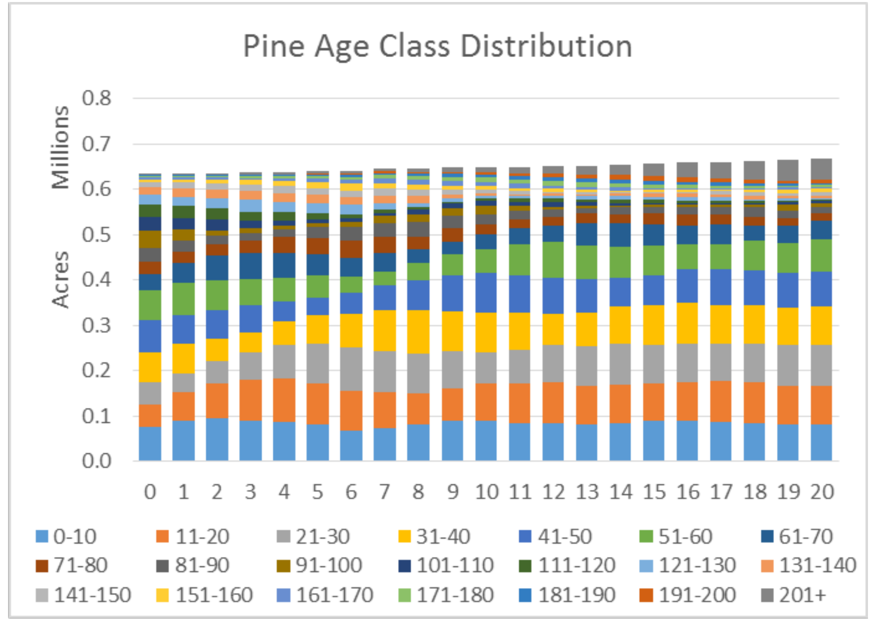


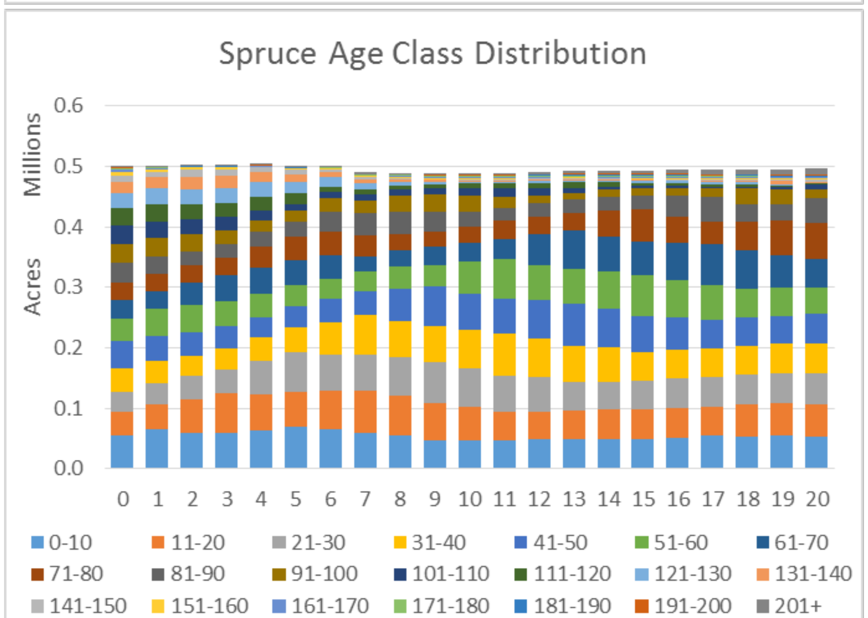
Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

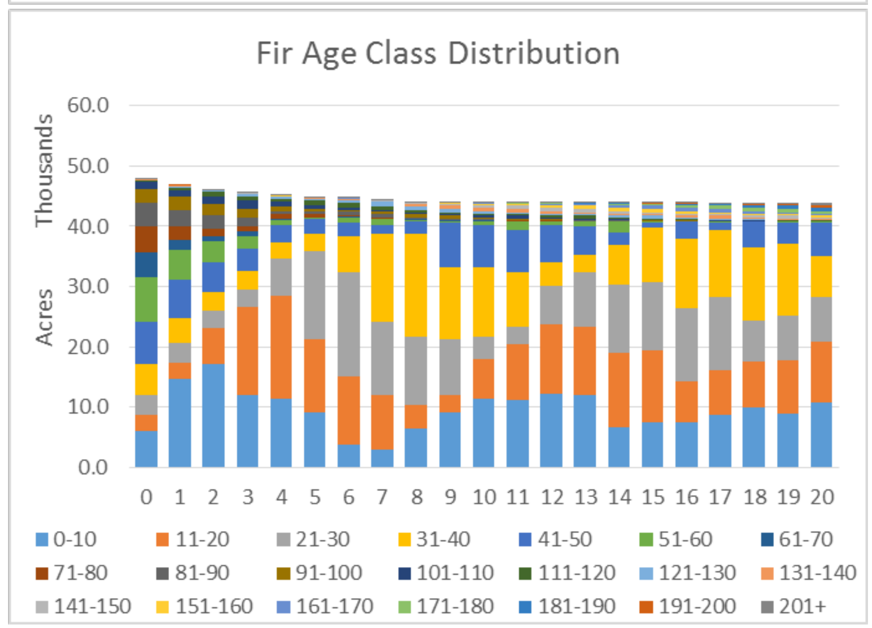


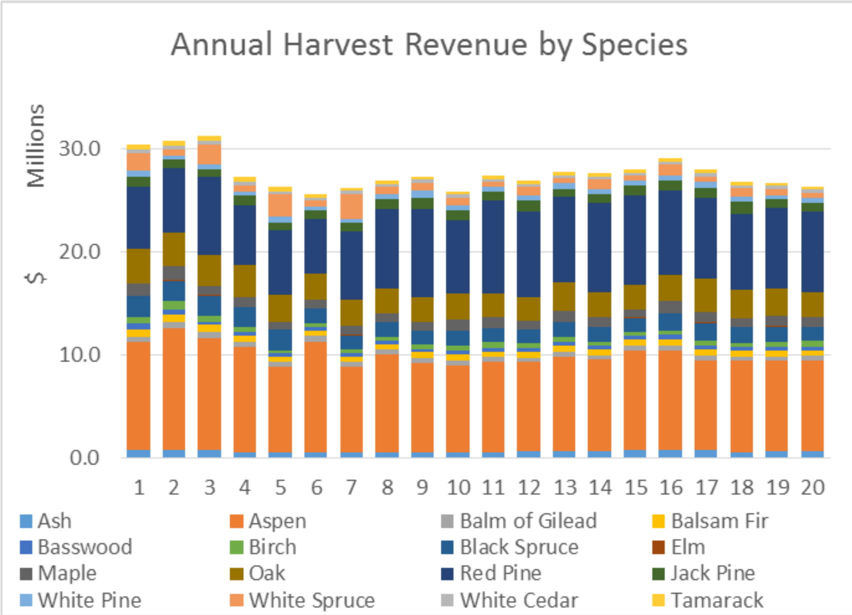
Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

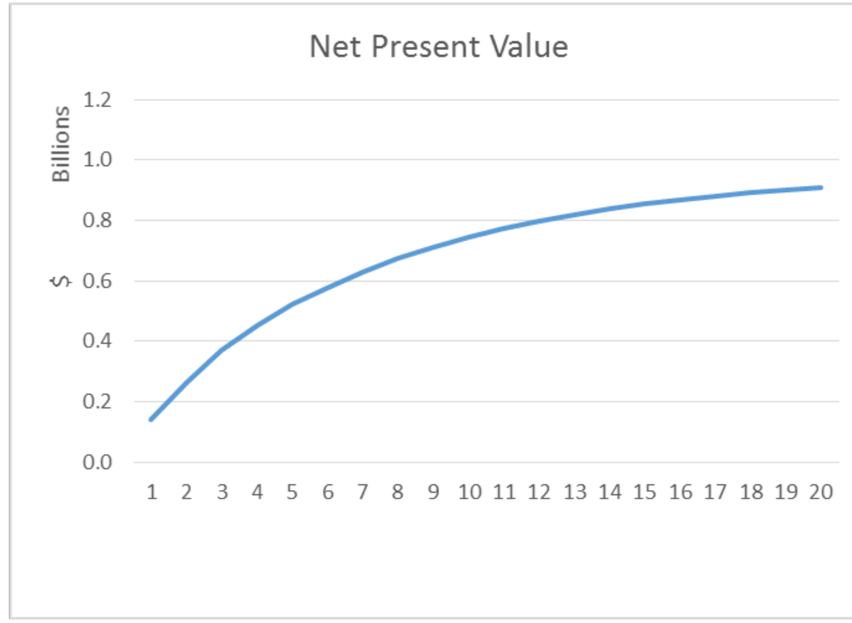

Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

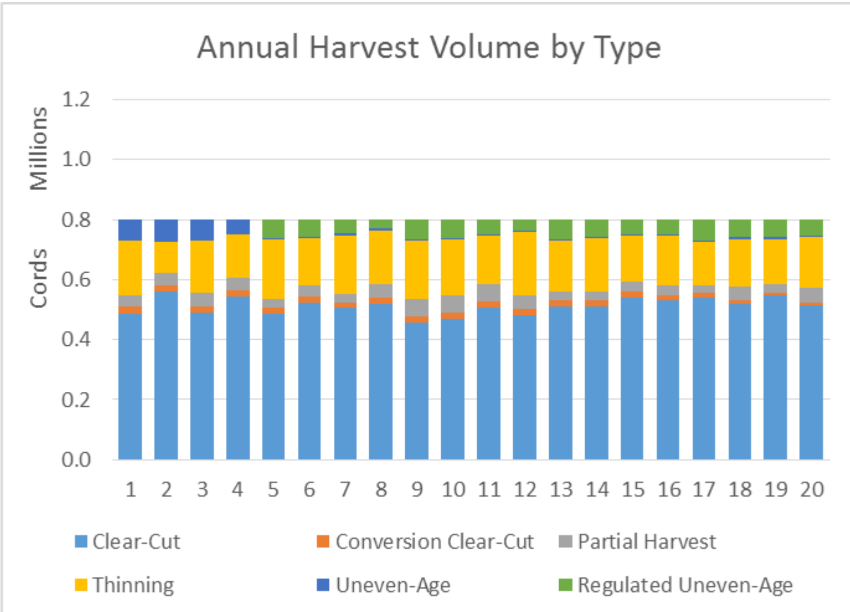

Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

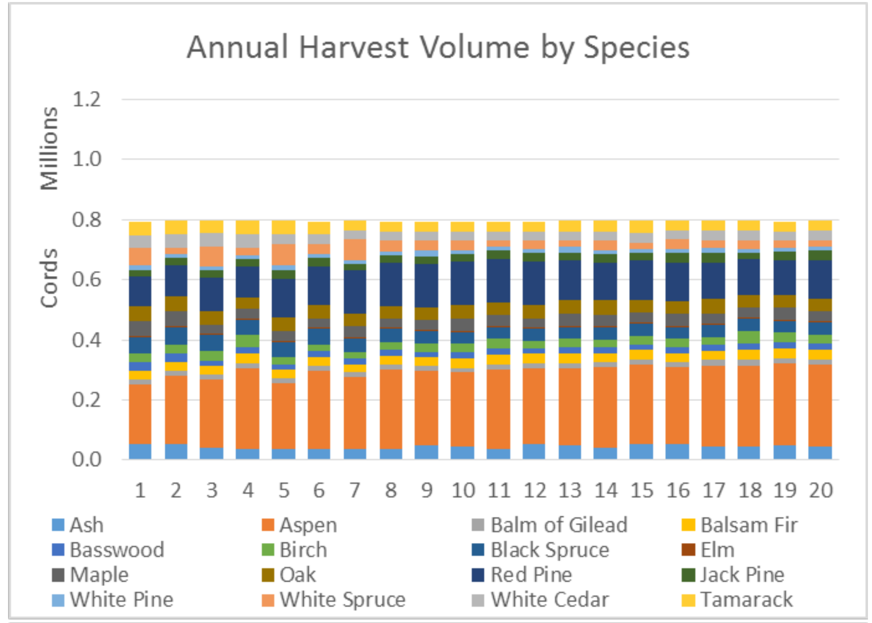

Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

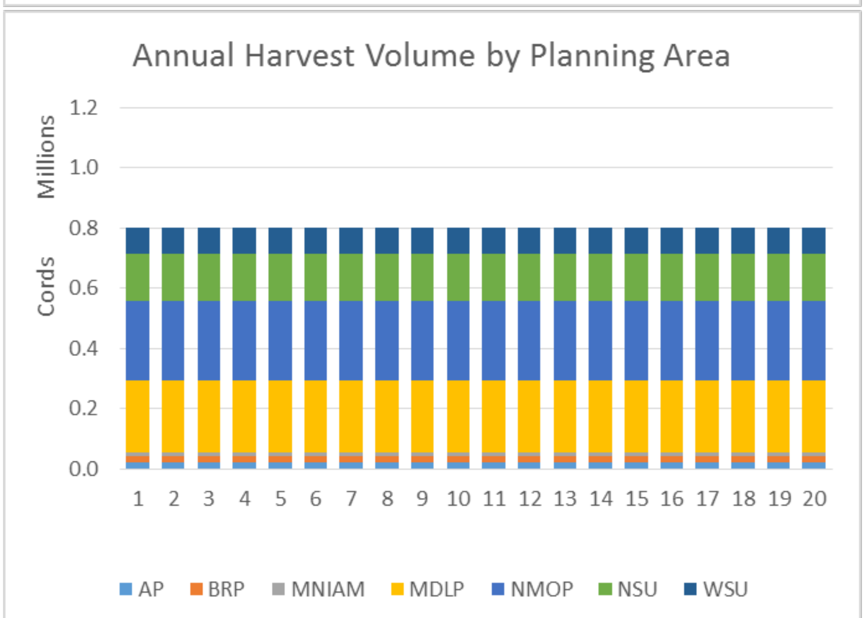

Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

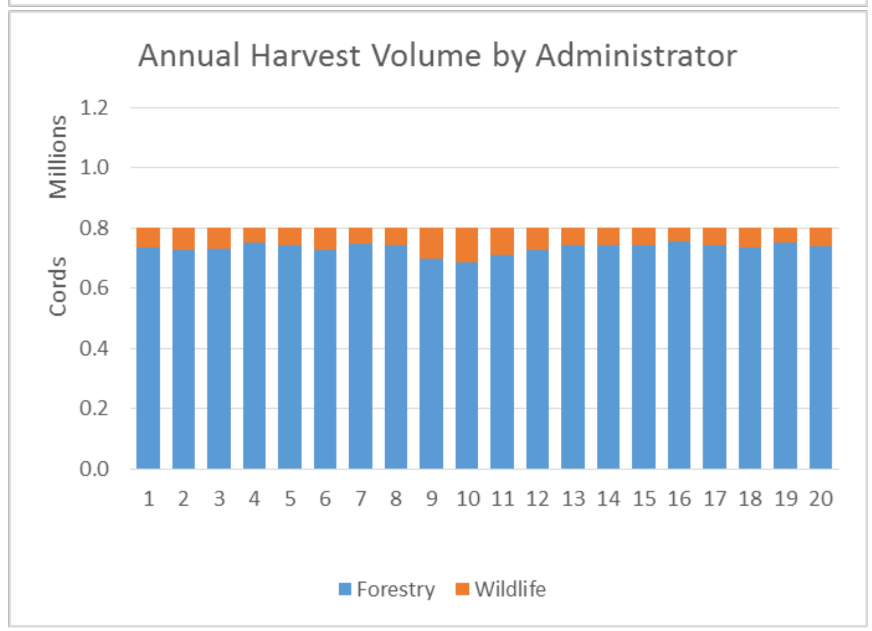

Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

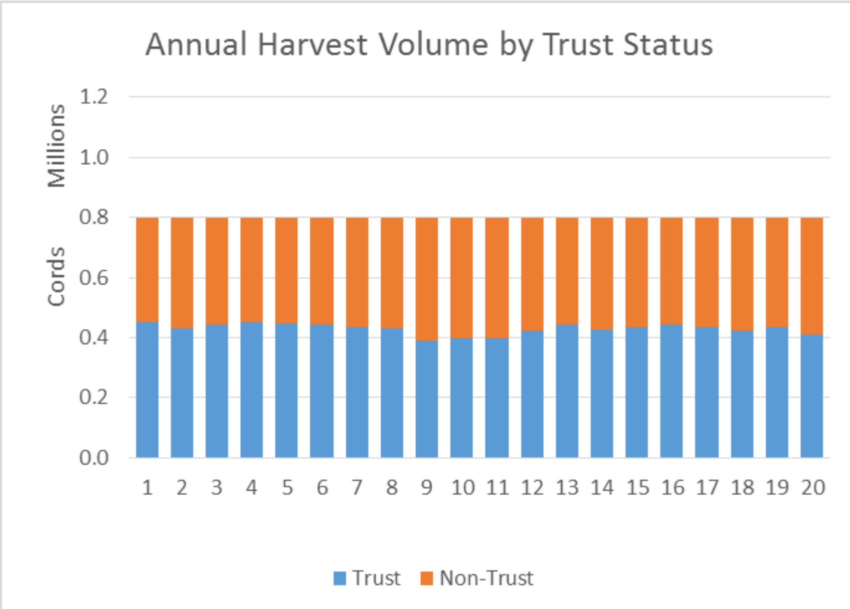
Scenario 2.2

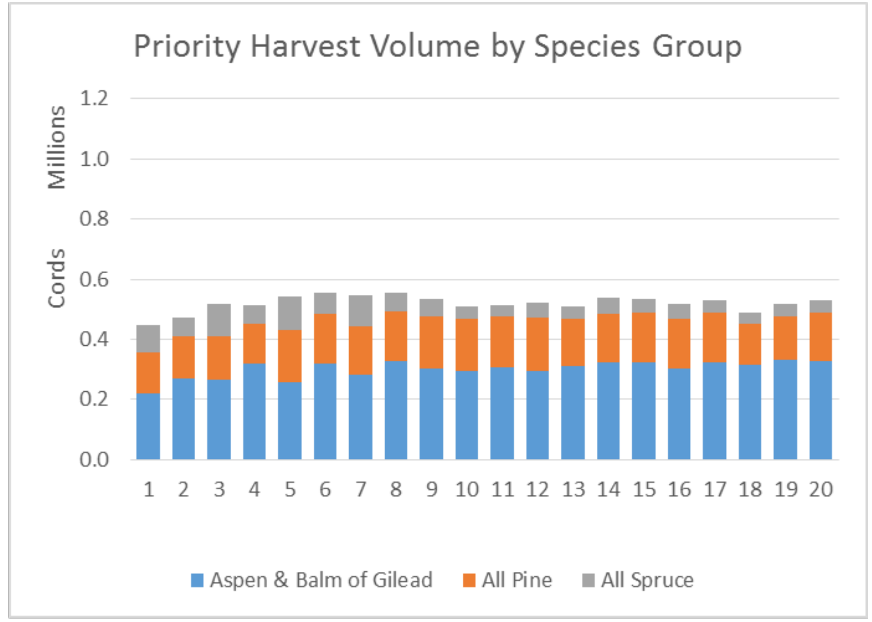

Annual Harvest Volume by Type
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

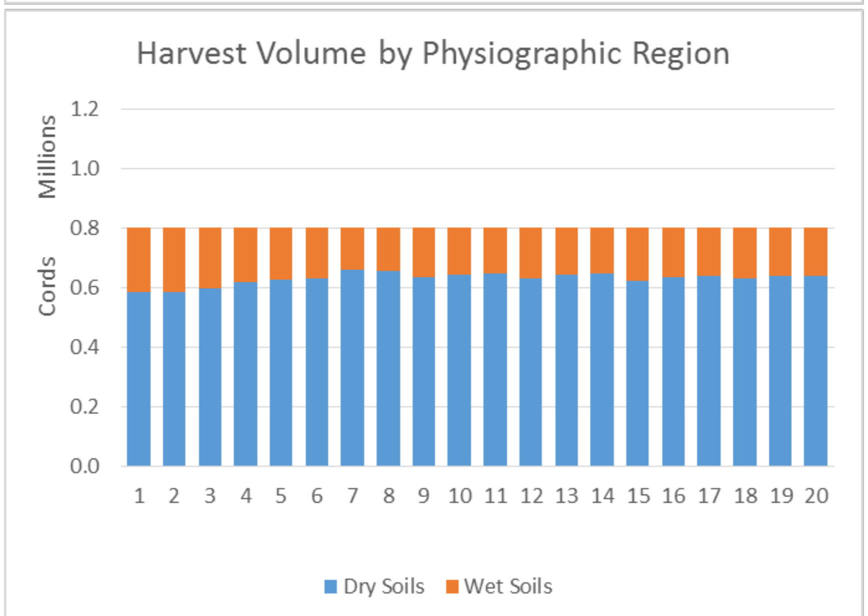

Annual Harvest Volume by Species
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

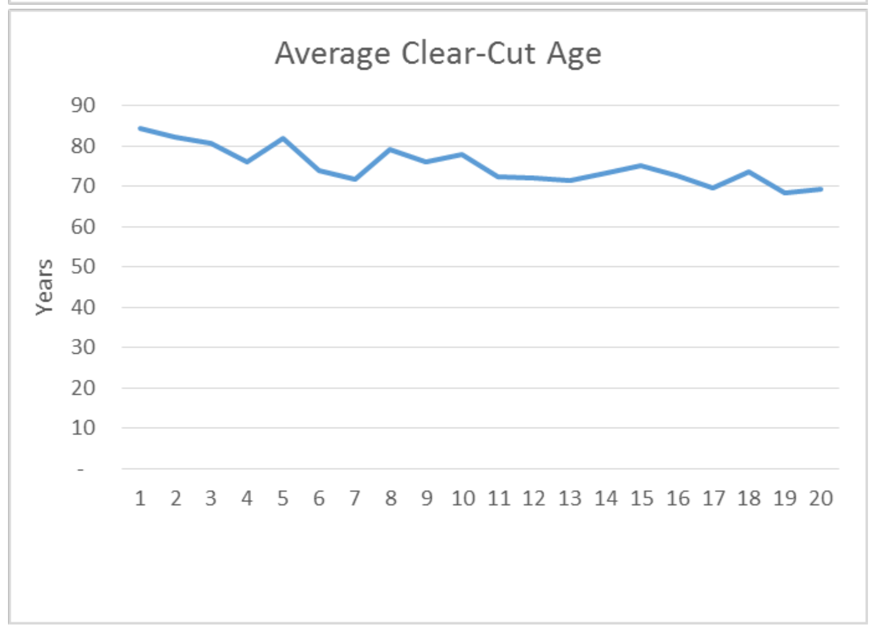

Annual Harvest Volume by Planning Area
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

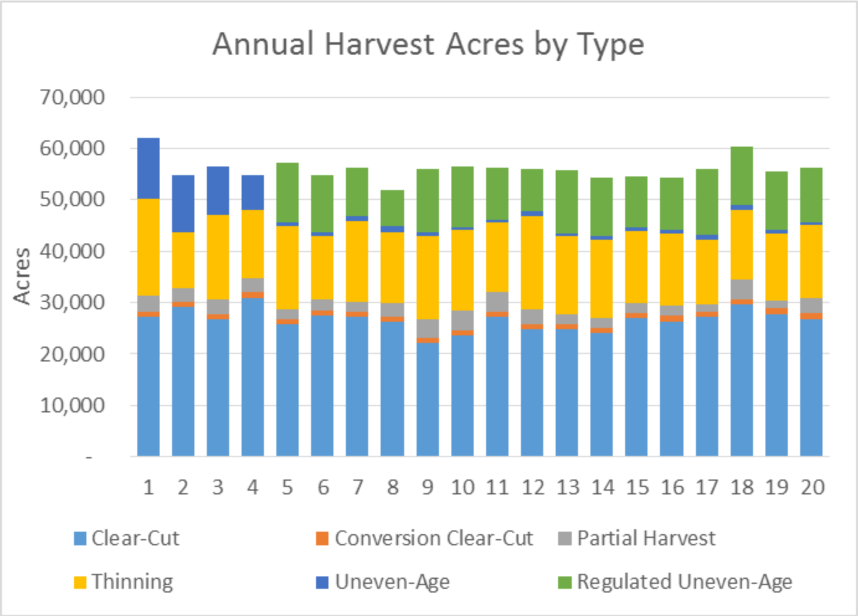

Annual Harvest Volume by Administrator
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Forestry
Wildlife

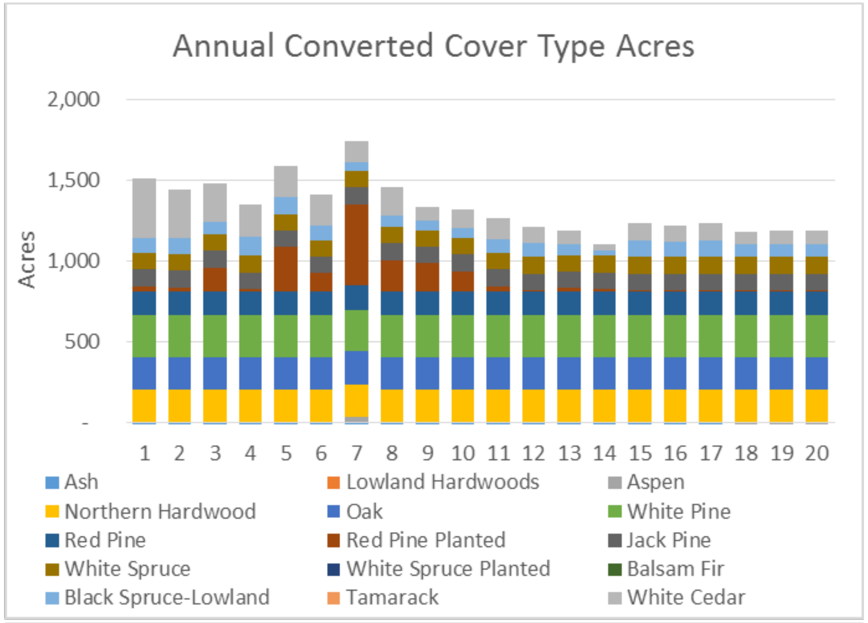

Annual Harvest Volume by Trust Status
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

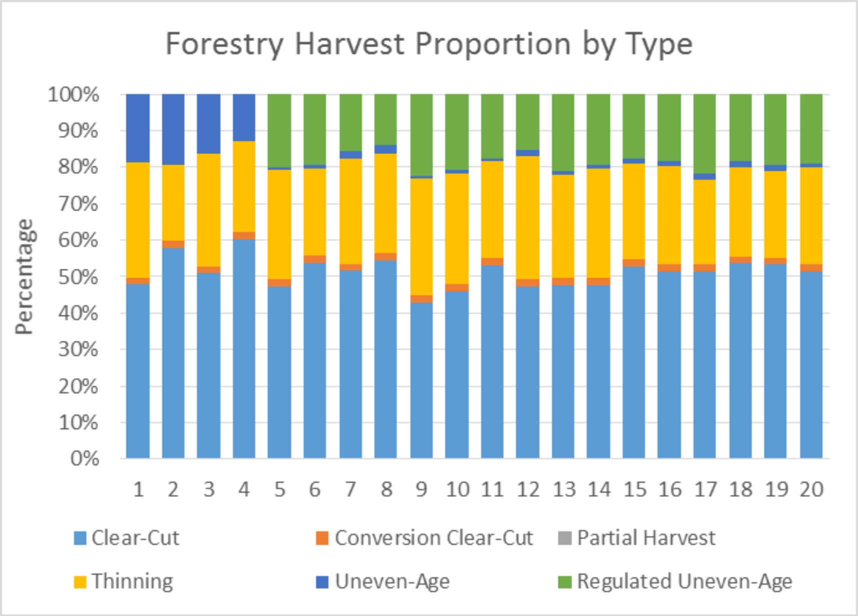

Priority Harvest Volume by Species Group
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

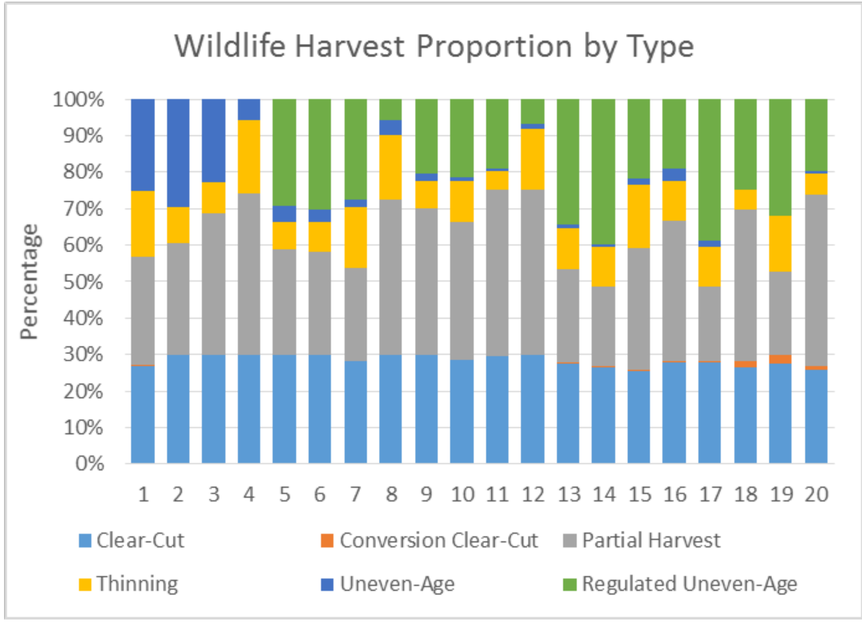

Harvest Volume by Physiographic Region
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
-
10
20
30
40
50
60
70
80
90
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

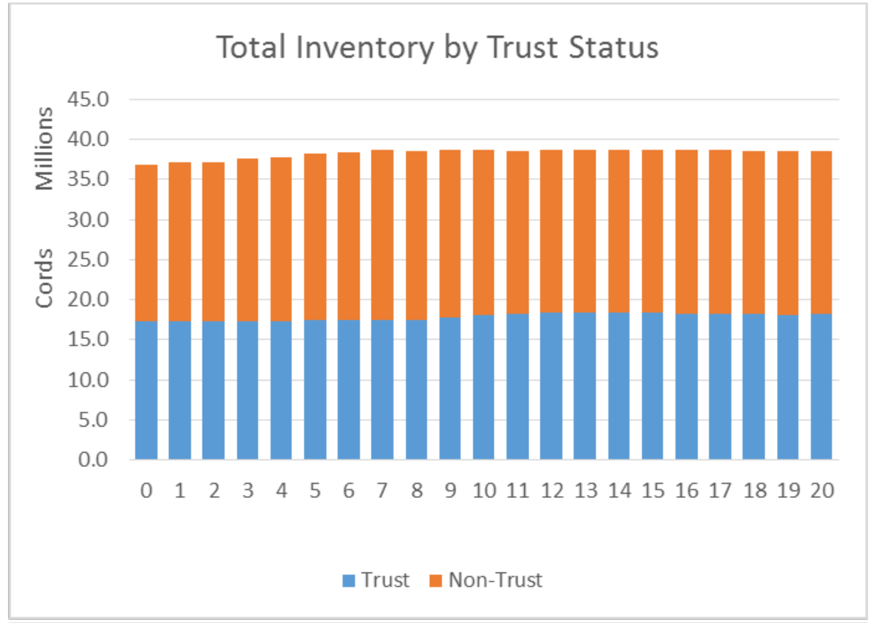

Annual Harvest Acres by Type
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

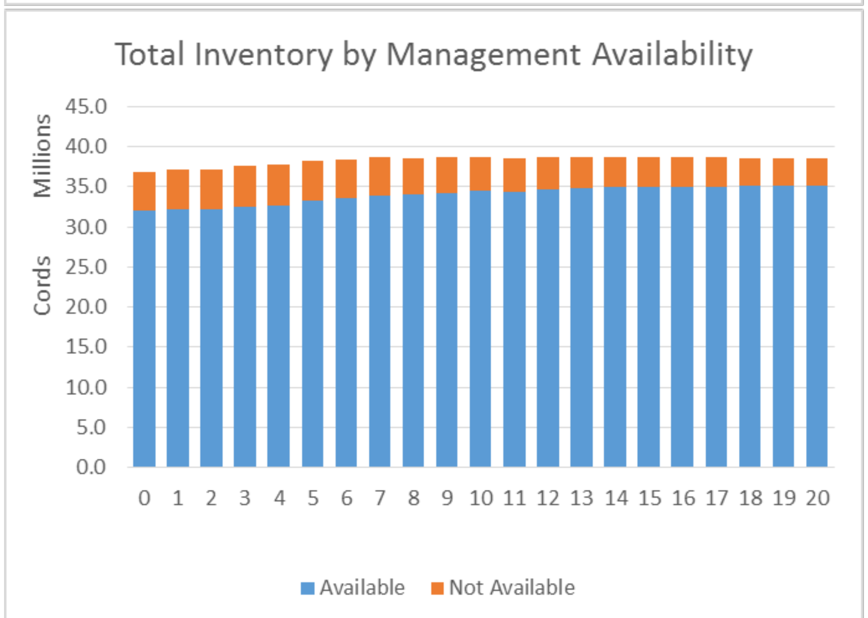

Annual Converted Cover Type Acres
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

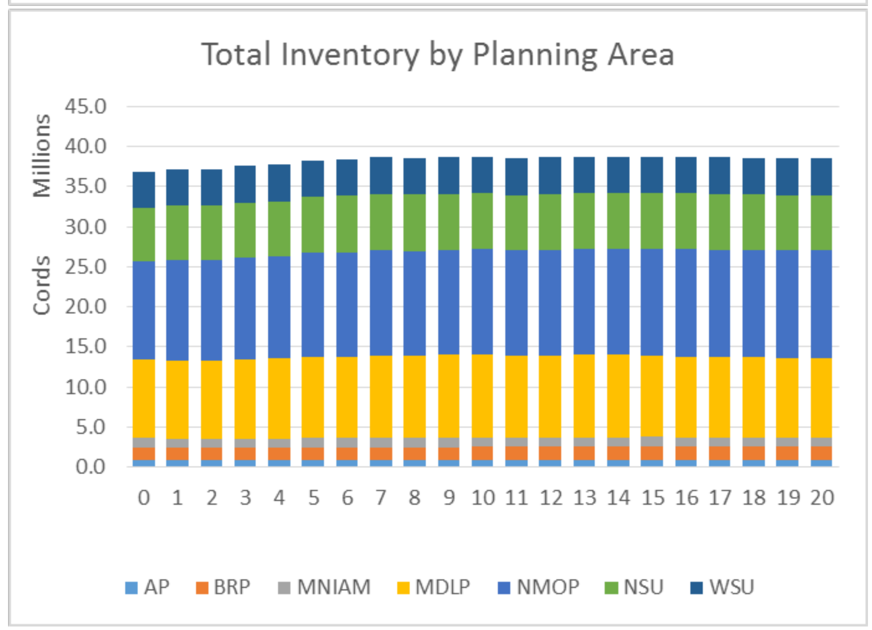

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

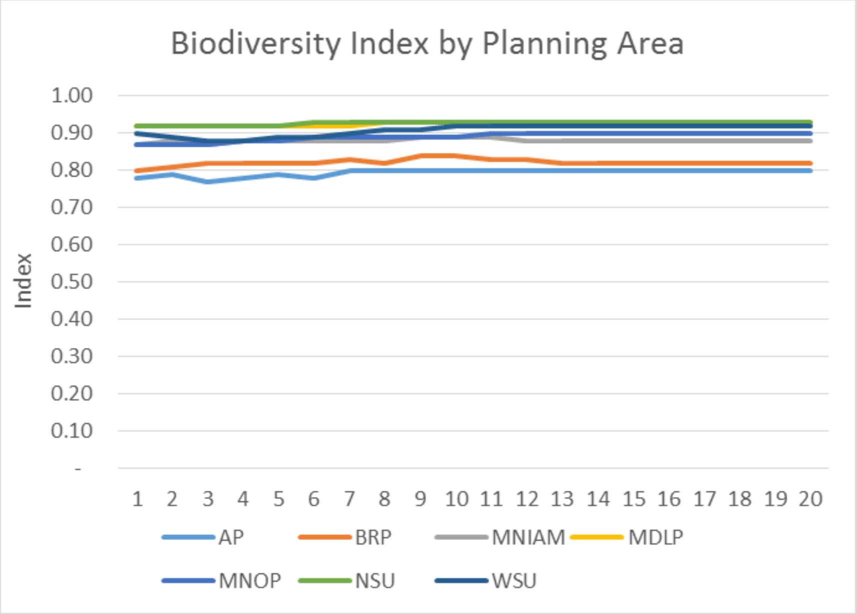

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

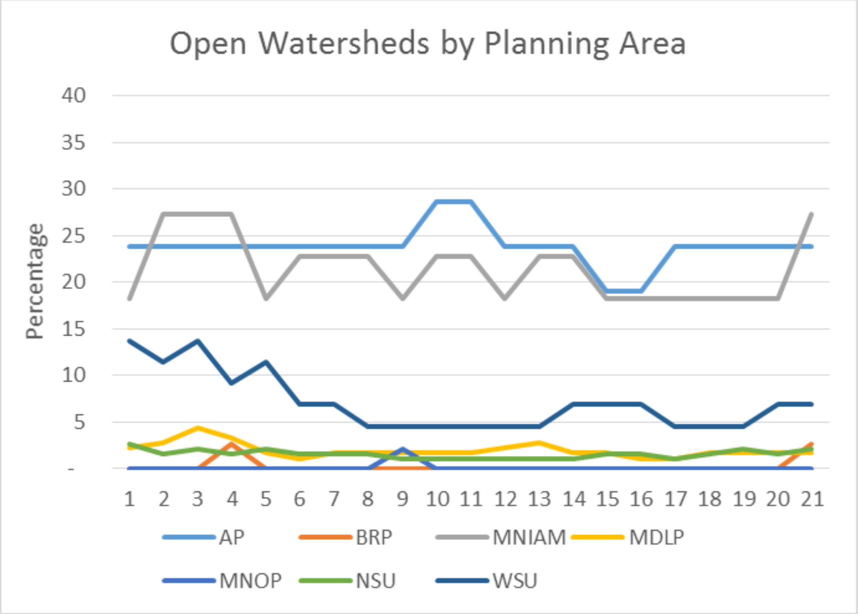

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

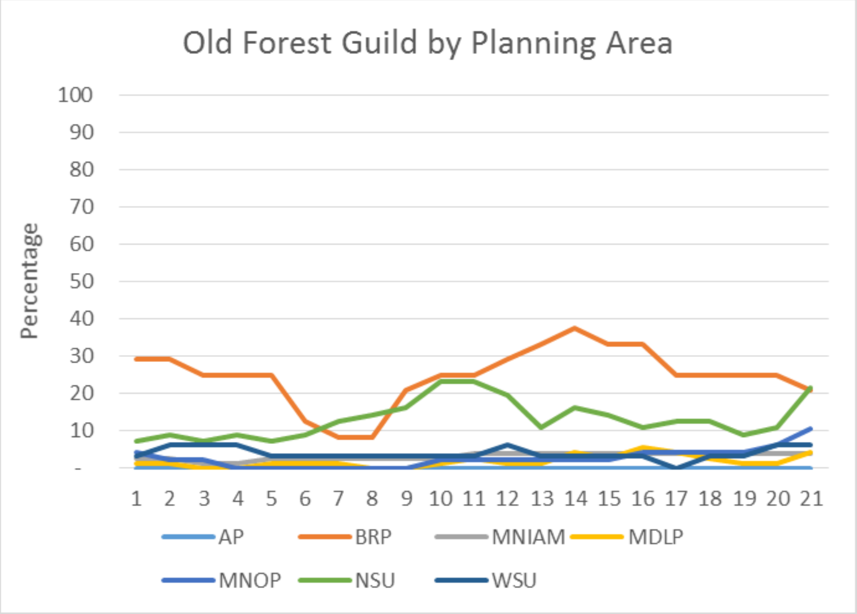

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

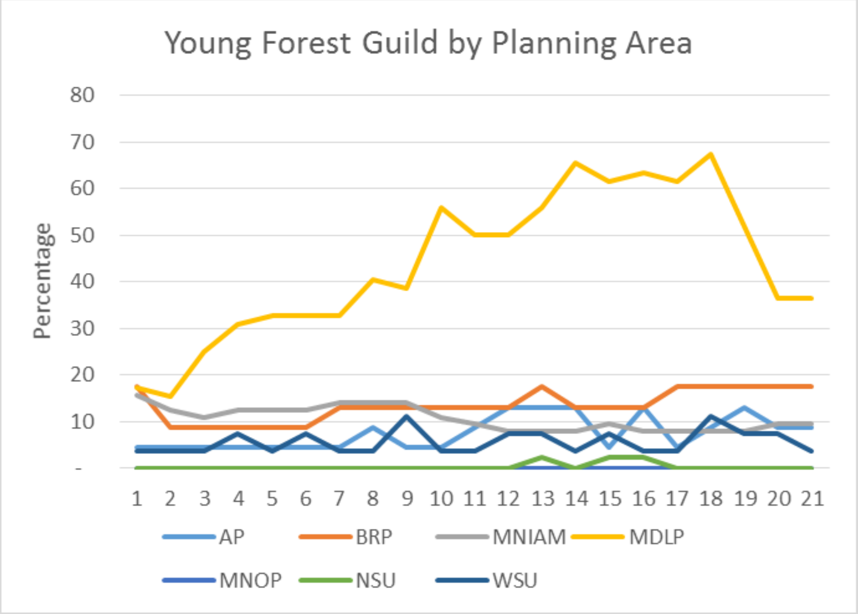

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

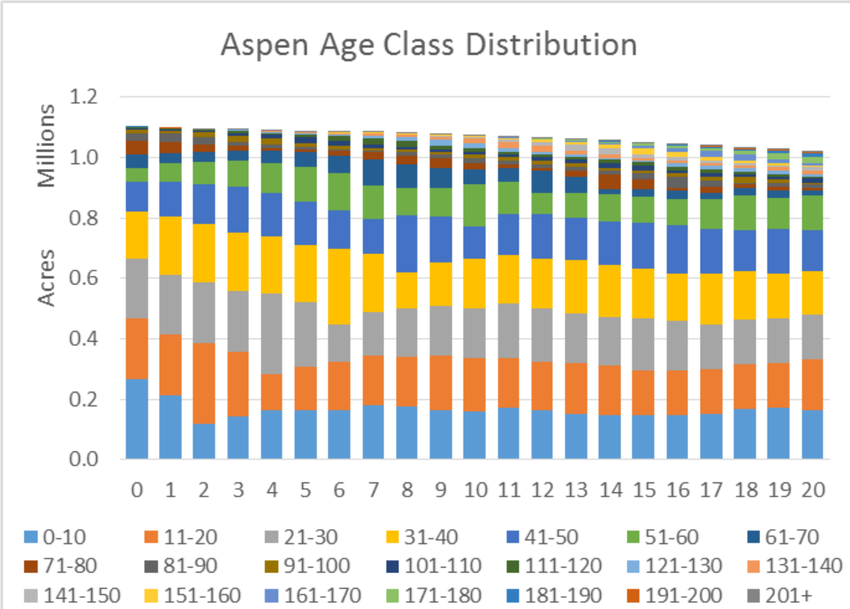

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

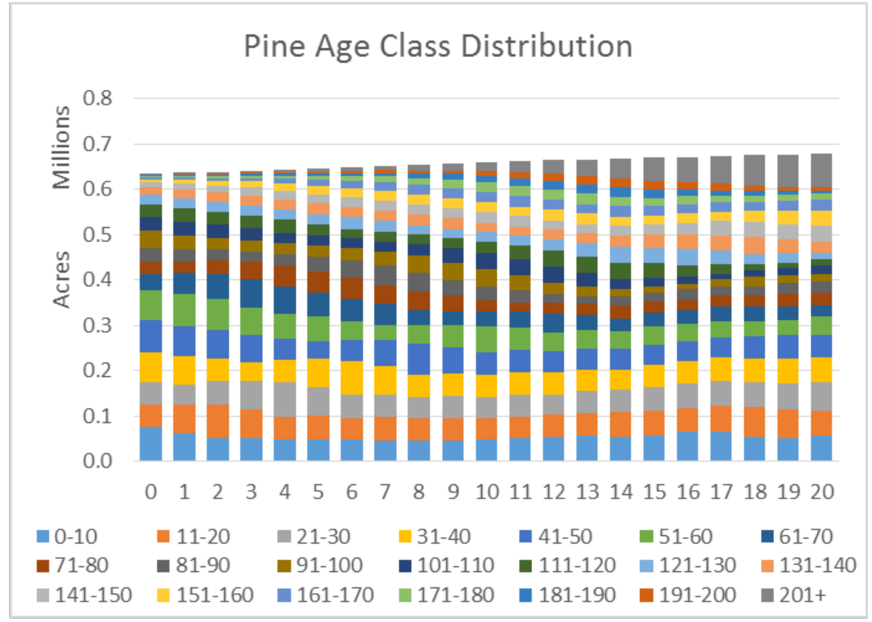

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

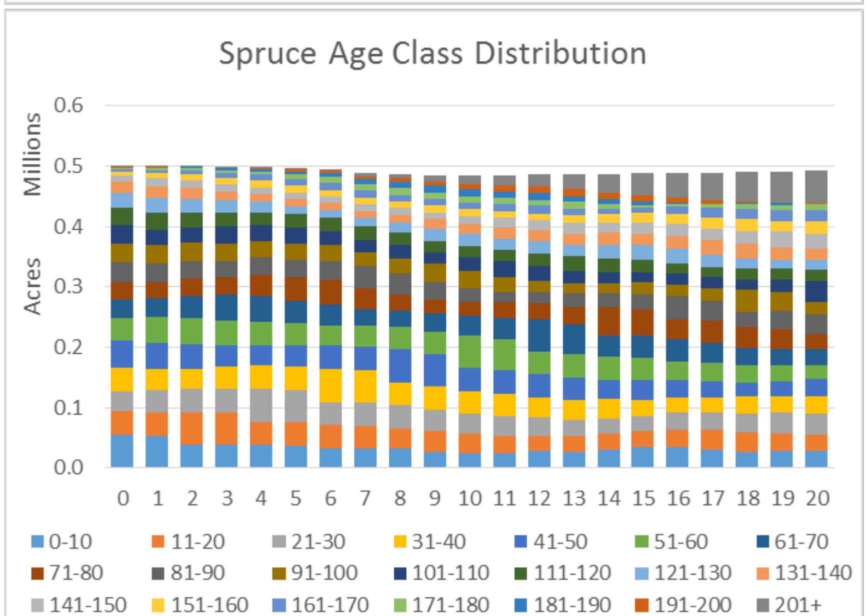

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

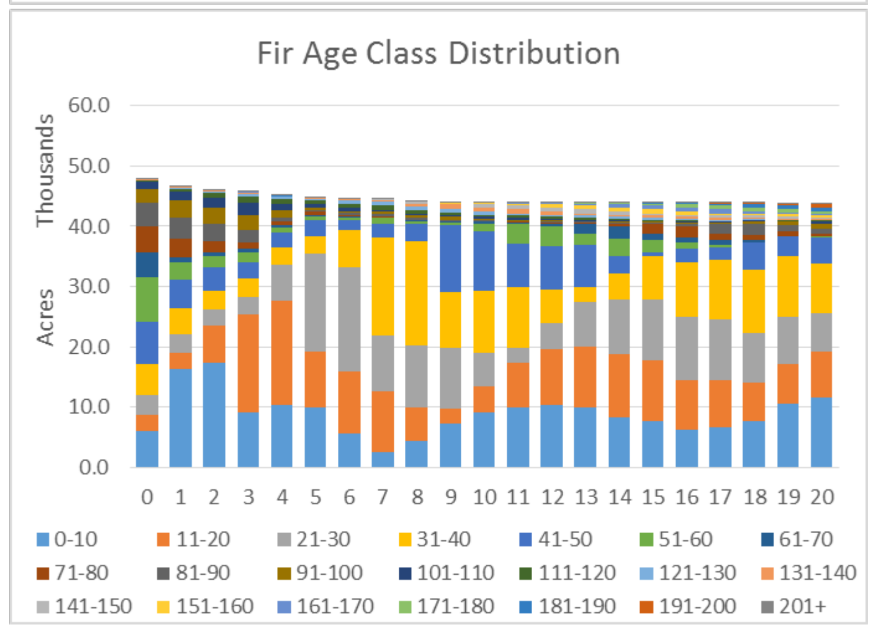

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

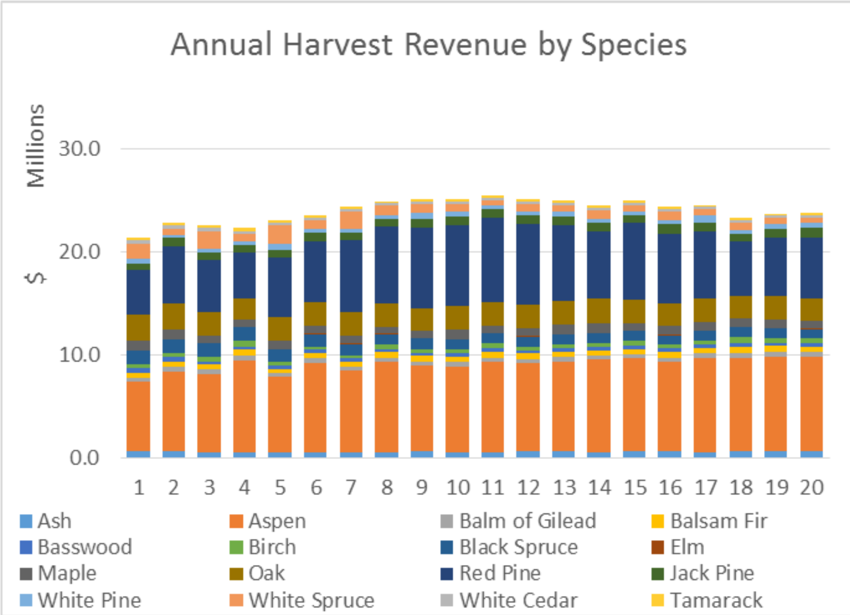

Young Forest Guild by Planning Area
Percentage
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

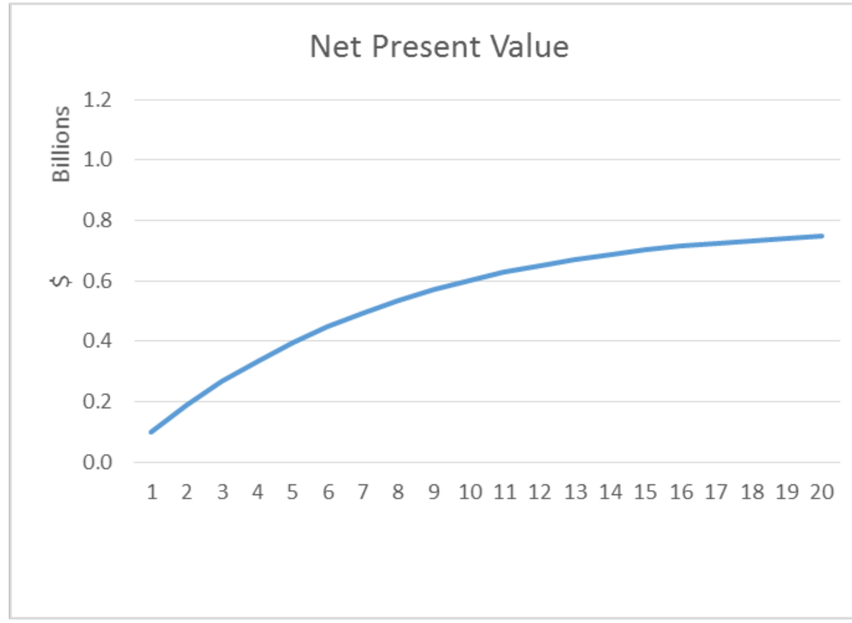

Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

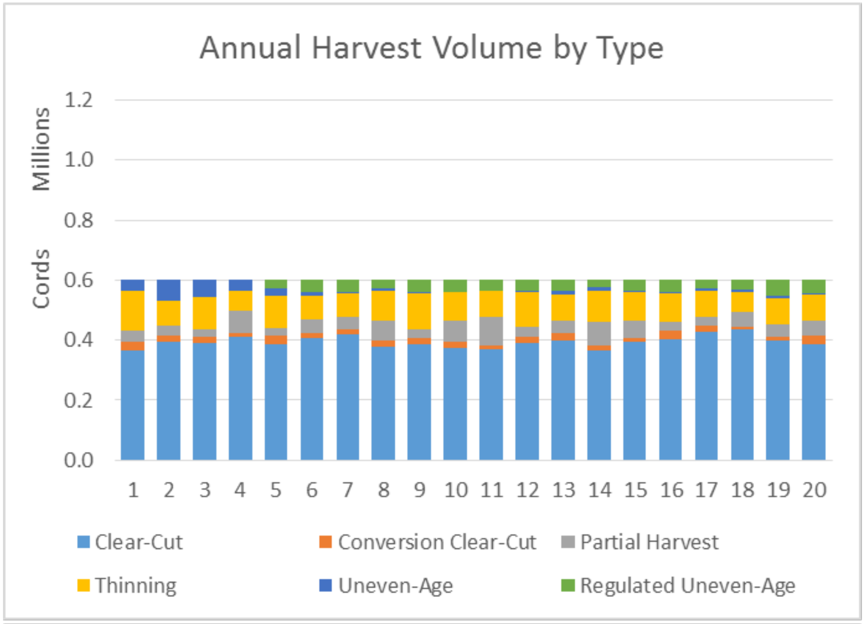


Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

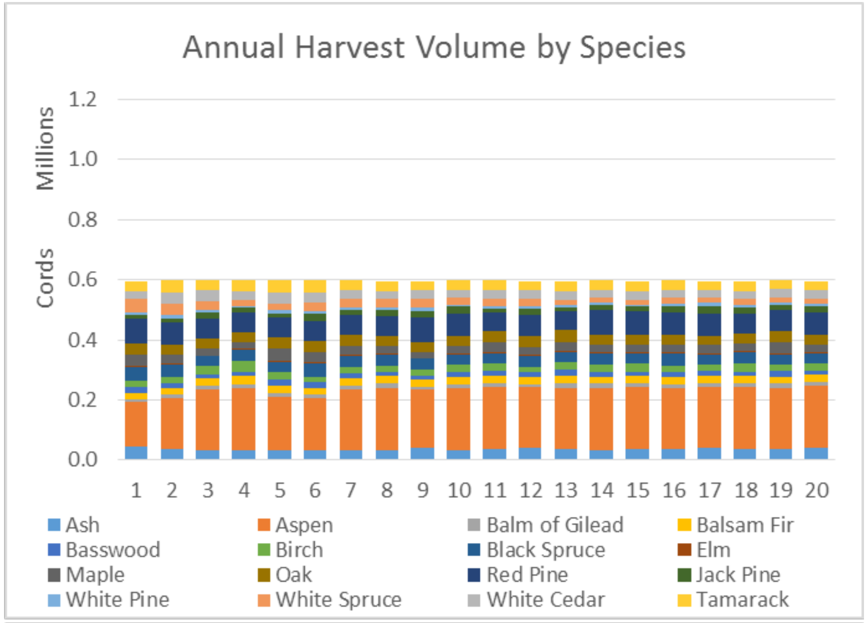


Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

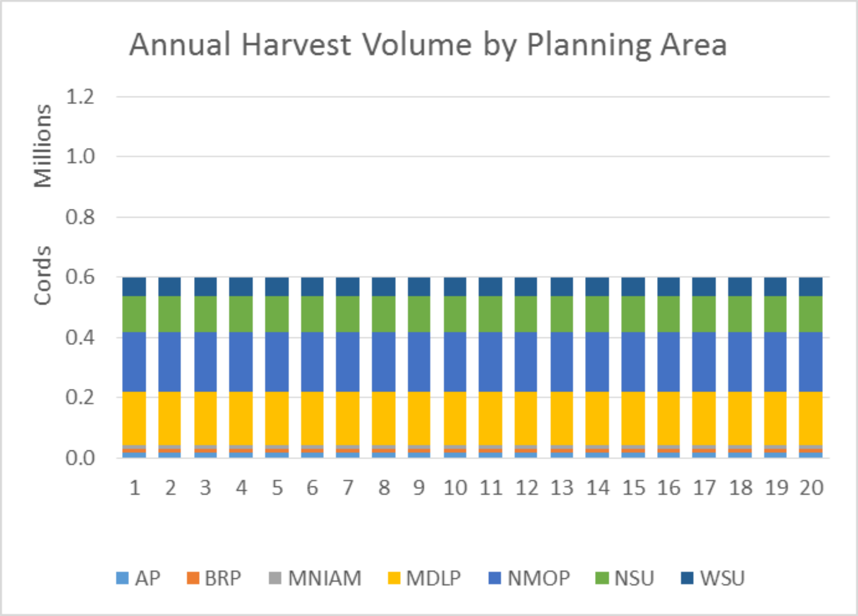
Scenario 2.3



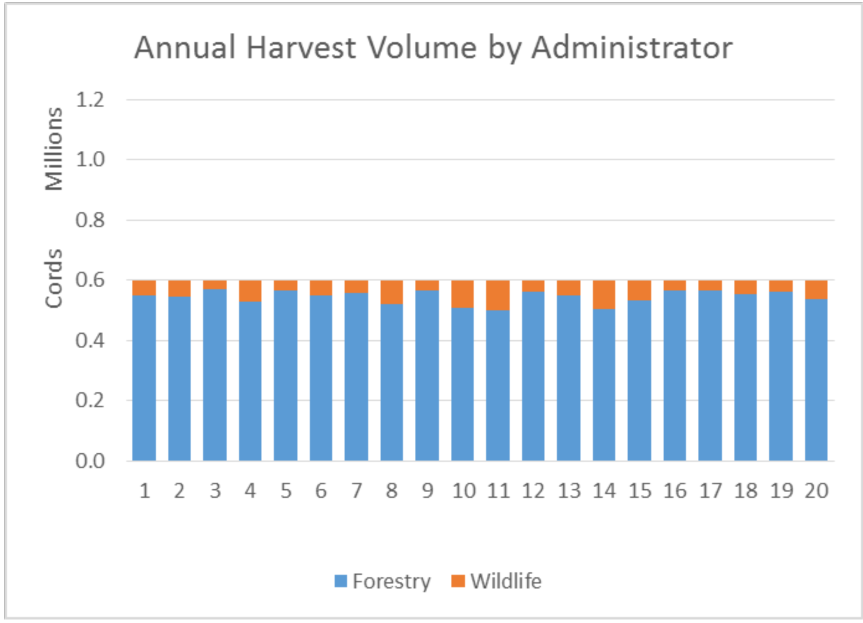
Annual Harvest Volume by Type
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age



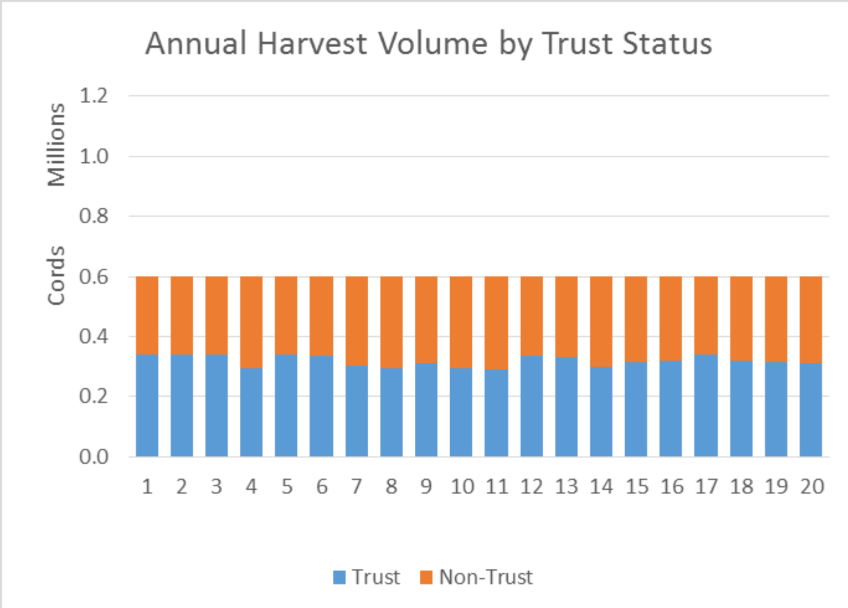
Annual Harvest Volume by Species
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

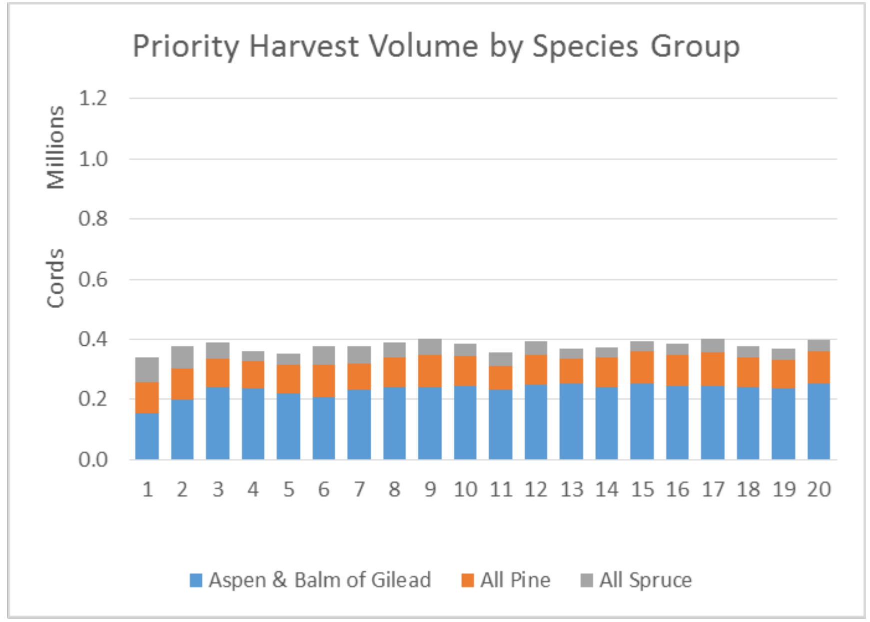


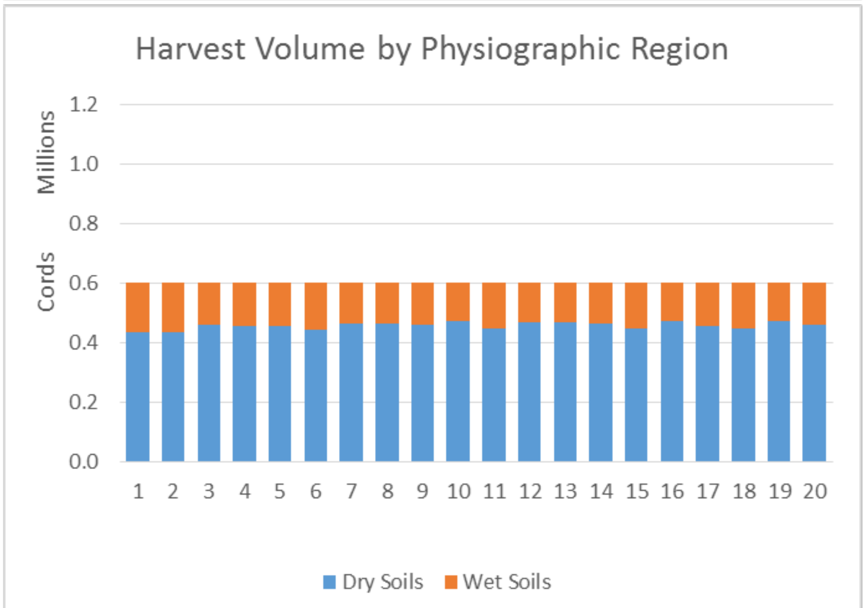
Annual Harvest Volume by Planning Area
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

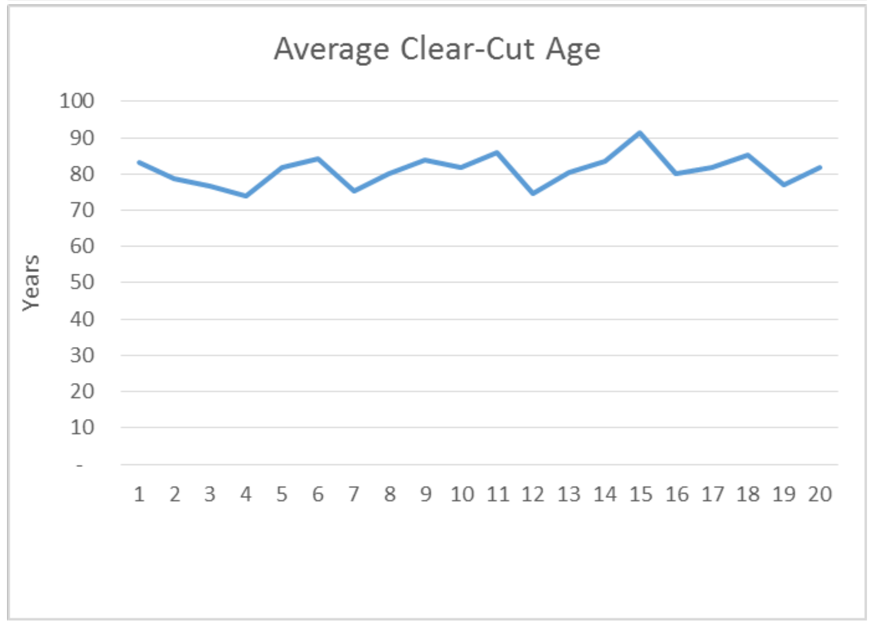


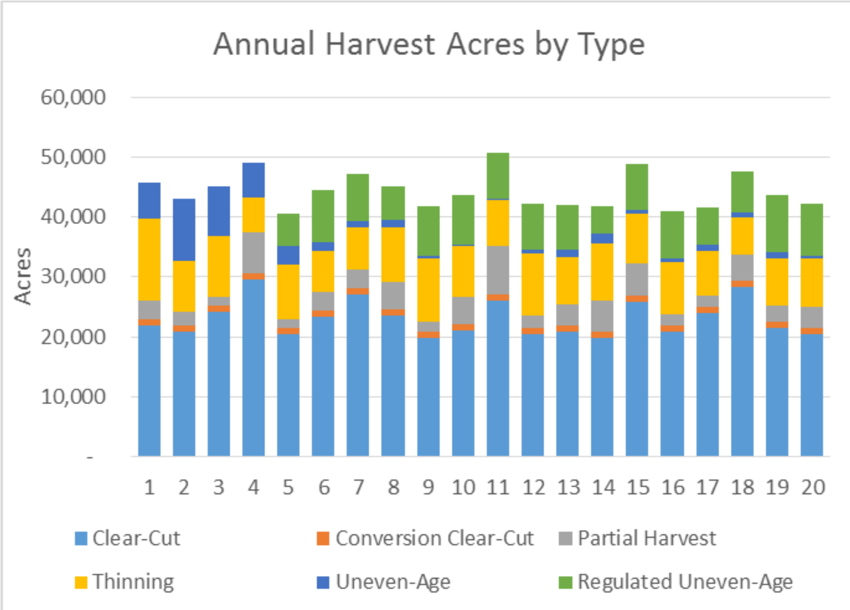
Annual Harvest Volume by Administrator
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Forestry
Wildlife

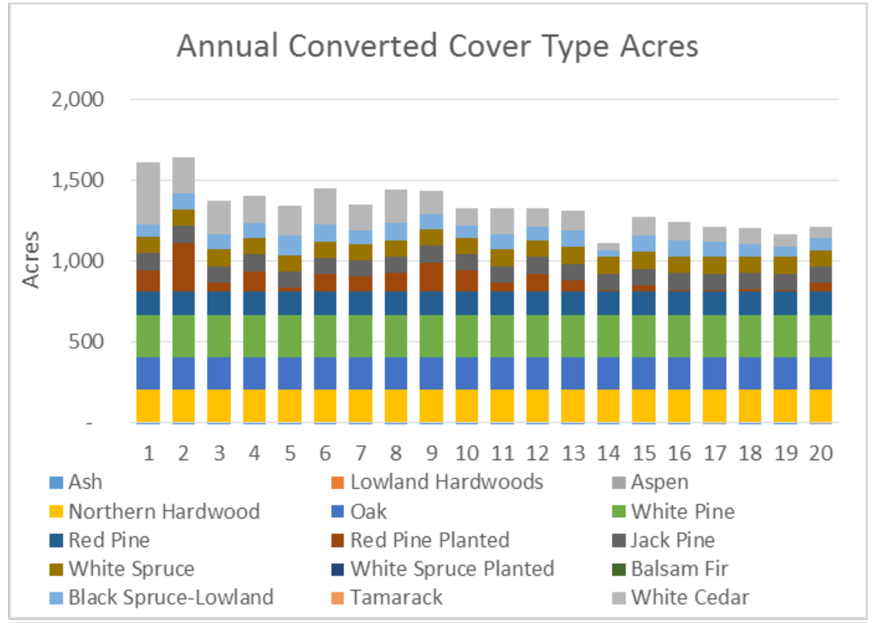

Annual Harvest Volume by Trust Status
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

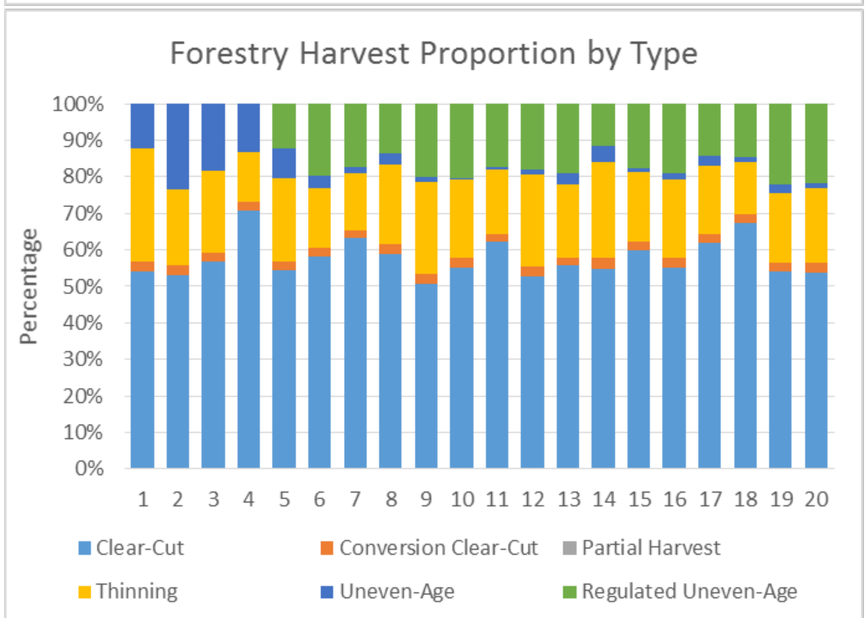

Priority Harvest Volume by Species Group
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

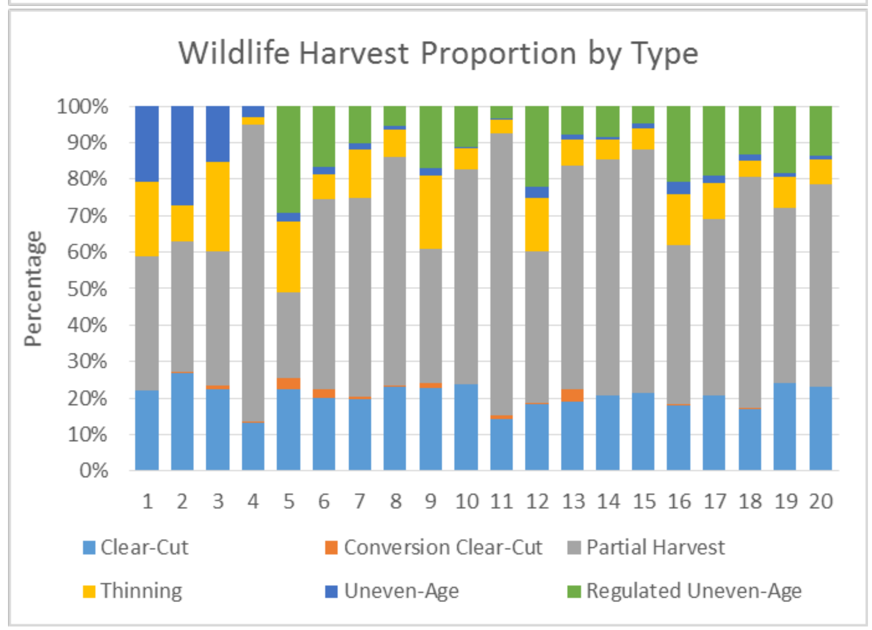

Harvest Volume by Physiographic Region
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

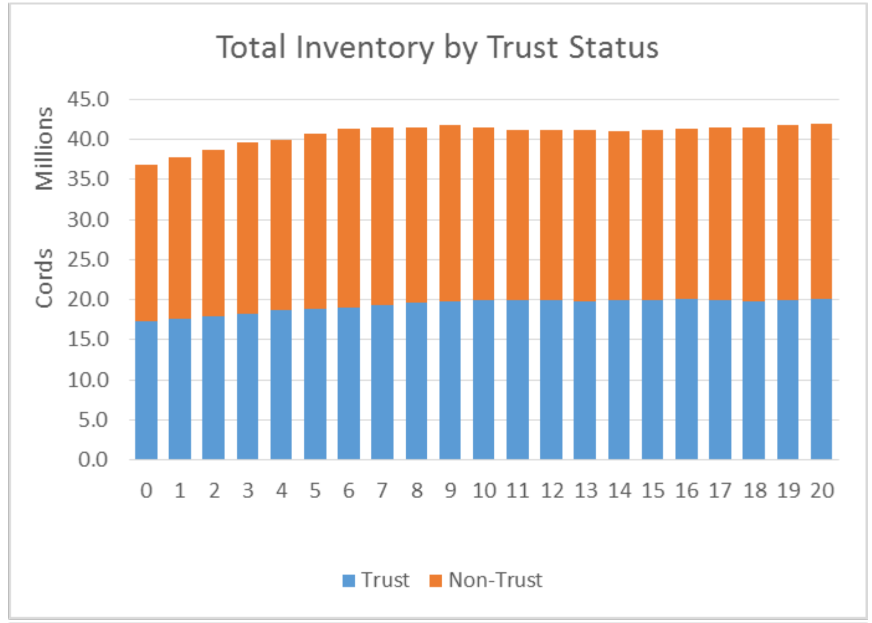

Annual Harvest Acres by Type
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

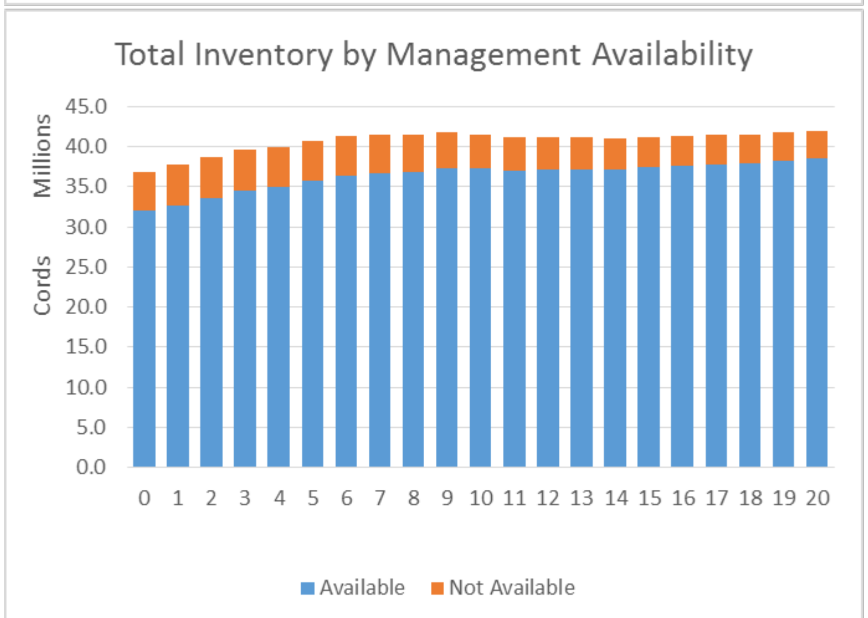

Annual Converted Cover Type Acres
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

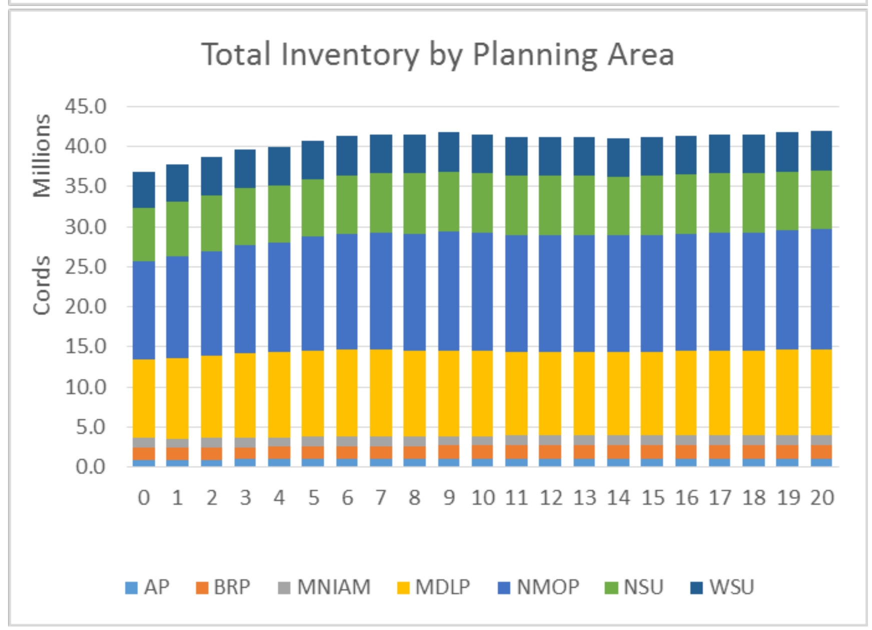

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

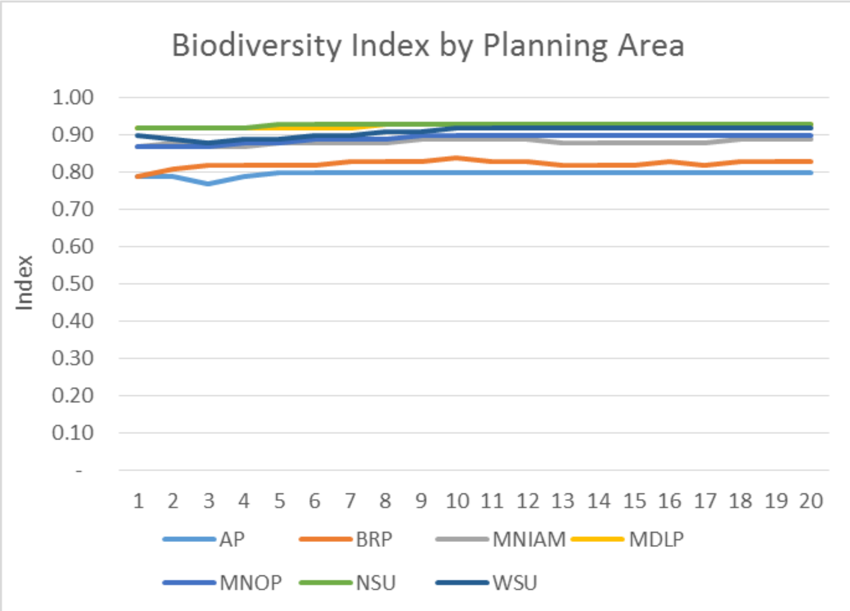

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

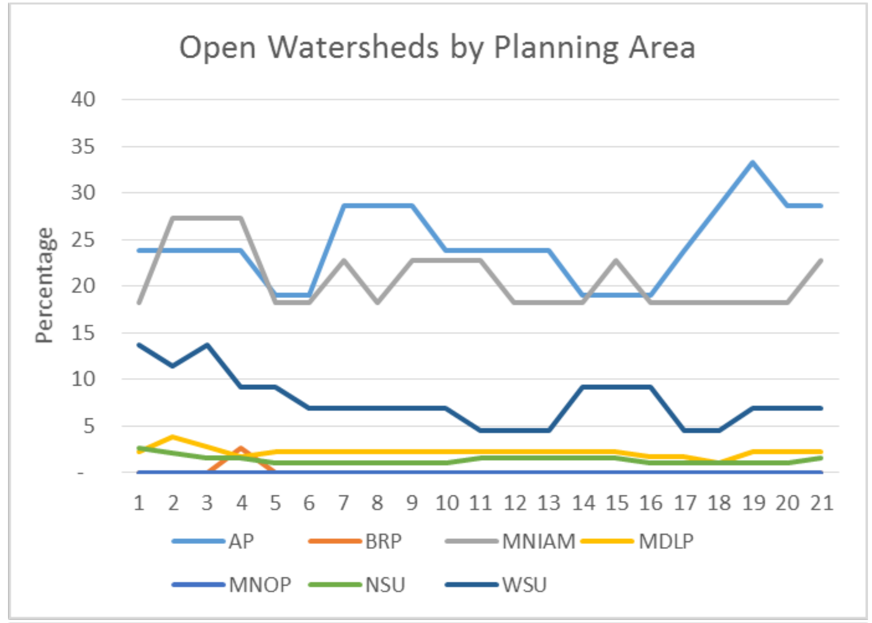

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

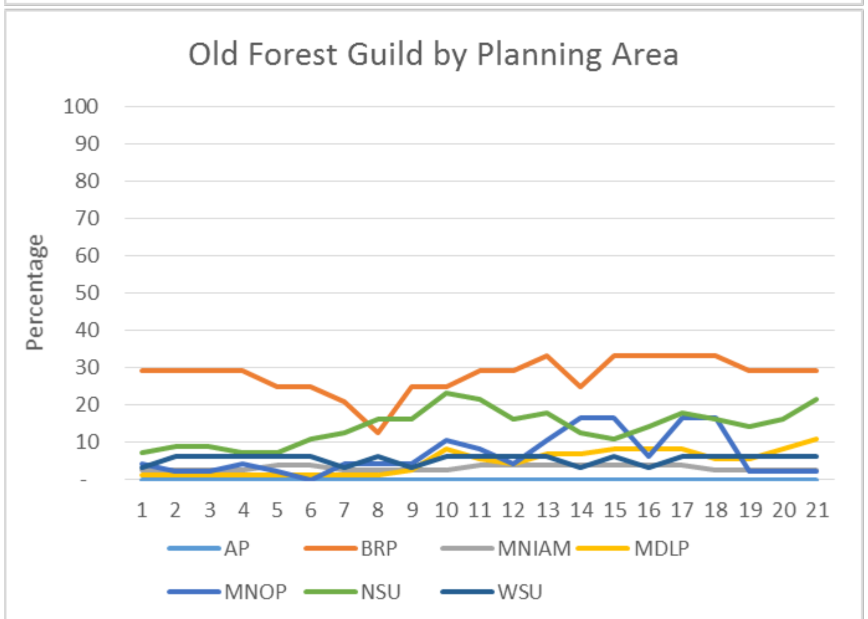

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

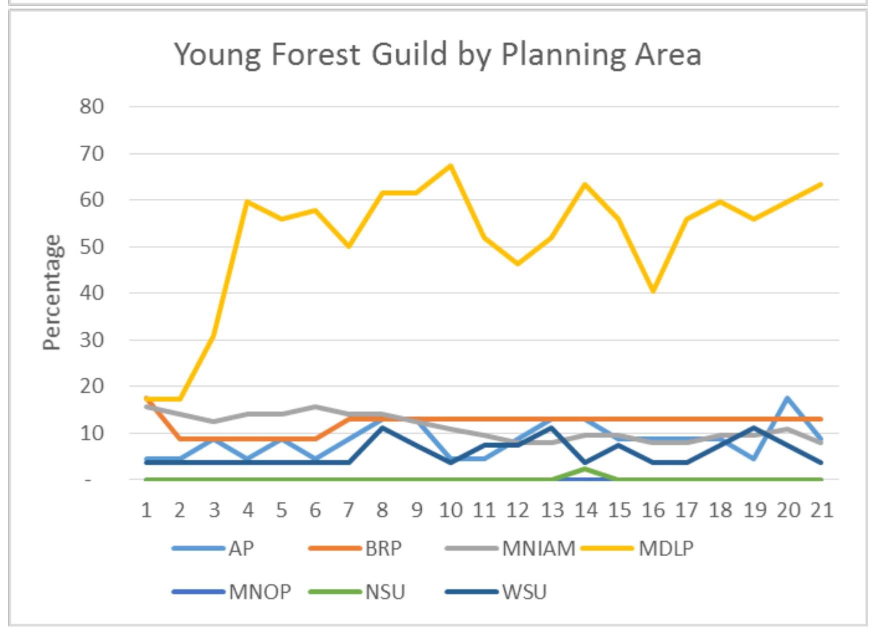

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

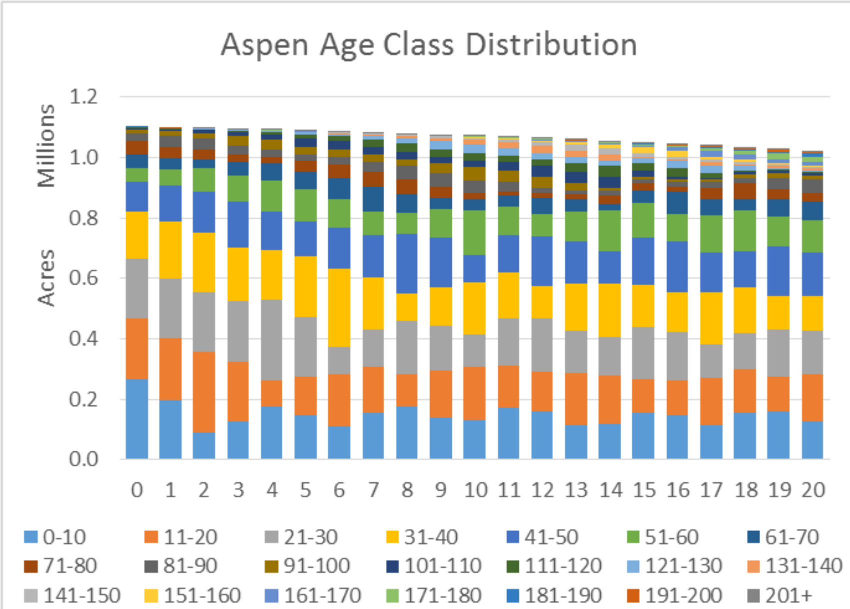

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

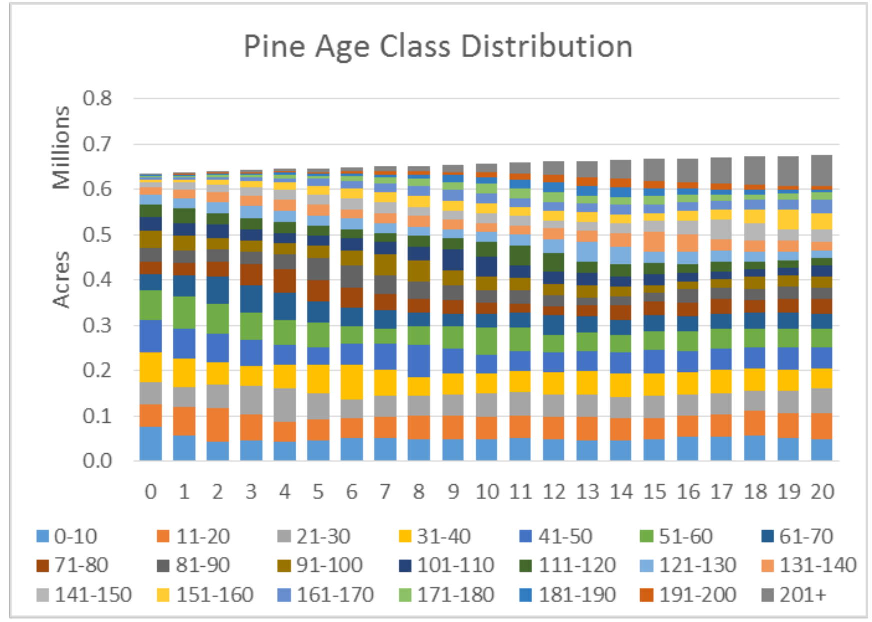

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP BRP MNIAM MDLP
MNOP NSU WSU

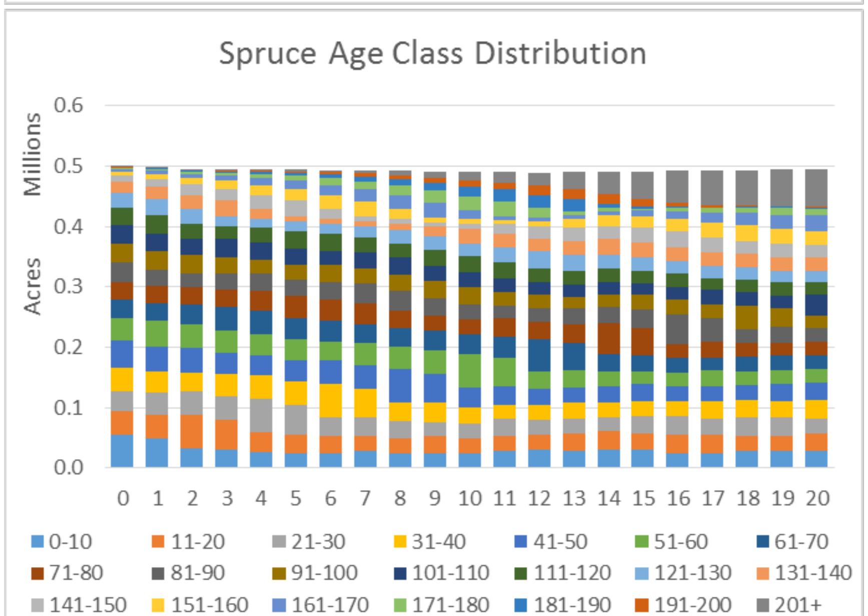

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP BRP MNIAM MDLP
MNOP NSU WSU

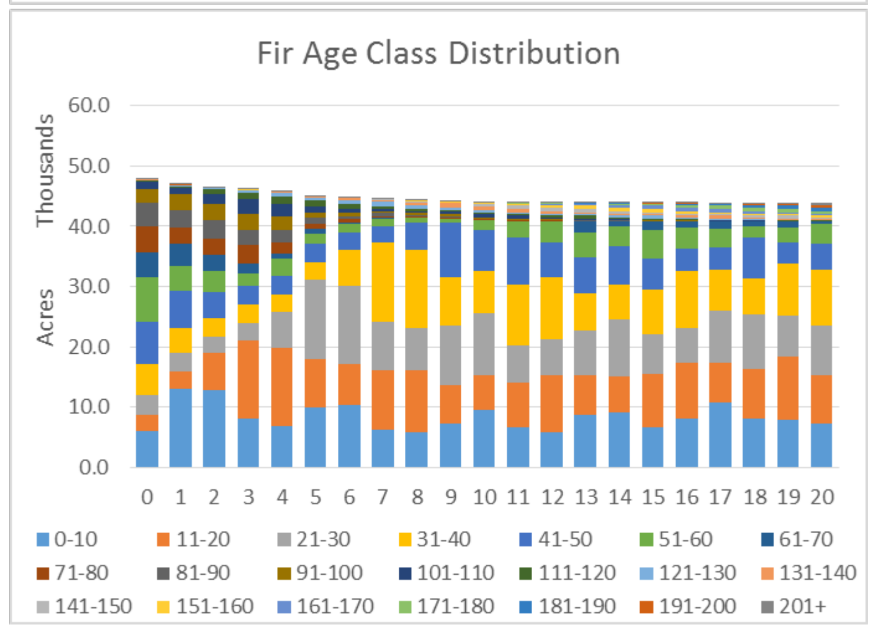

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP BRP MNIAM MDLP
MNOP NSU WSU

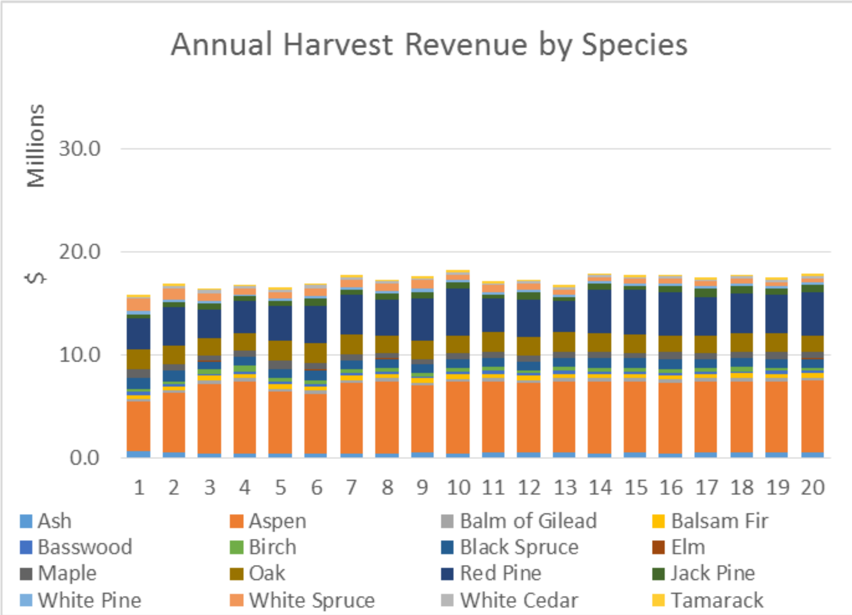

Young Forest Guild by Planning Area
Percentage
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP BRP MNIAM MDLP
MNOP NSU WSU

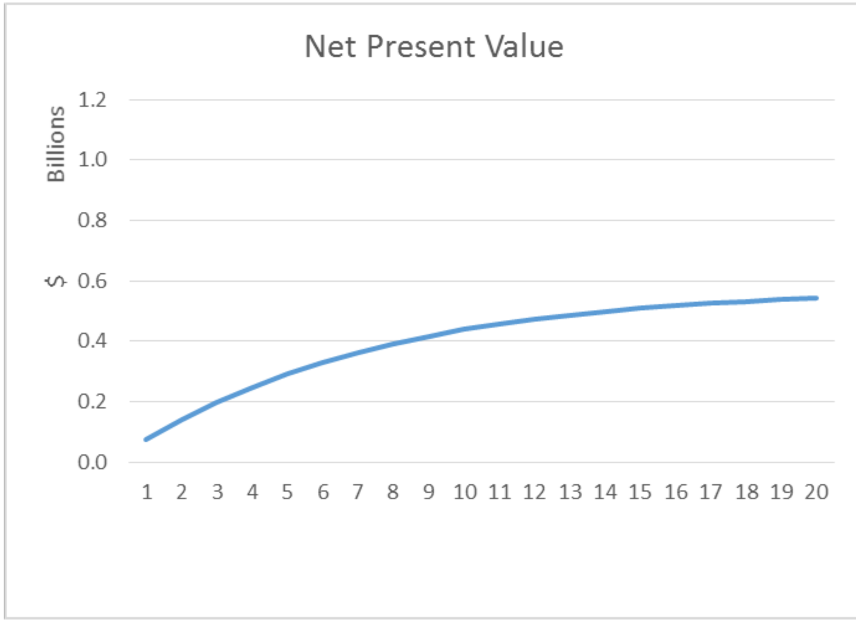

Aspen Age Class Distribution
Millions
Acres
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
101-110
111-120
121-130
131-140
141-150
151-160
161-170
171-180
181-190
191-200
201+


Pine Age Class Distribution
Millions
Acres
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
101-110
111-120
121-130
131-140
141-150
151-160
161-170
171-180
181-190
191-200
201+

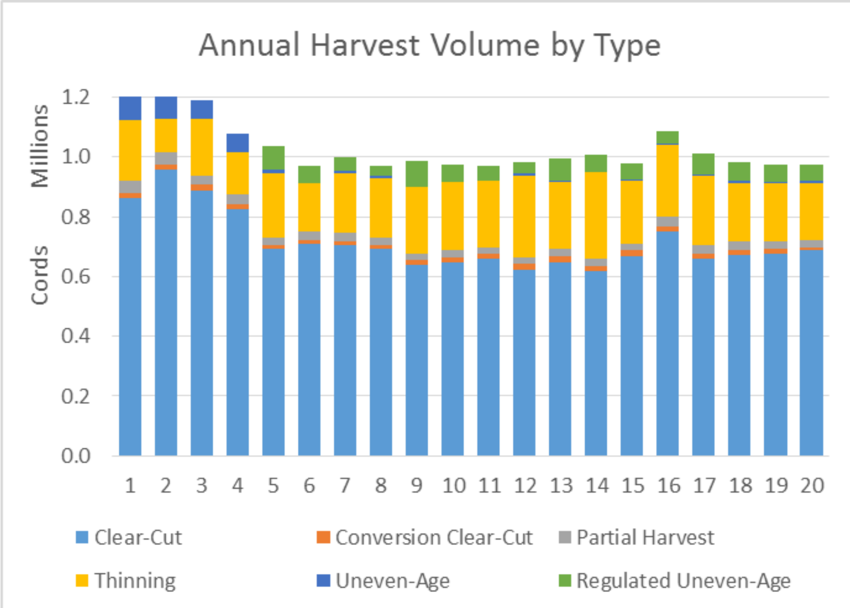

Spruce Age Class Distribution
Millions
Acres
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
101-110
111-120
121-130
131-140
141-150
151-160
161-170
171-180
181-190
191-200
201+

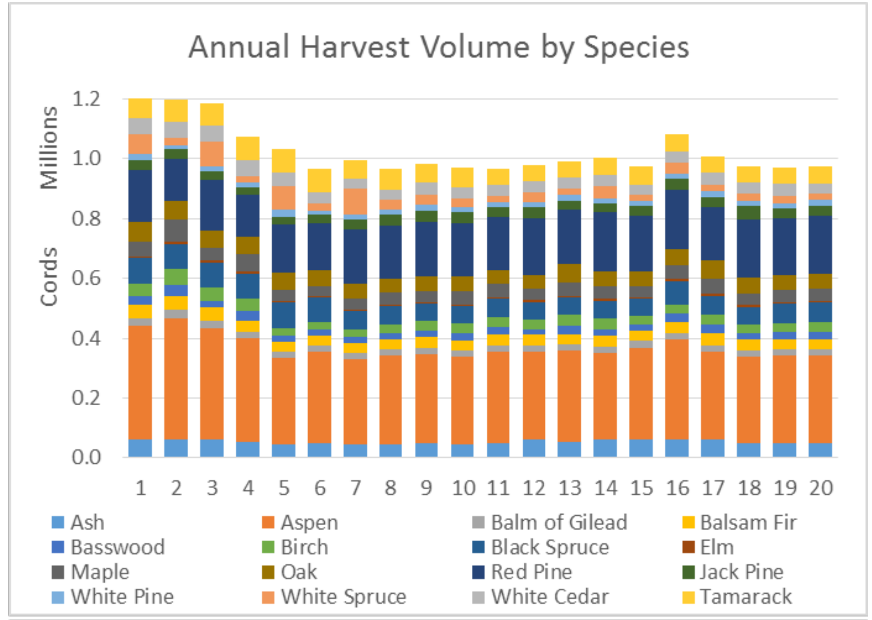

Fir Age Class Distribution
Thousands
Acres
0.0
10.0
20.0
30.0
40.0
50.0
60.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
101-110
111-120
121-130
131-140
141-150
151-160
161-170
171-180
181-190
191-200
201+

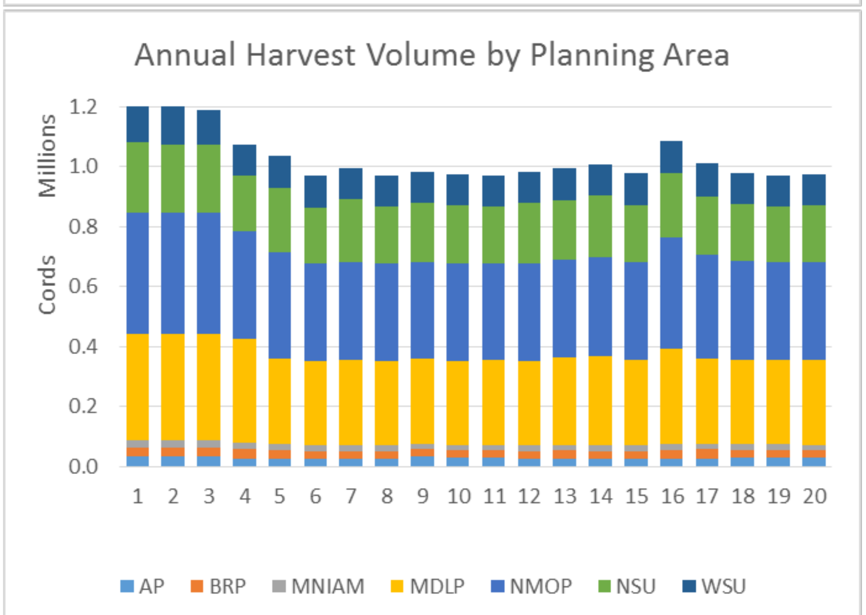

Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

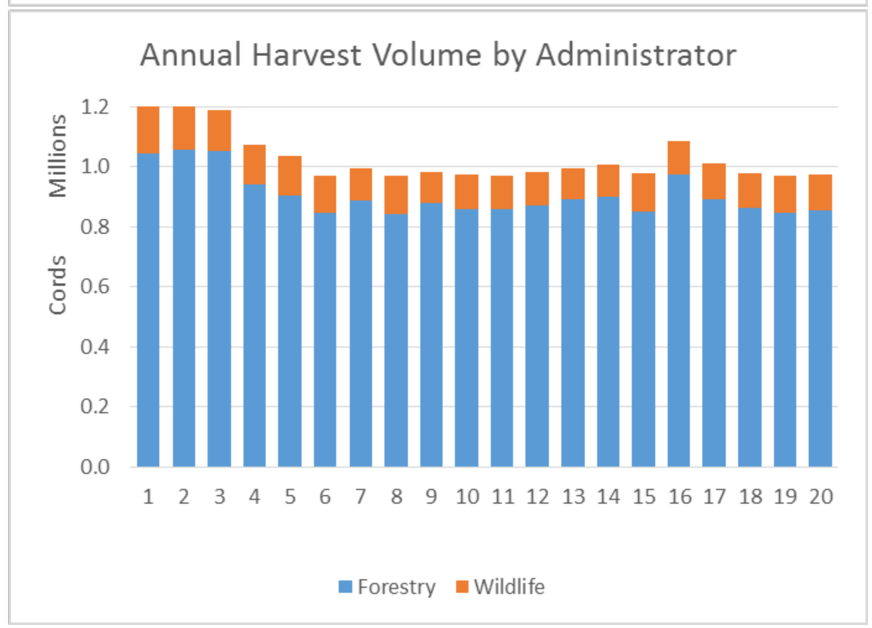

Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

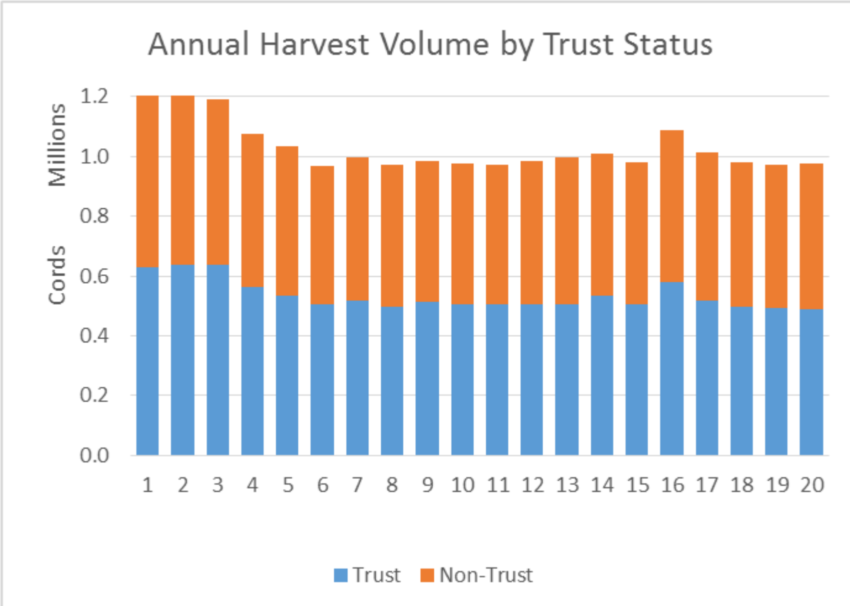
Scenario 3.1.1



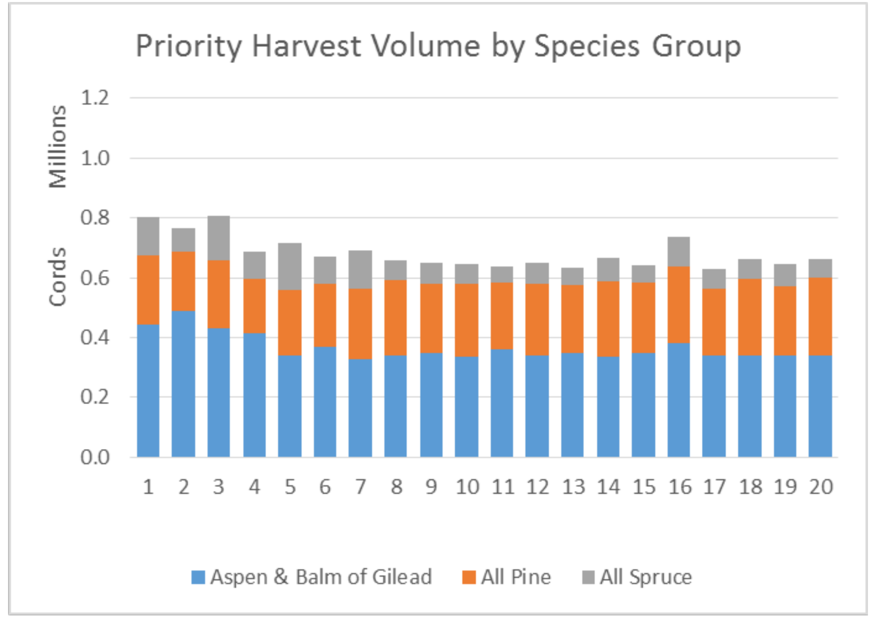




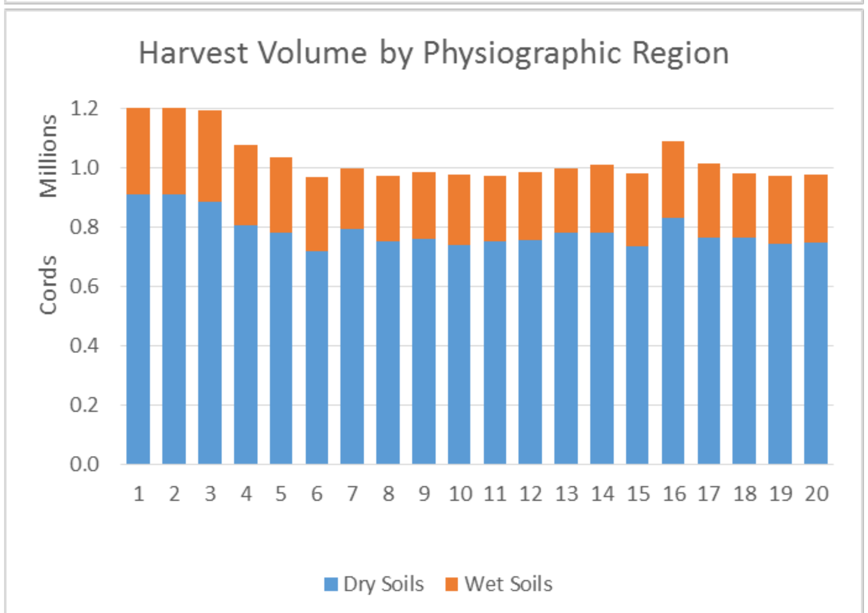




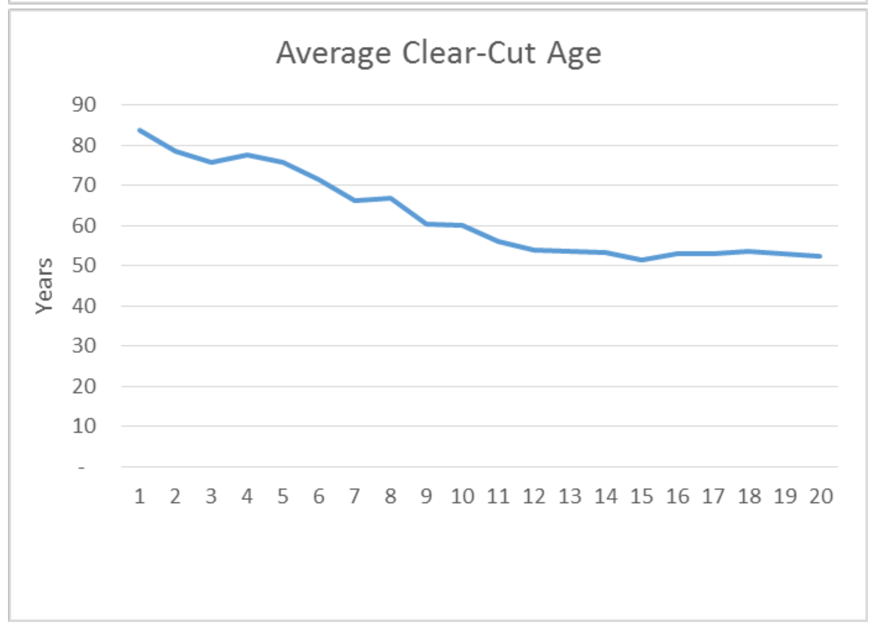
Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust



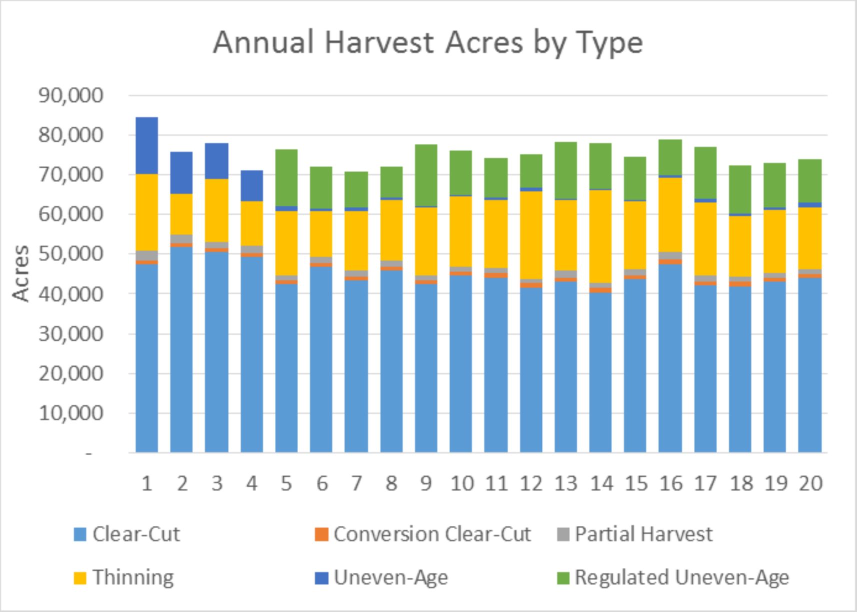
Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

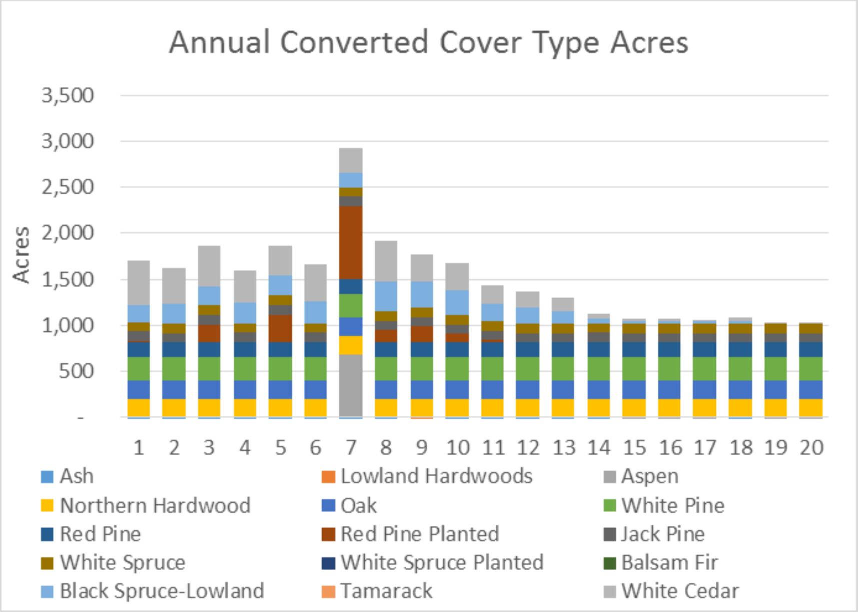


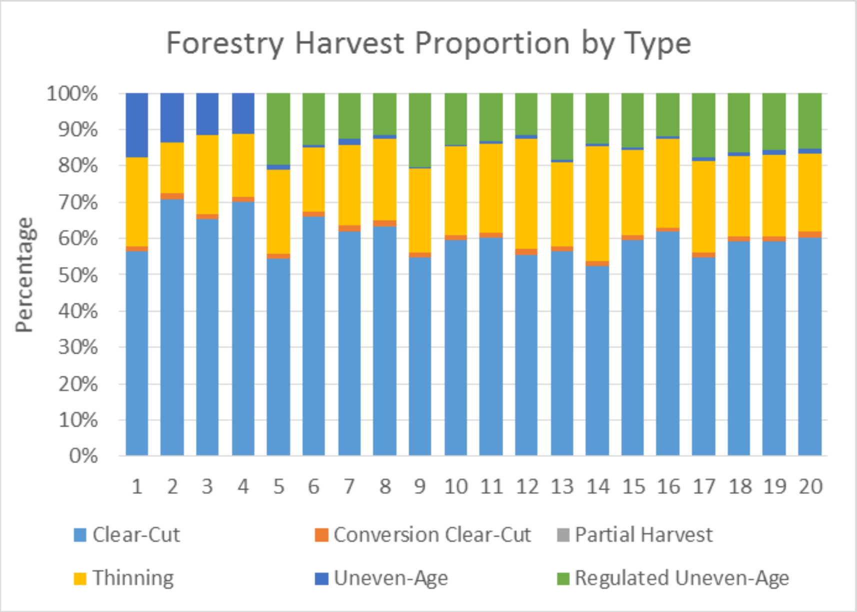
Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

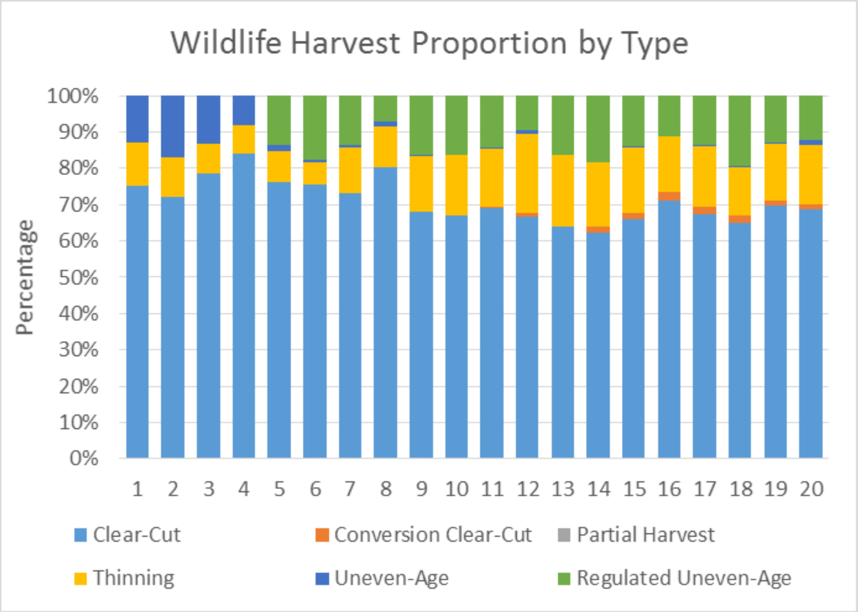


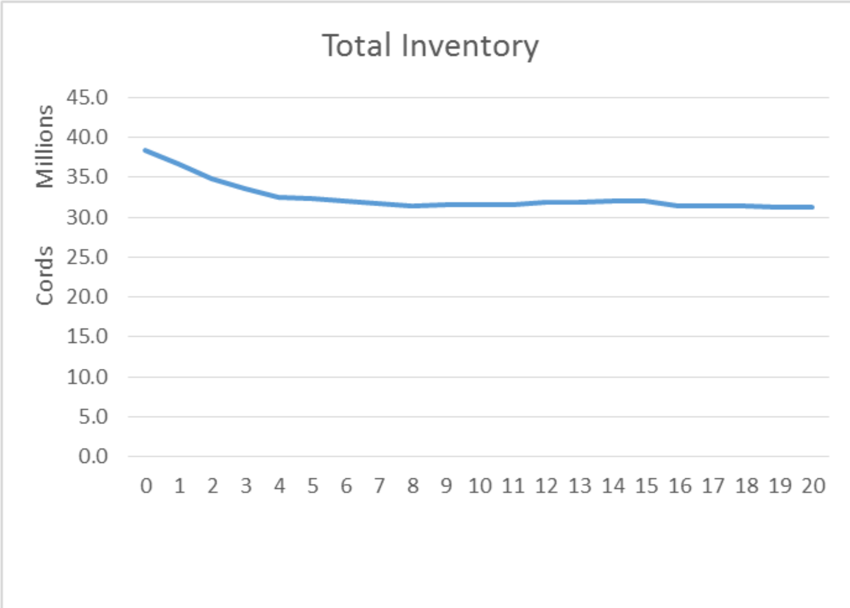
Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

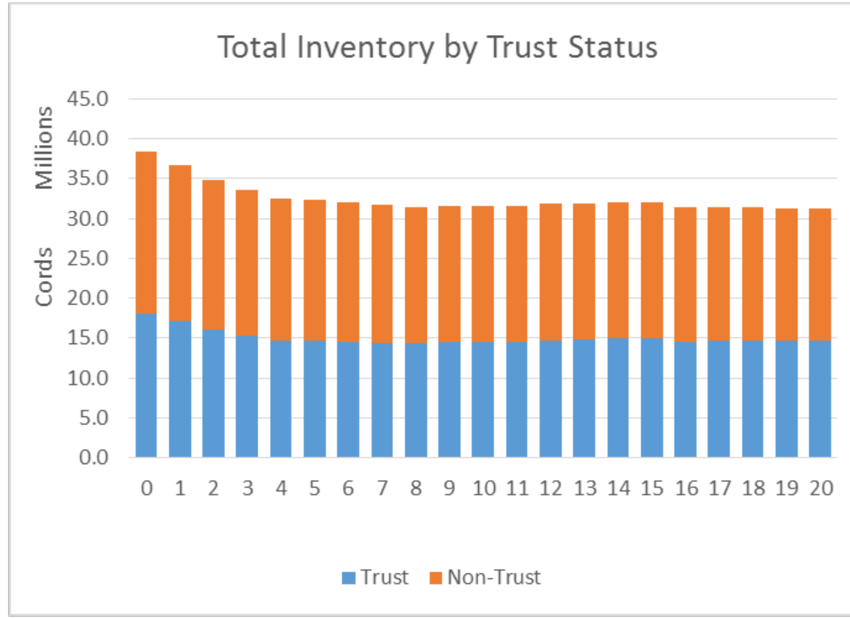

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

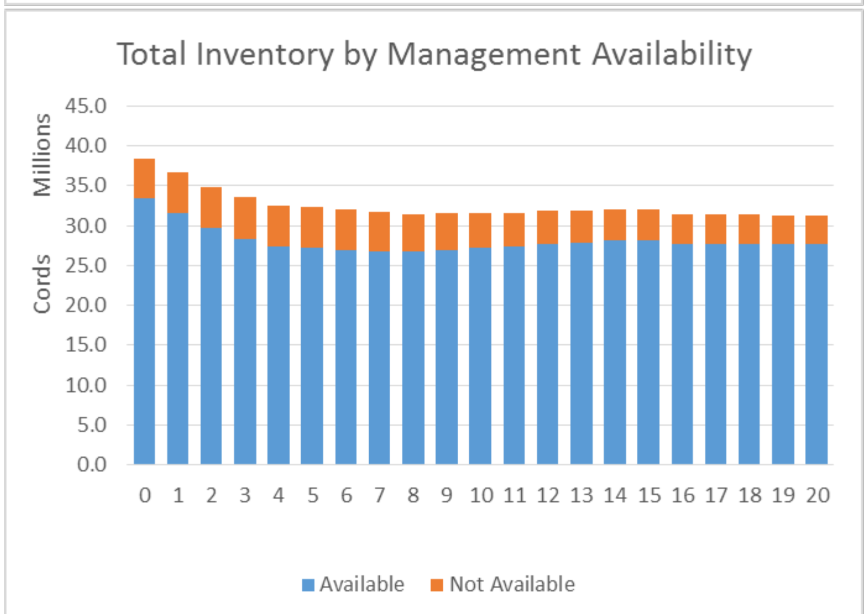

Annual Converted Cover Type Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

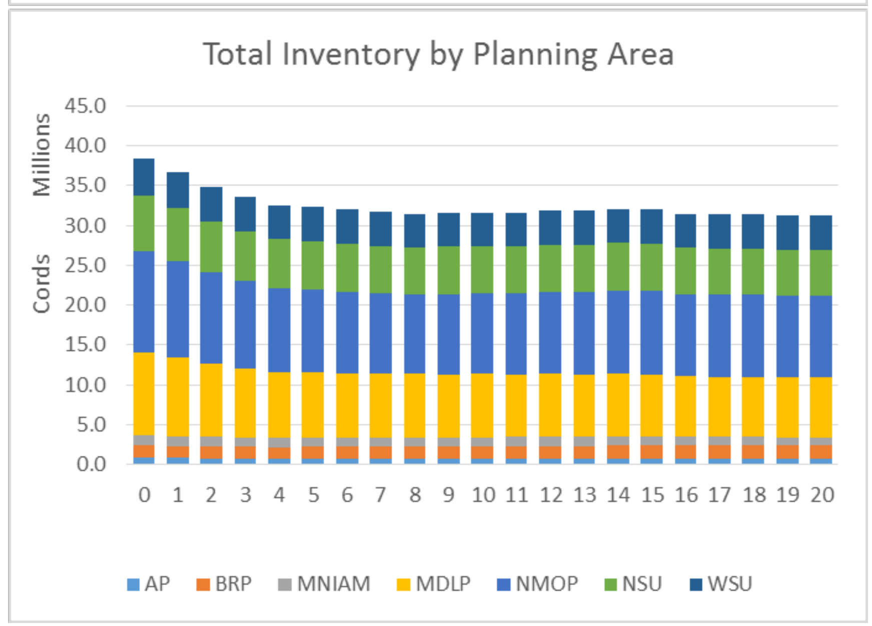

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

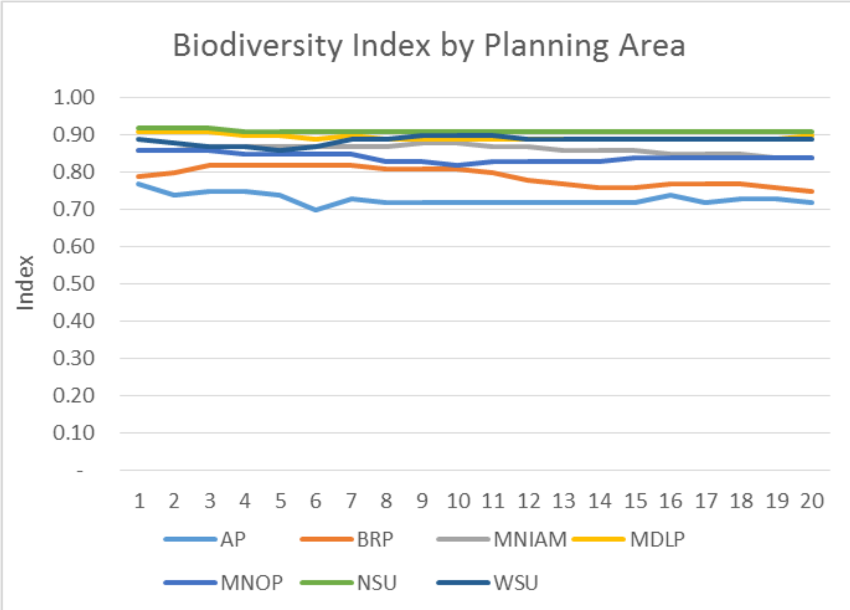

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

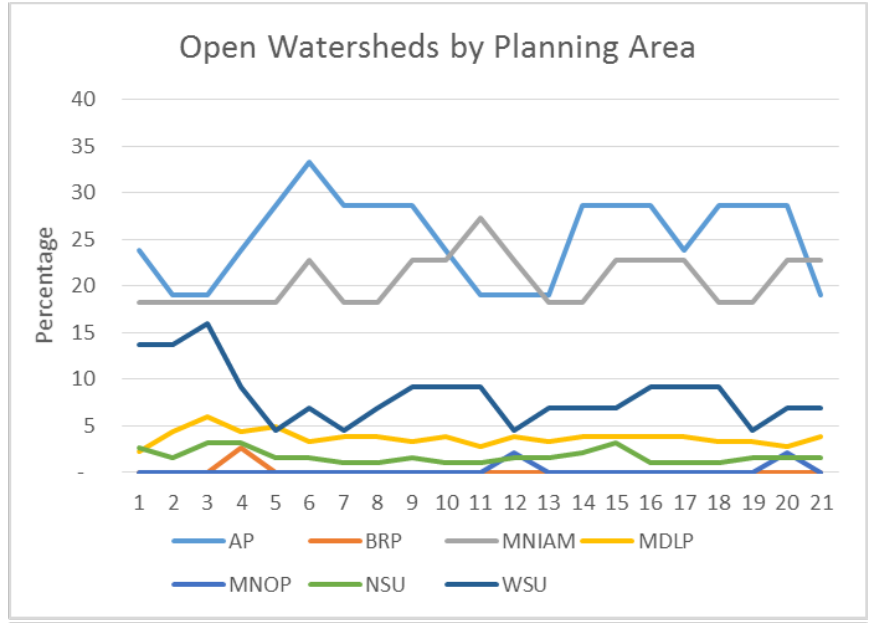

Total Inventory
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

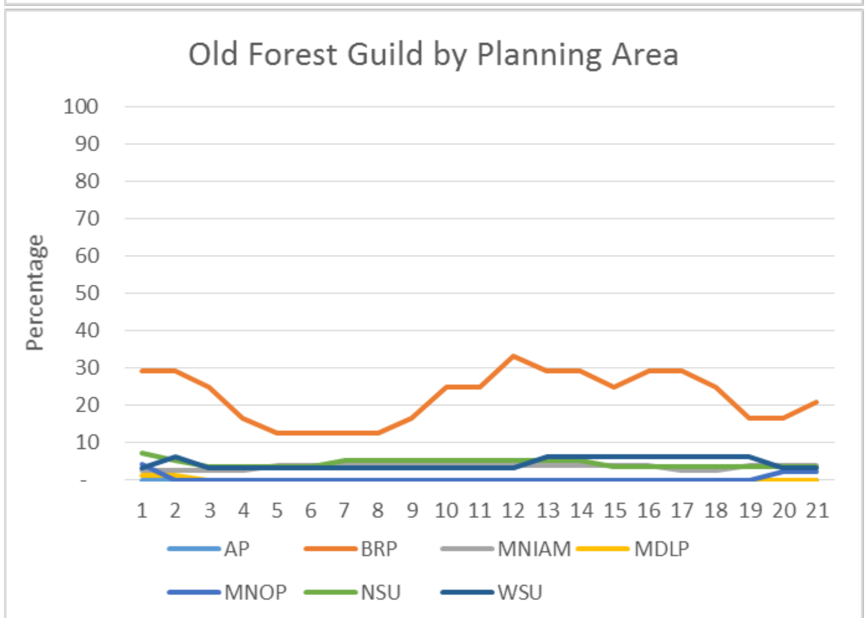

Total Inventory by Trust Status
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

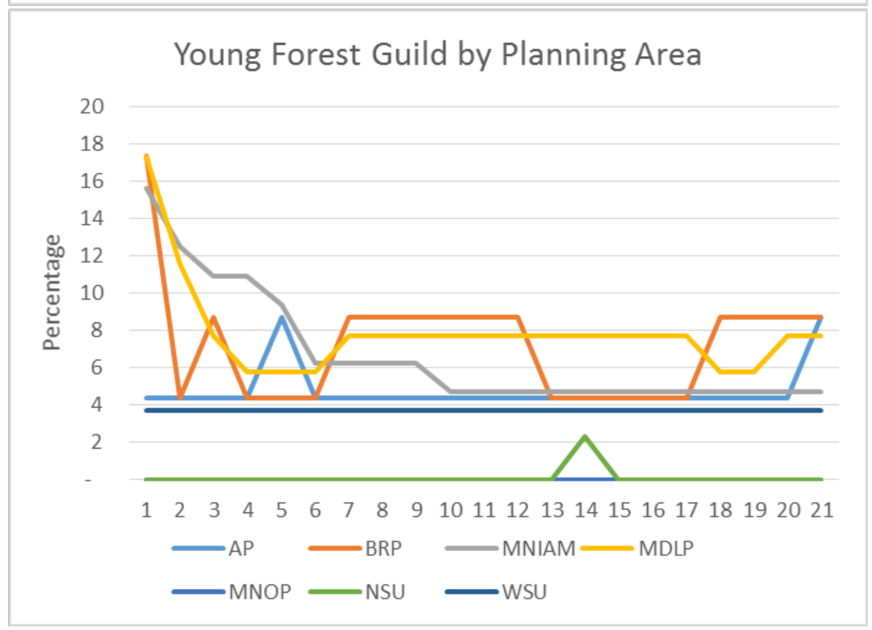

Total Inventory by Management Availability
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

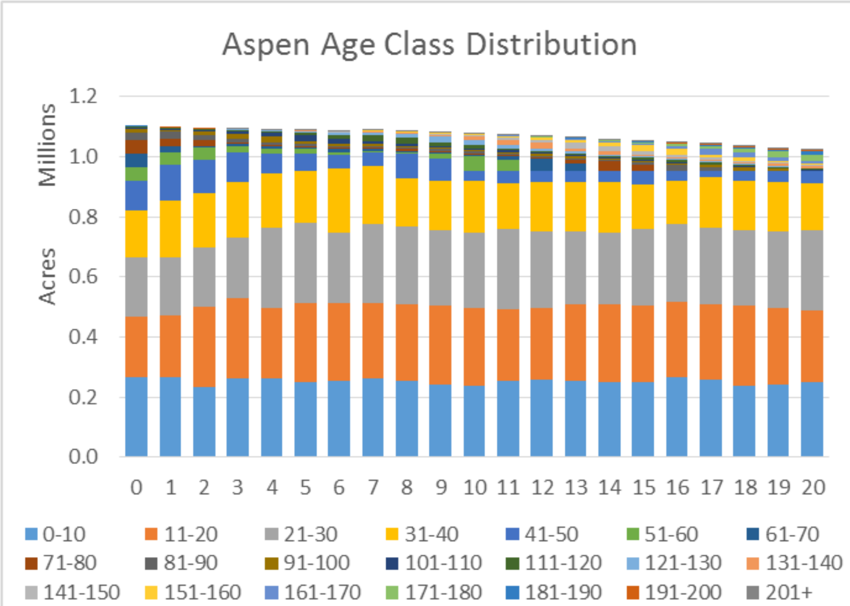

Total Inventory by Planning Area
Millions
Cords
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

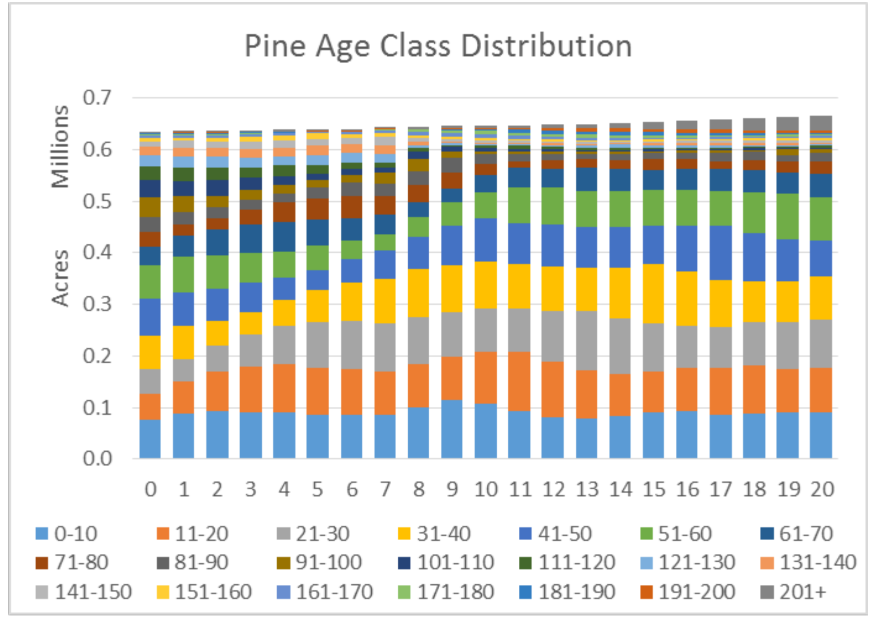

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

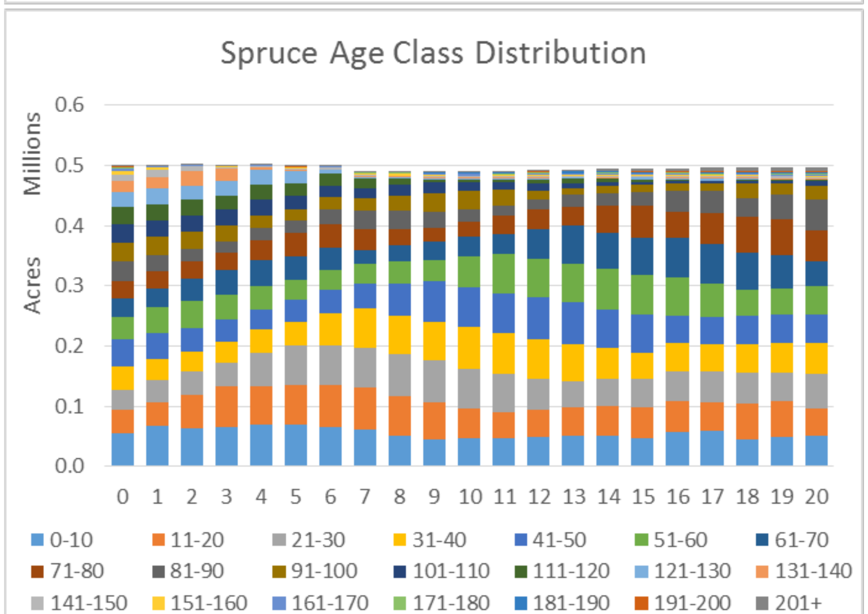

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

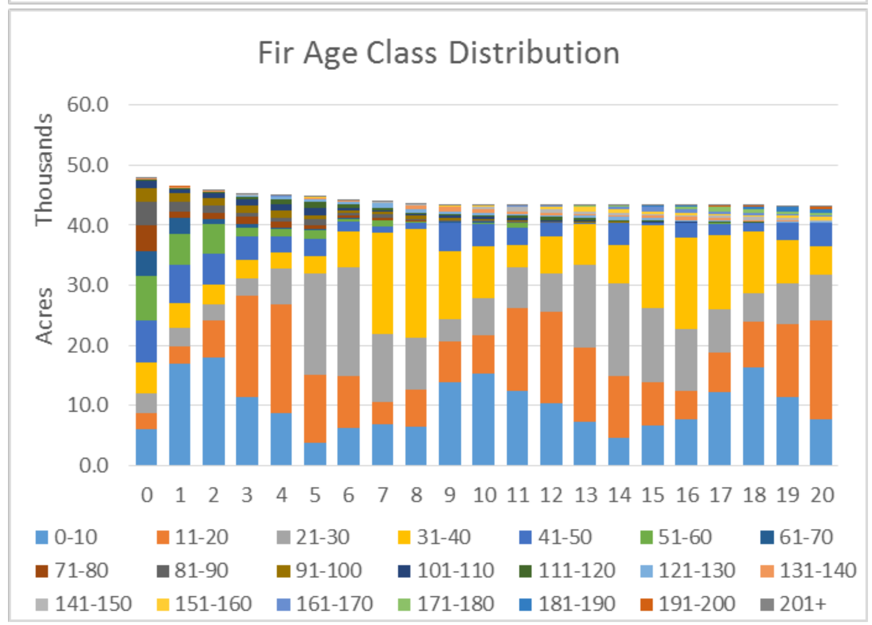

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

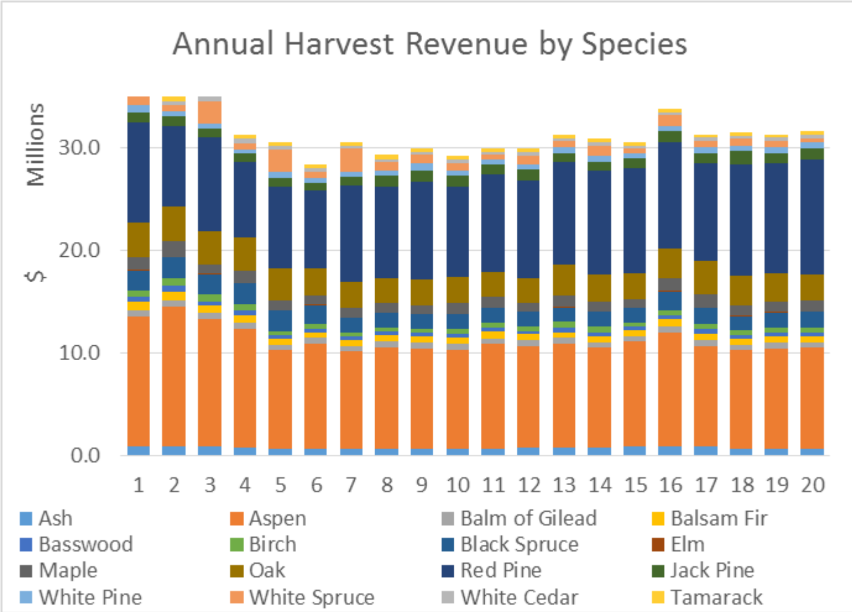

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

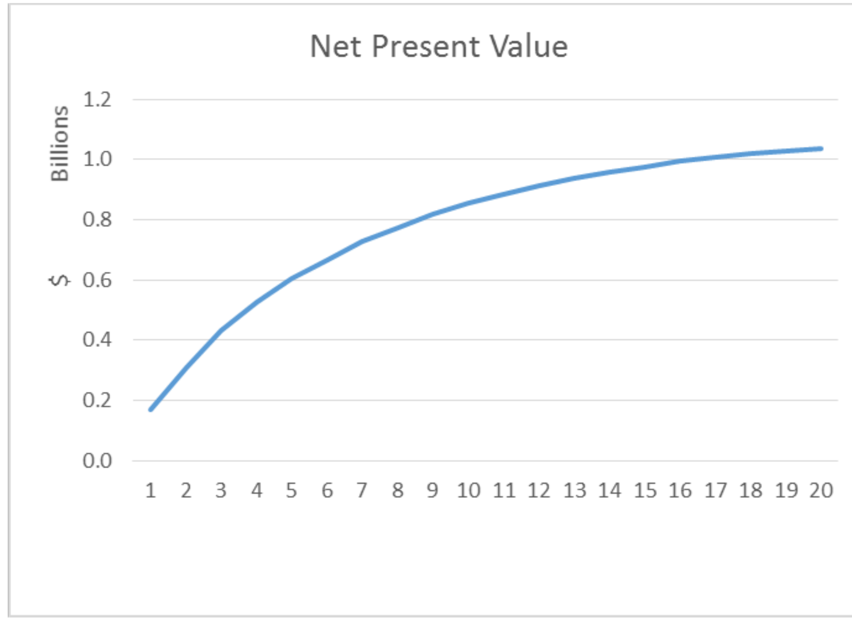

Aspen Age Class Distribution
Acres
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Acres
Millions
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

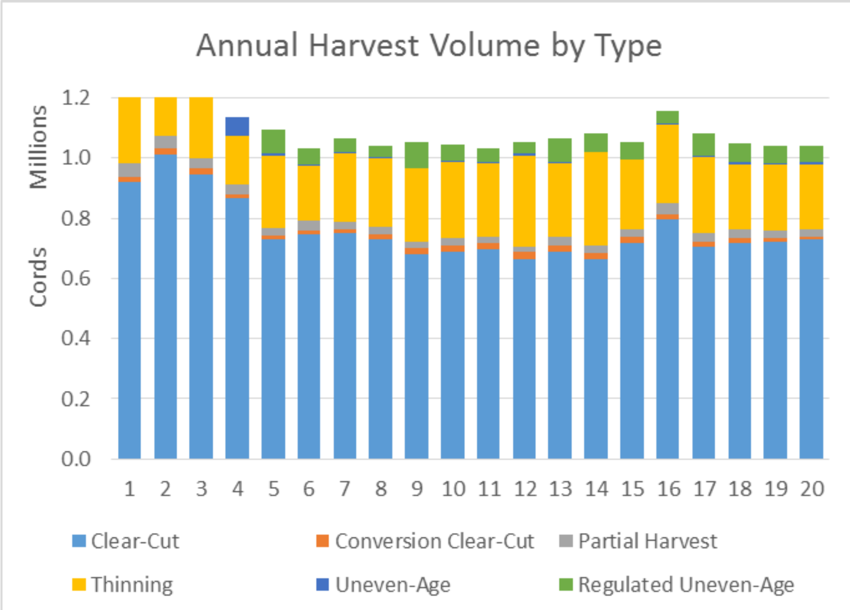

Spruce Age Class Distribution
Acres
Millions
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

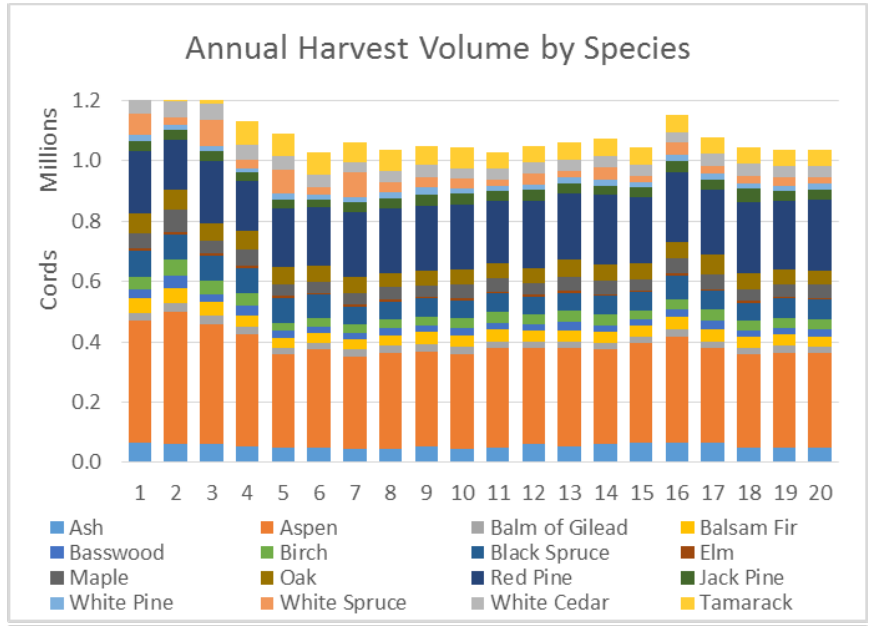

Fir Age Class Distribution
Acres
Thousands
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

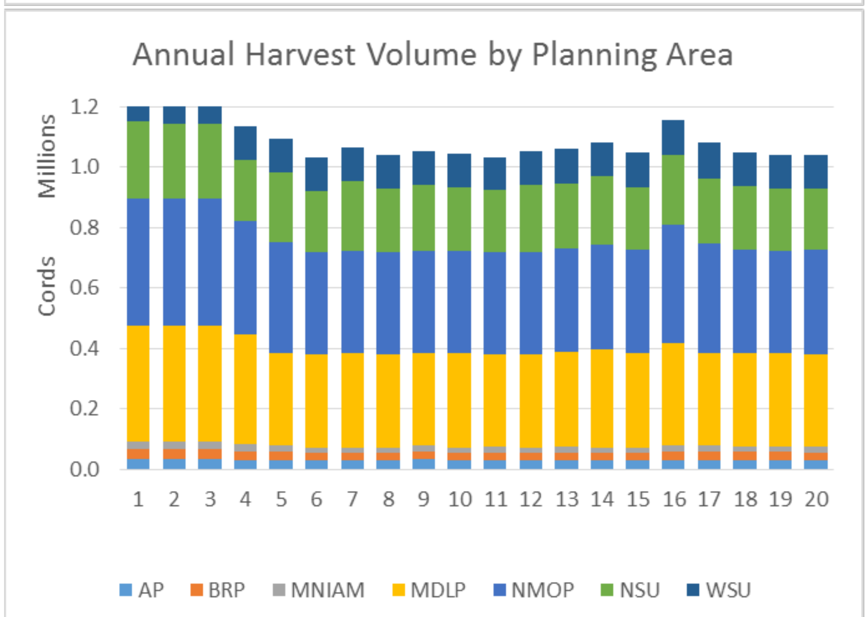

Annual Harvest Revenue by Species
Millions
$
0.0
10.0
20.0
30.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

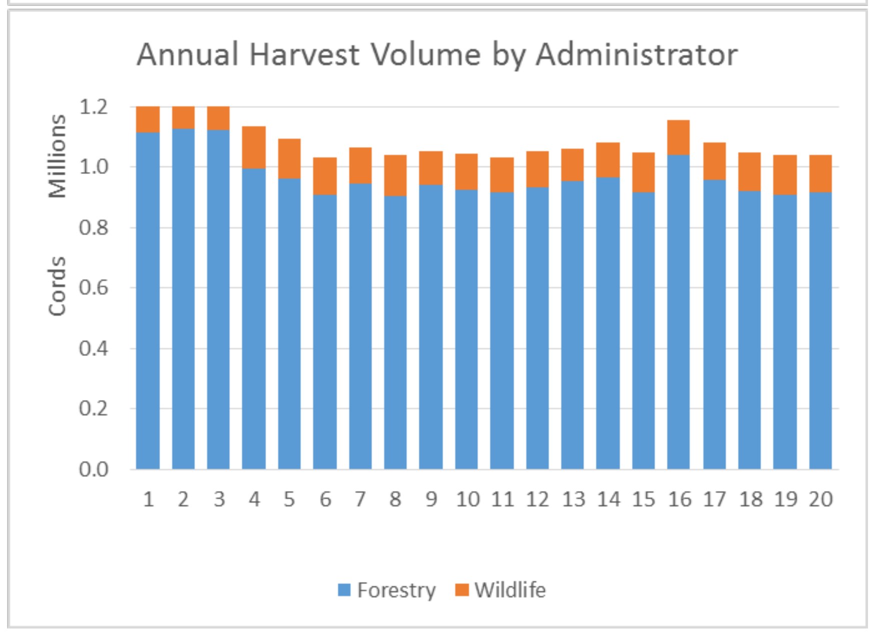

Net Present Value
Billions
$
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

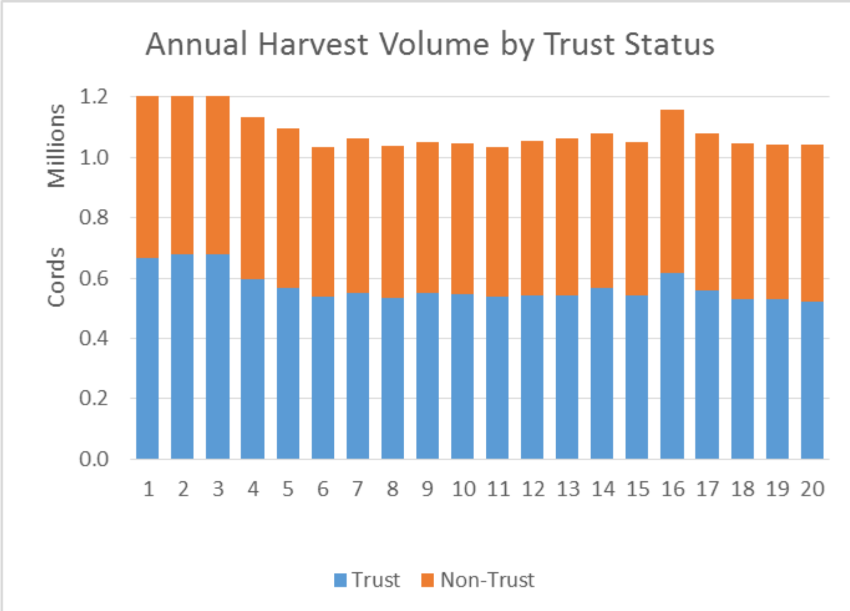
Scenario 3.1.2

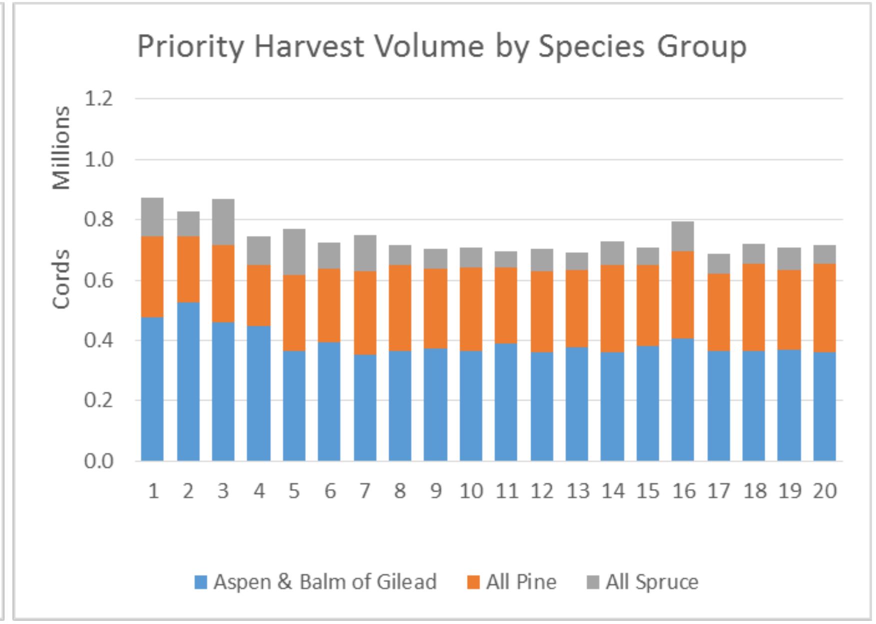


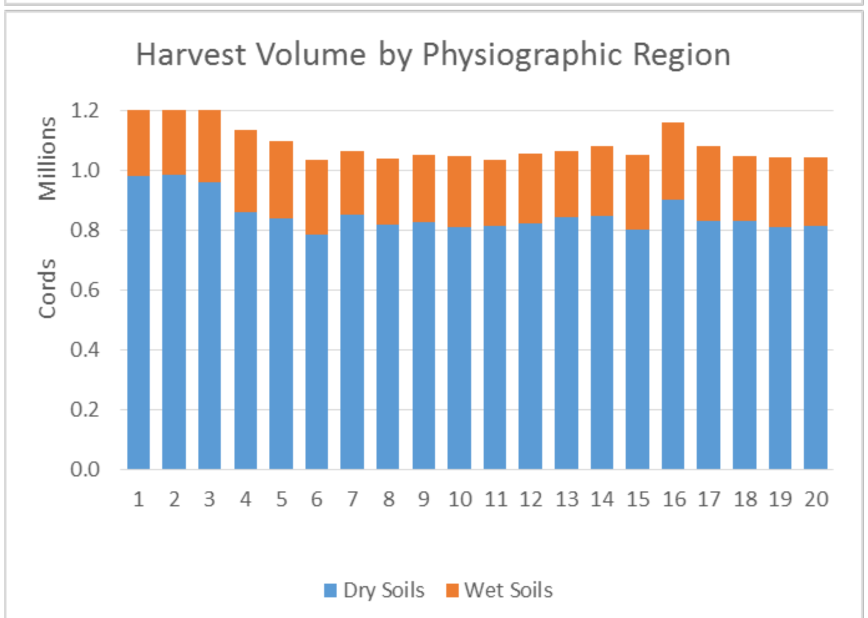


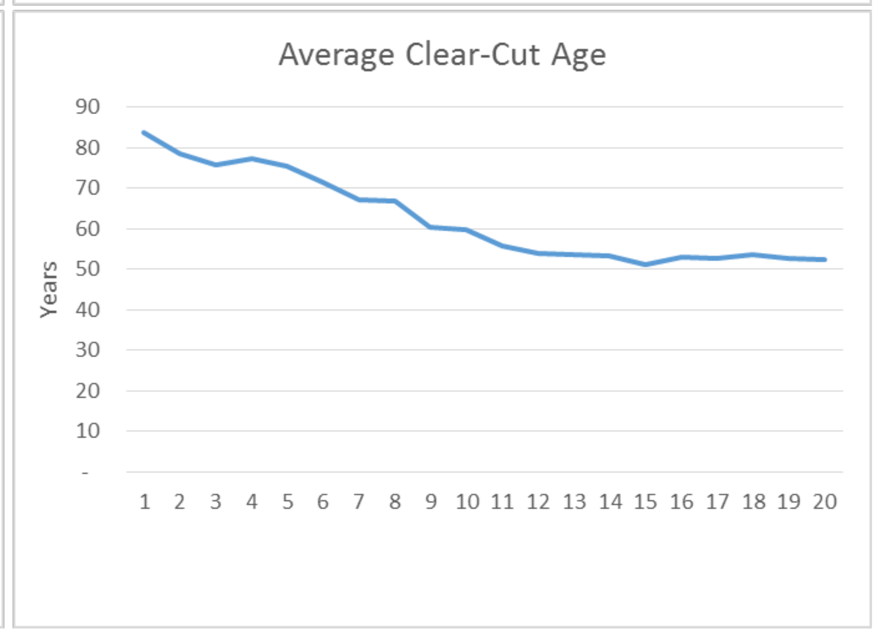


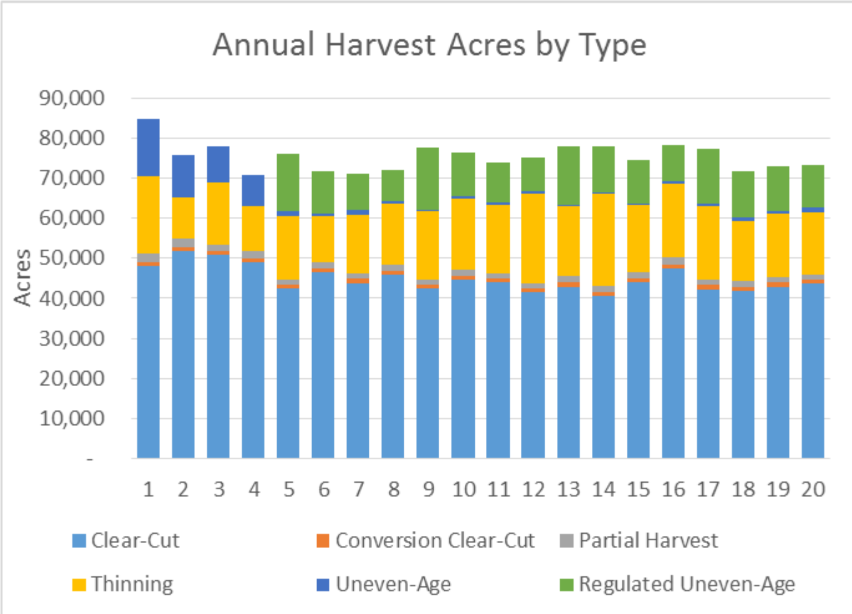


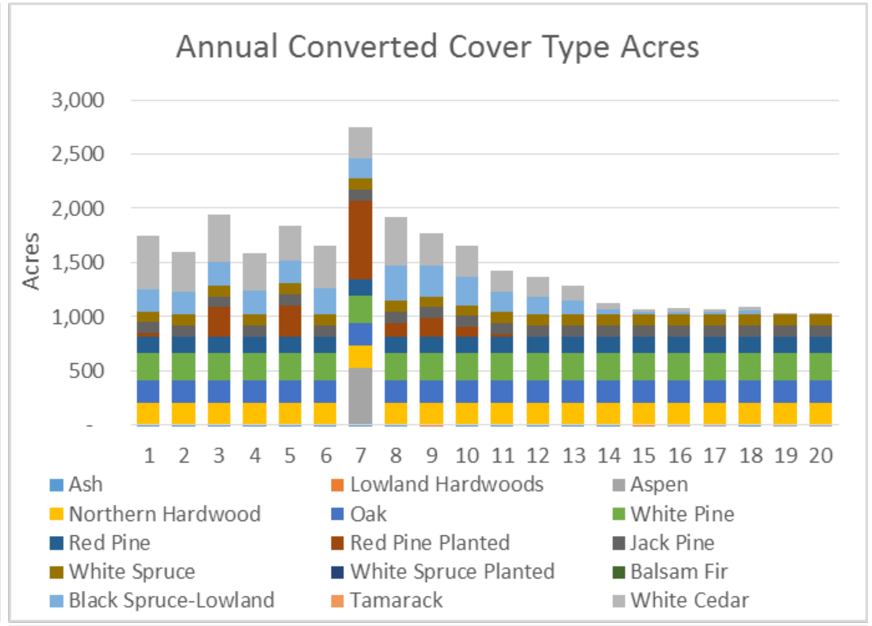

Annual Harvest Volume by Trust Status
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

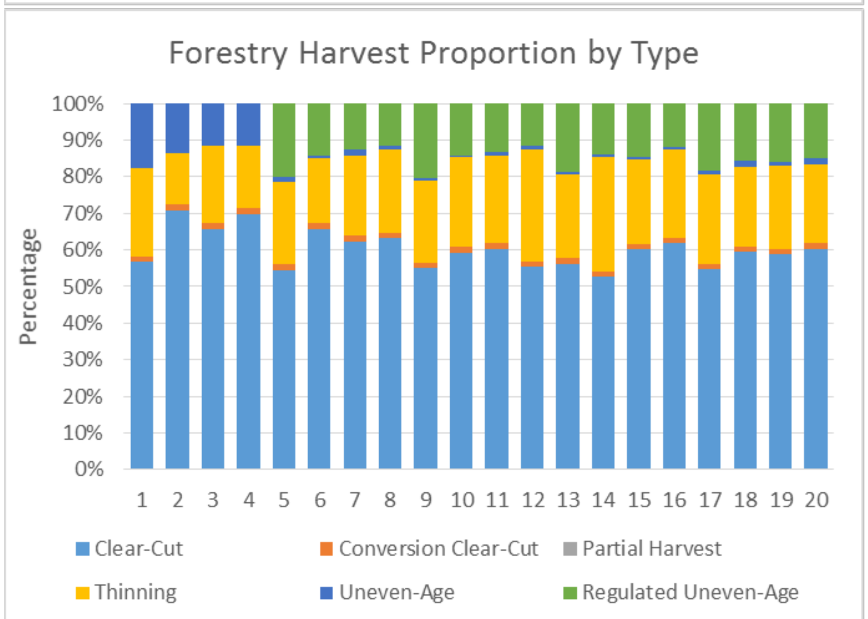

Priority Harvest Volume by Species Group
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

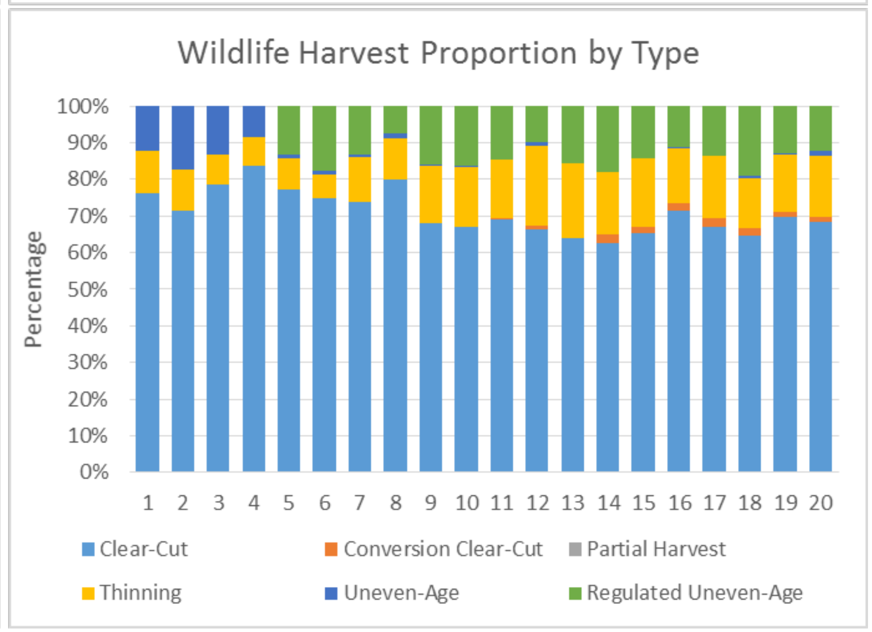

Harvest Volume by Physiographic Region
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
-
10
20
30
40
50
60
70
80
90
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

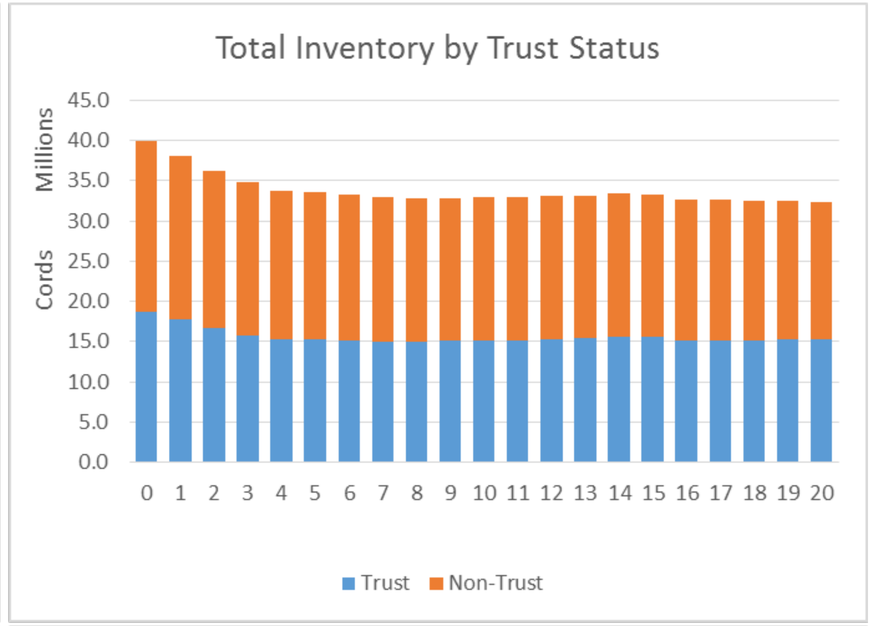

Annual Harvest Acres by Type
Acres
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

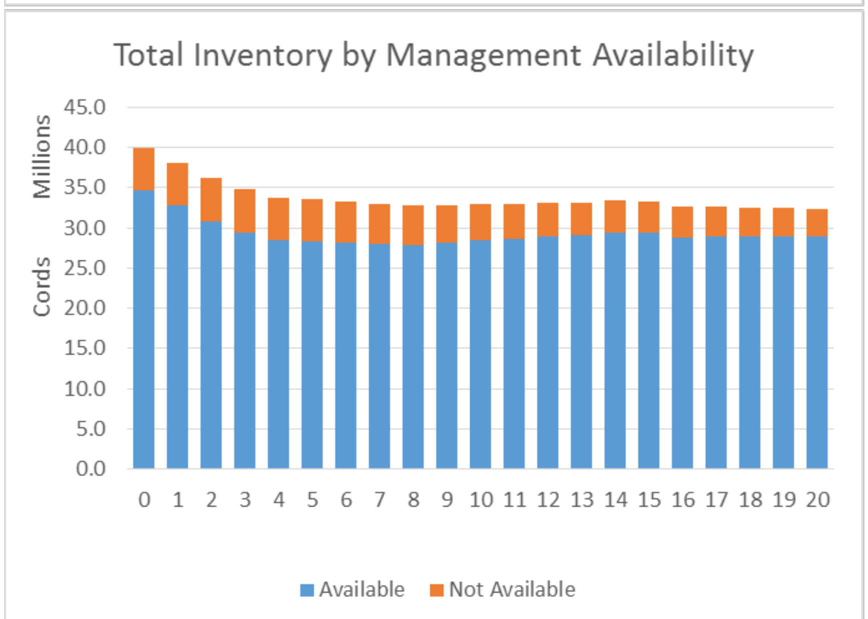

Annual Converted Cover Type Acres
Acres
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

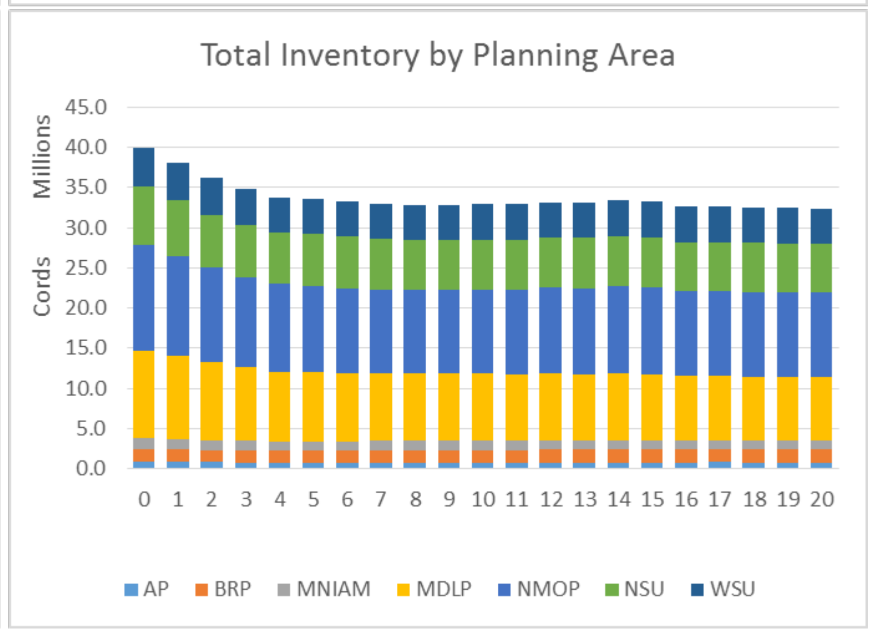

Forestry Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

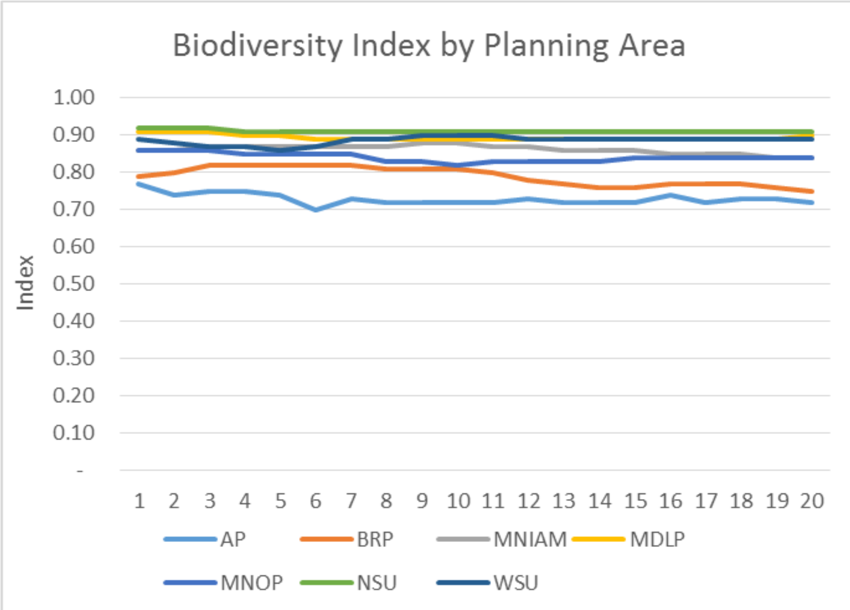

Wildlife Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

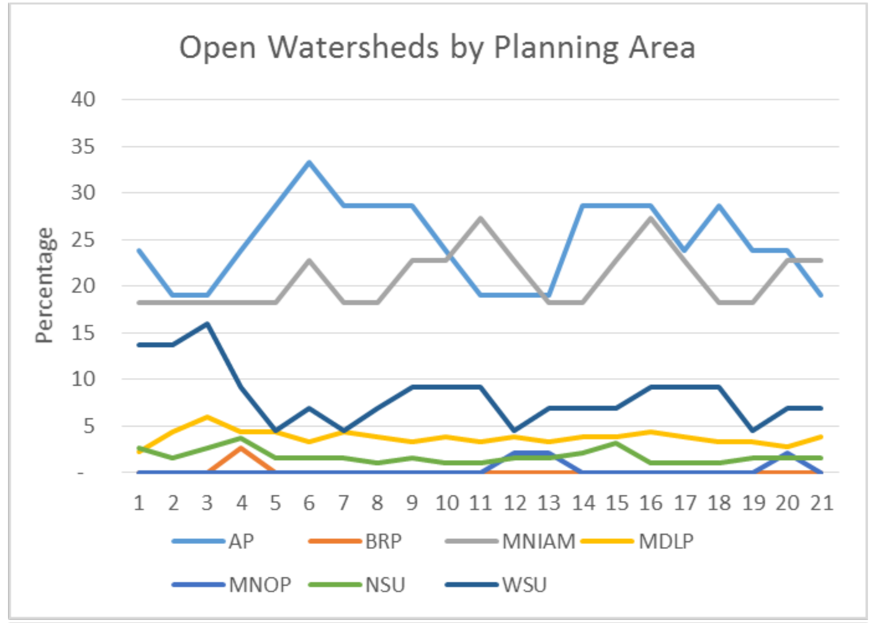

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

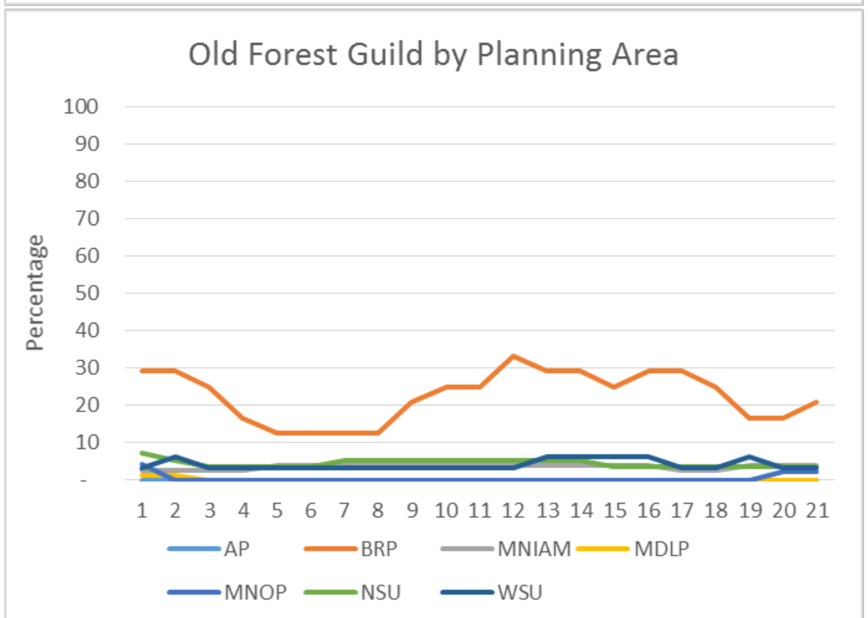

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

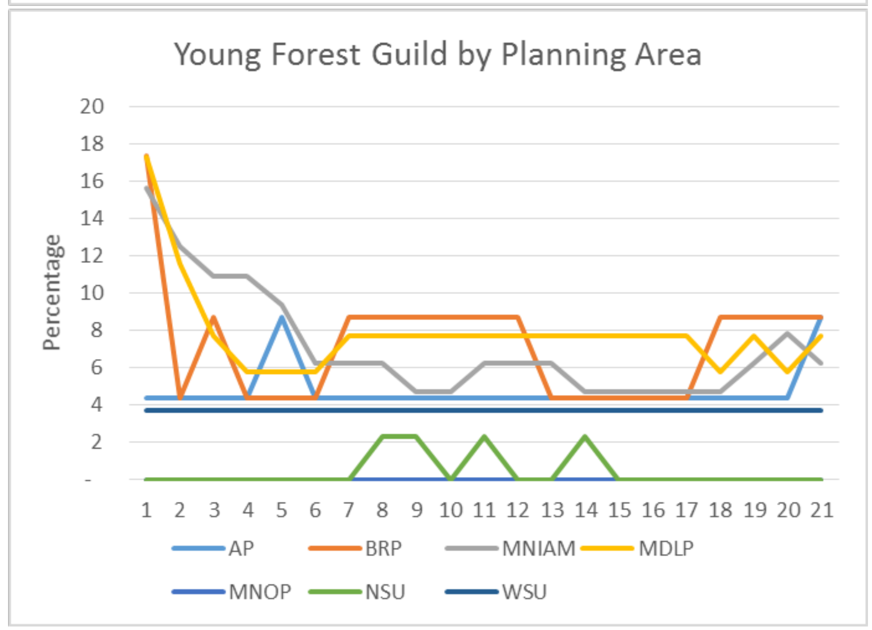

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

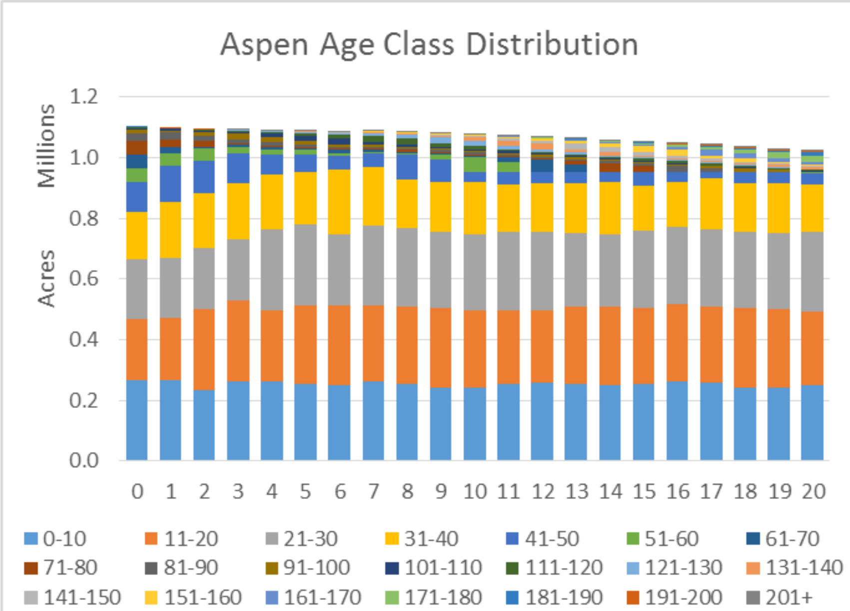

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

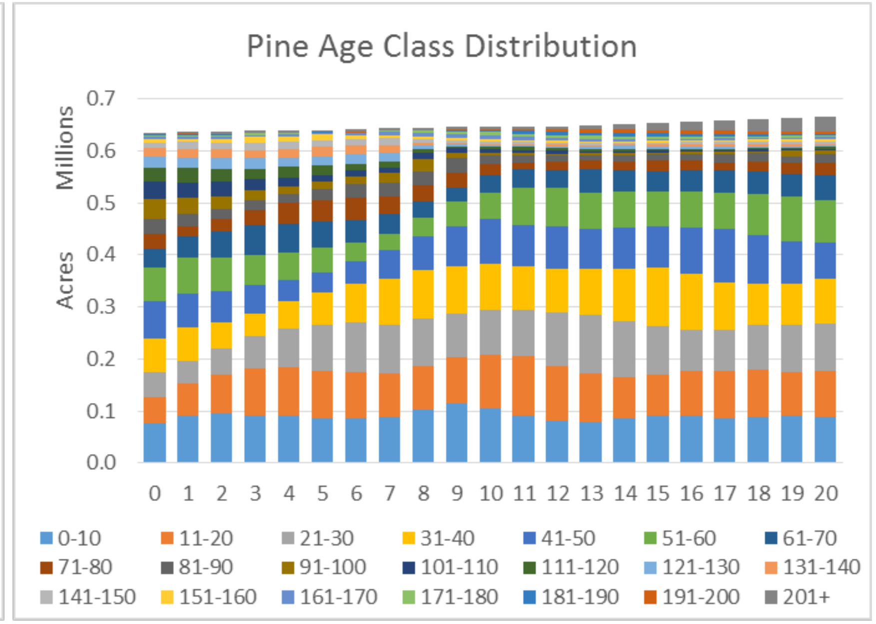

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

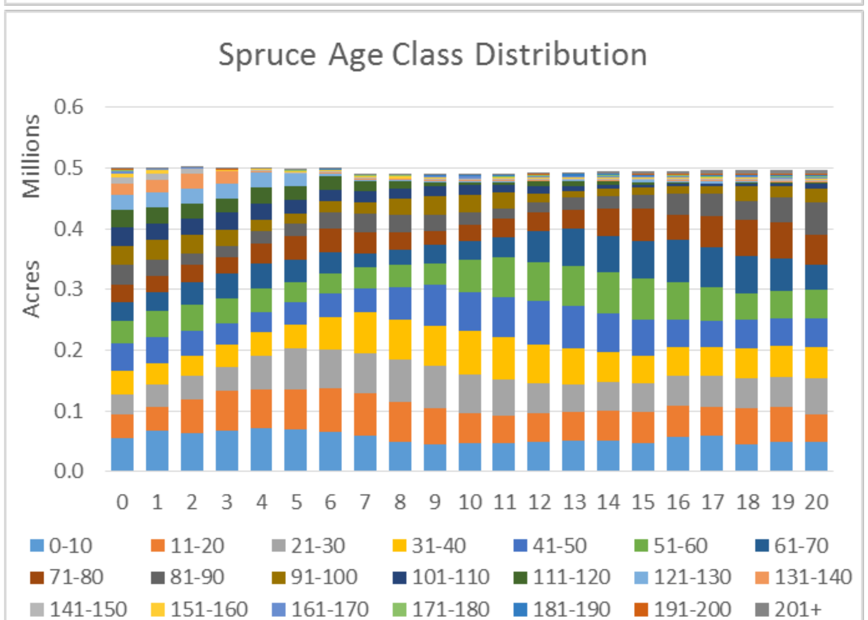

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

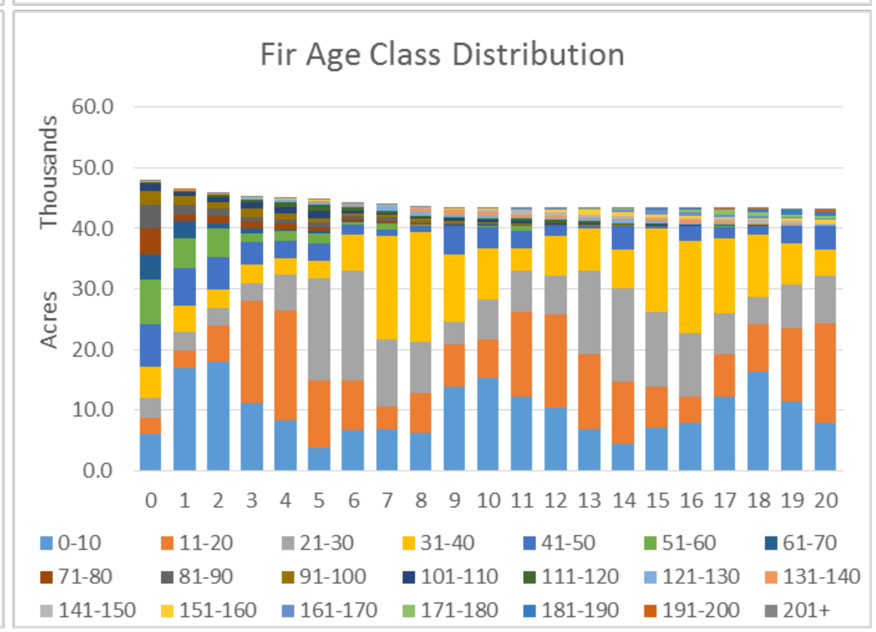

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

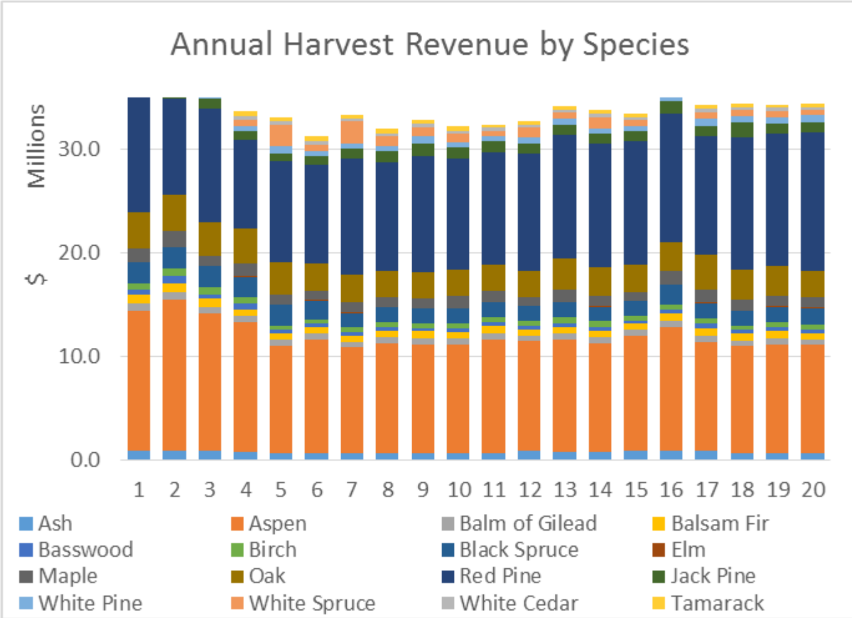

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

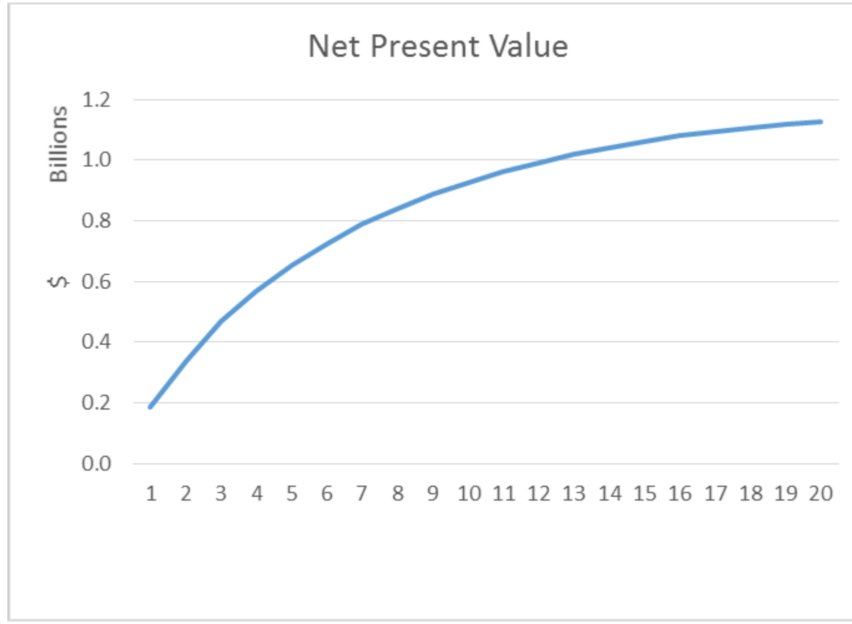

Pine Age Class Distribution
Millions
Acres
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

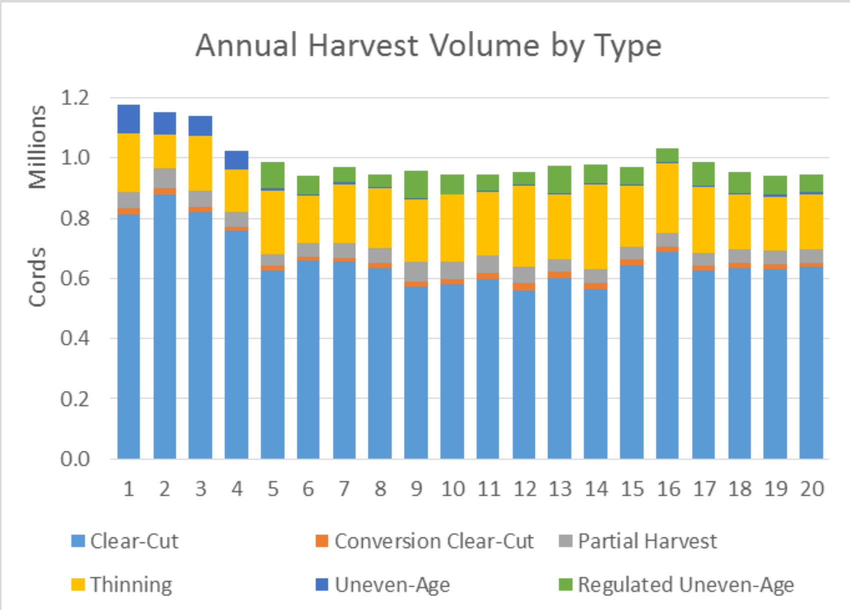


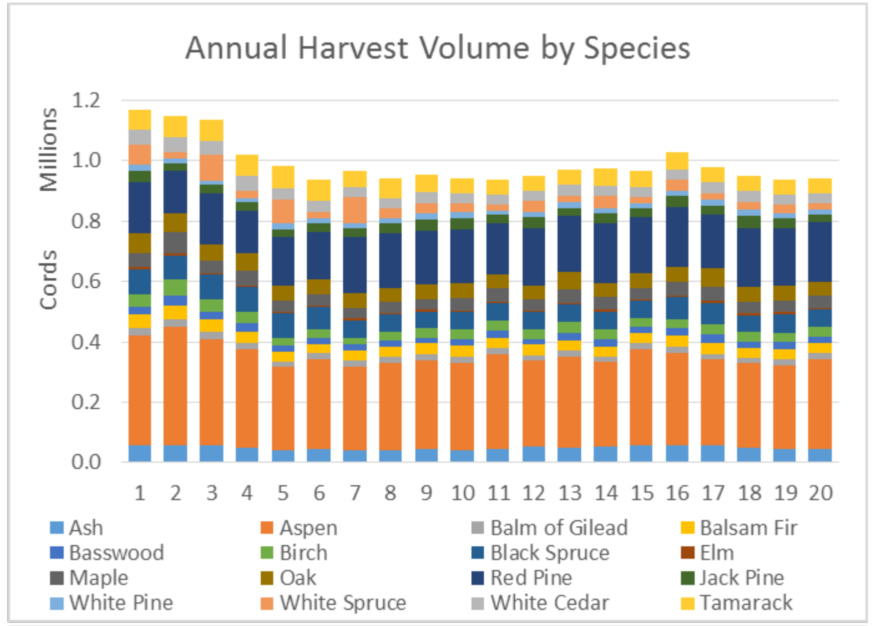
Annual Harvest Revenue by Species
Millions
$
0.0
10.0
20.0
30.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

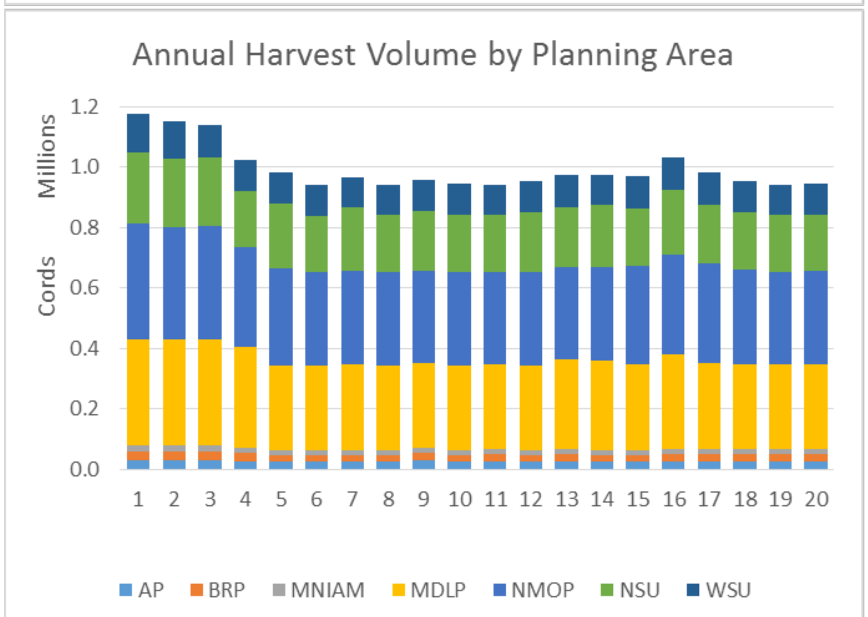


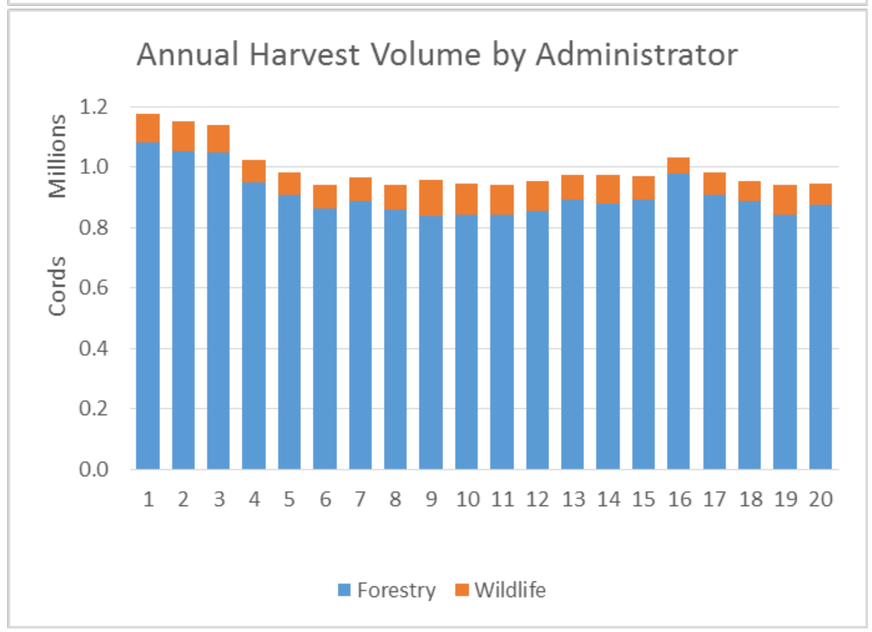
Net Present Value
Billions
$
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

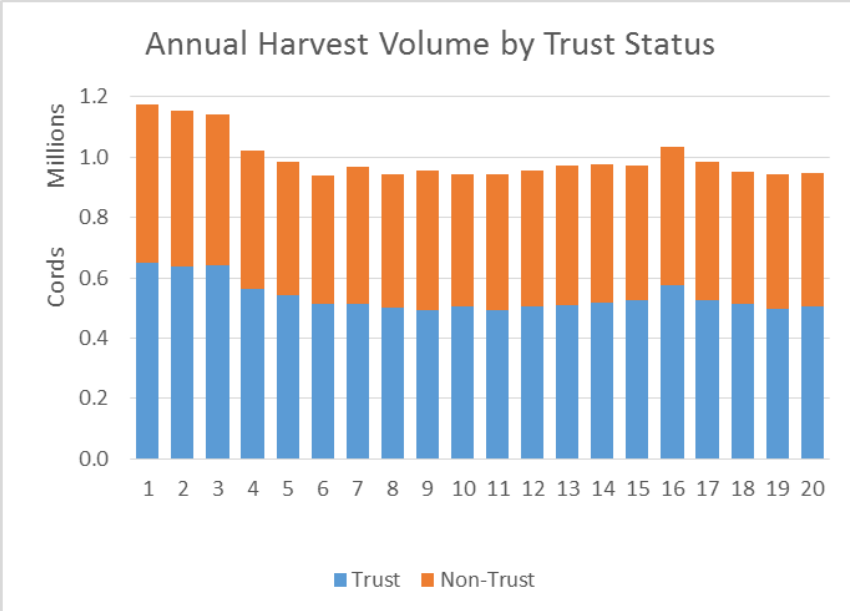
Scenario 3.2.1

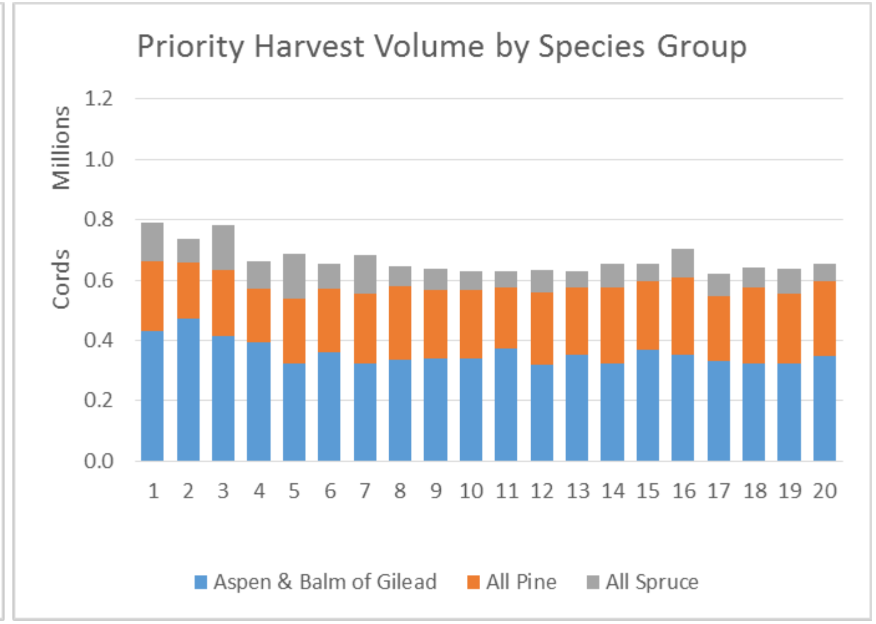


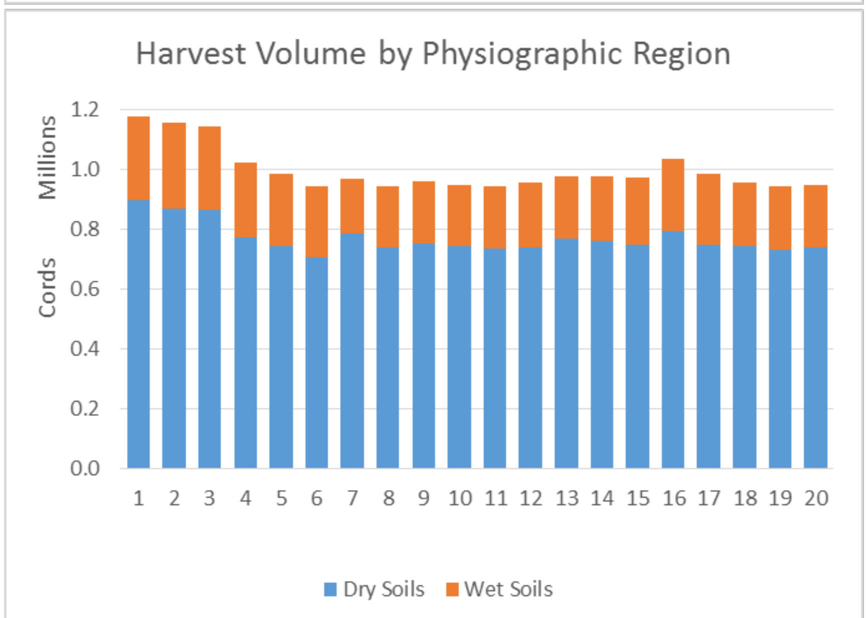


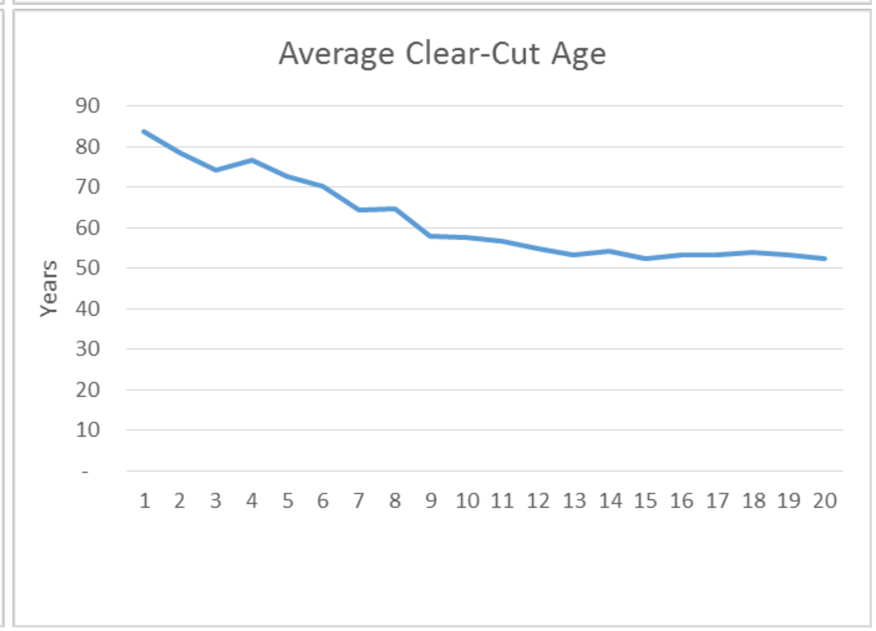


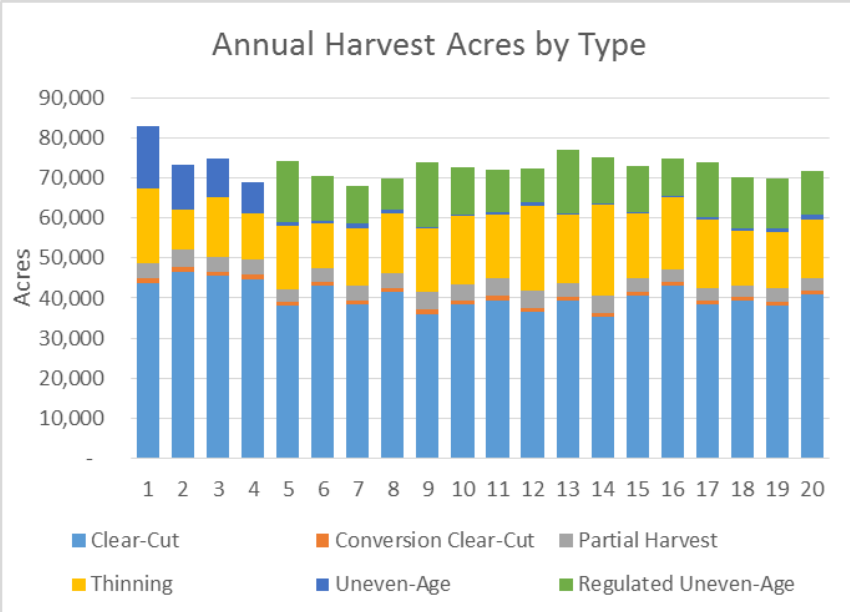



Annual Harvest Volume by Trust Status
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

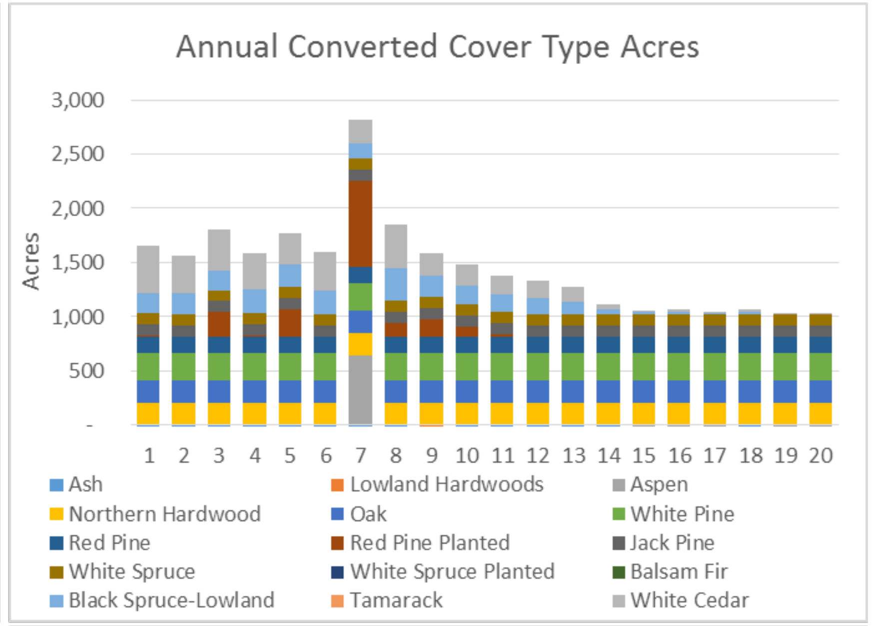

Priority Harvest Volume by Species Group
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce


Harvest Volume by Physiographic Region
Millions
Cords
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

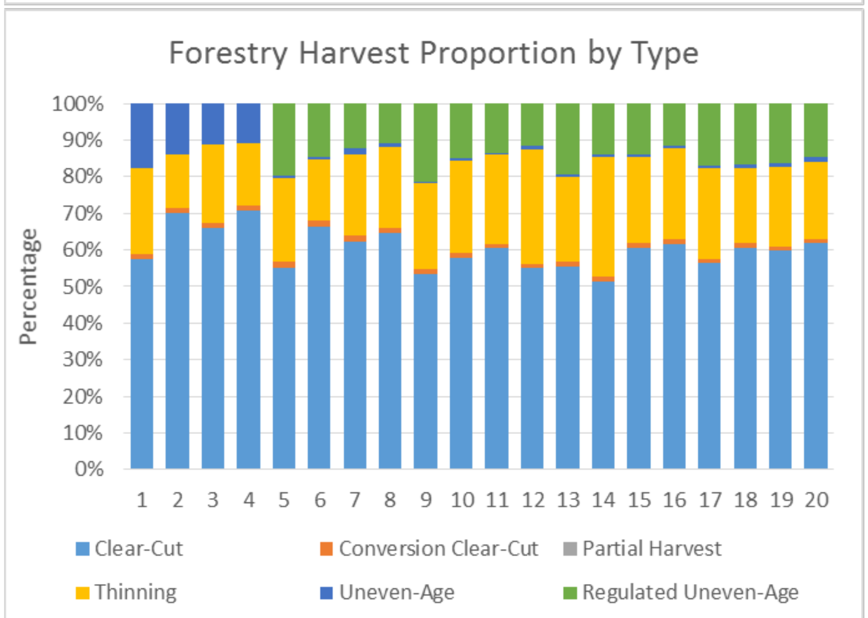

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



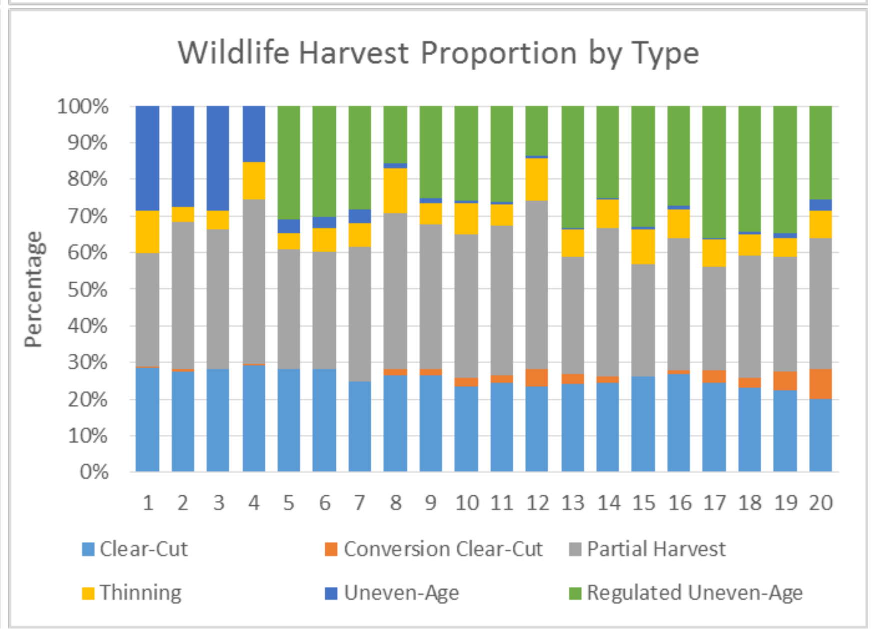
Annual Harvest Acres by Type
Acres
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age



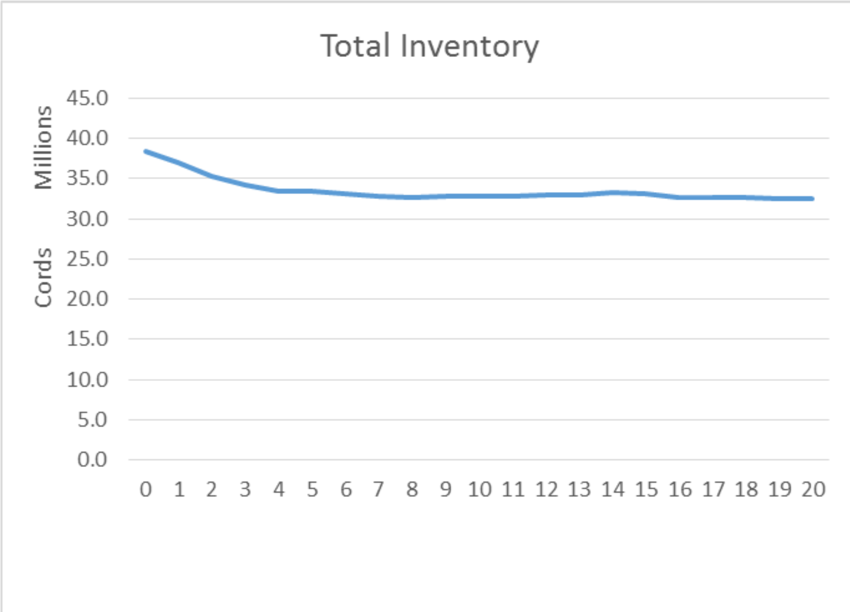
Annual Converted Cover Type Acres
Acres
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

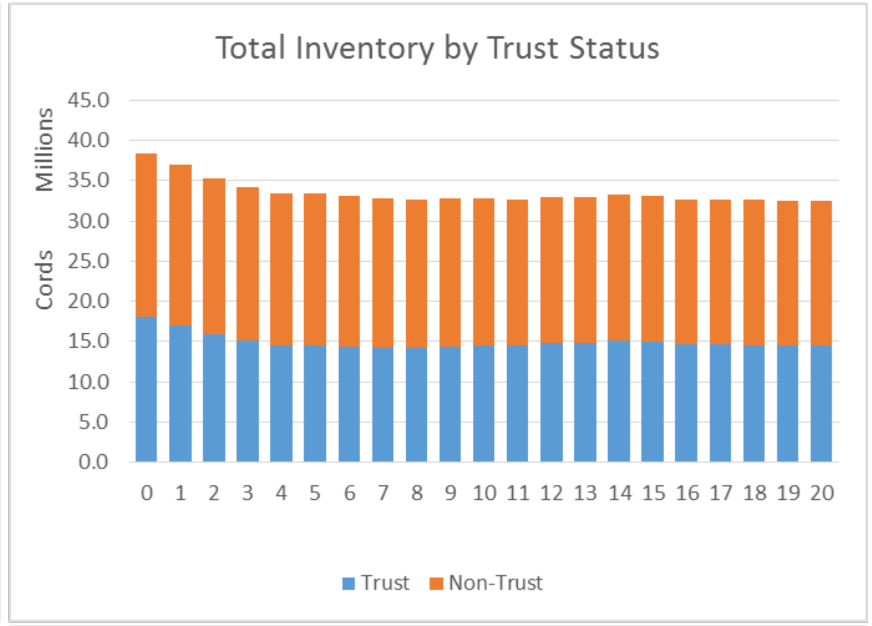


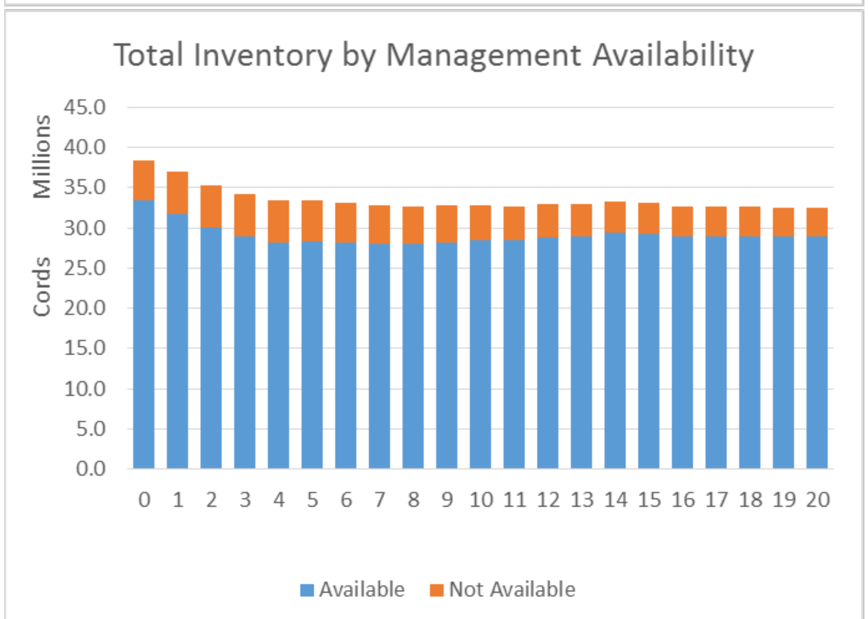
Forestry Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

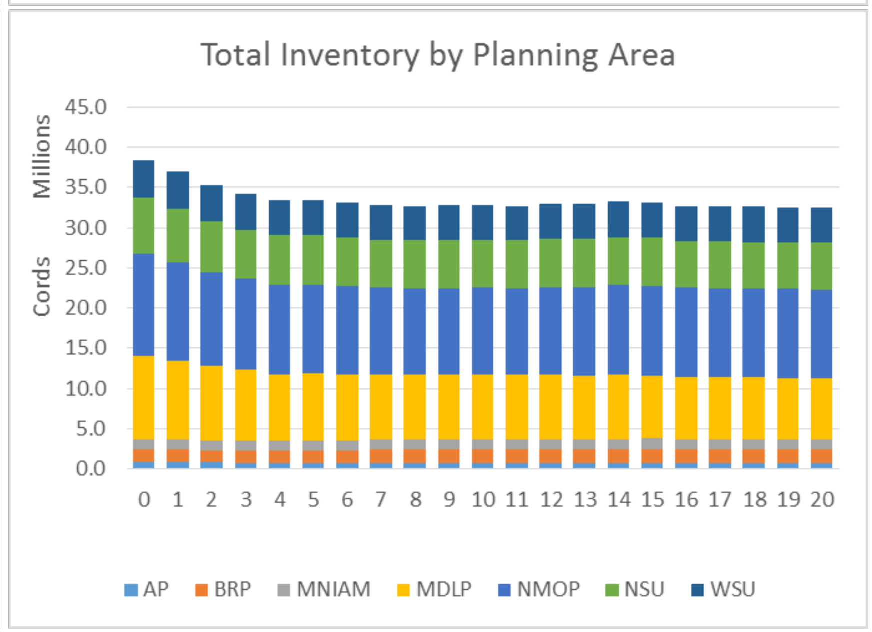


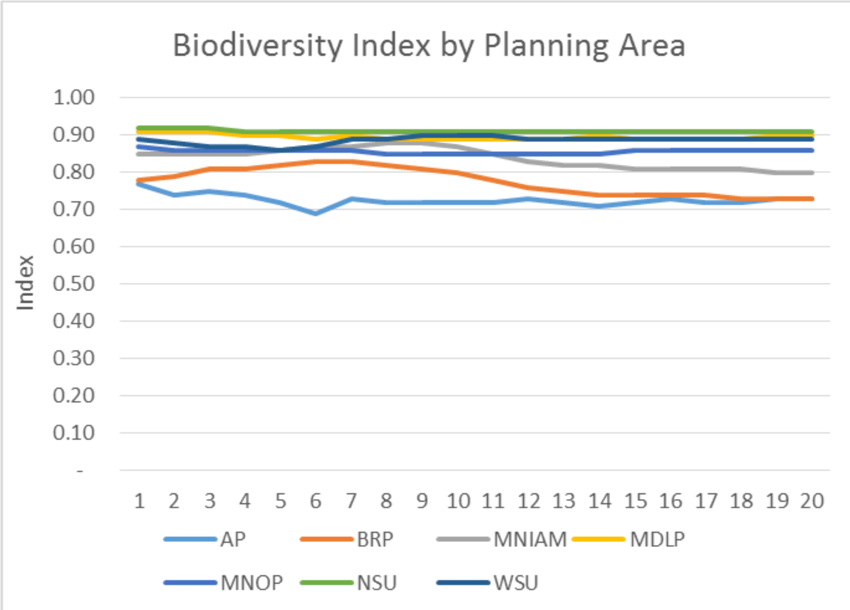
Wildlife Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

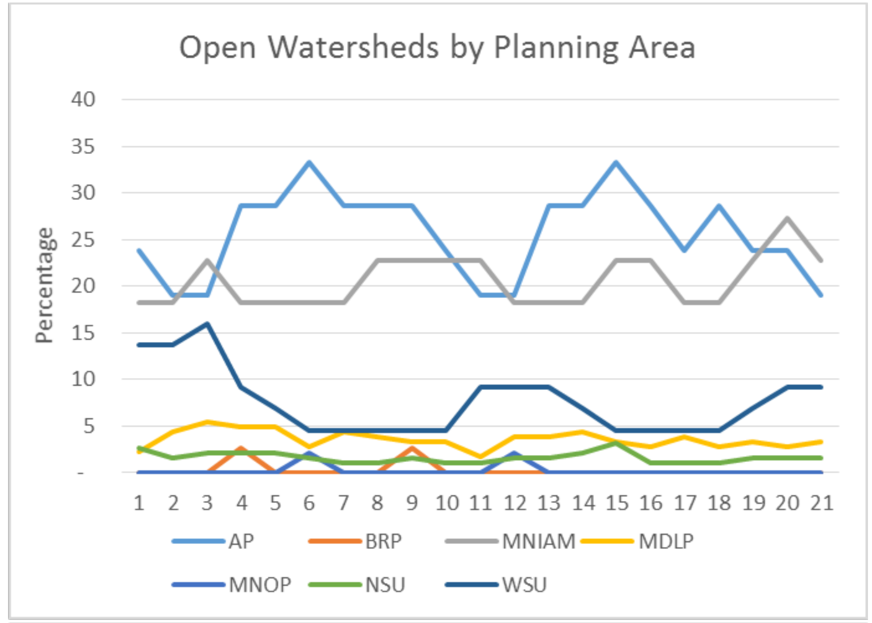

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

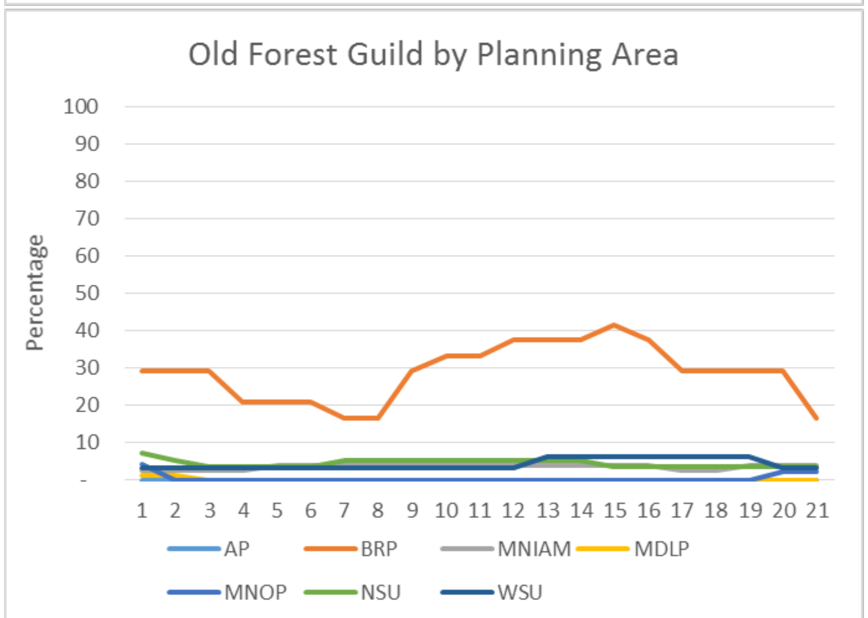

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

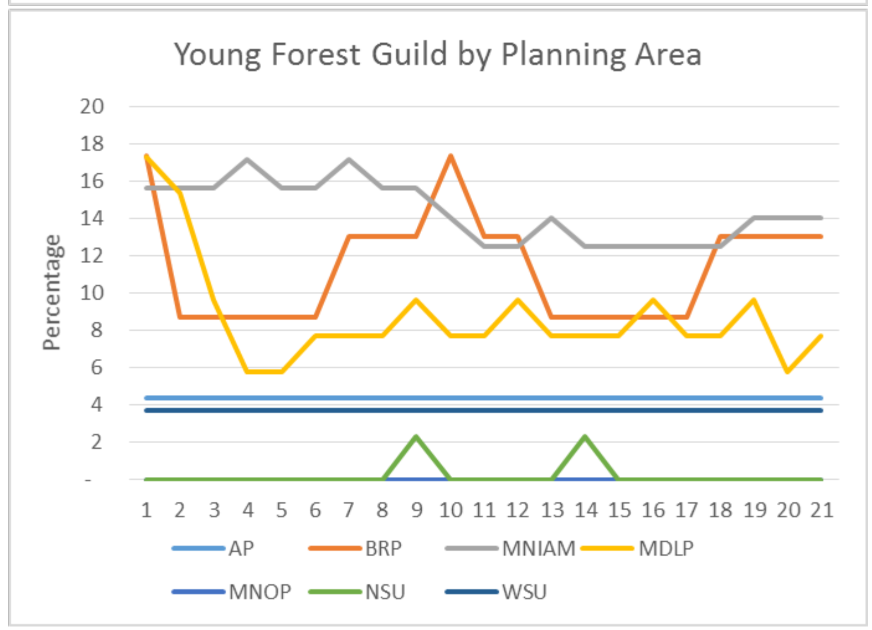

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

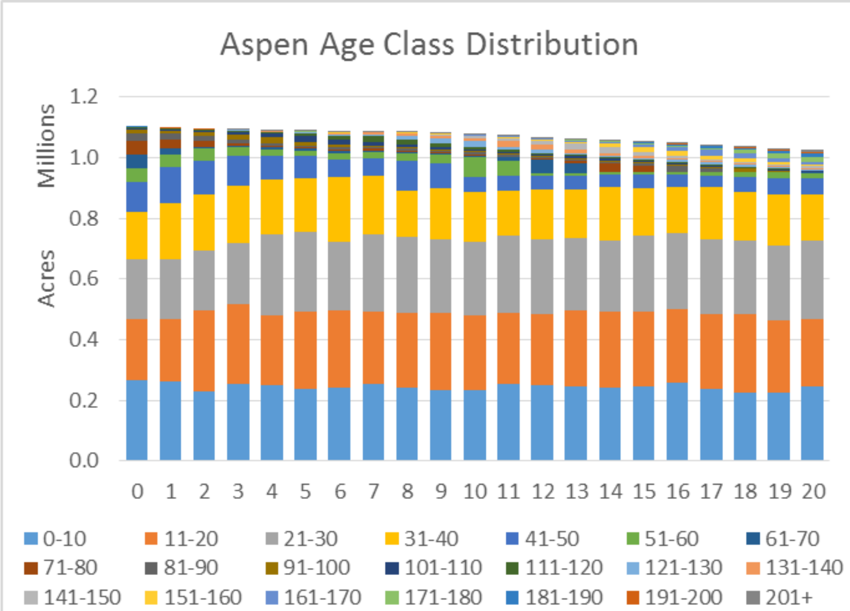

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

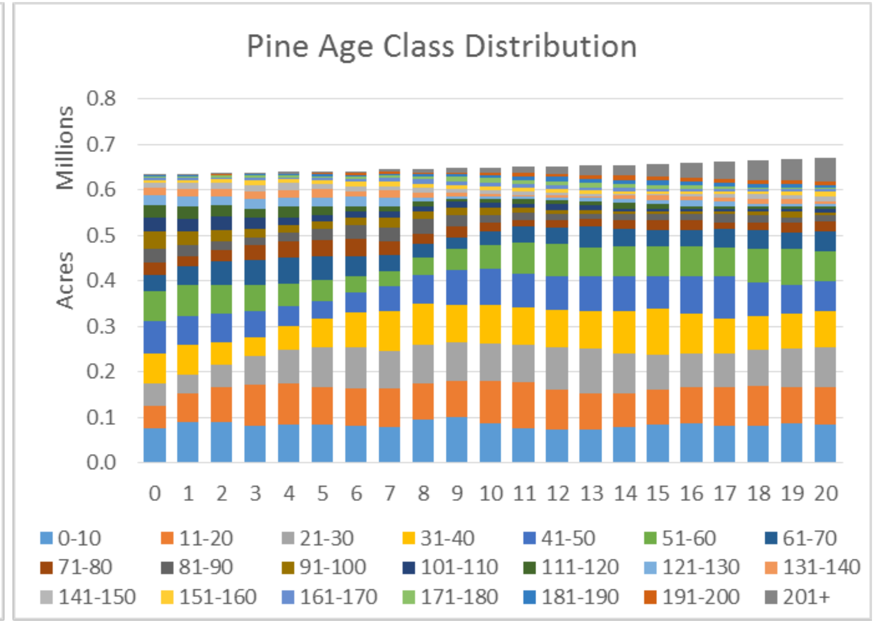

Biodiversity Index by Planning Area
Index
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

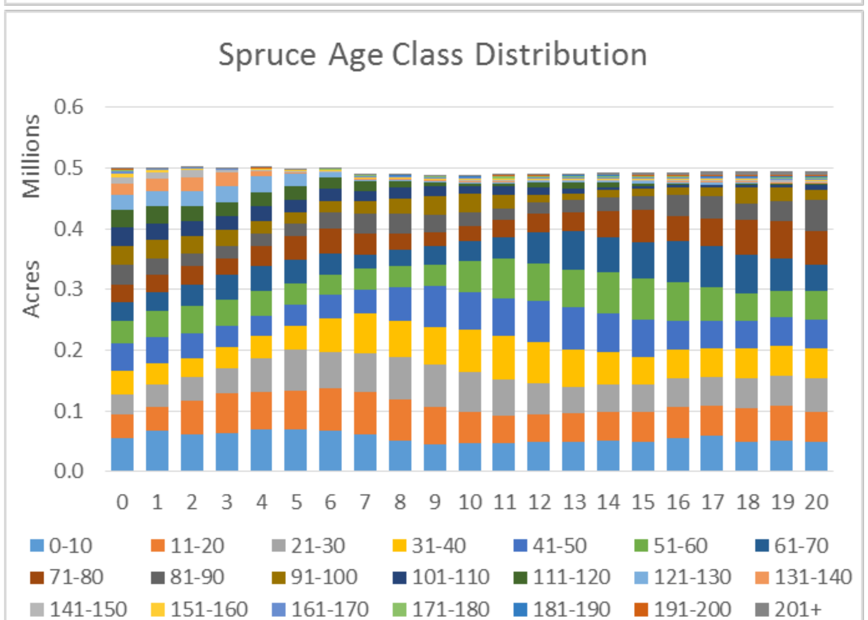

Open Watersheds by Planning Area
Percentage
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

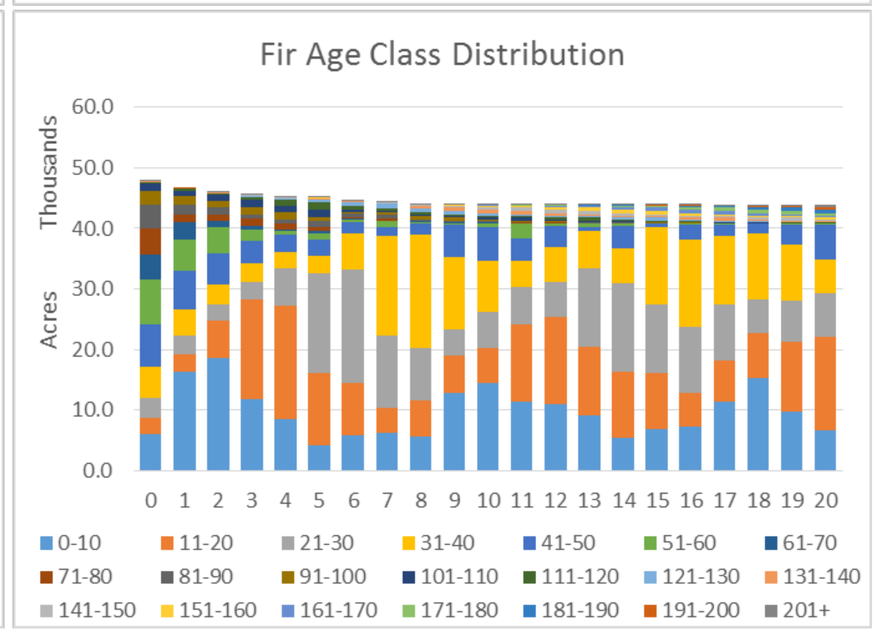

Old Forest Guild by Planning Area
Percentage
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

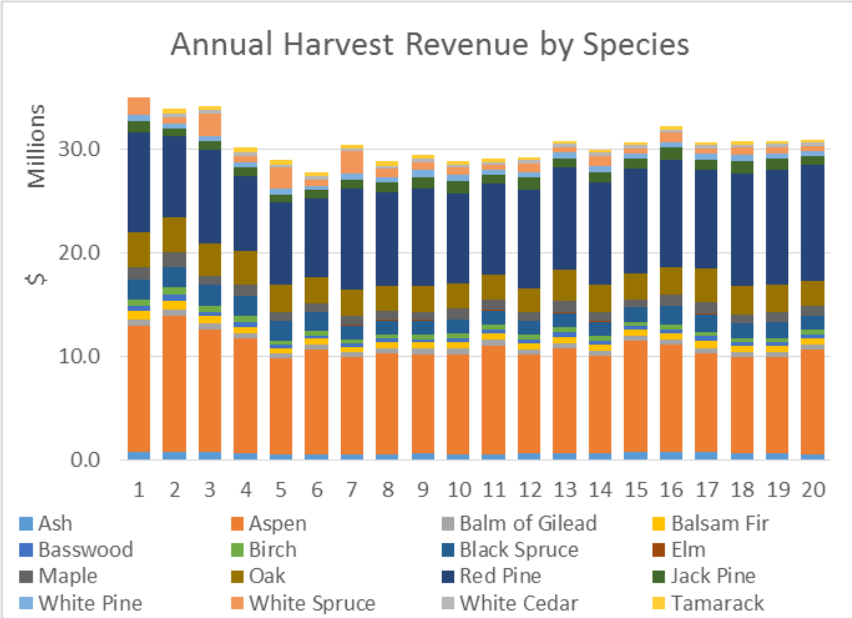

Young Forest Guild by Planning Area
Percentage
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

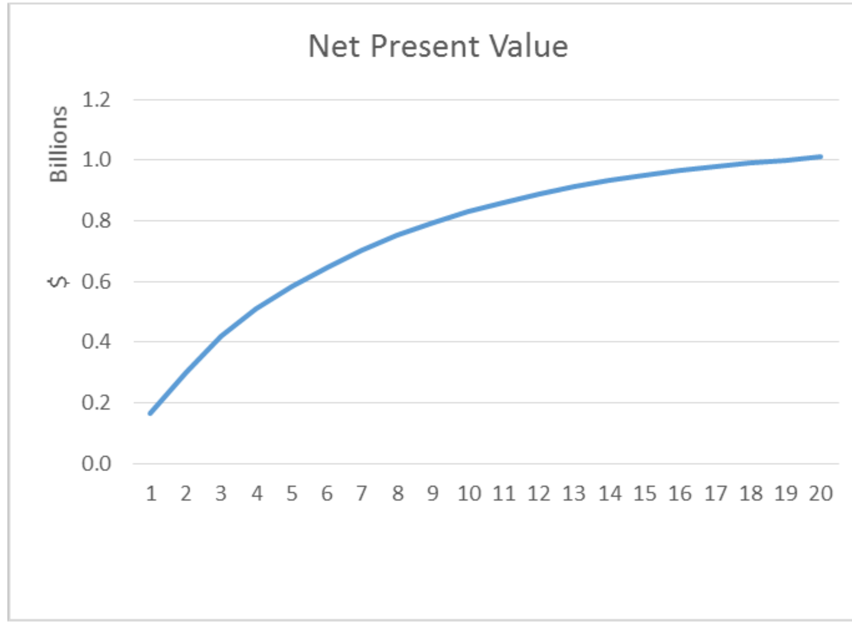

Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

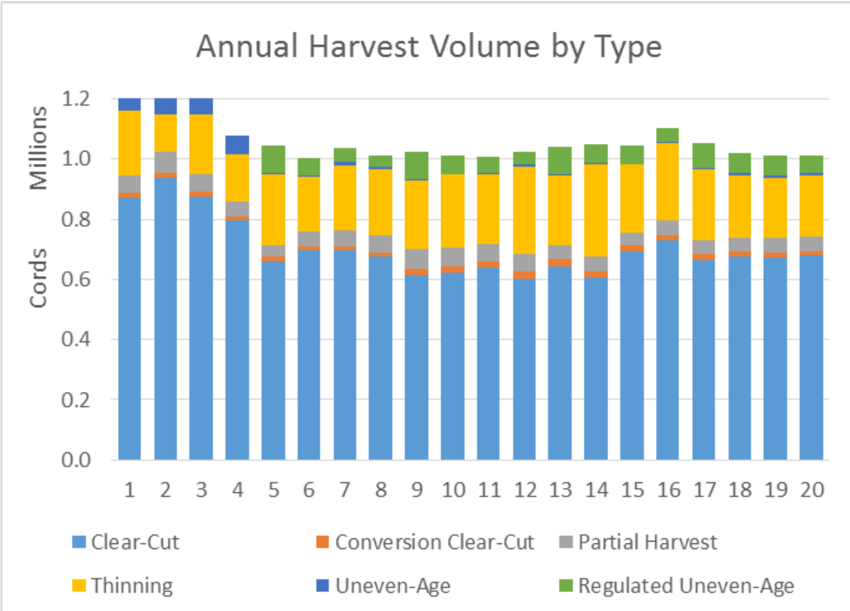


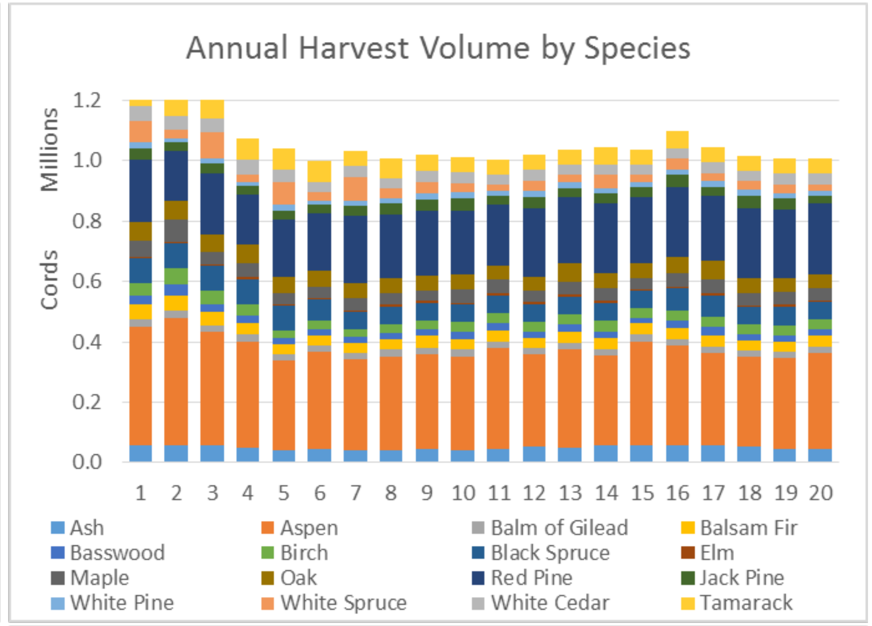
Annual Harvest Revenue by Species
Millions
$
0.0
10.0
20.0
30.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

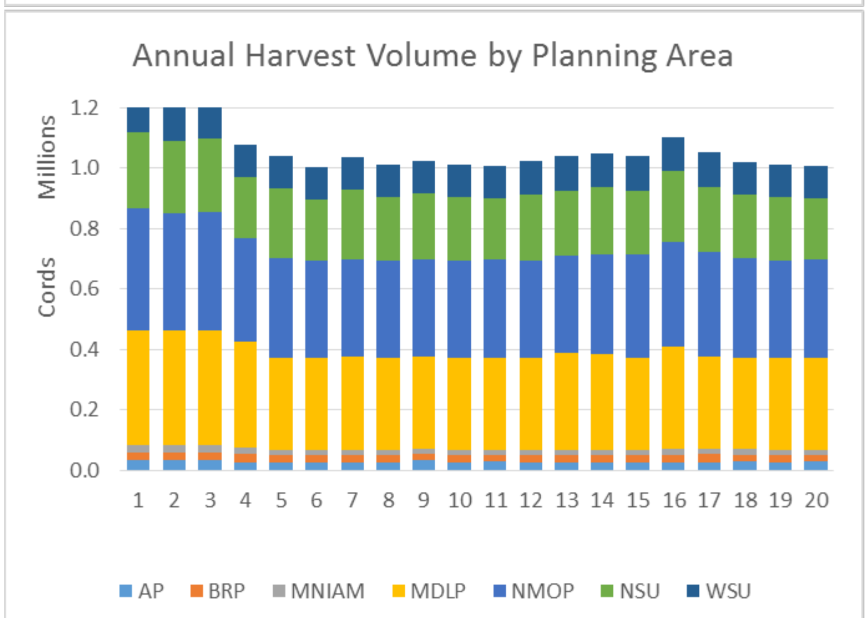


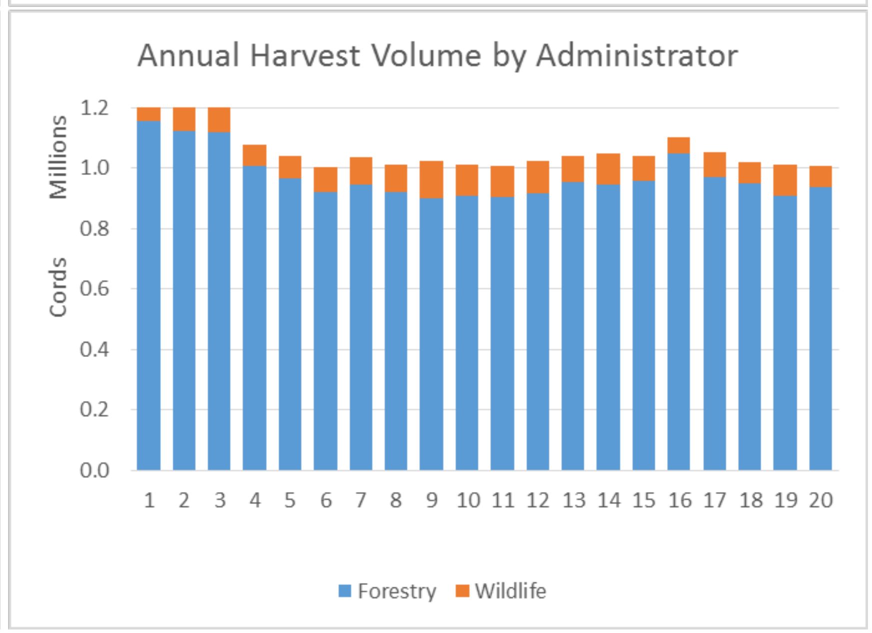
Net Present Value
Billions
$
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

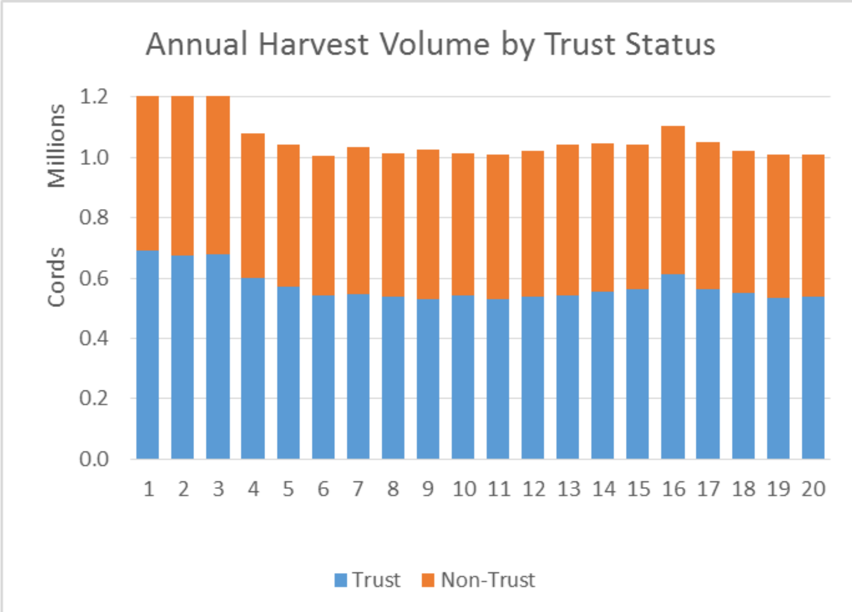
Scenario 3.2.2

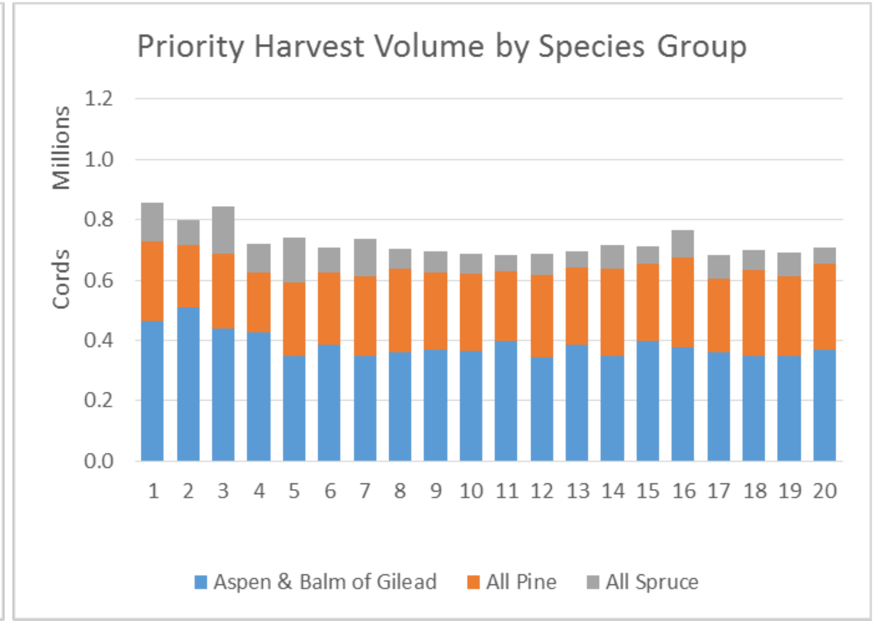


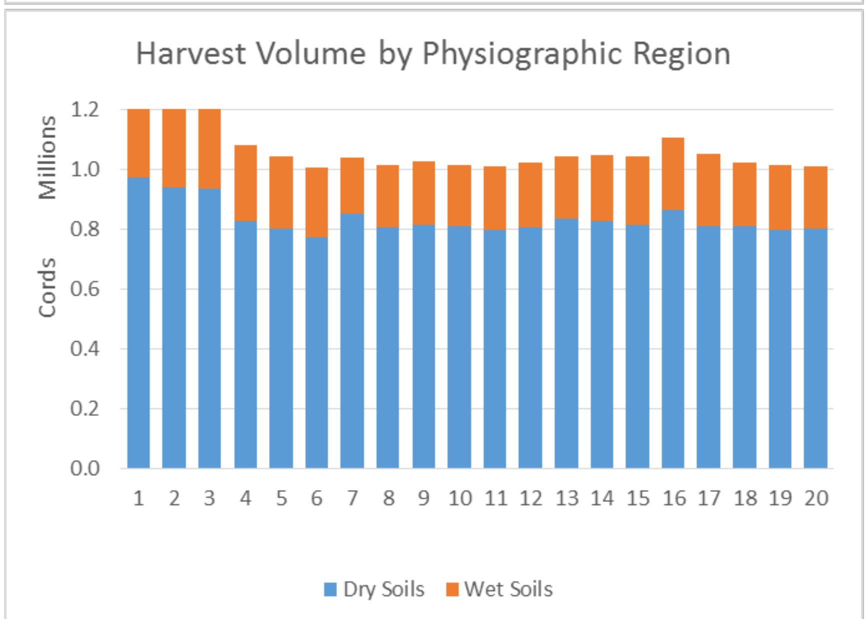


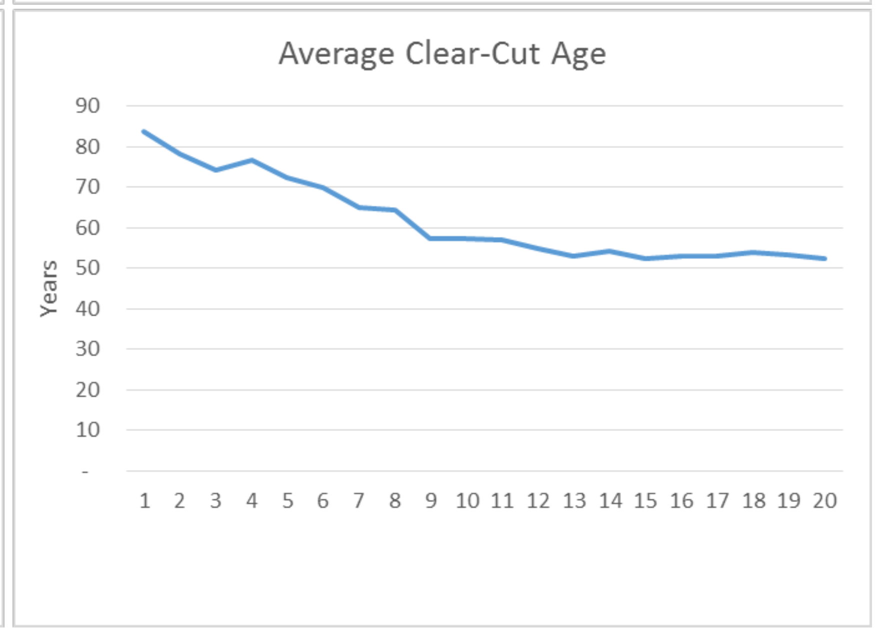


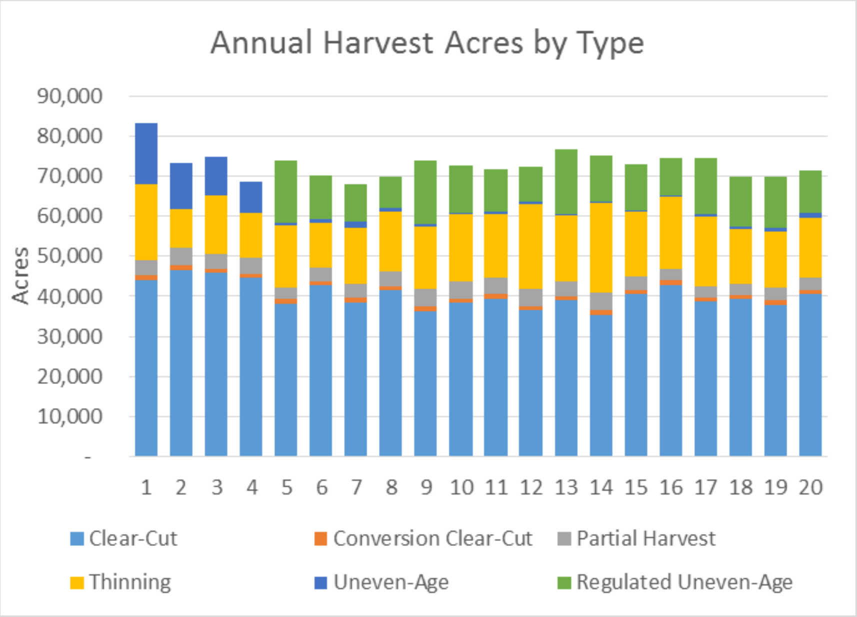


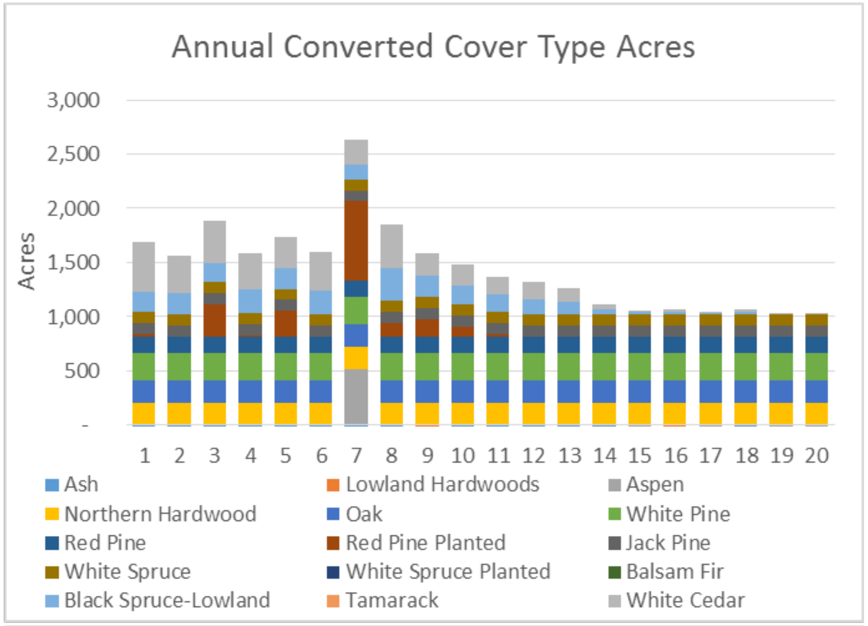

Annual Harvest Volume by Trust Status
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

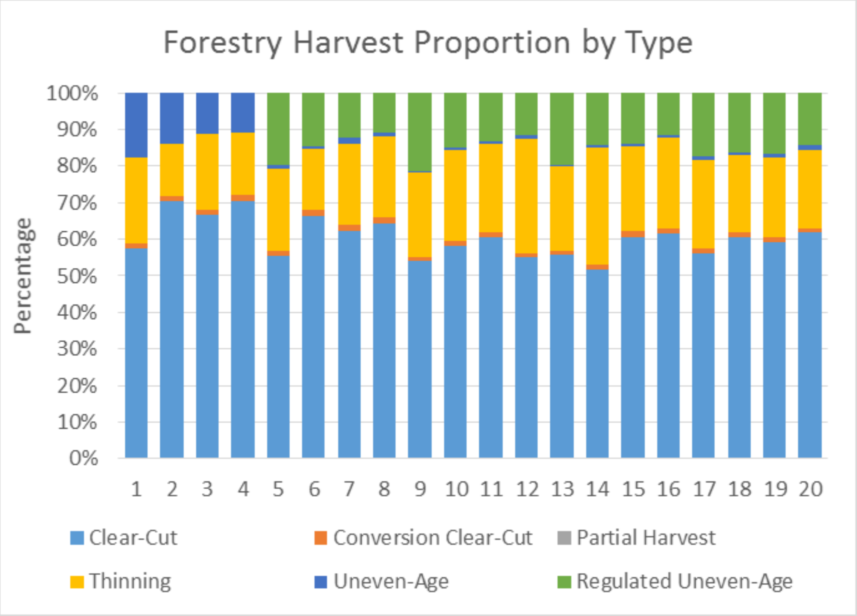

Priority Harvest Volume by Species Group
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

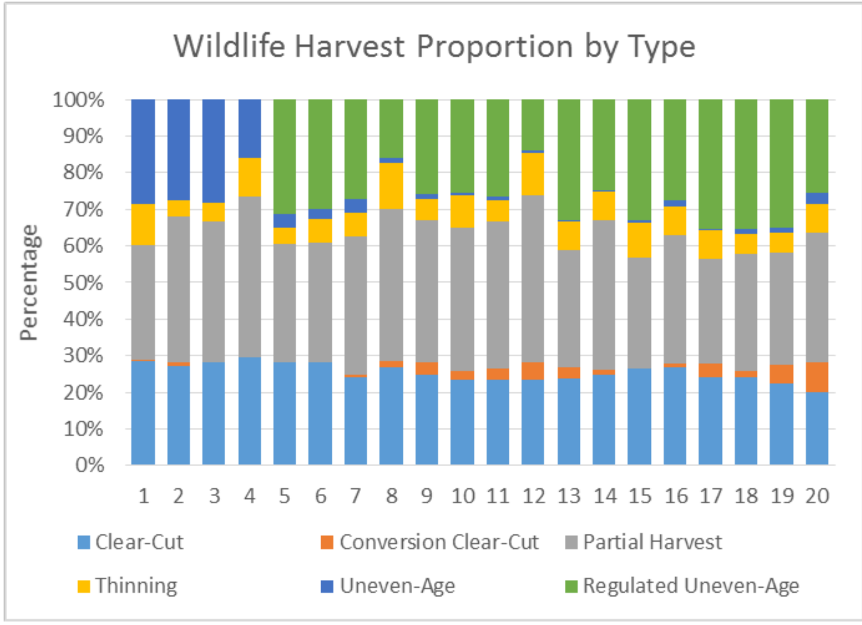

Harvest Volume by Physiographic Region
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

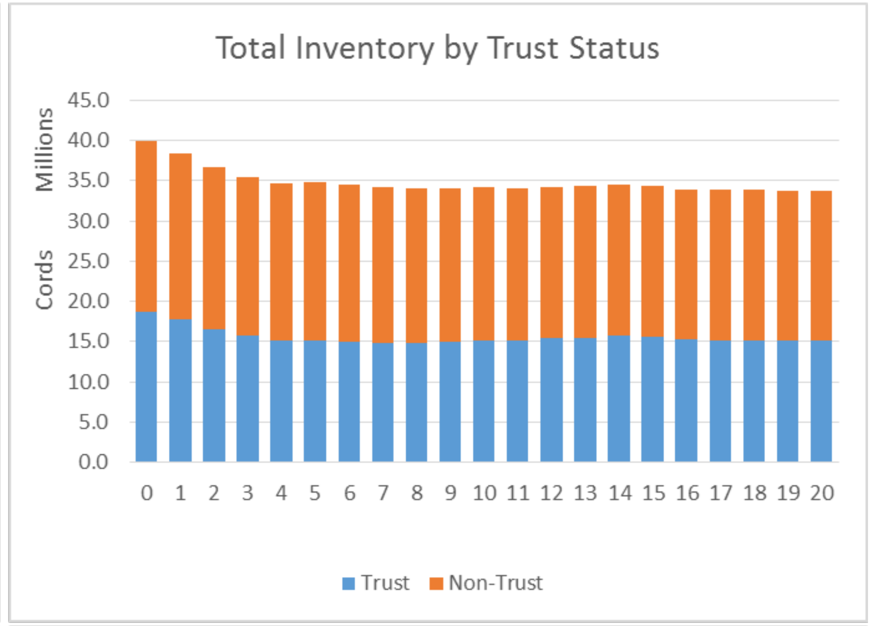

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

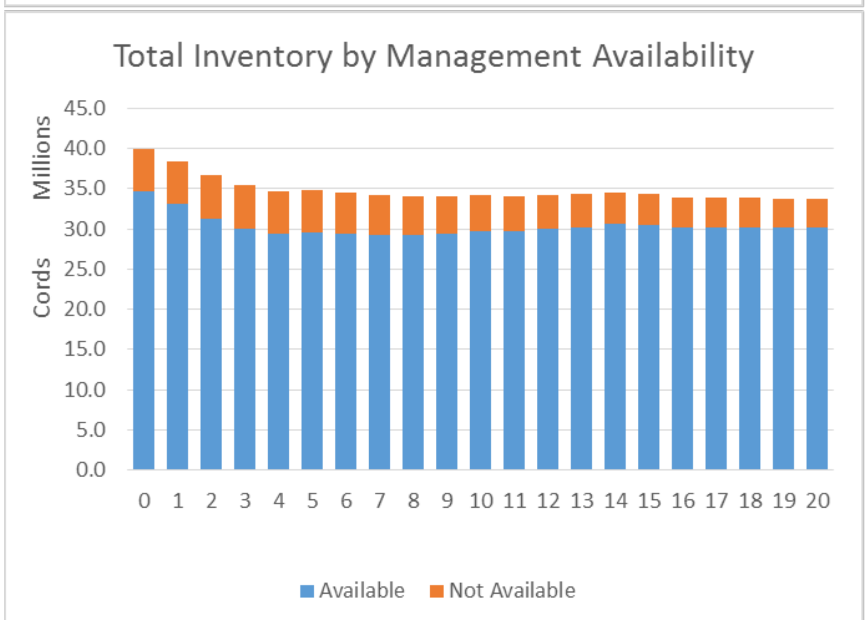

Annual Converted Cover Type Acres
3,000
2,500
2,000
1,500
1,000
500
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

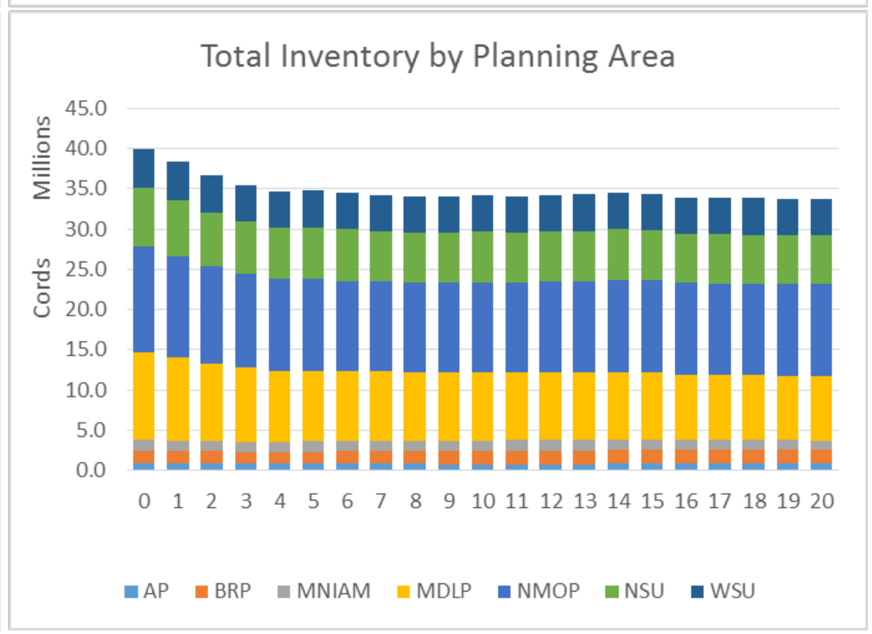

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

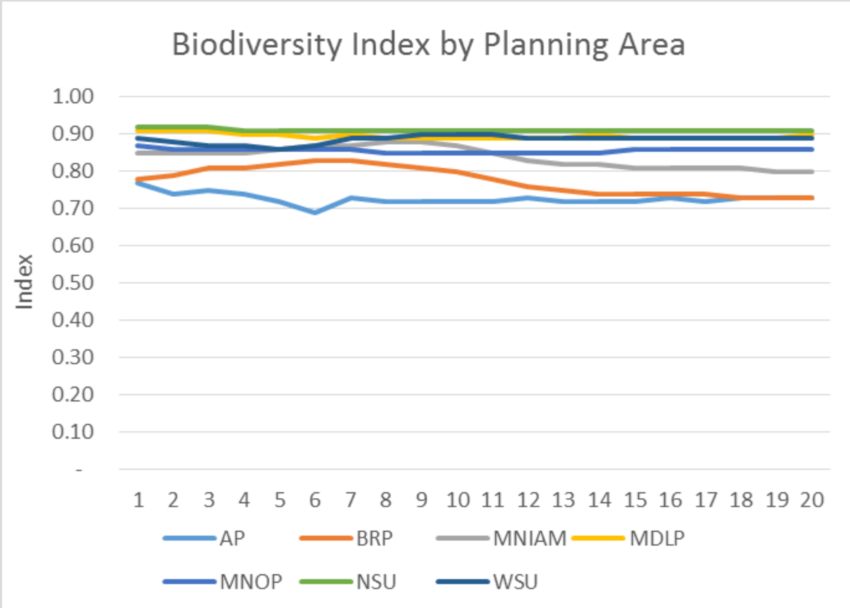

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

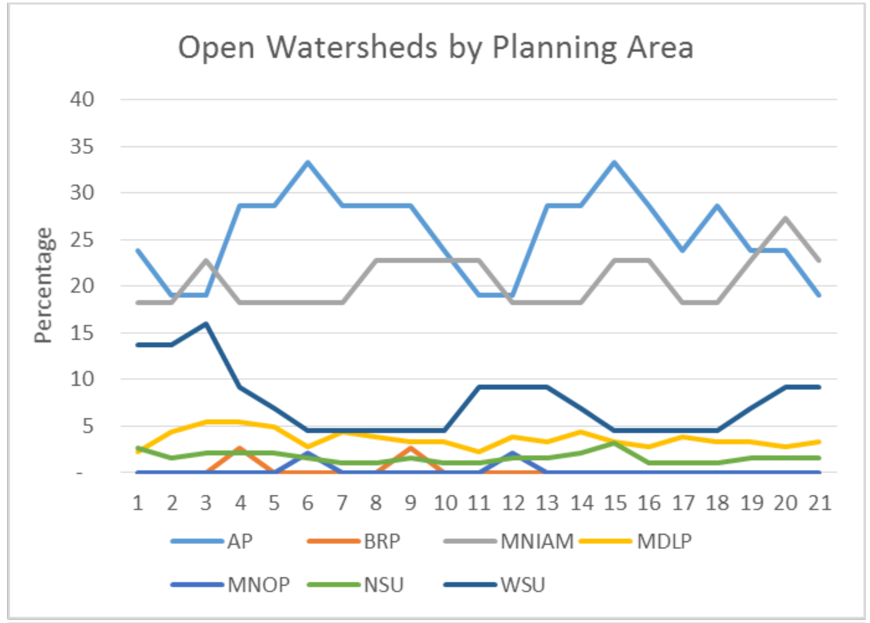

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

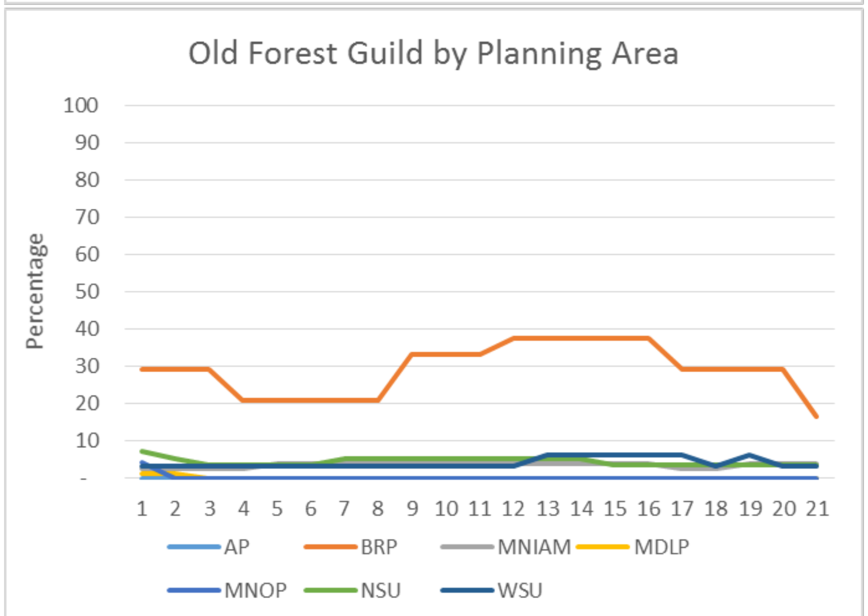

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

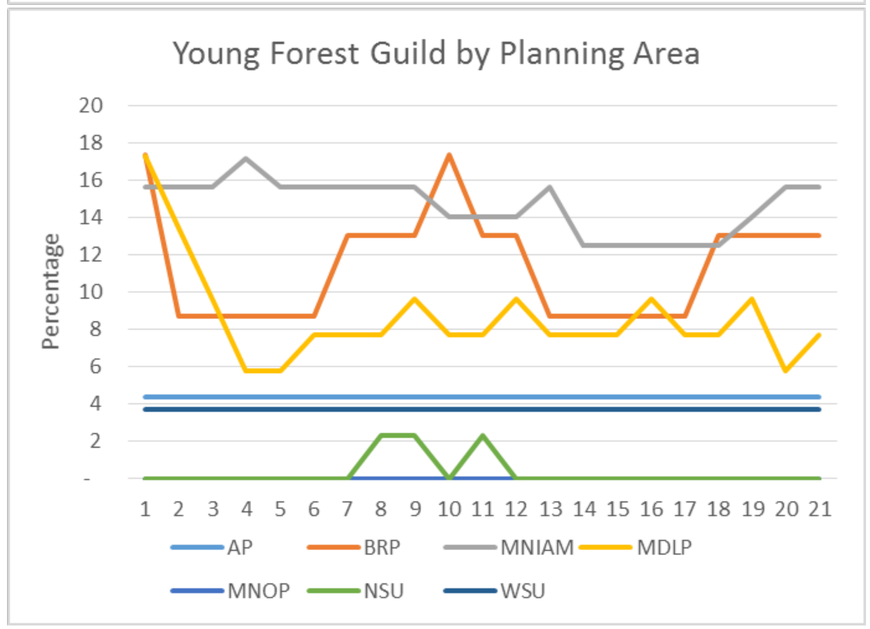

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

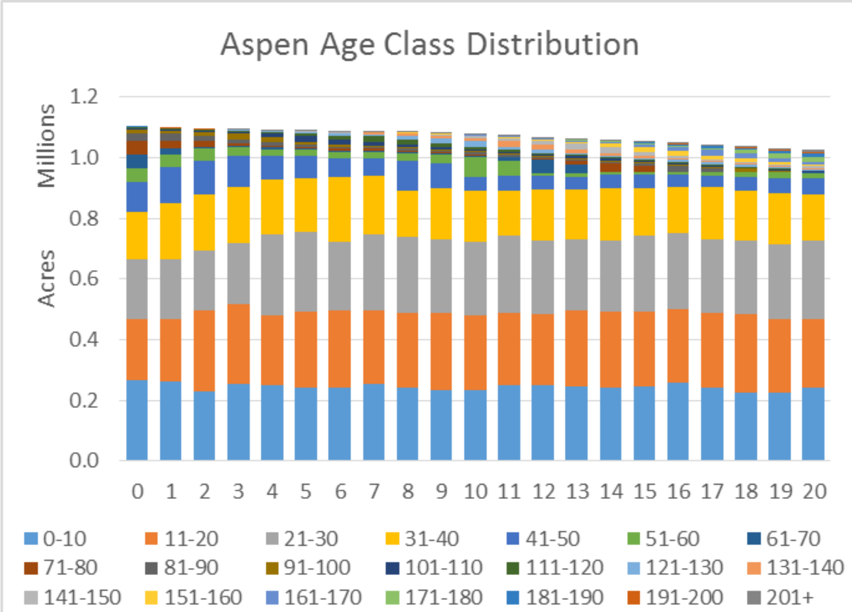

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

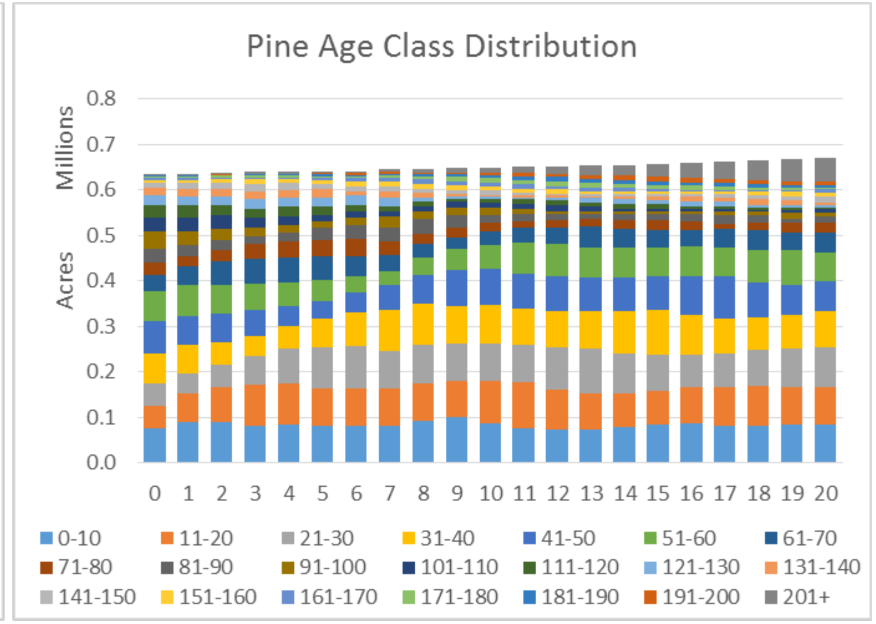

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

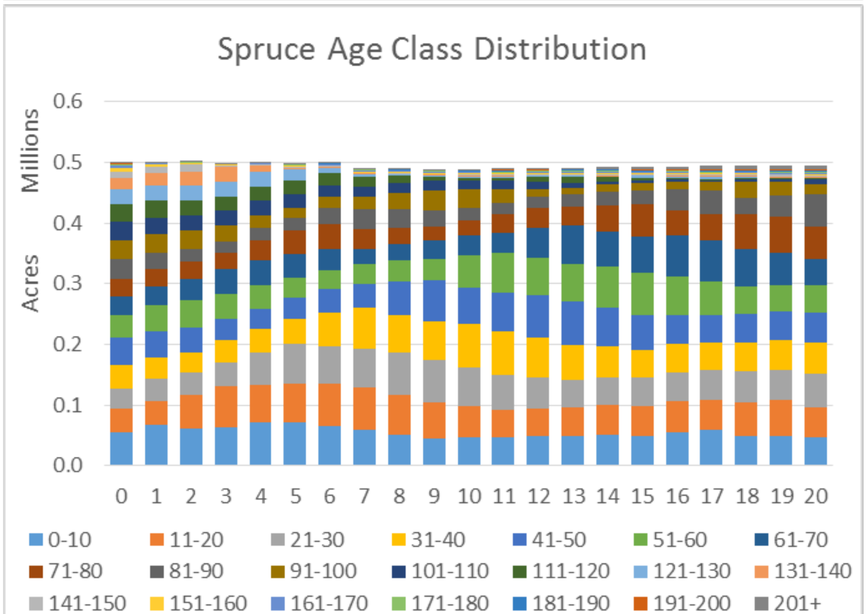

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

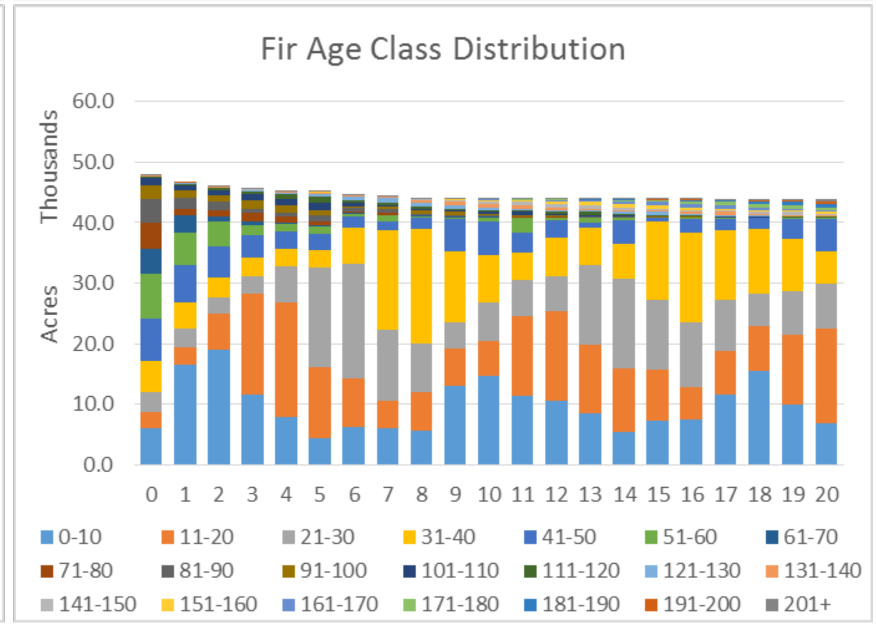

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

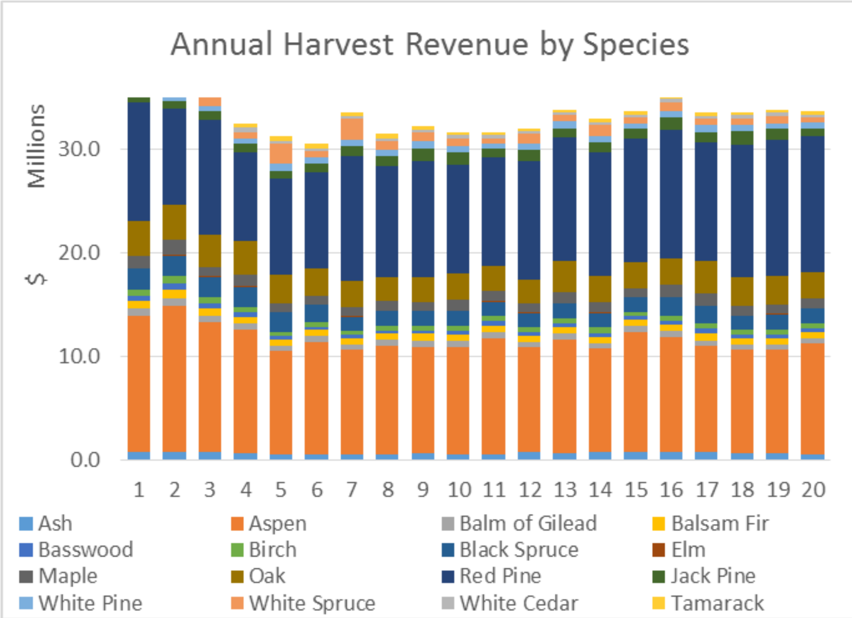

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

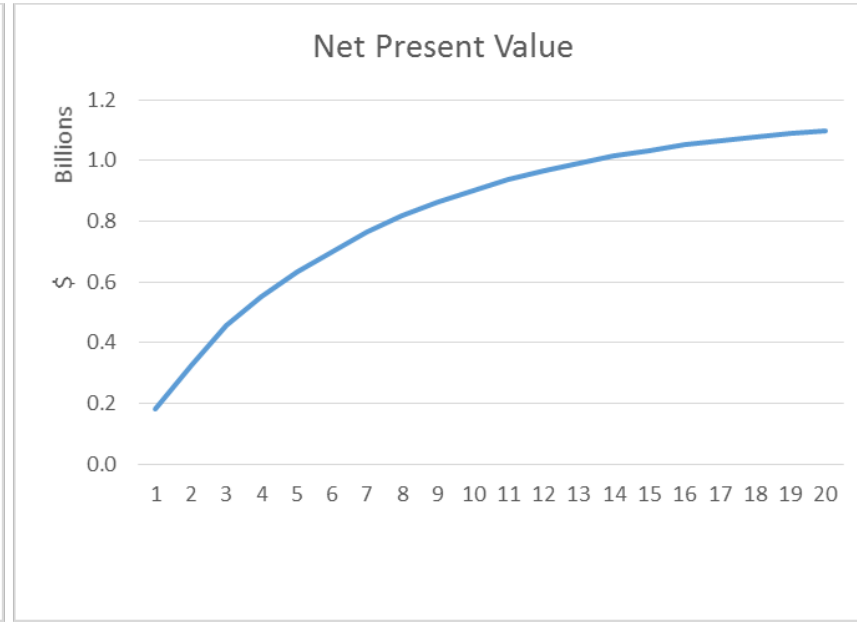

Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

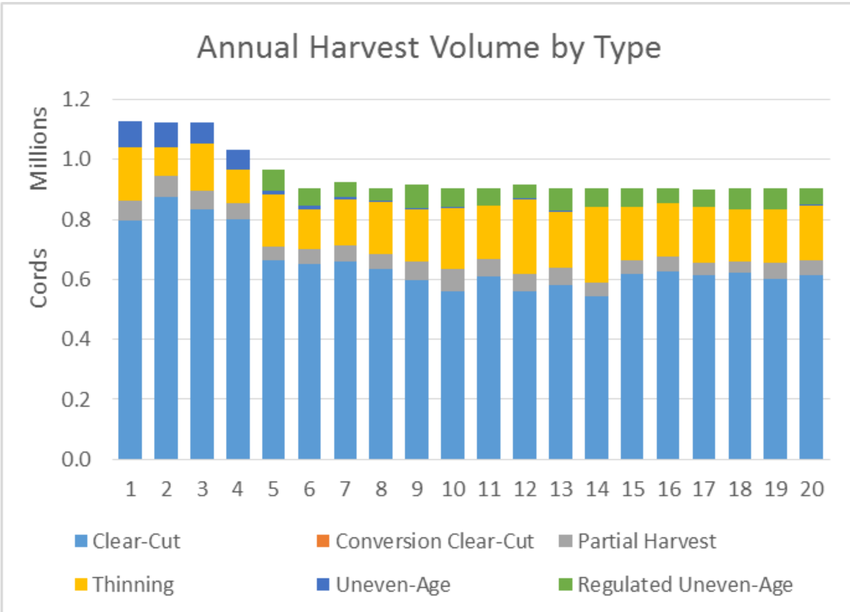


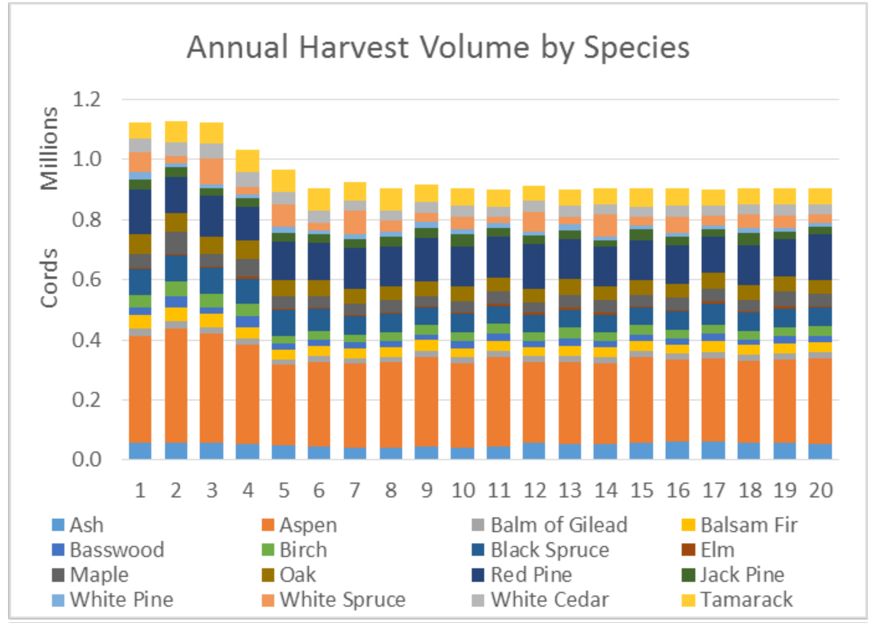
Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

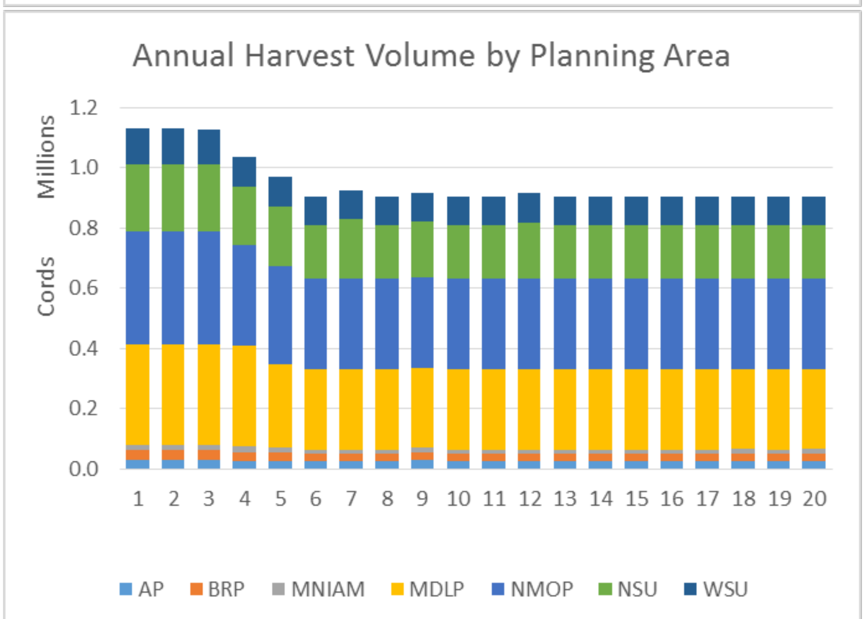


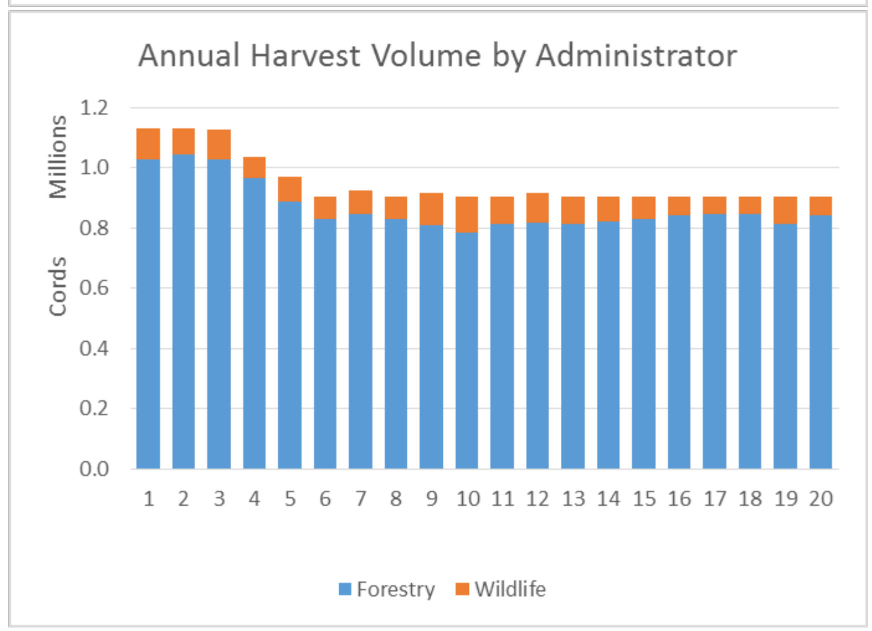
Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

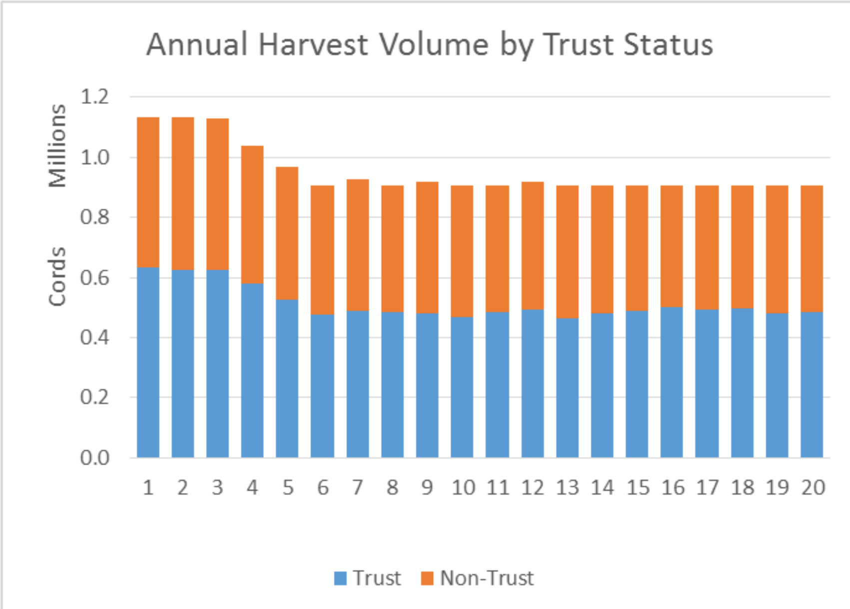
Scenario 4.1.1

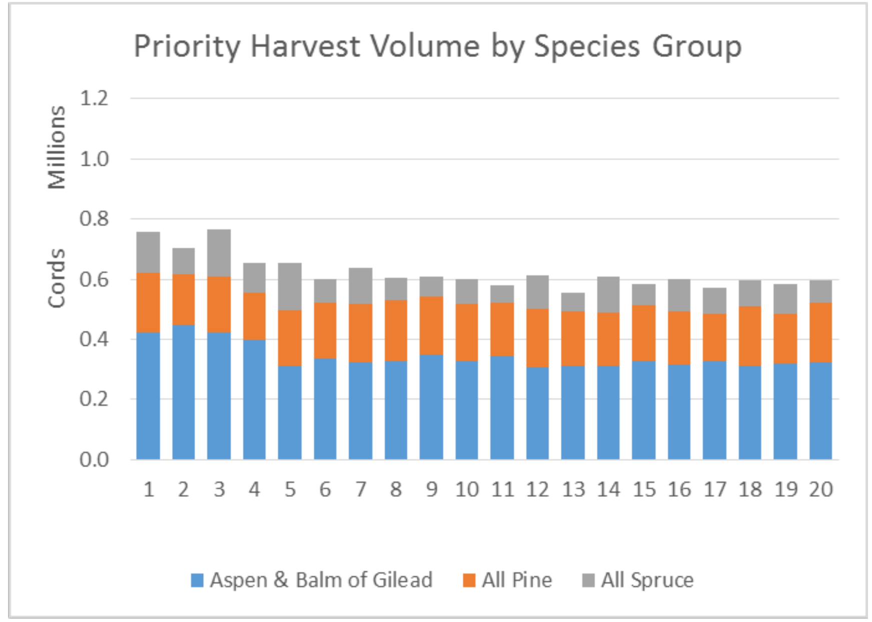


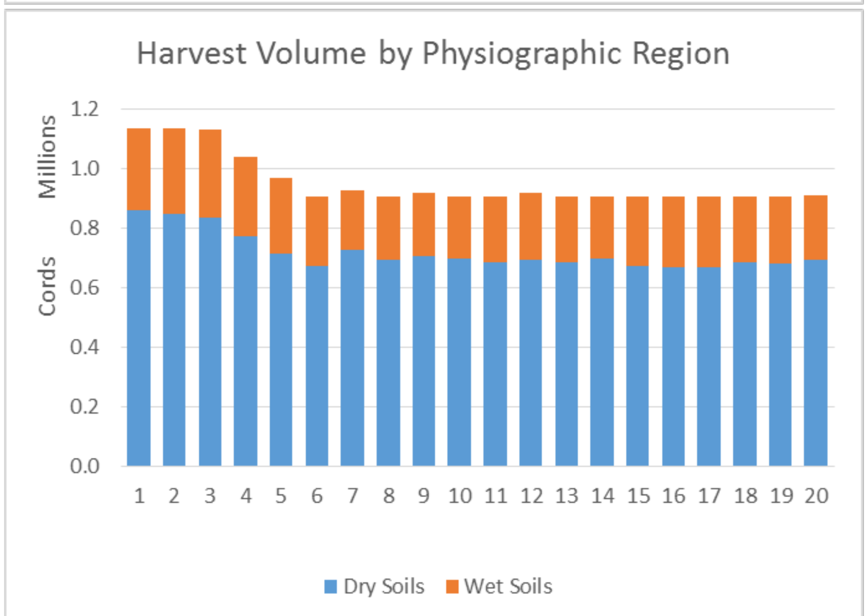


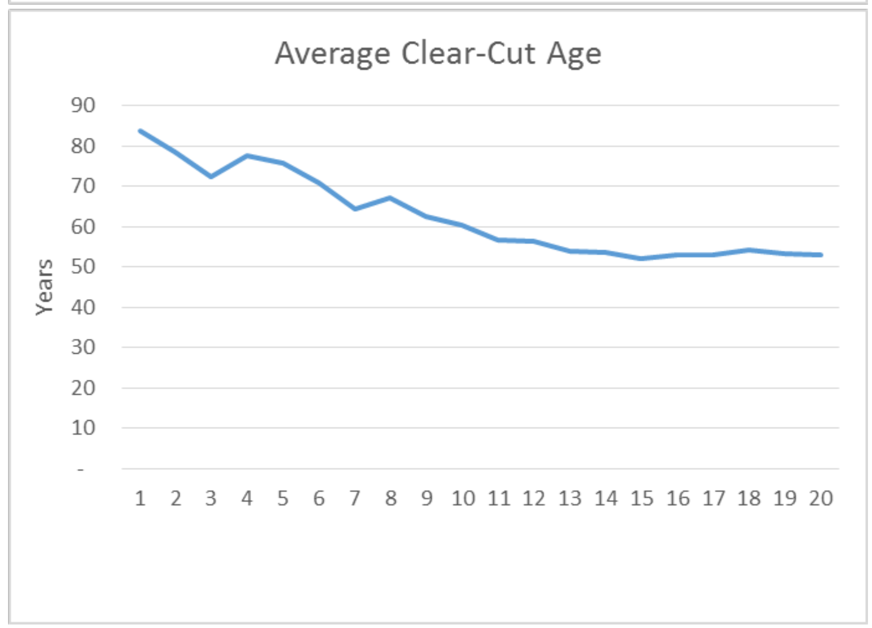


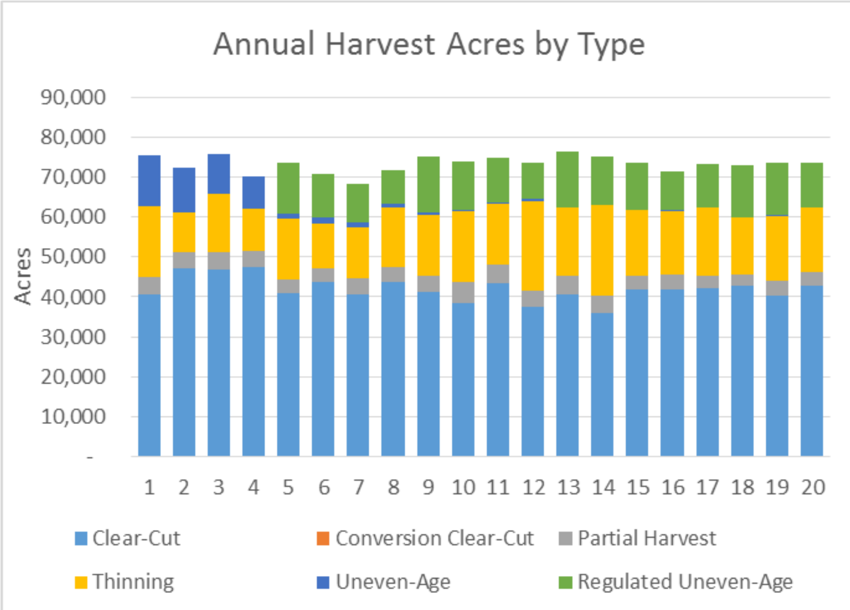



Annual Harvest Volume by Trust Status
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

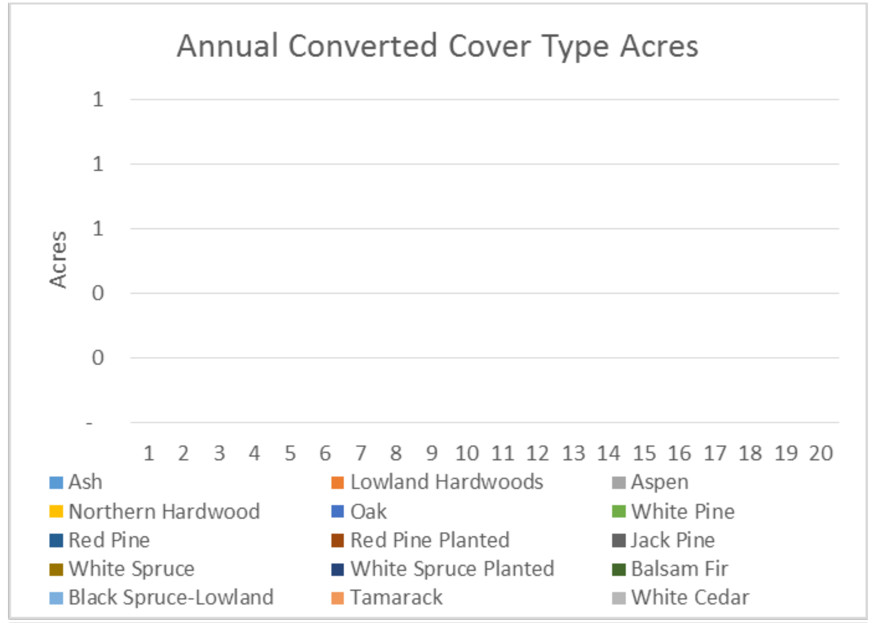

Priority Harvest Volume by Species Group
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce


Harvest Volume by Physiographic Region
Cords
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

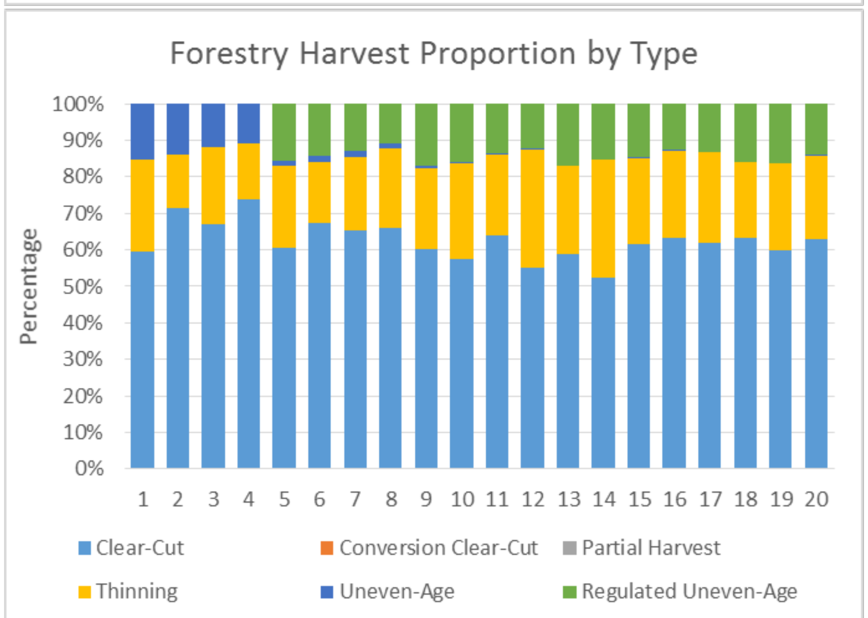

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



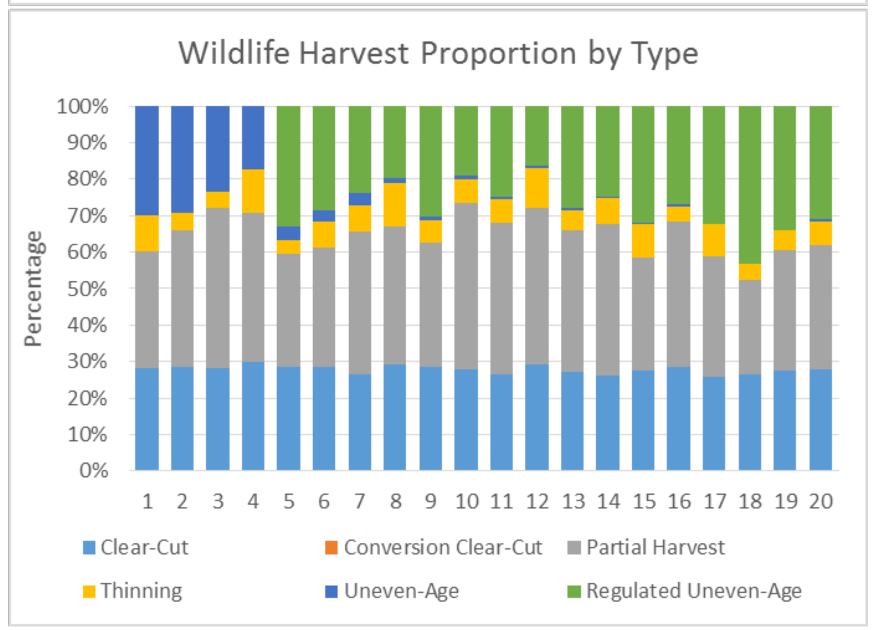
Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age



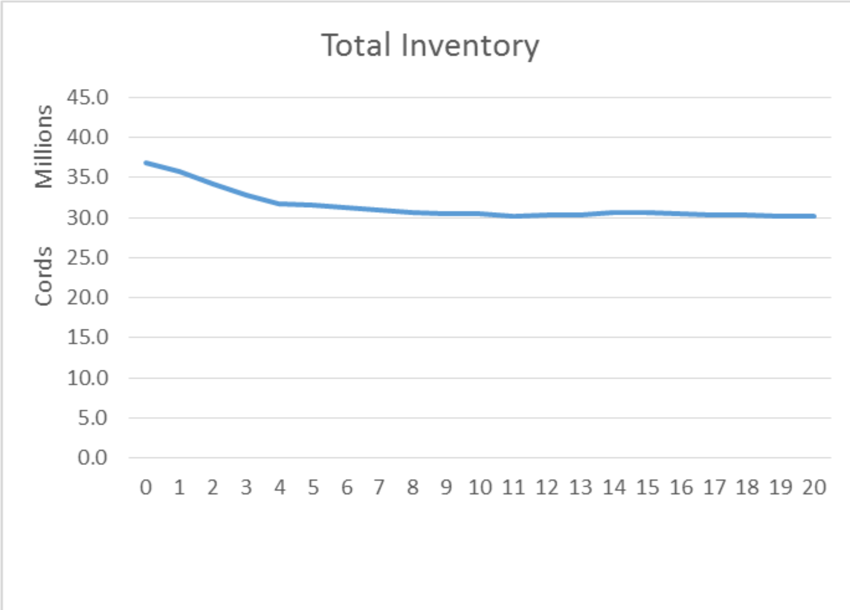
Annual Converted Cover Type Acres
1
1
1
0
0
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

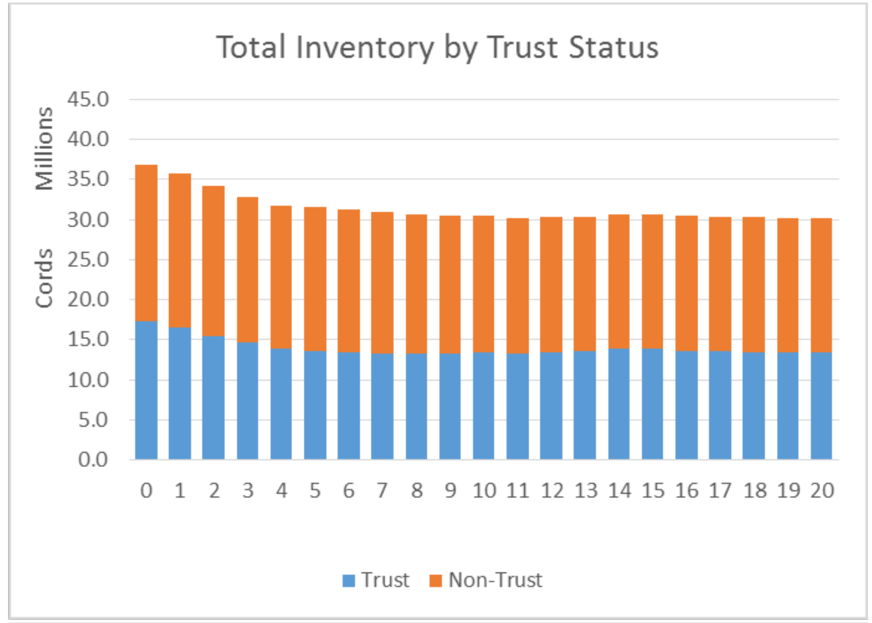


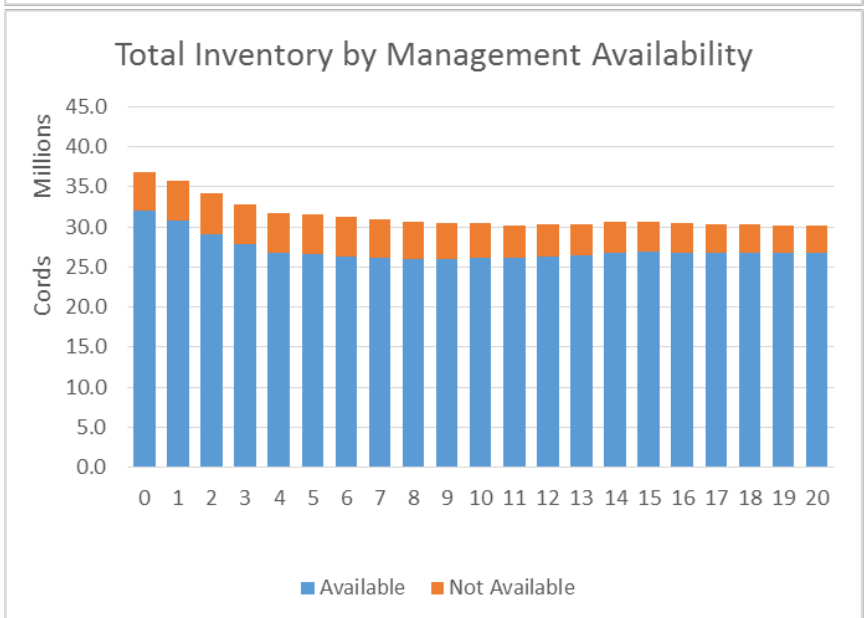
Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

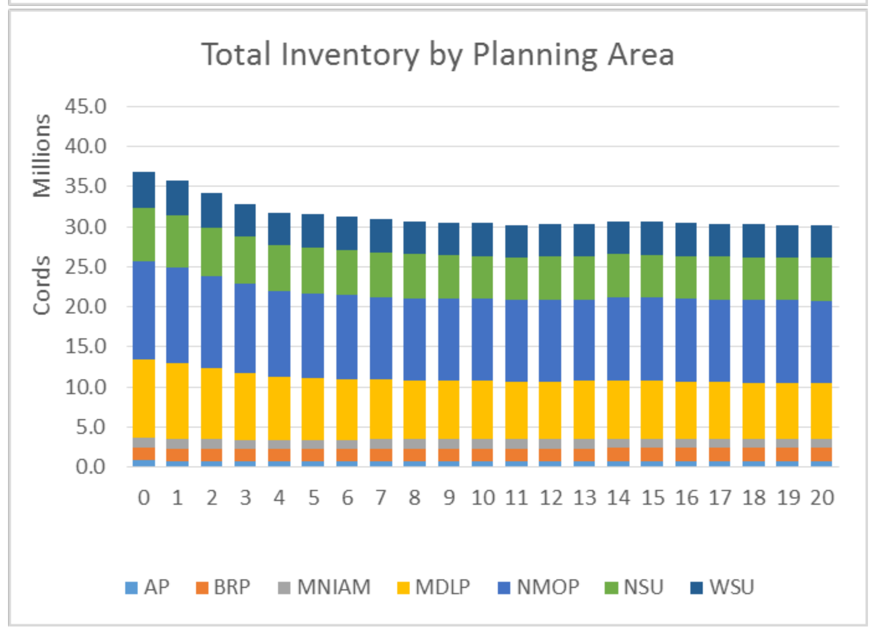


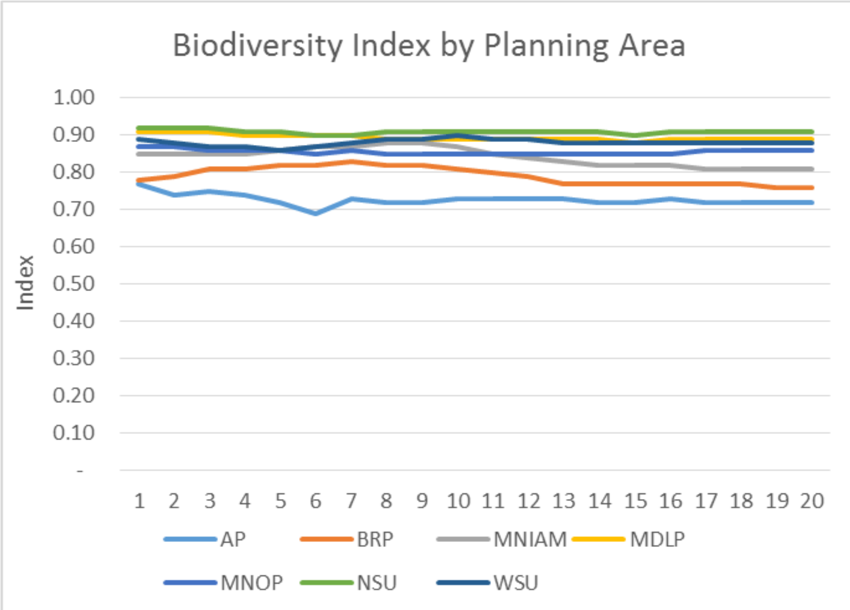
Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

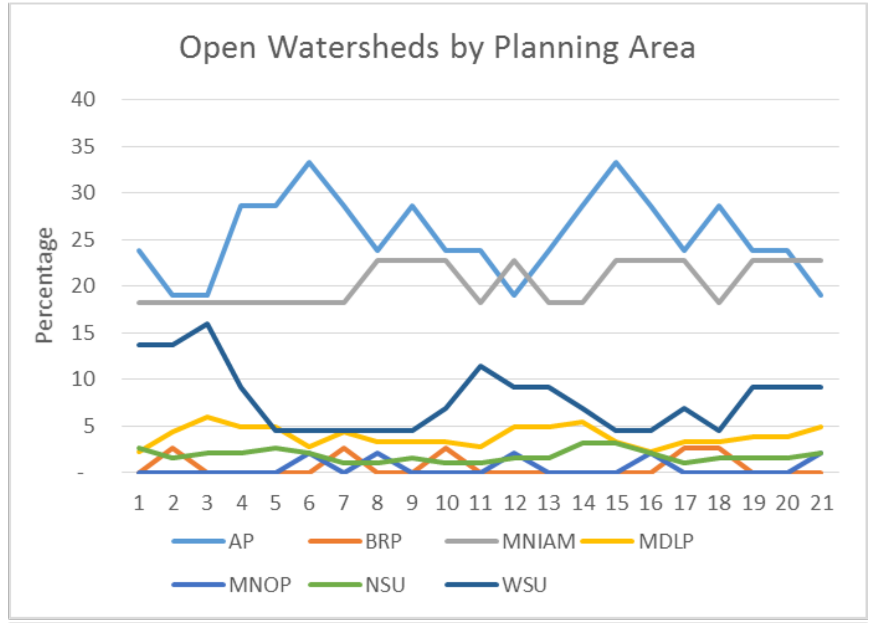

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

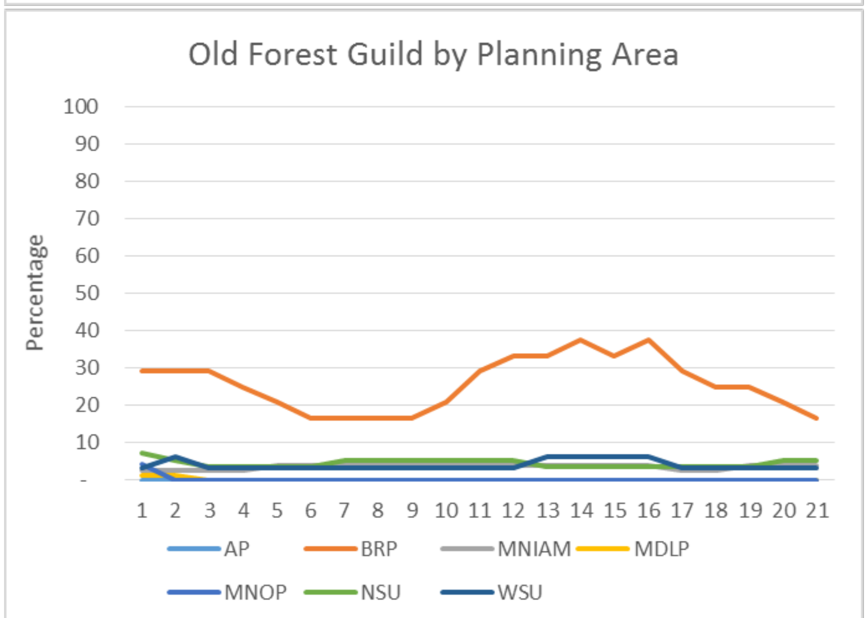

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

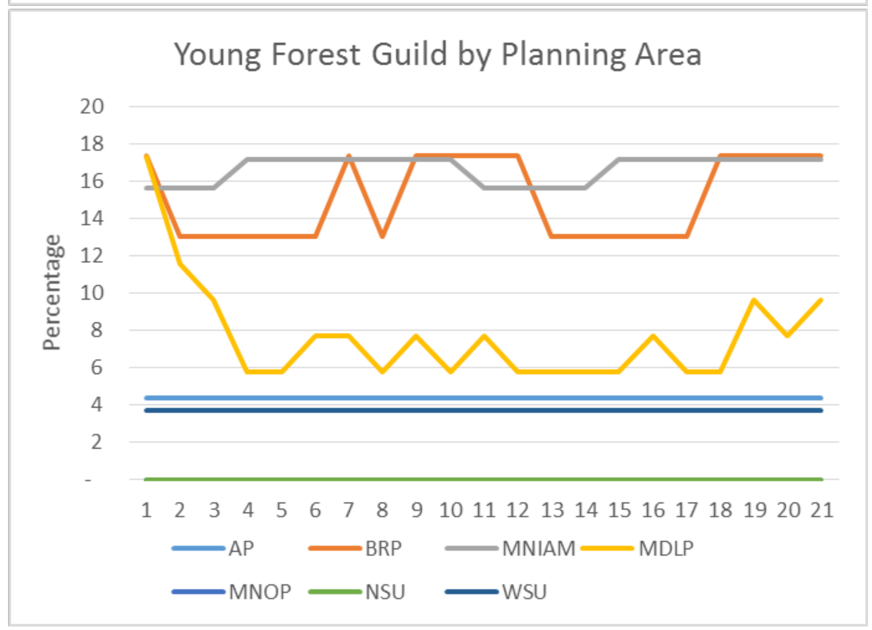

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

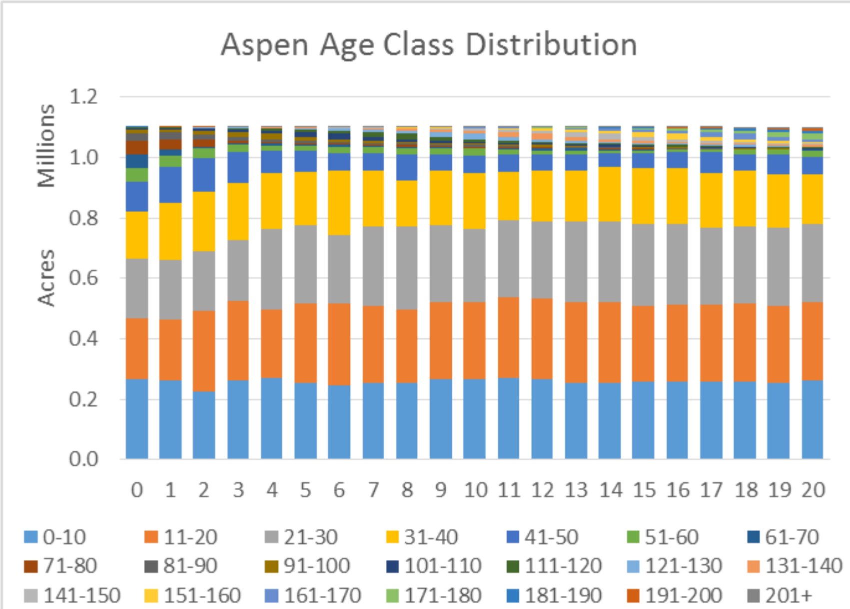

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

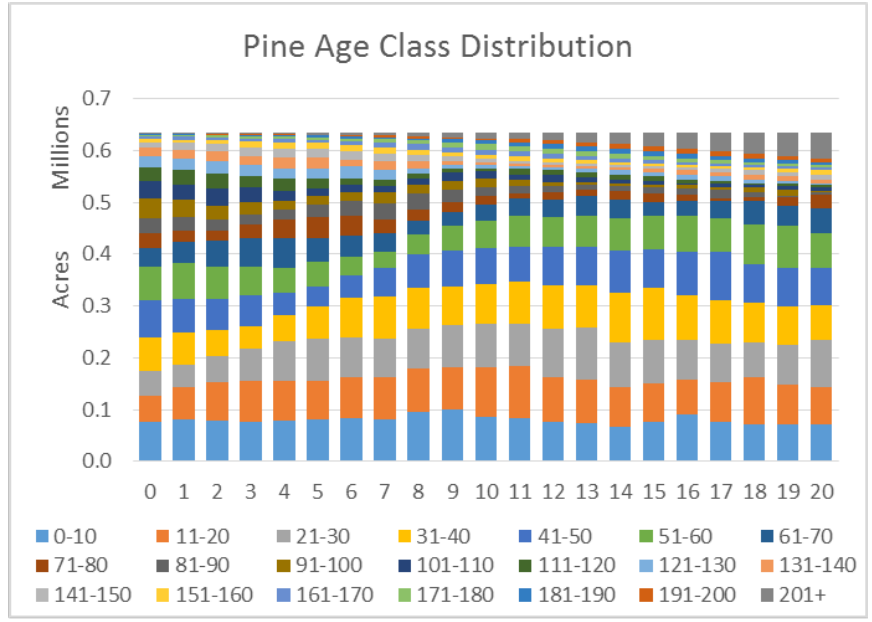

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

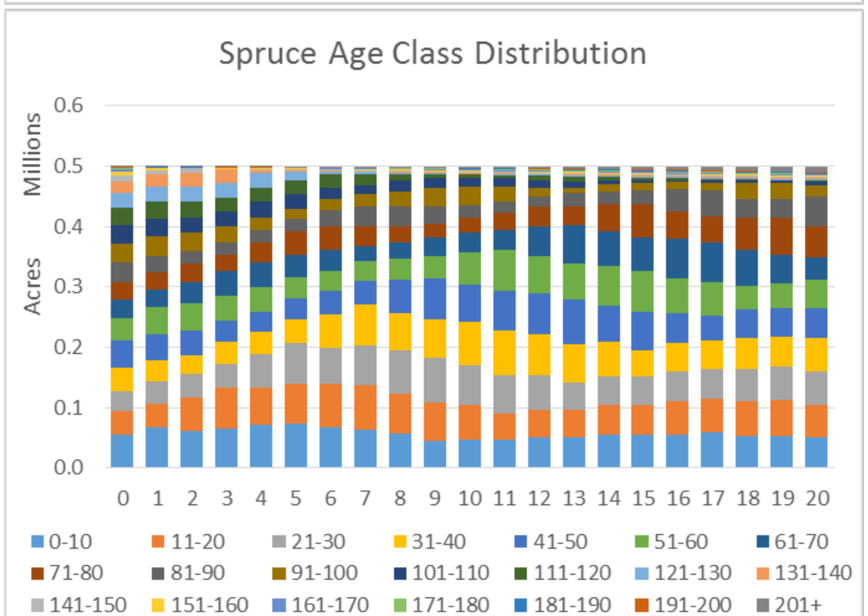

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

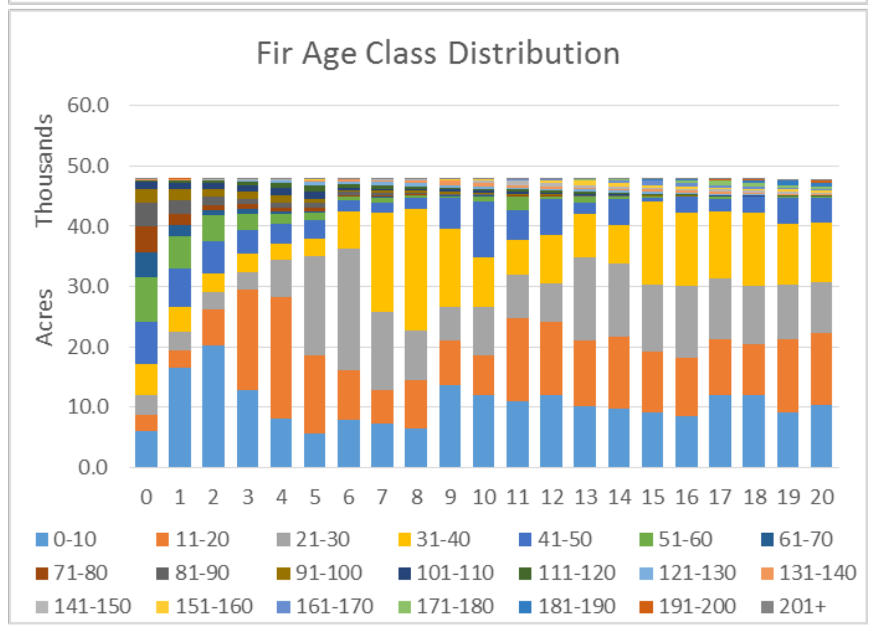

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

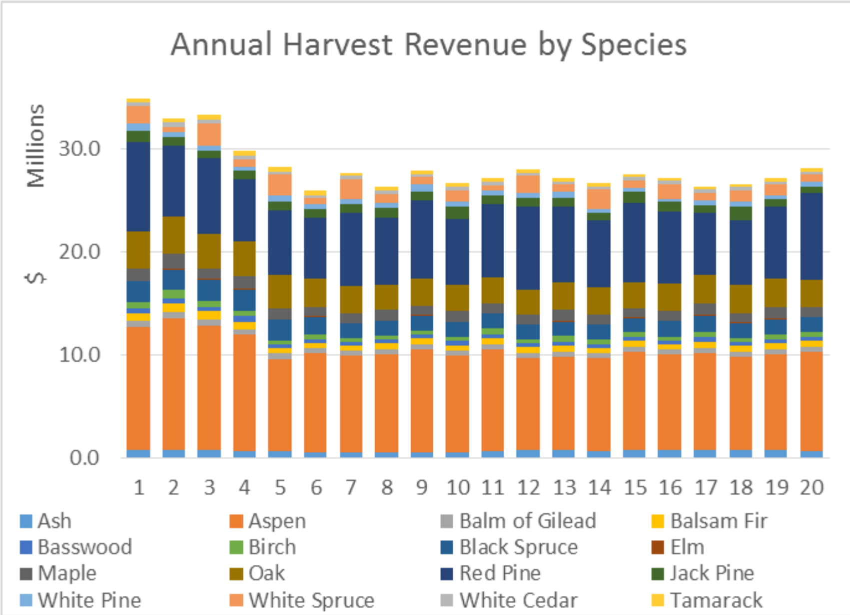

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

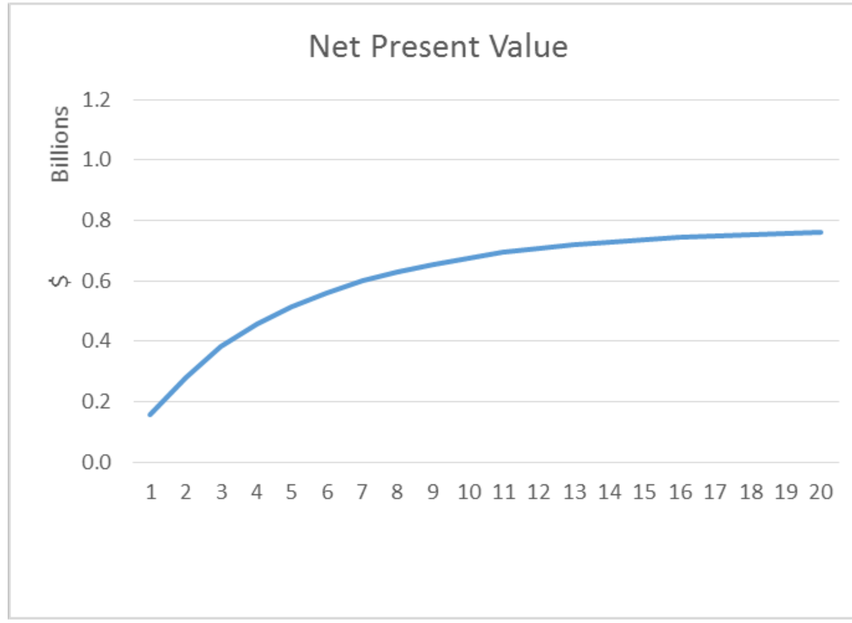

Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Millions
Acres
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

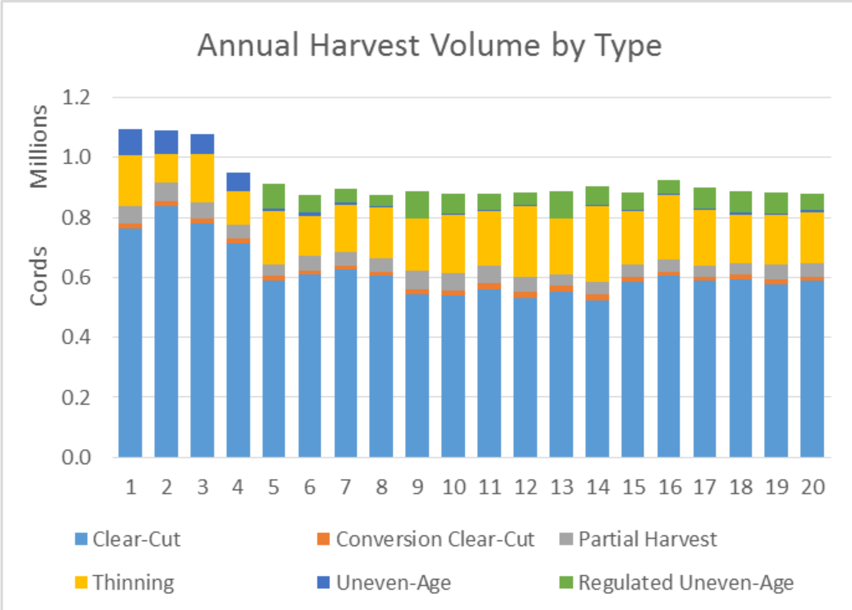

Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

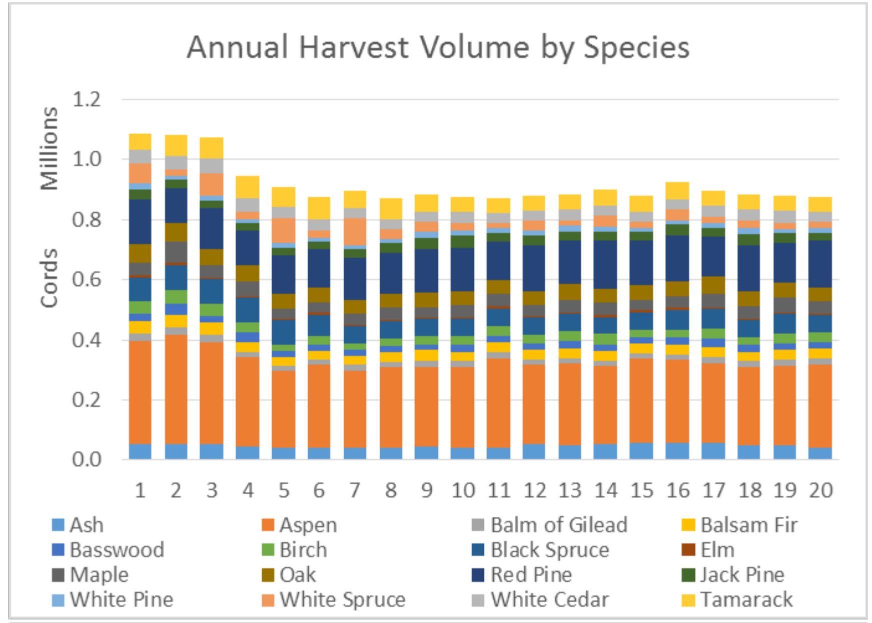

Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

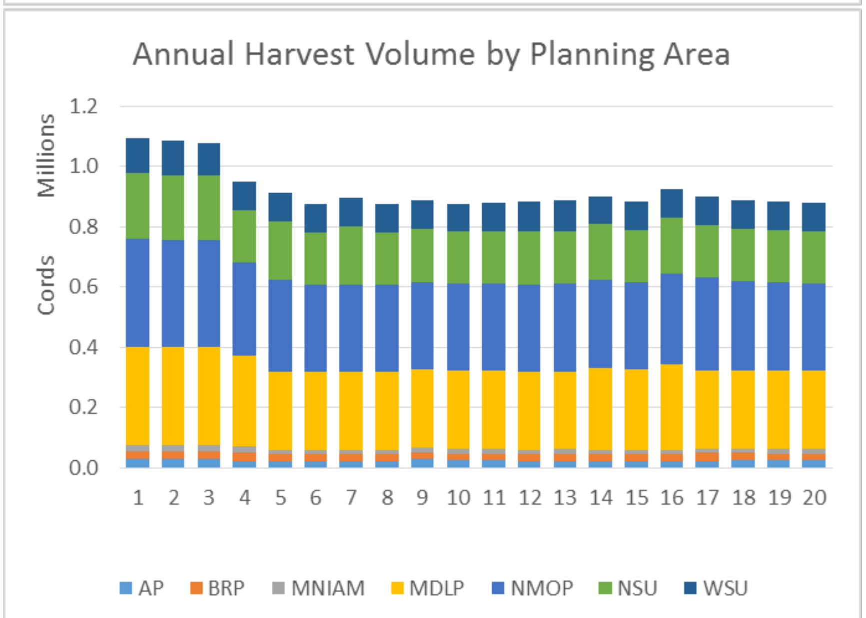

Annual Harvest Revenue by Species
$ Millions
0.0
10.0
20.0
30.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

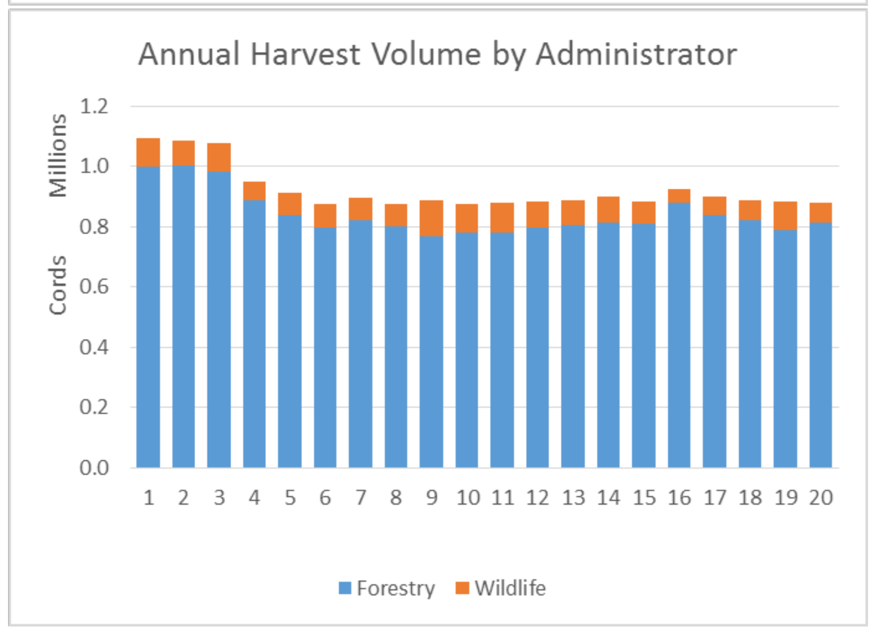

Net Present Value
$ Billions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

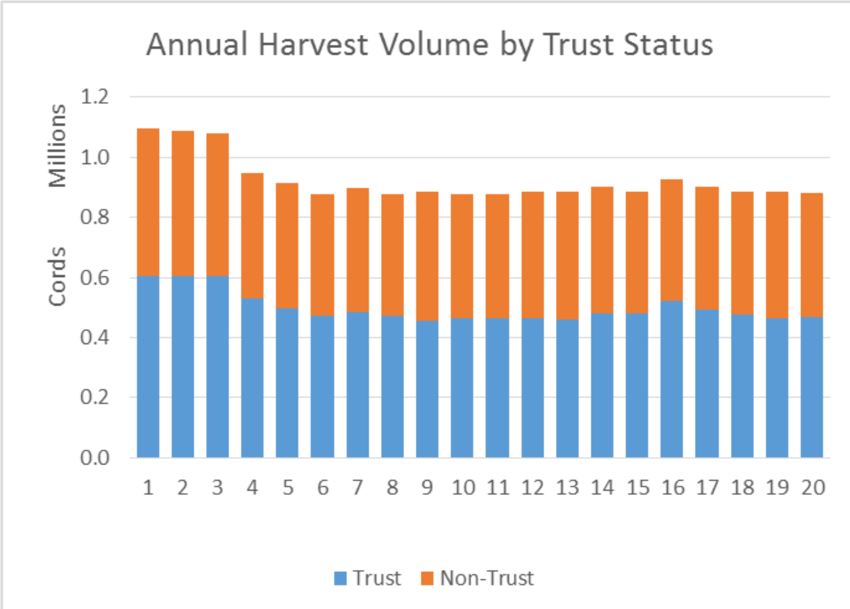
Scenario 4.1.2

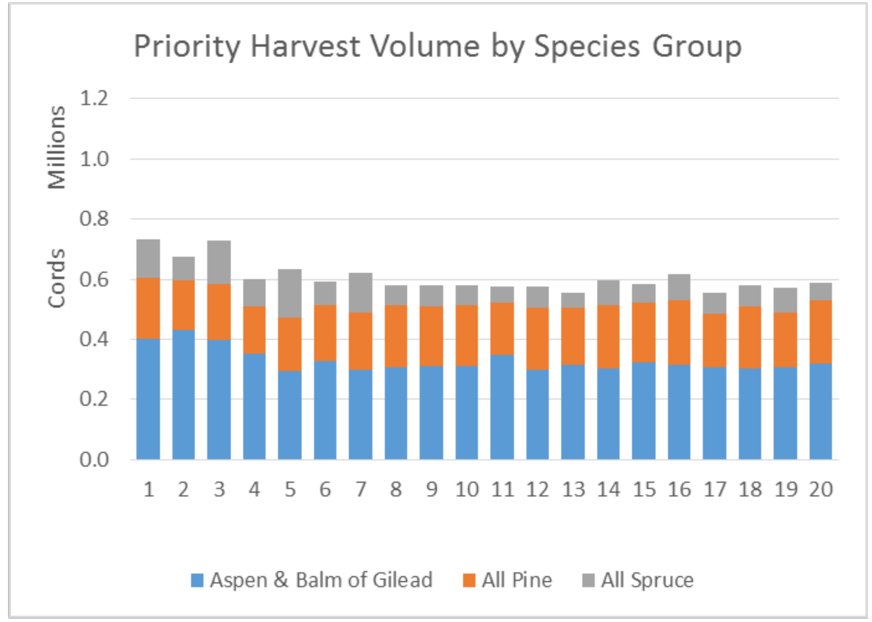


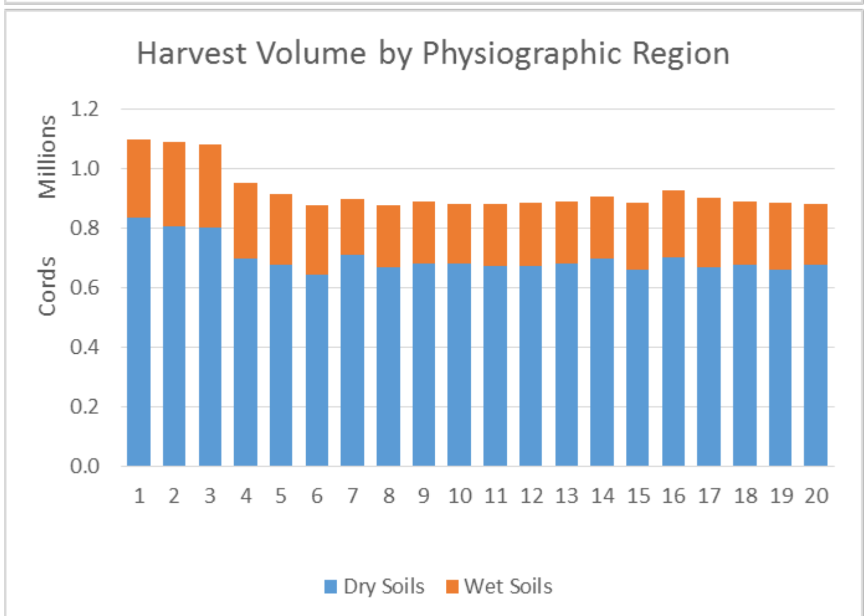


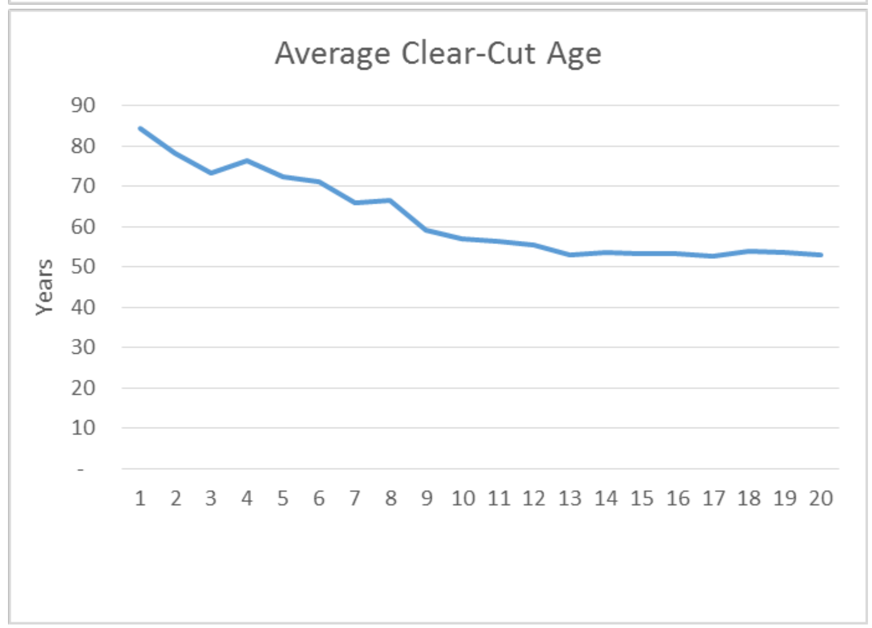


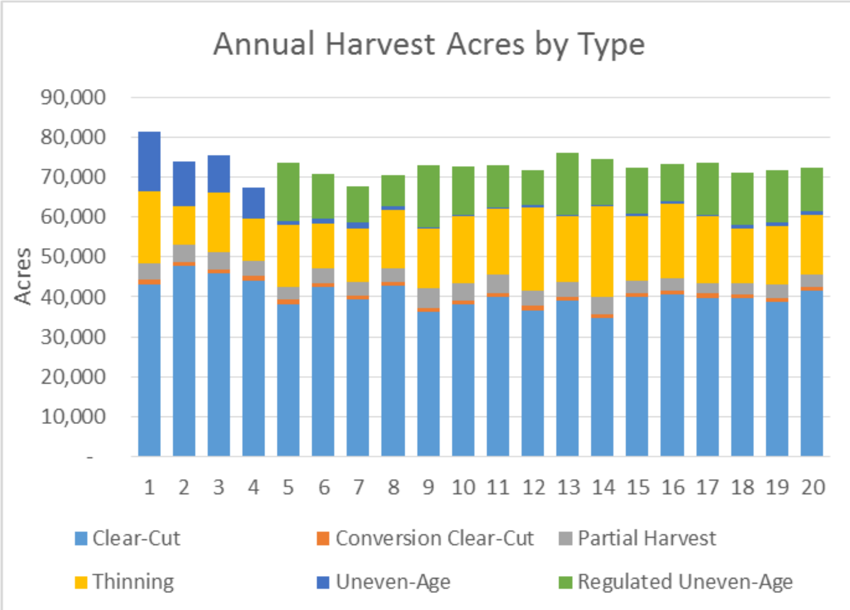



Annual Harvest Volume by Trust Status
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

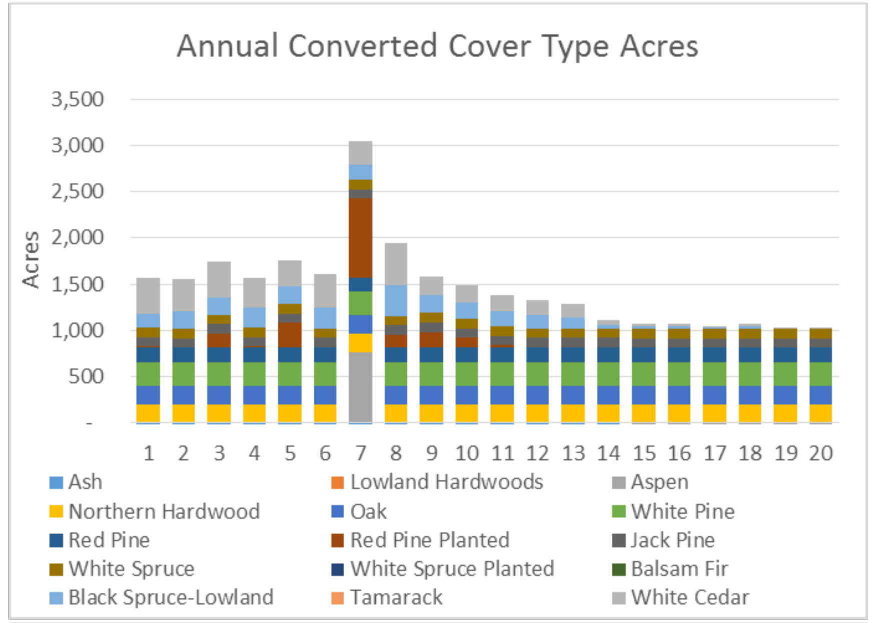

Priority Harvest Volume by Species Group
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce


Harvest Volume by Physiographic Region
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

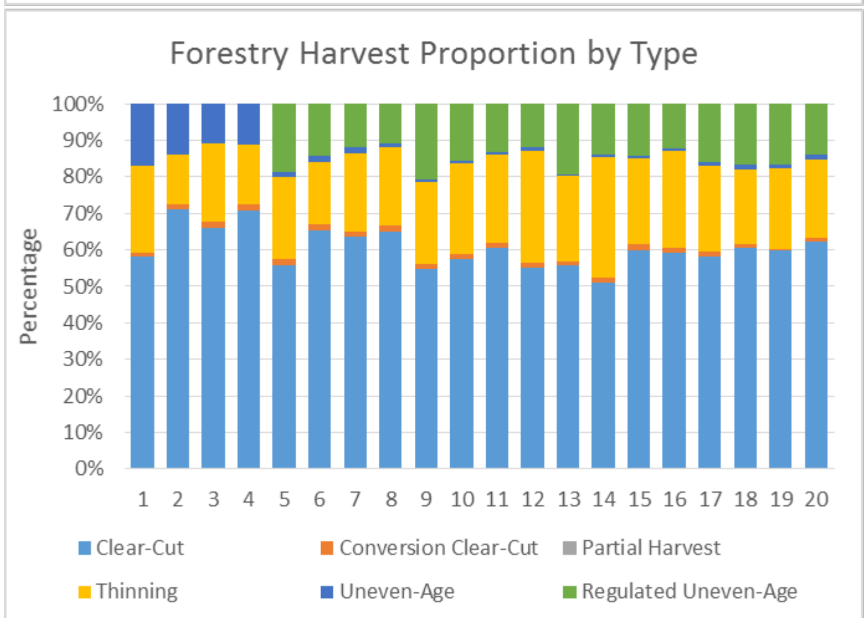

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20



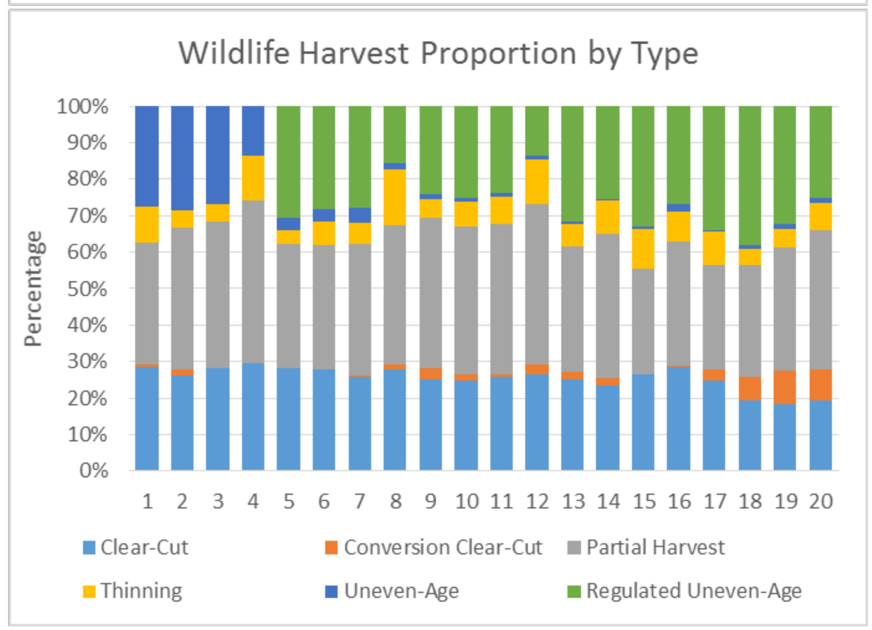
Annual Harvest Acres by Type
Acres
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age



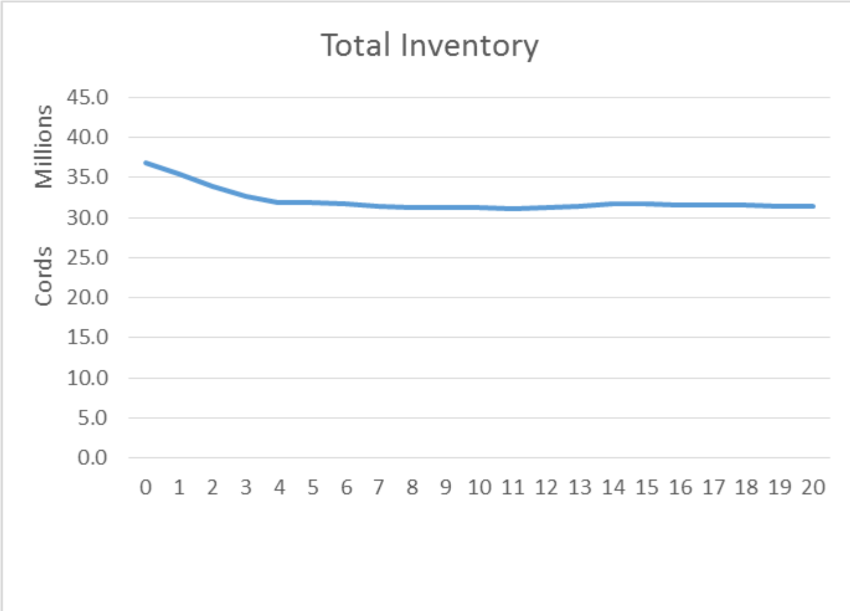
Annual Converted Cover Type Acres
Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

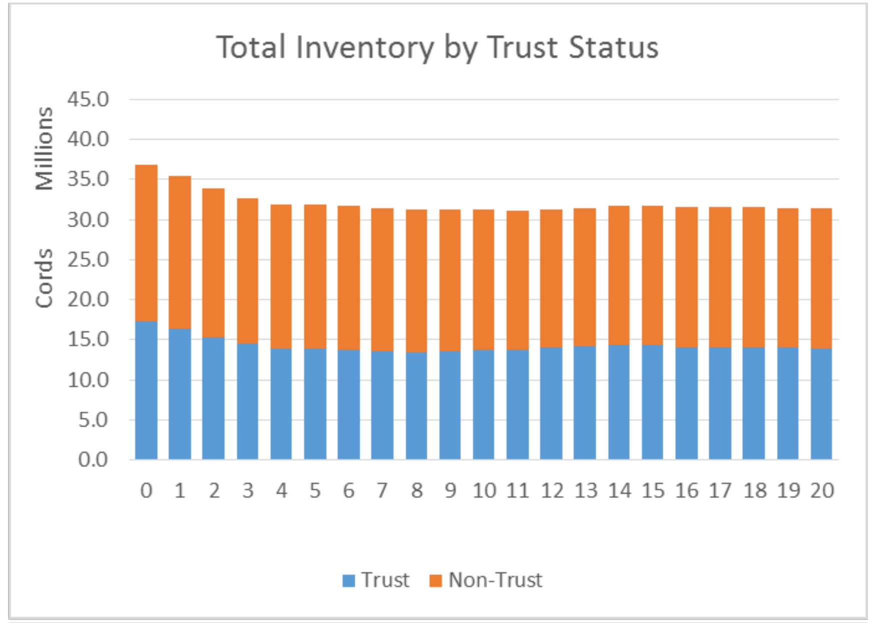


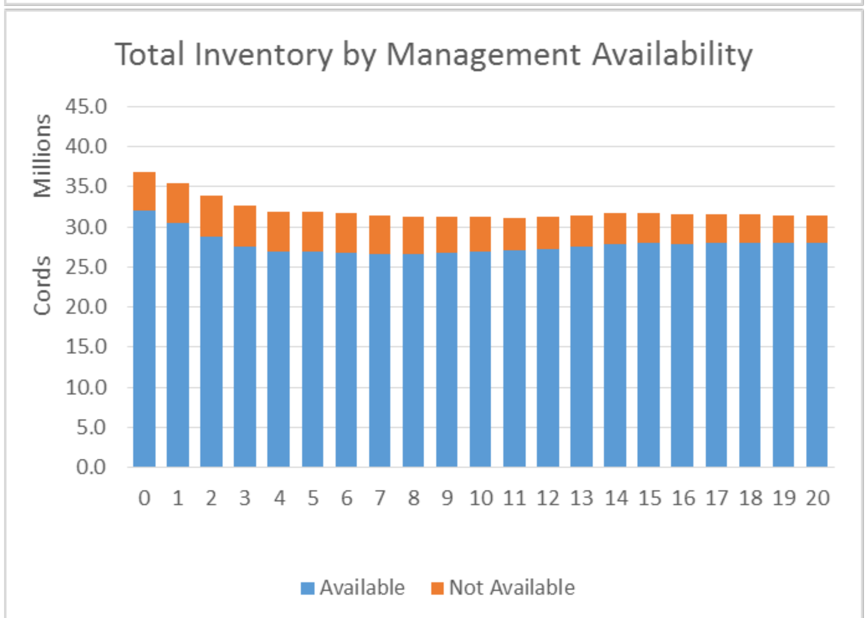
Forestry Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

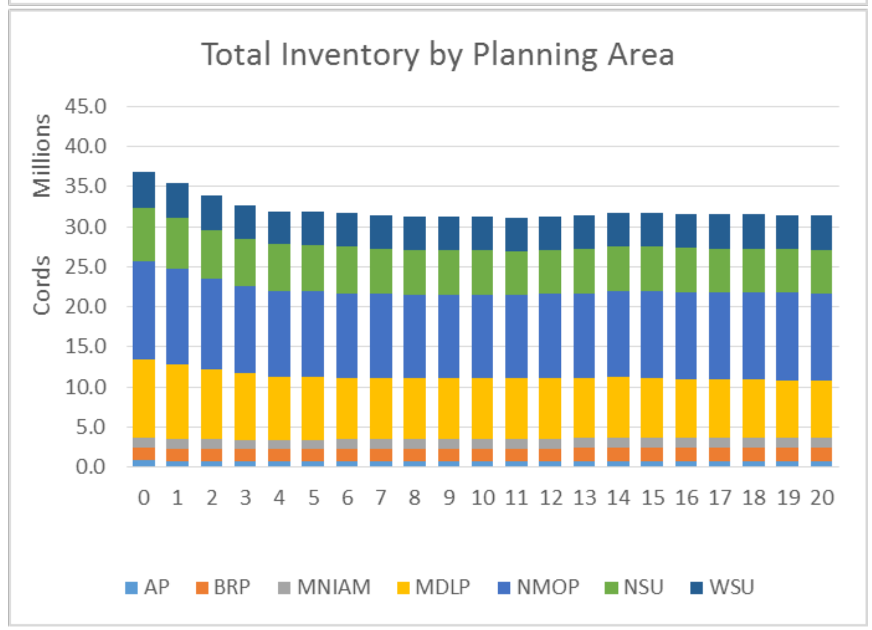


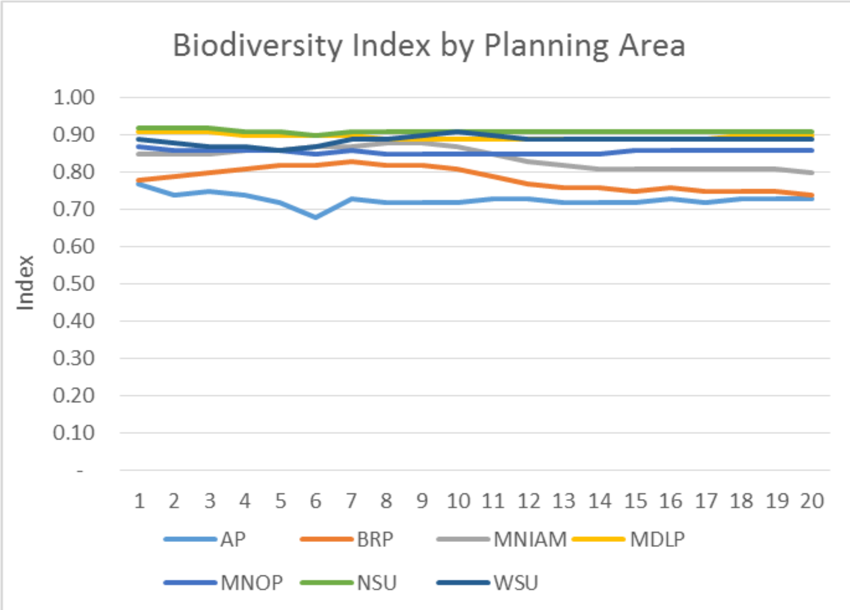
Wildlife Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

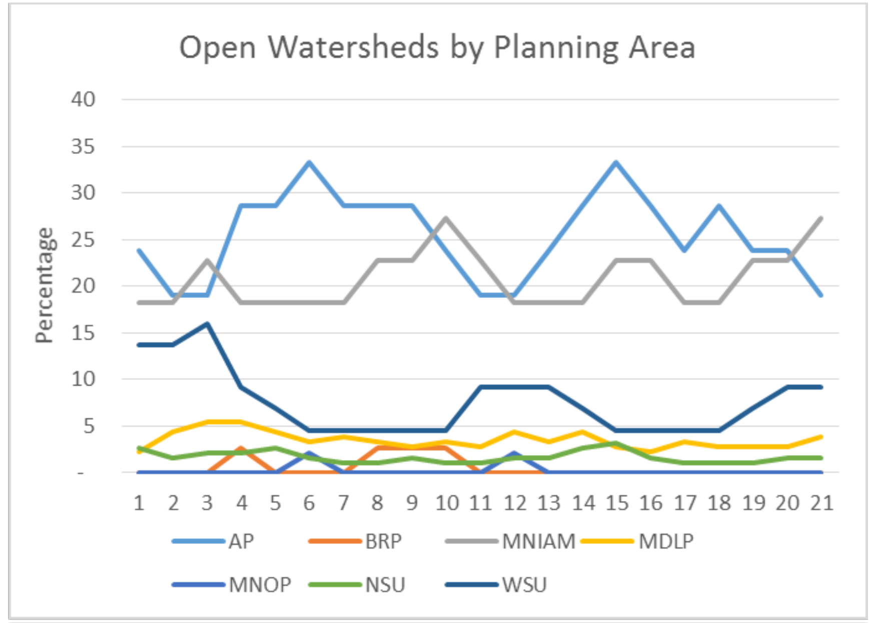

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

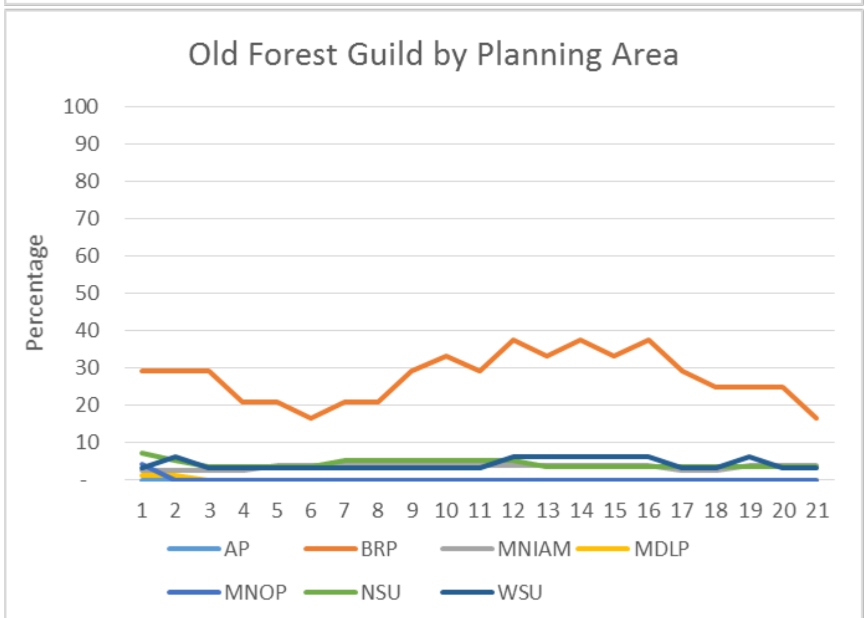

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

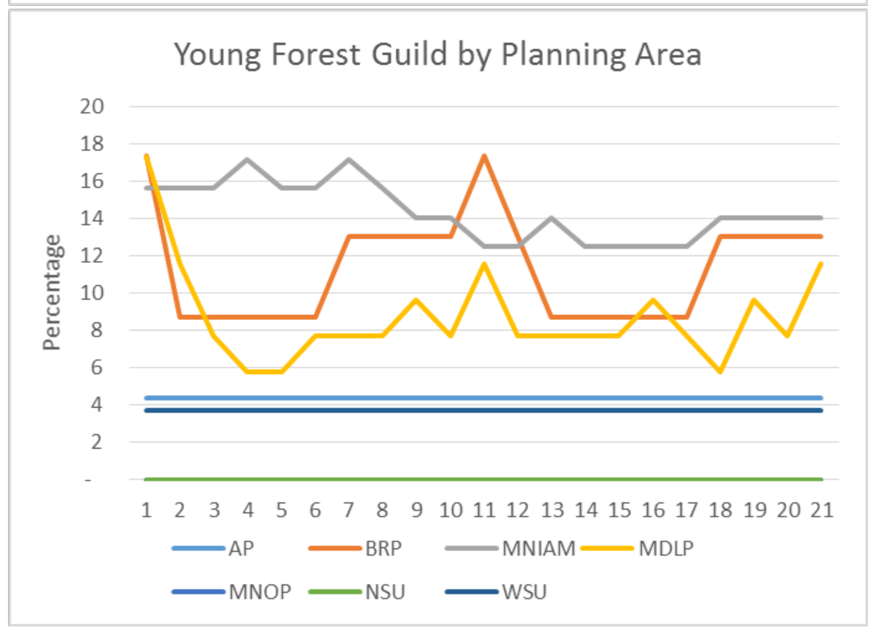

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

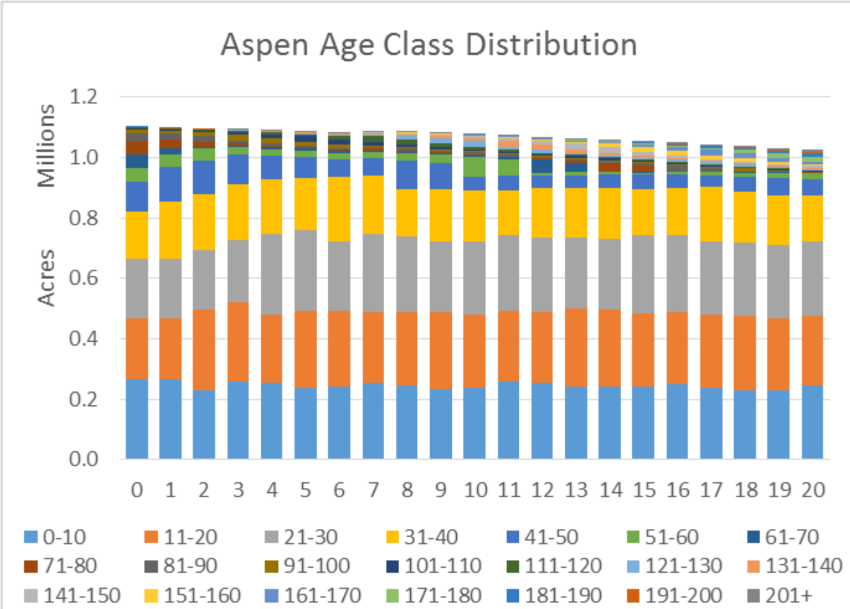

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

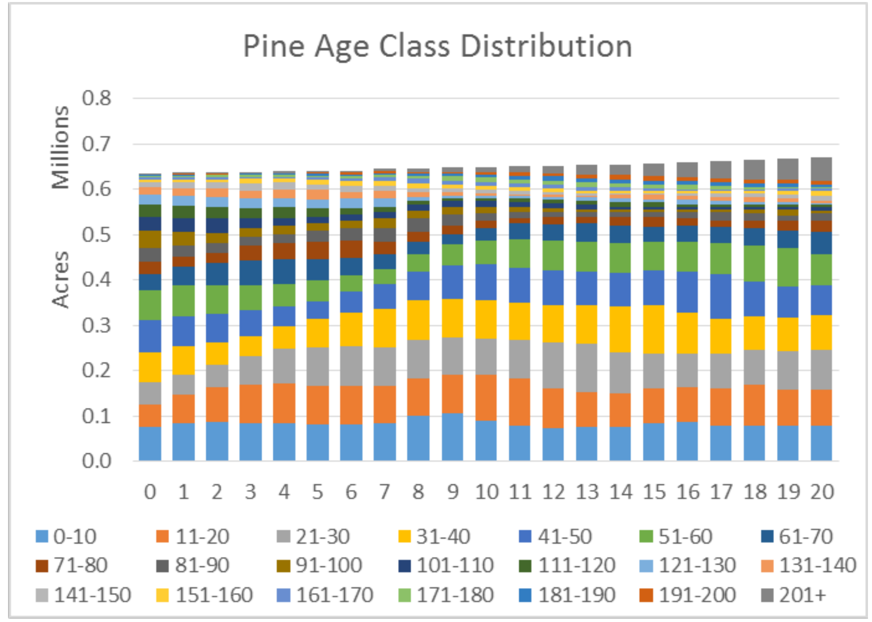

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

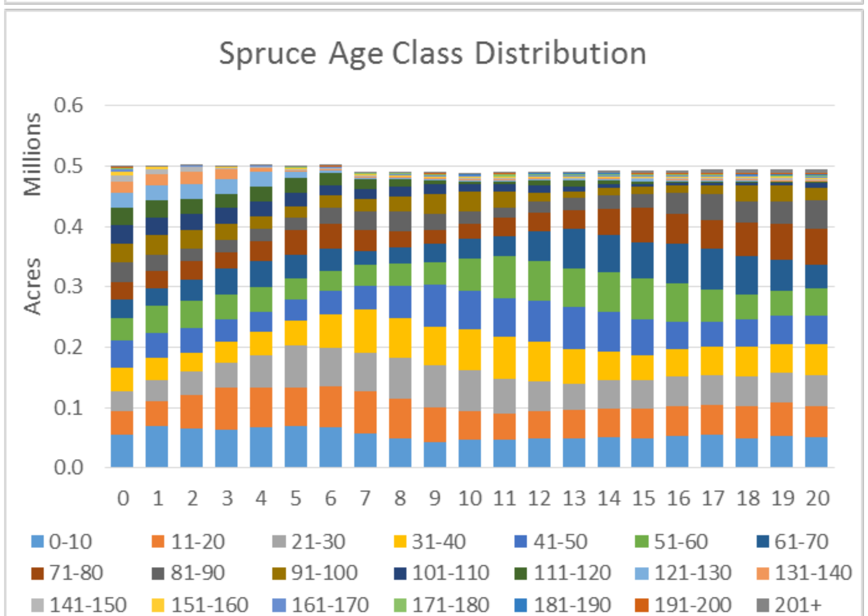

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

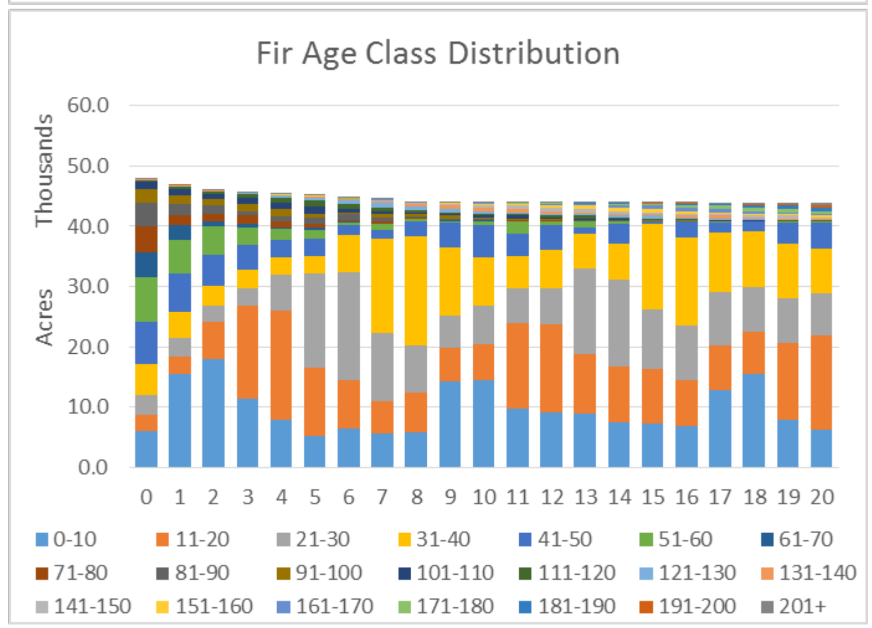

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

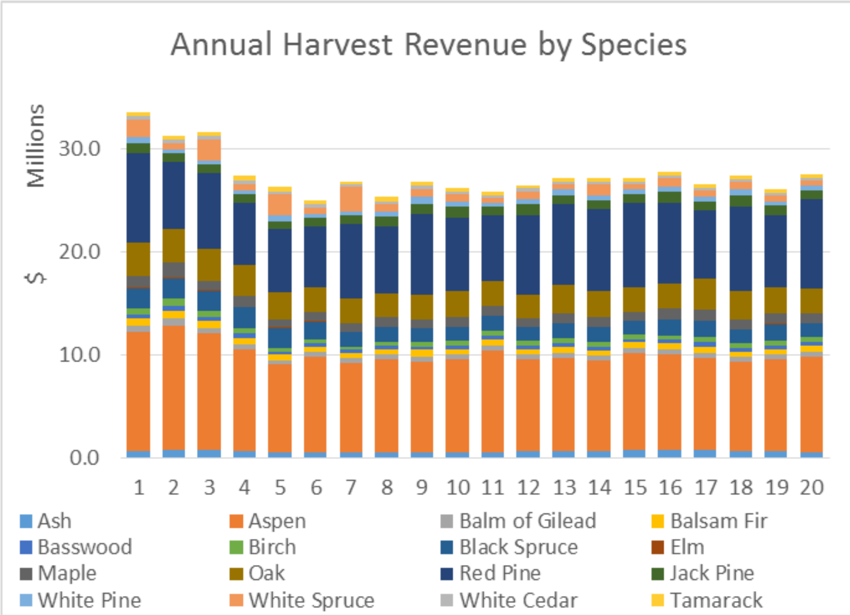

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Millions
Acres
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

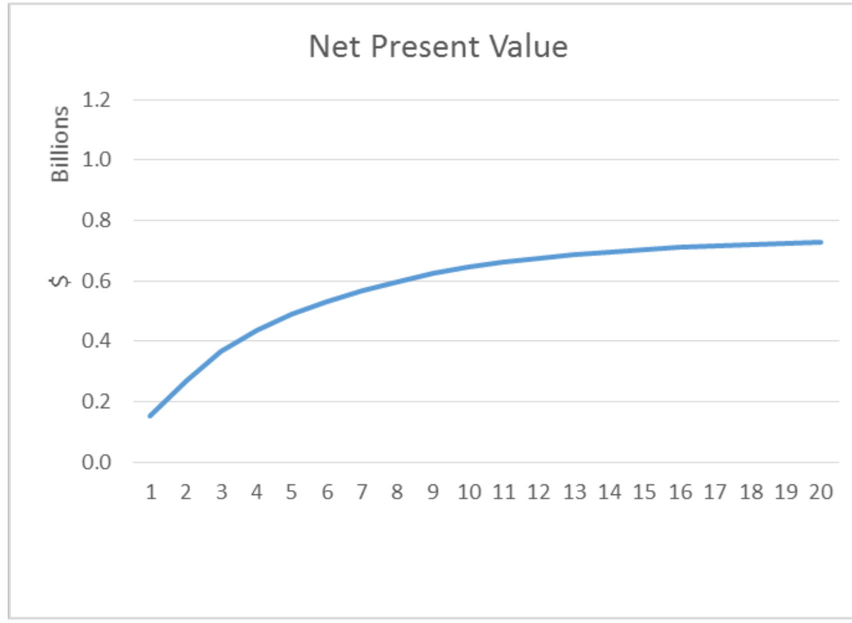

Pine Age Class Distribution
Millions
Acres
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Millions
Acres
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Thousands
Acres
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

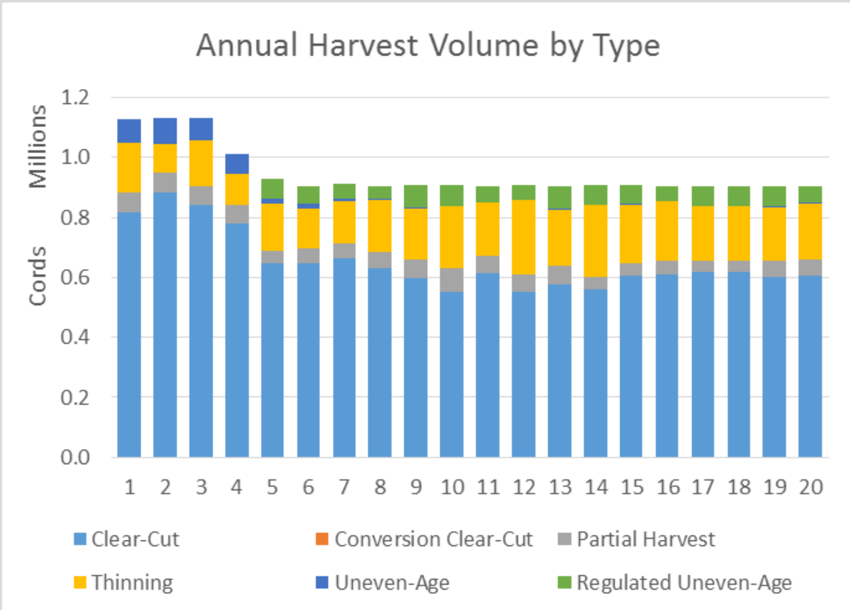


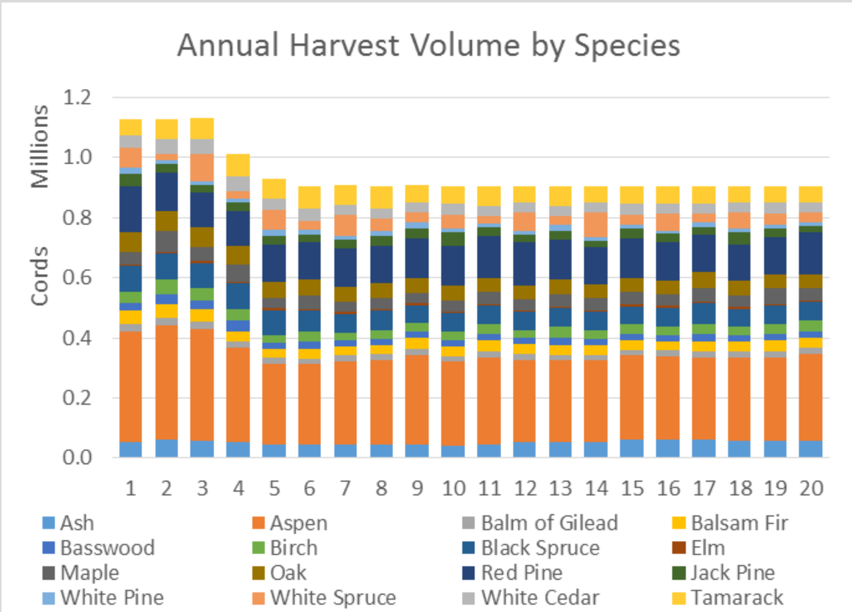
Annual Harvest Revenue by Species
Millions
$
0.0
10.0
20.0
30.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

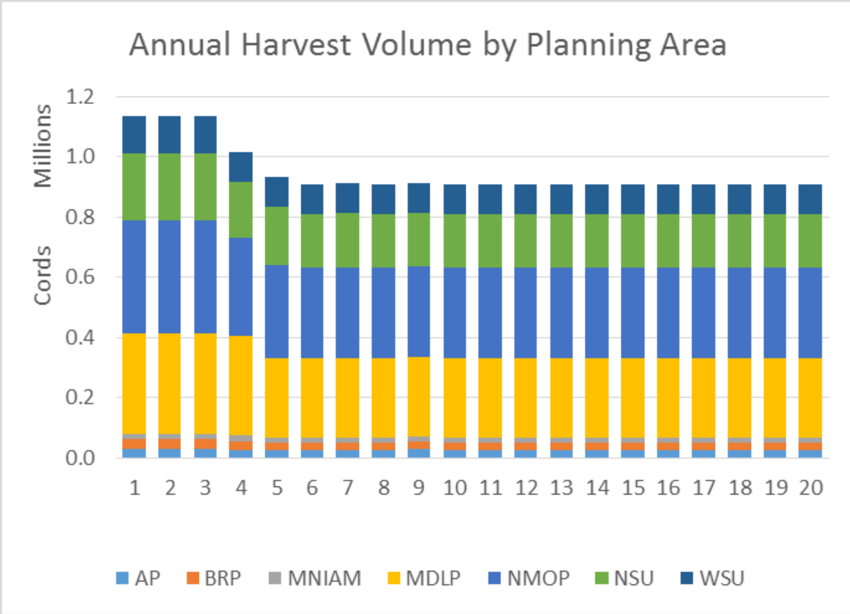


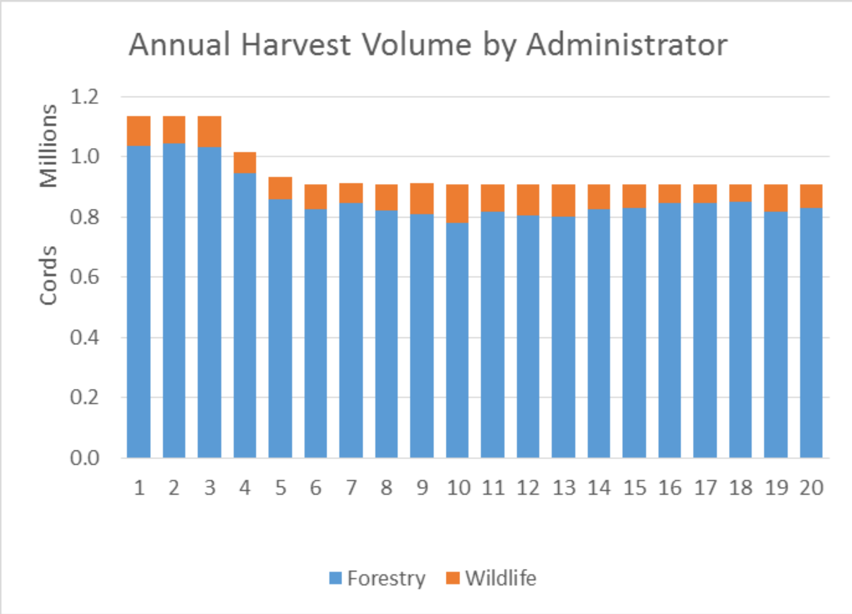
Net Present Value
Billions
$
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

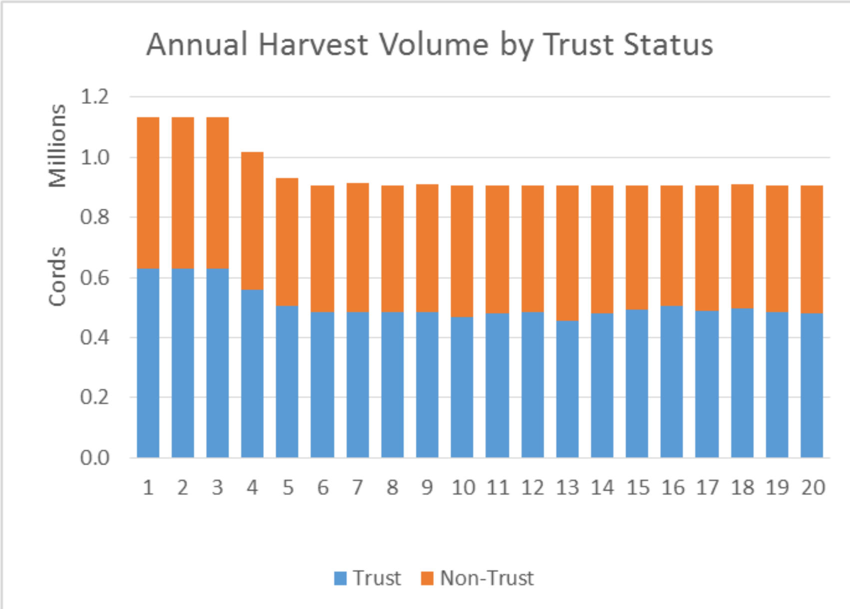
Scenario 4.2.1

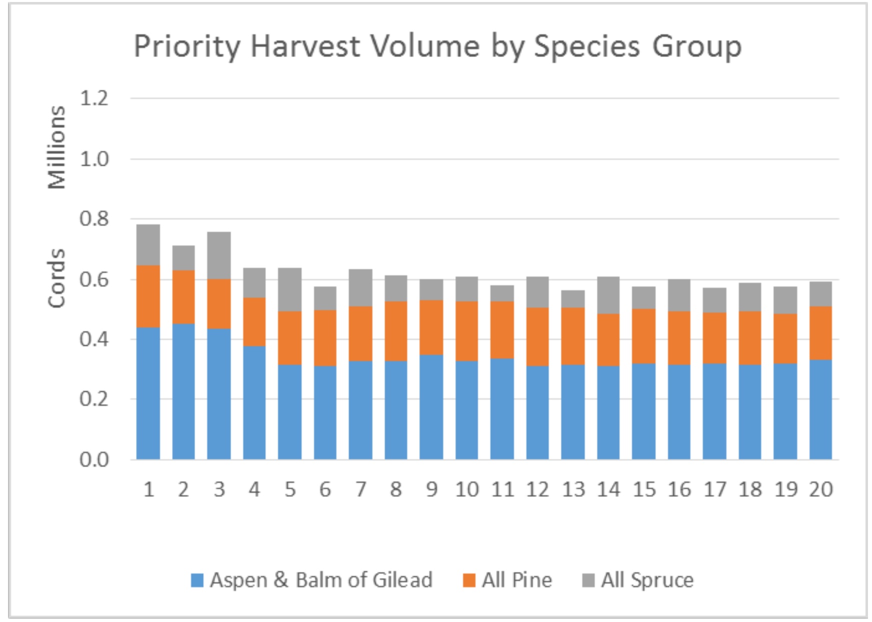


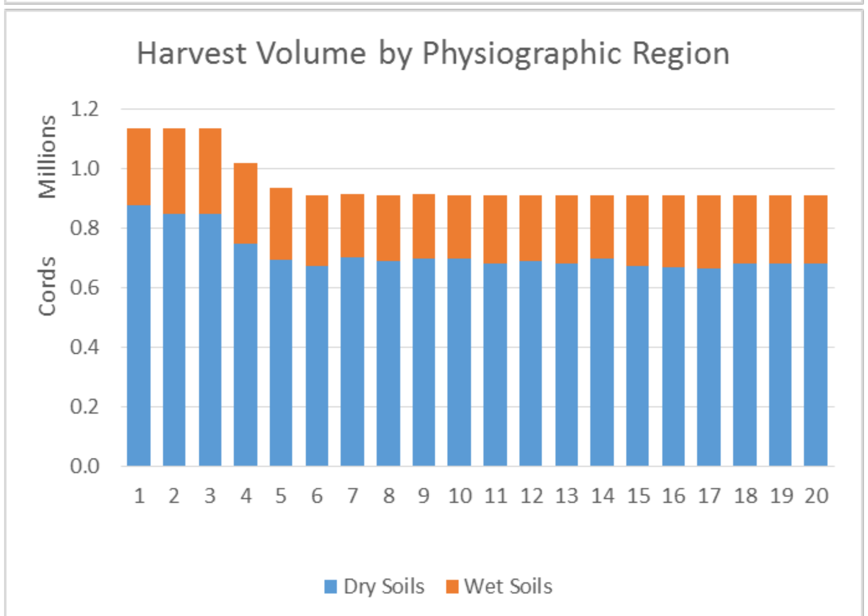


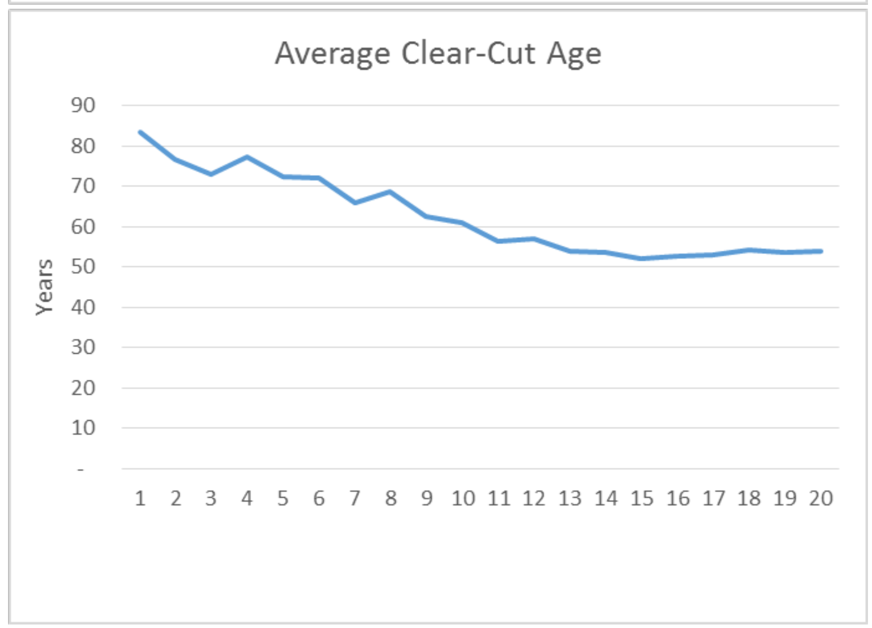


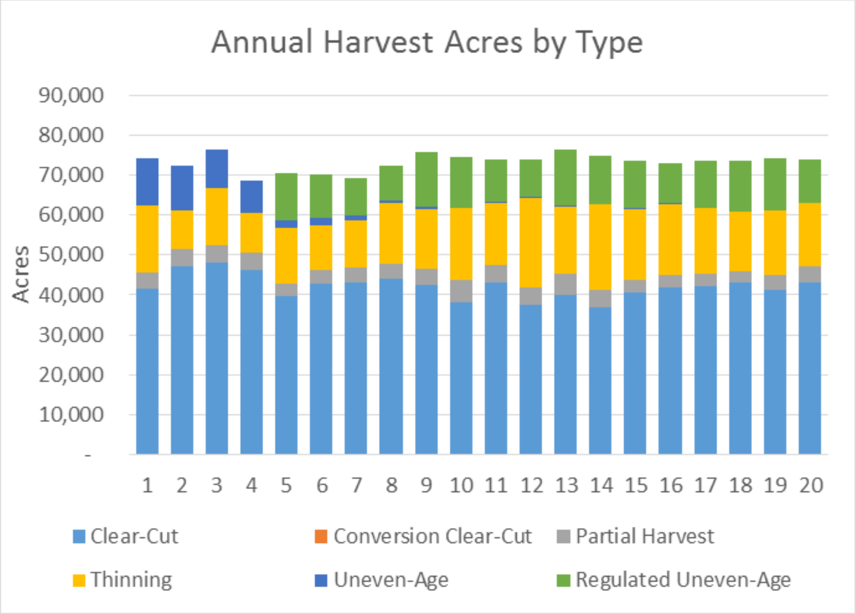


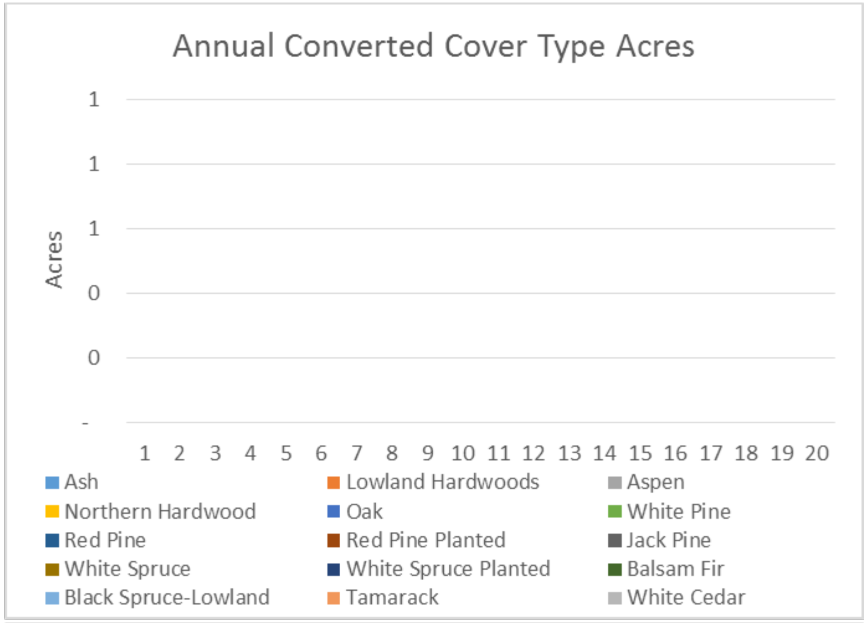

Annual Harvest Volume by Trust Status
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

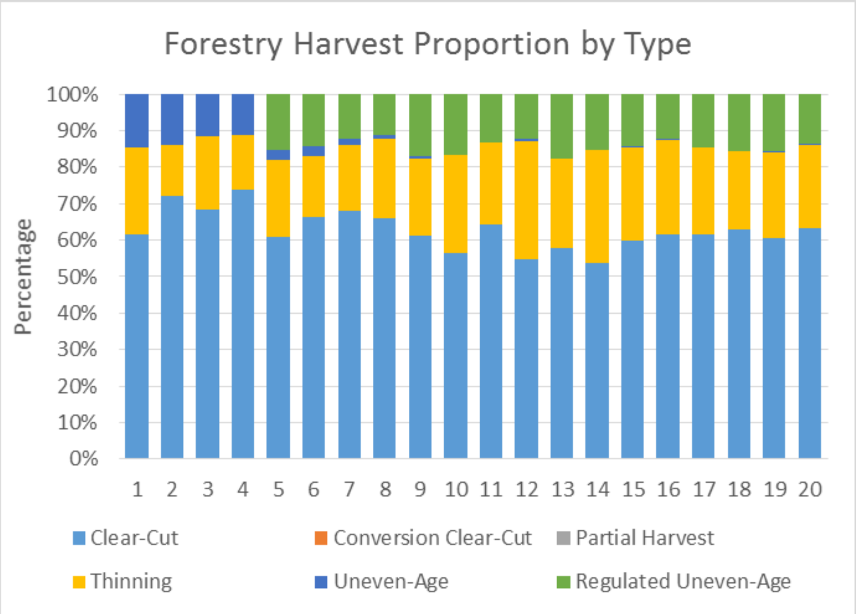

Priority Harvest Volume by Species Group
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

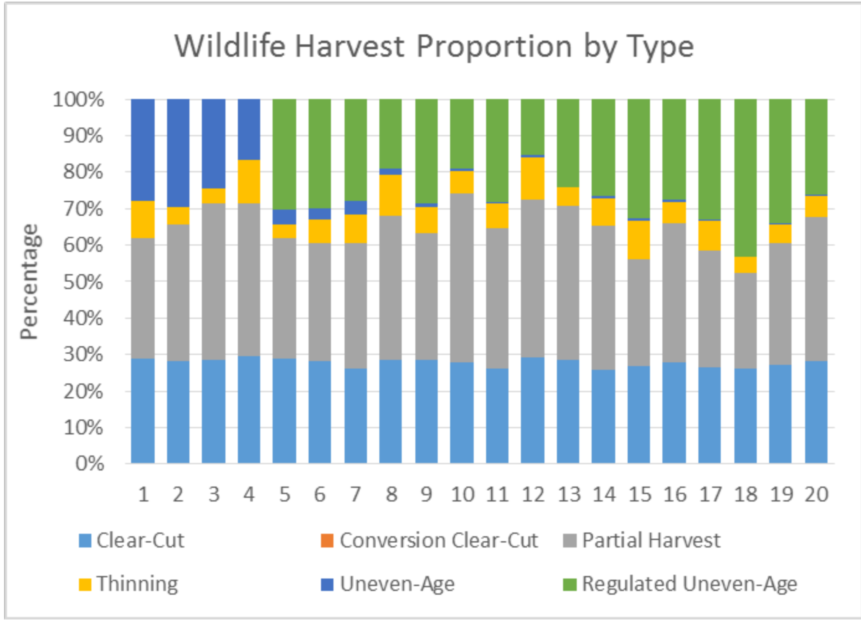

Harvest Volume by Physiographic Region
Cords
Millions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils


Average Clear-Cut Age
Years
-
10
20
30
40
50
60
70
80
90
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

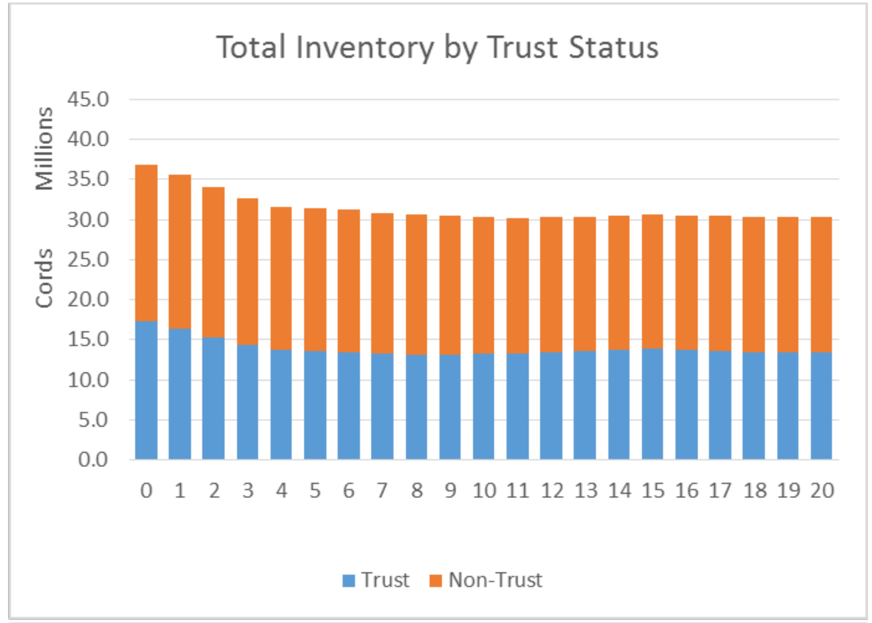

Annual Harvest Acres by Type
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

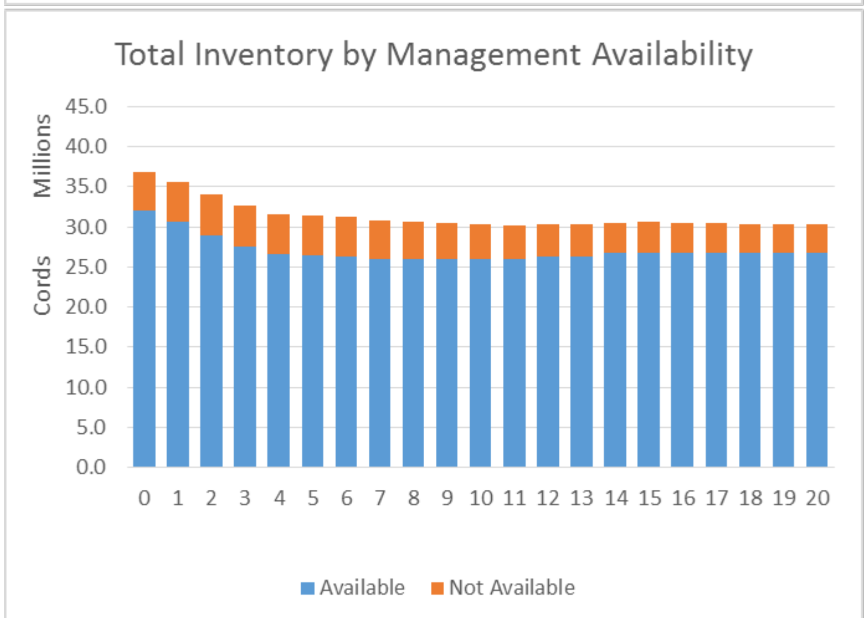

Annual Converted Cover Type Acres
1
1
1
0
0
-
Acres
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

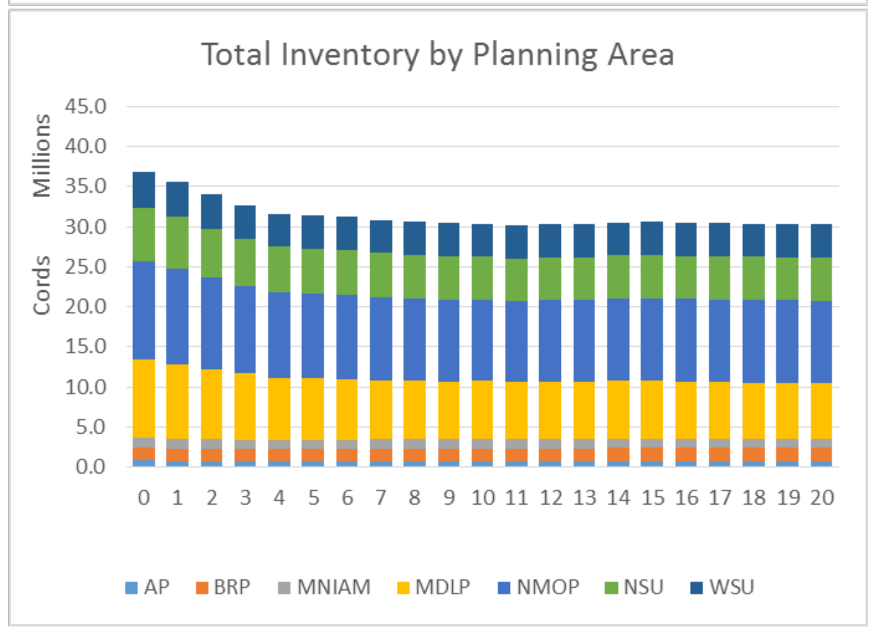

Forestry Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

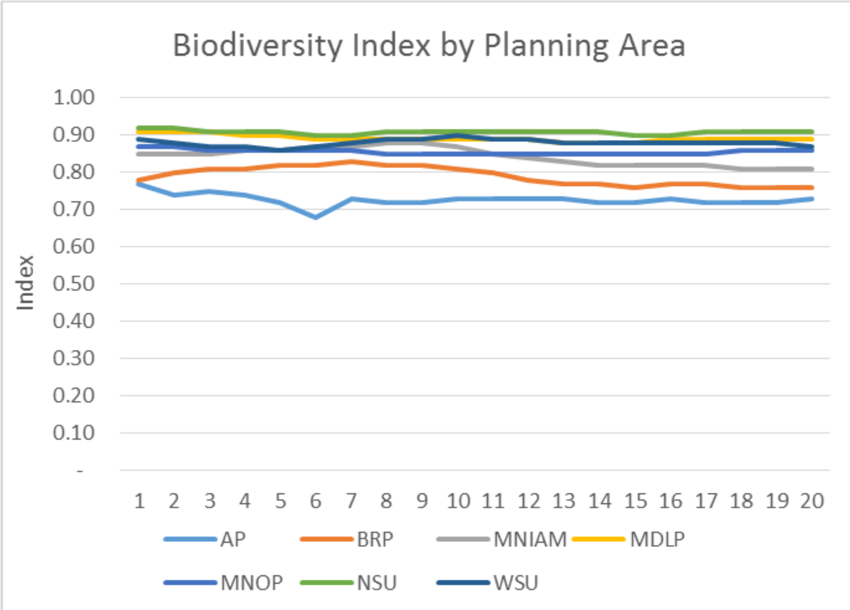

Wildlife Harvest Proportion by Type
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

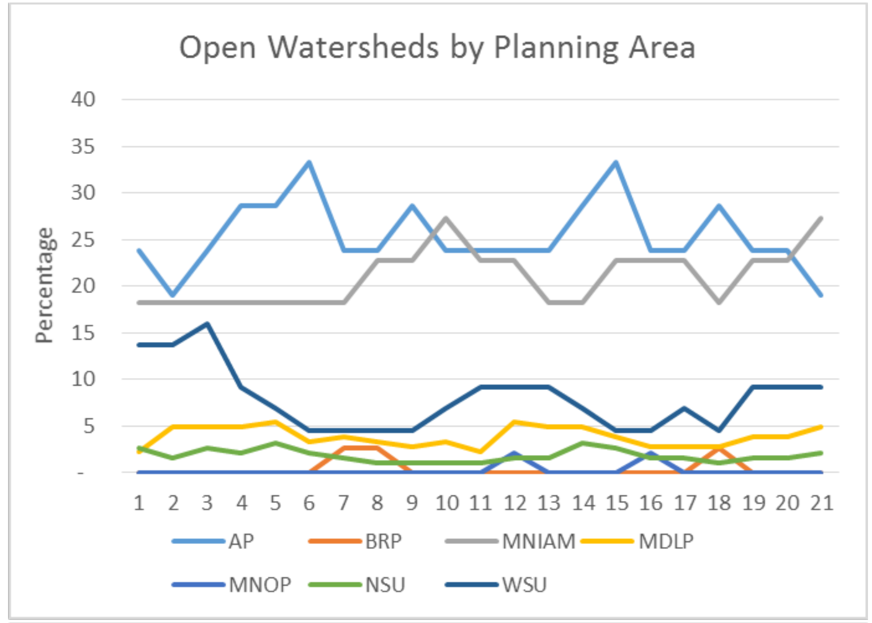

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

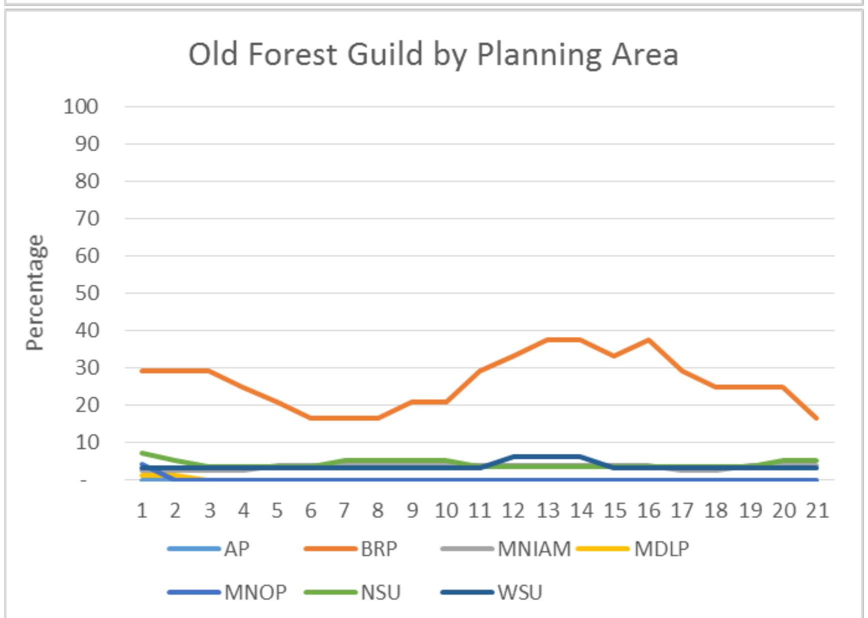

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

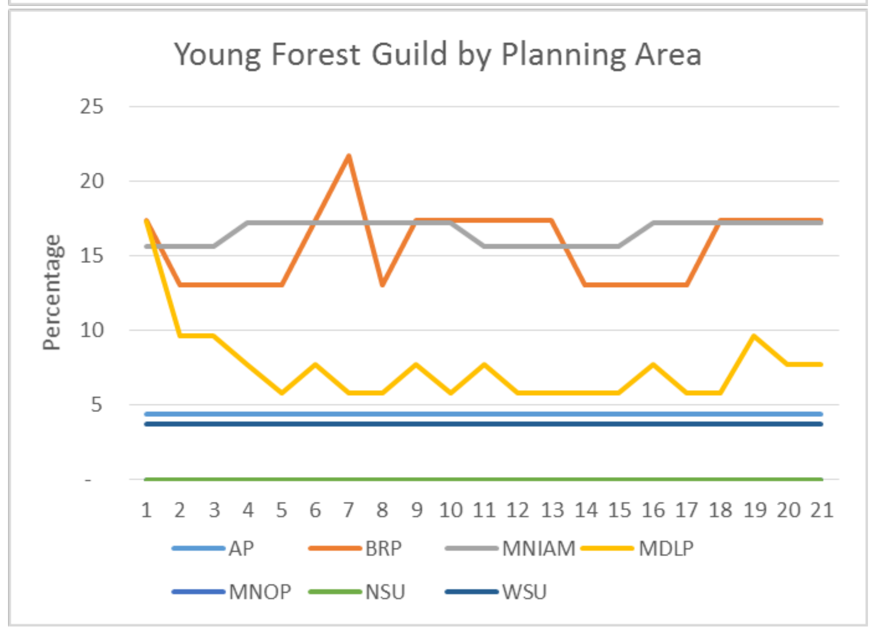

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

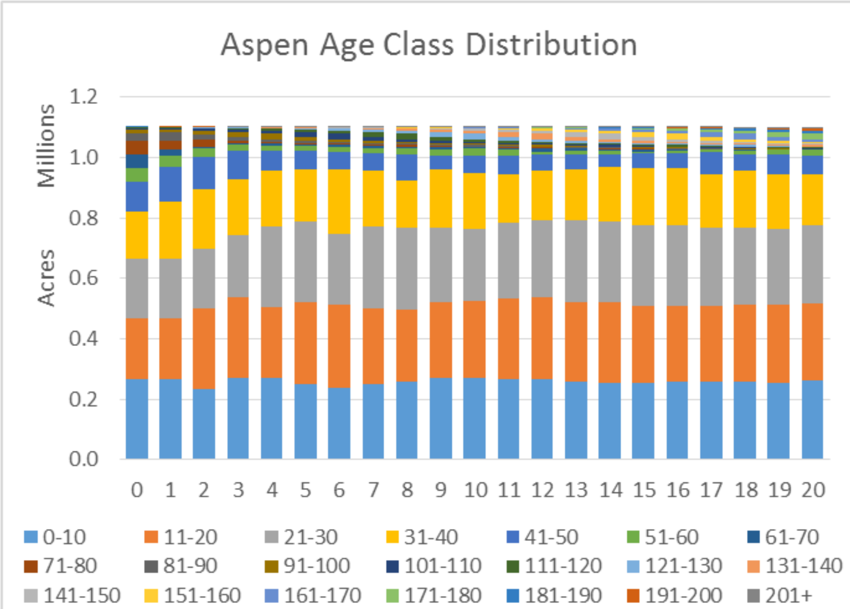

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

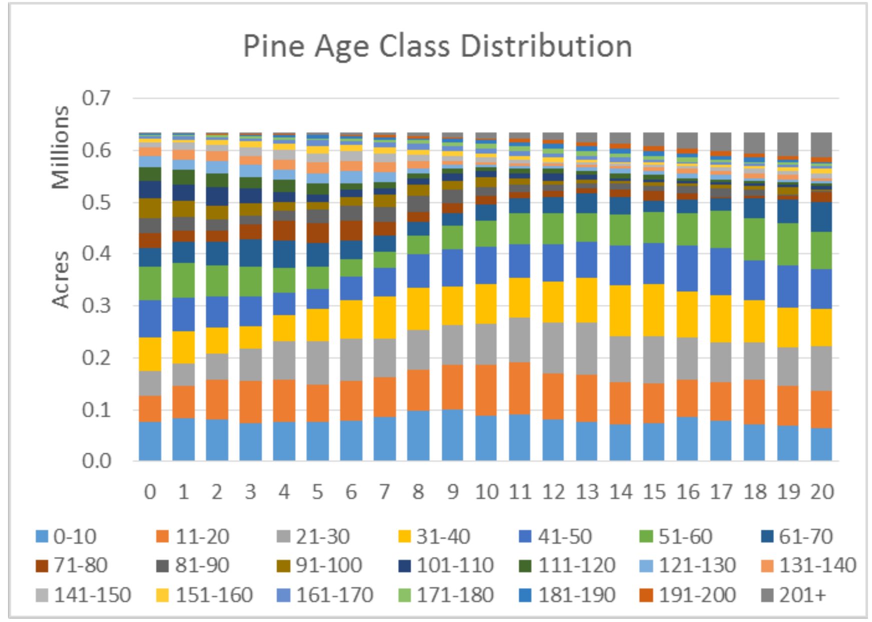

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

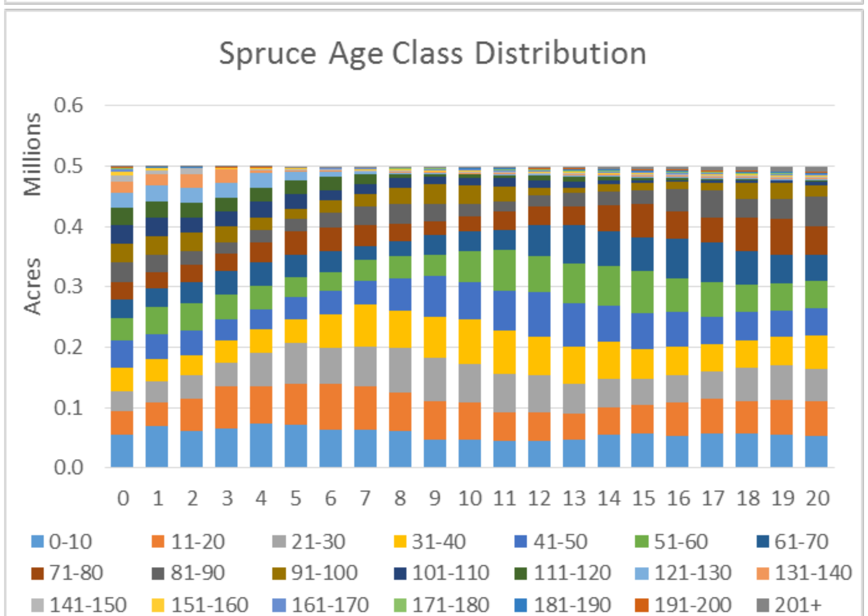

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

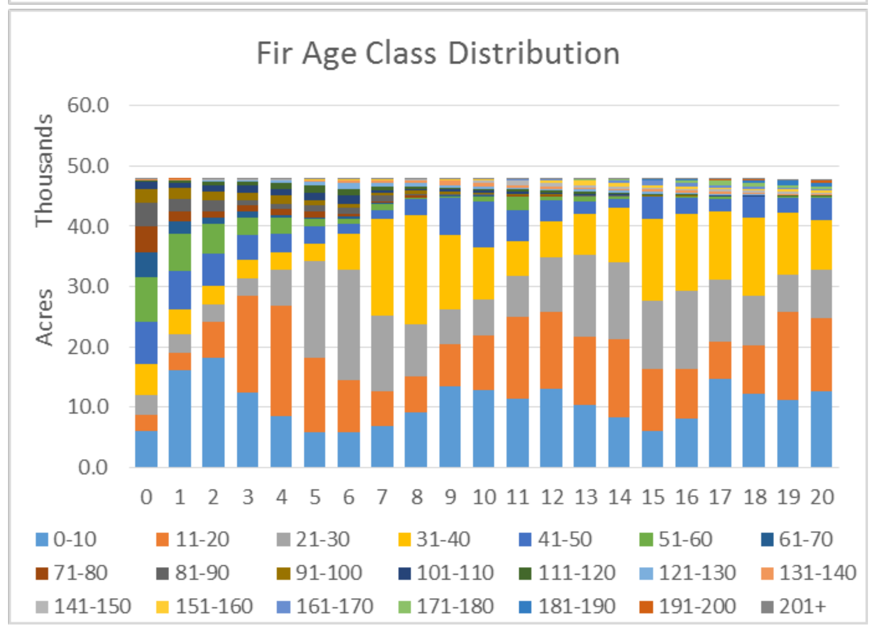

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

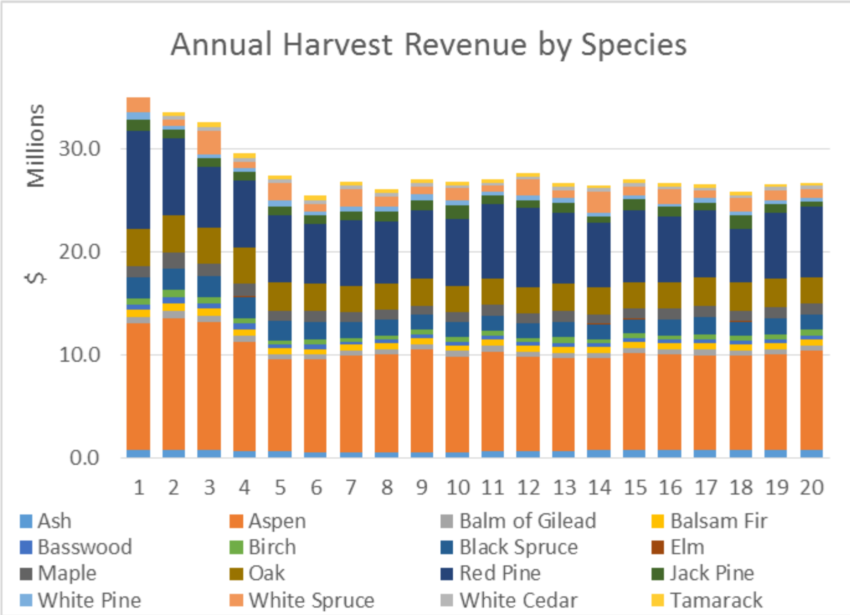

Young Forest Guild by Planning Area
Percentage
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

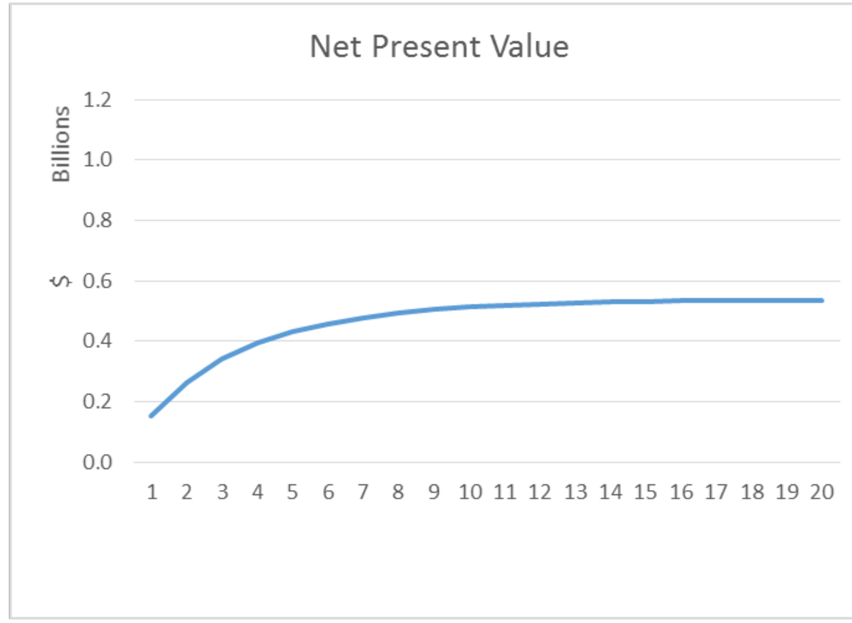

Aspen Age Class Distribution
Acres
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Pine Age Class Distribution
Acres
Millions
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

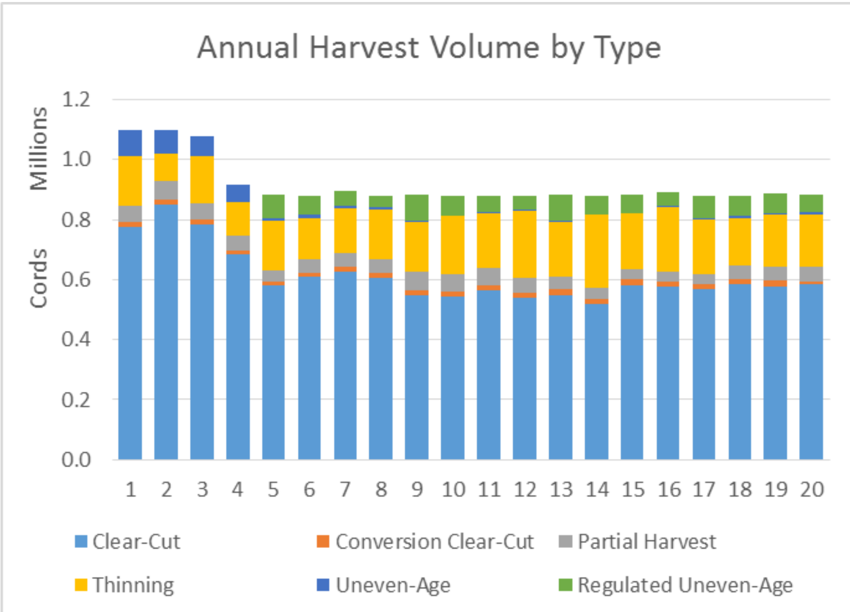

Spruce Age Class Distribution
Acres
Millions
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

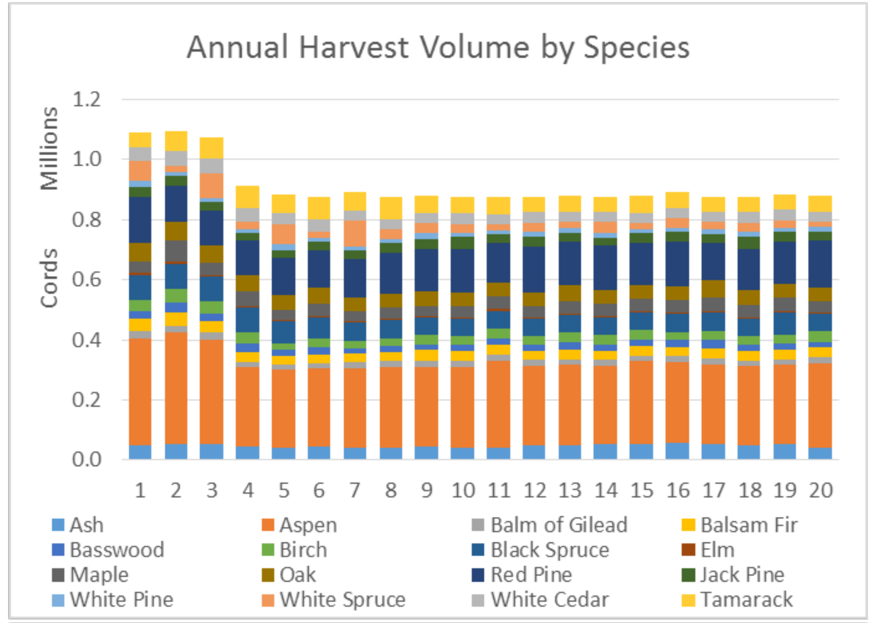

Fir Age Class Distribution
Acres
Thousands
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

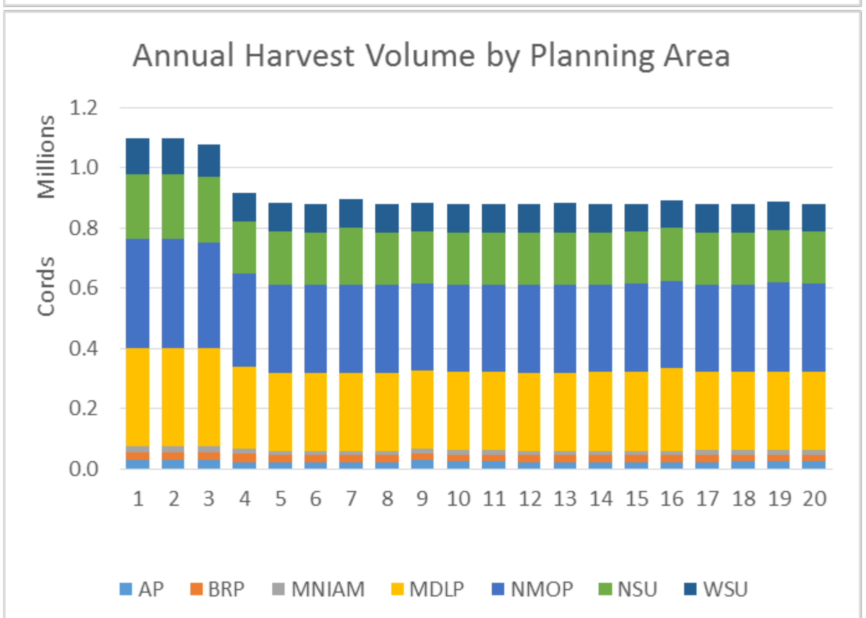

Annual Harvest Revenue by Species
$ Millions
0.0
10.0
20.0
30.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

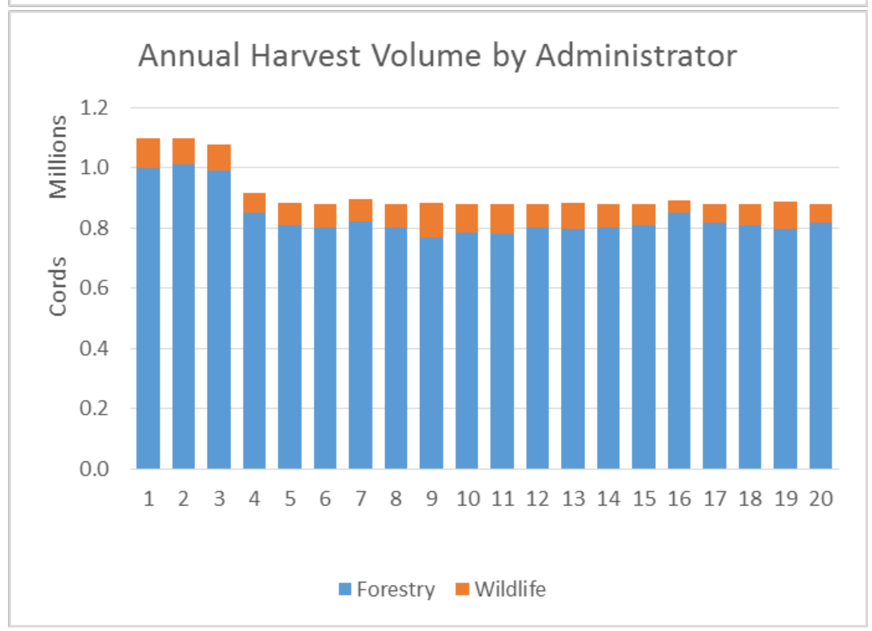

Net Present Value
$ Billions
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

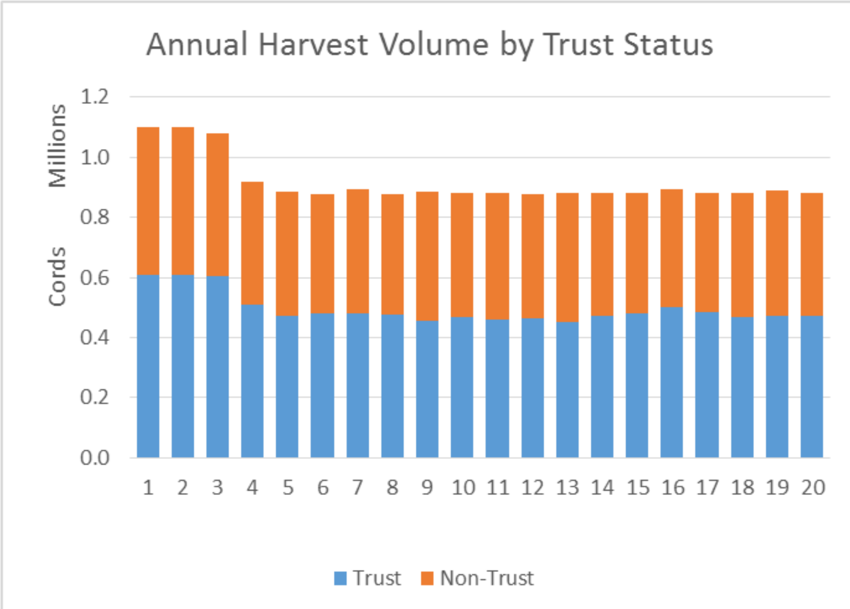
Scenario 4.2.2

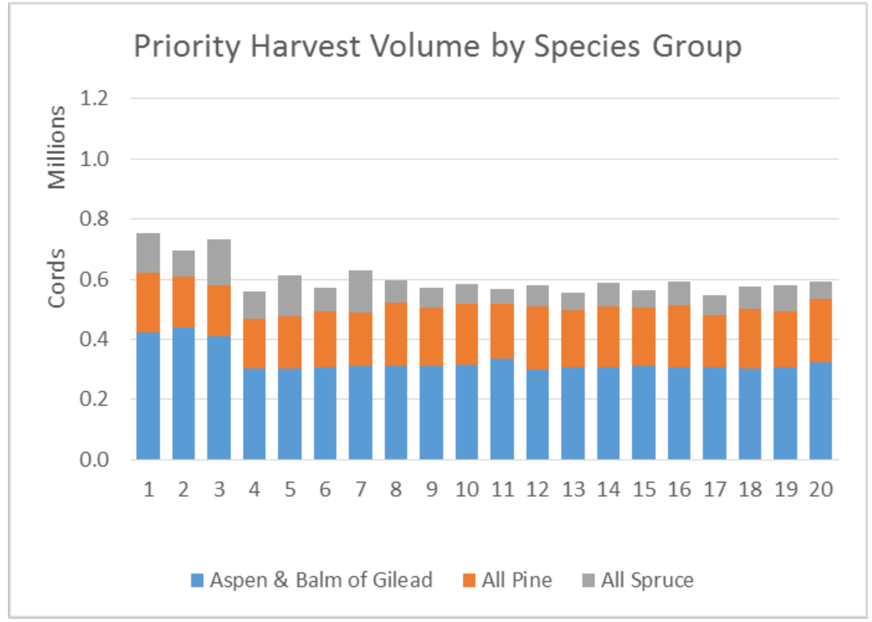


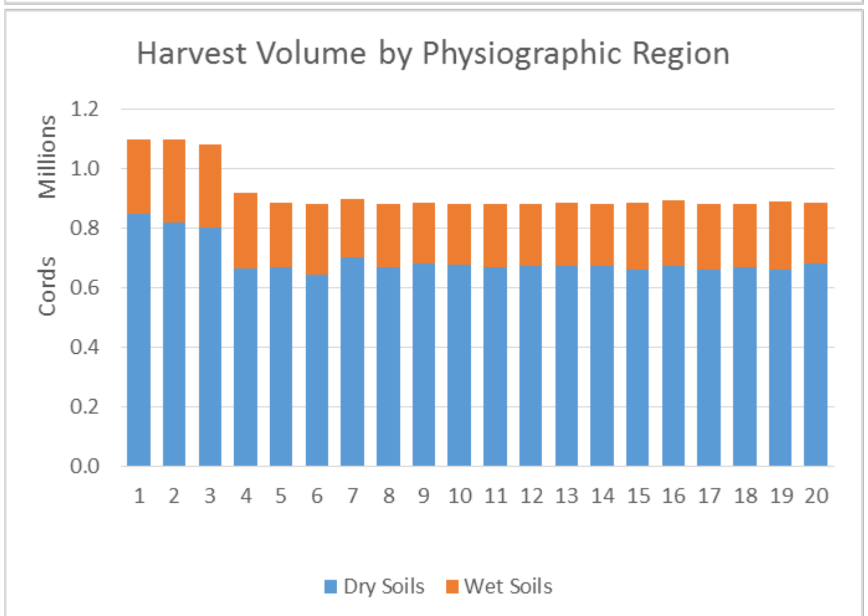


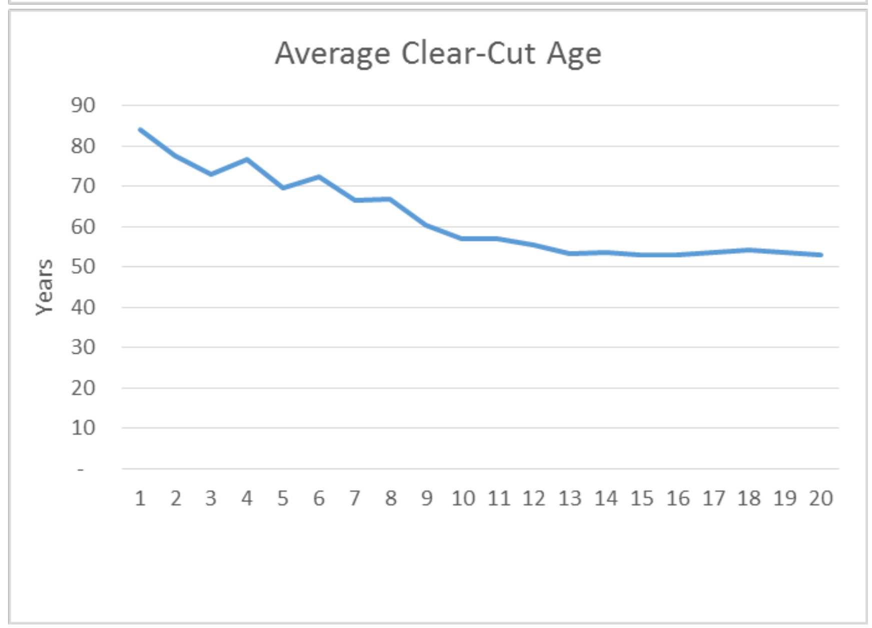


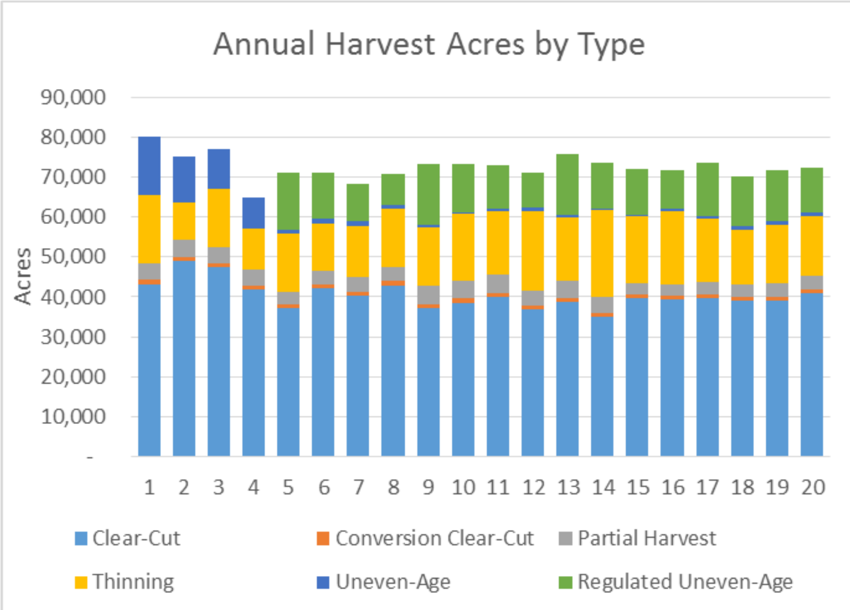


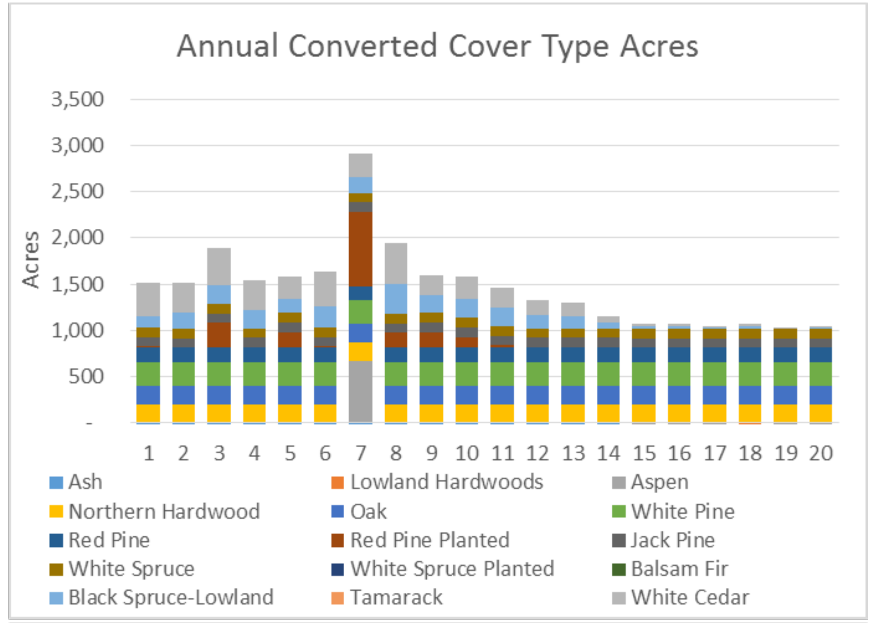

Annual Harvest Volume by Trust Status
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

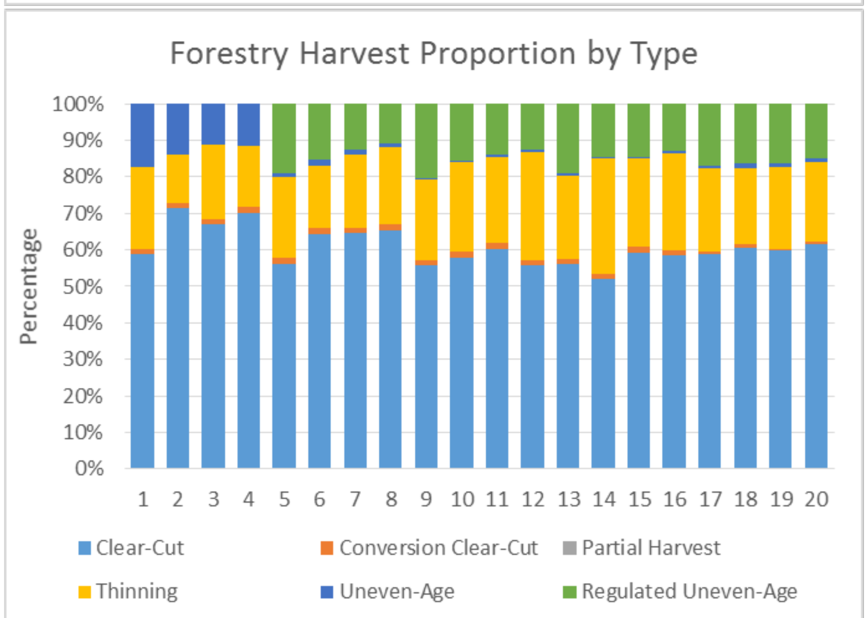

Priority Harvest Volume by Species Group
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Aspen & Balm of Gilead
All Pine
All Spruce

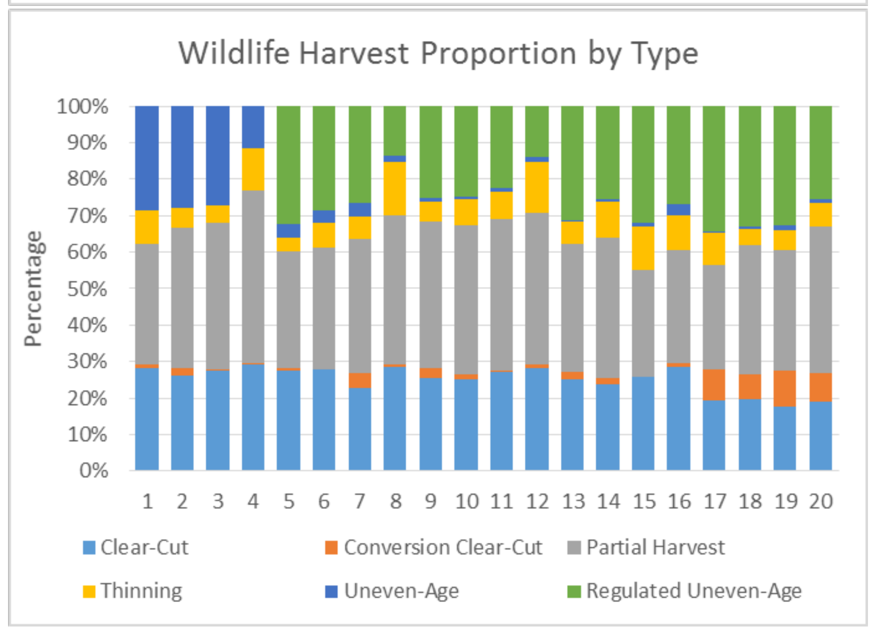

Harvest Volume by Physiographic Region
Cords Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Dry Soils
Wet Soils

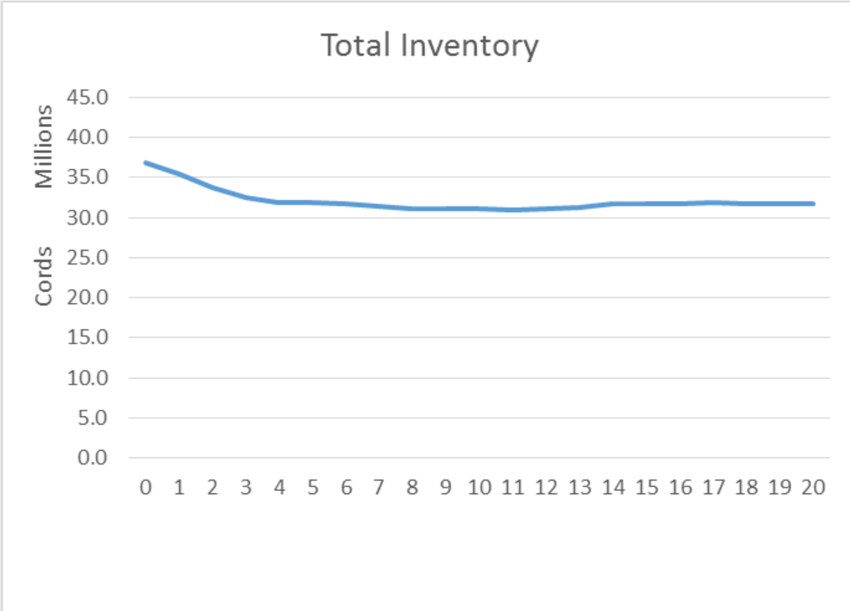

Average Clear-Cut Age
Years
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

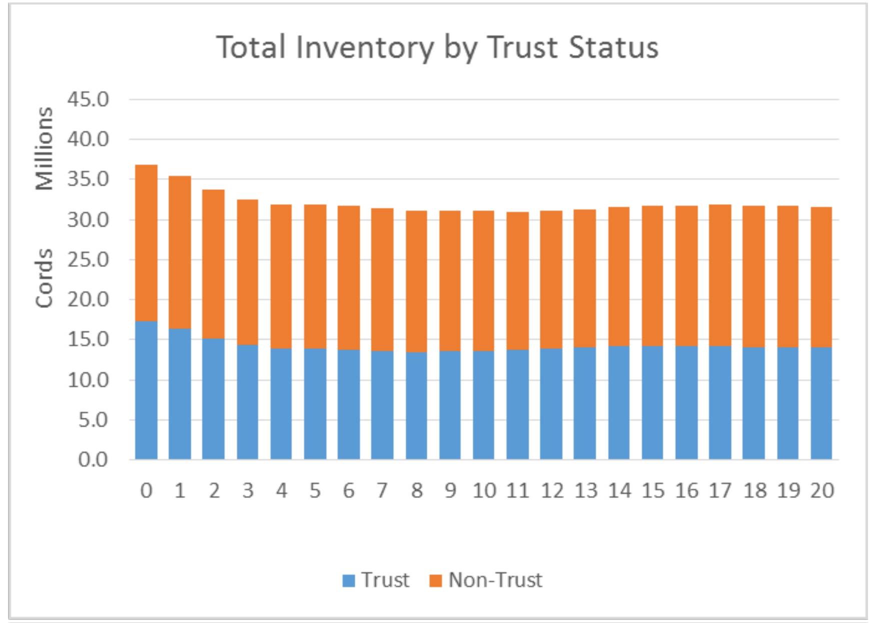

Annual Harvest Acres by Type
Acres
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

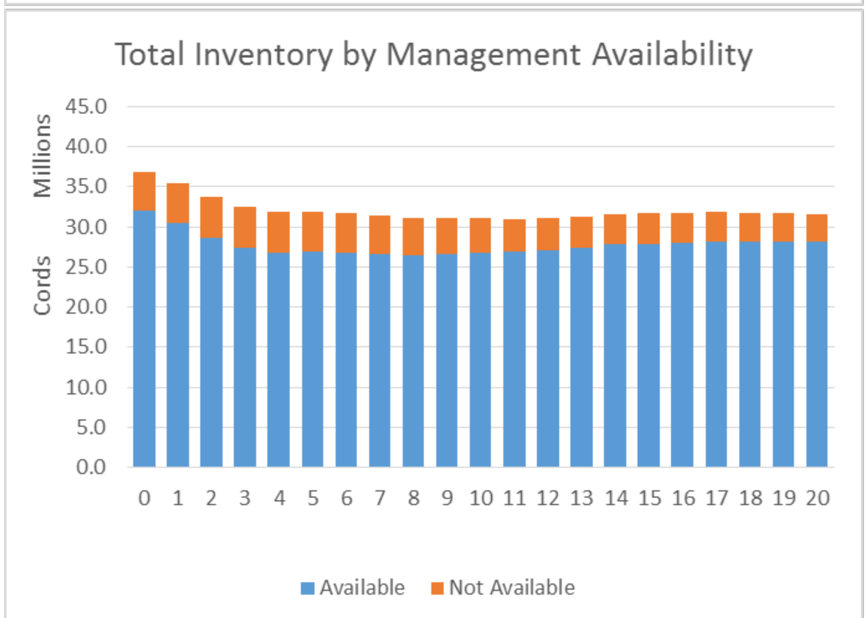

Annual Converted Cover Type Acres
Acres
3,500
3,000
2,500
2,000
1,500
1,000
500
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Lowland Hardwoods
Aspen
Northern Hardwood
Oak
White Pine
Red Pine
Red Pine Planted
Jack Pine
White Spruce
White Spruce Planted
Balsam Fir
Black Spruce-Lowland
Tamarack
White Cedar

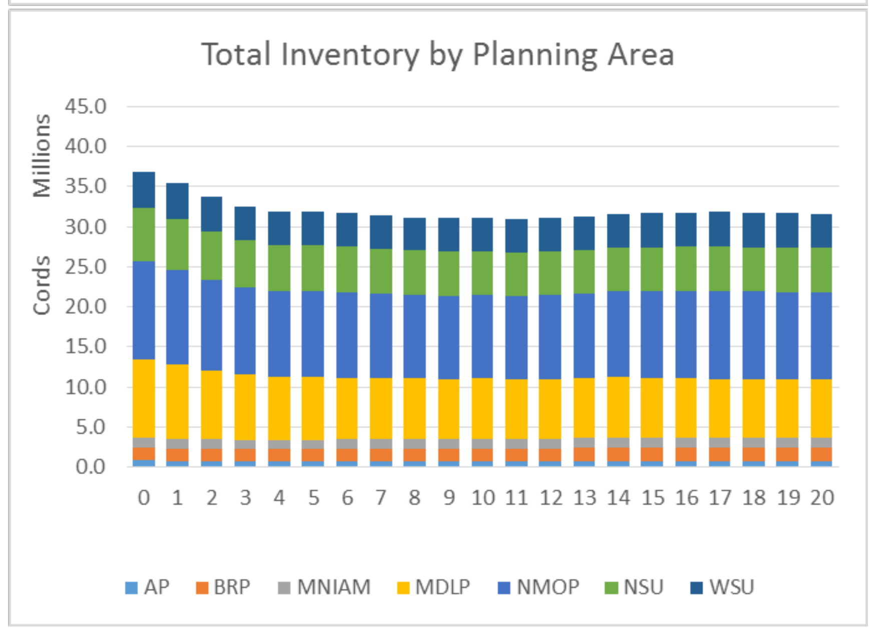

Forestry Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

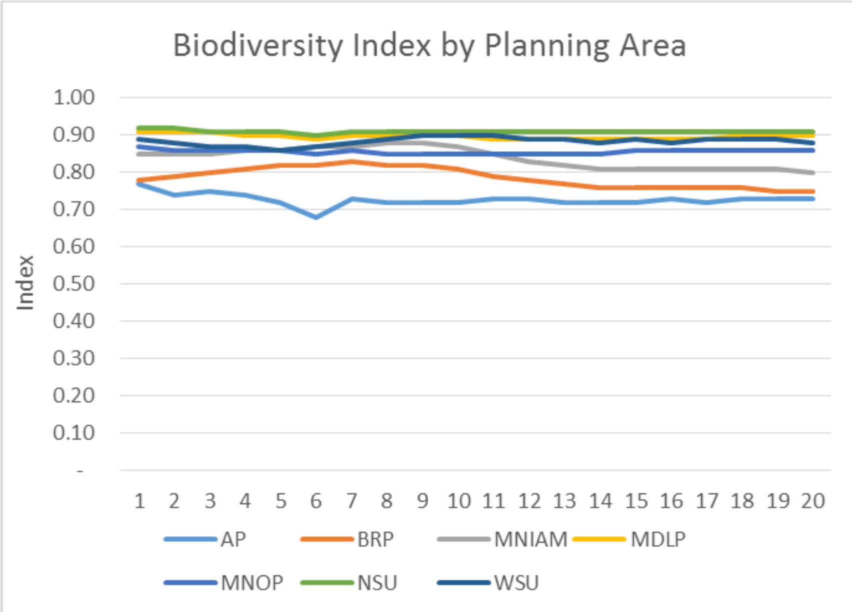

Wildlife Harvest Proportion by Type
Percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Clear-Cut
Conversion Clear-Cut
Partial Harvest
Thinning
Uneven-Age
Regulated Uneven-Age

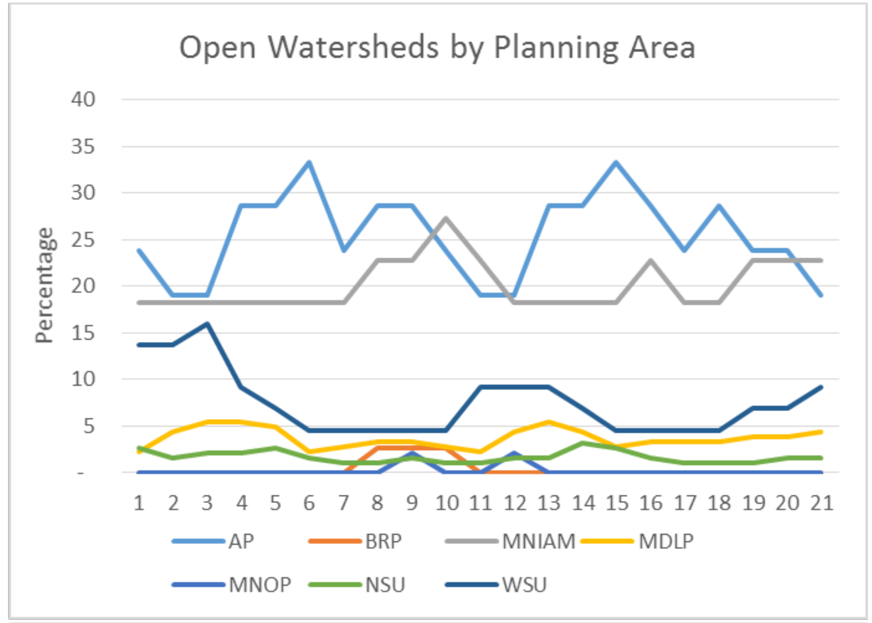

Total Inventory
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

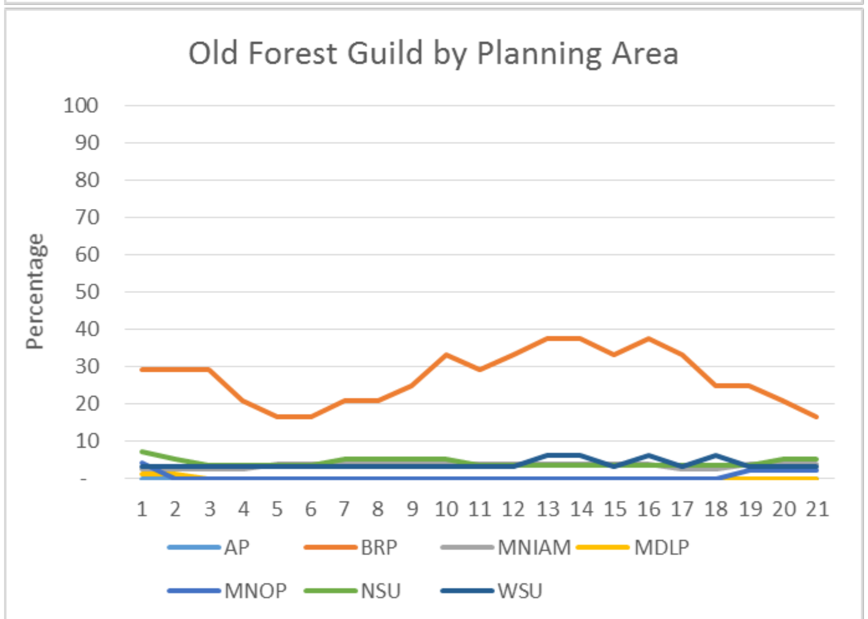

Total Inventory by Trust Status
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Trust
Non-Trust

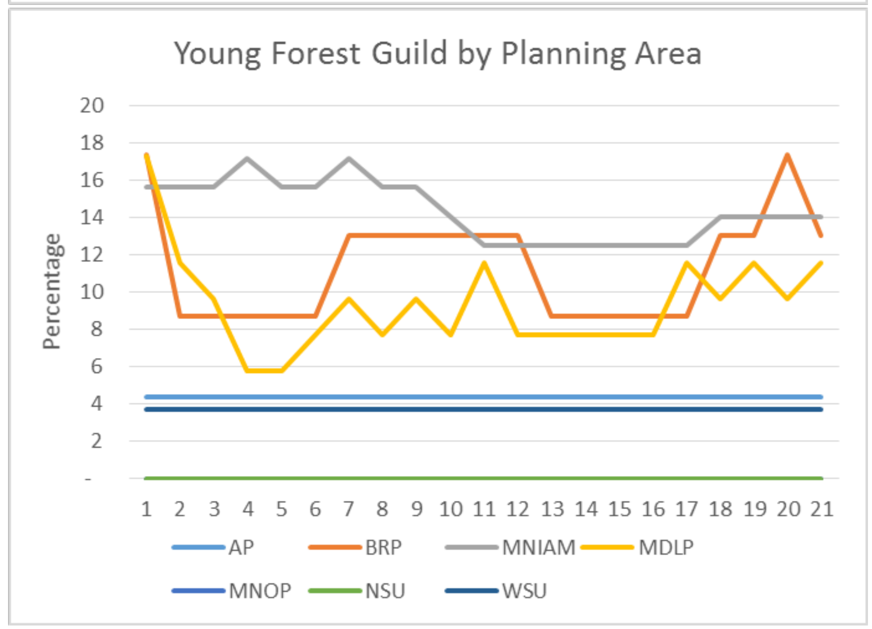

Total Inventory by Management Availability
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Available
Not Available

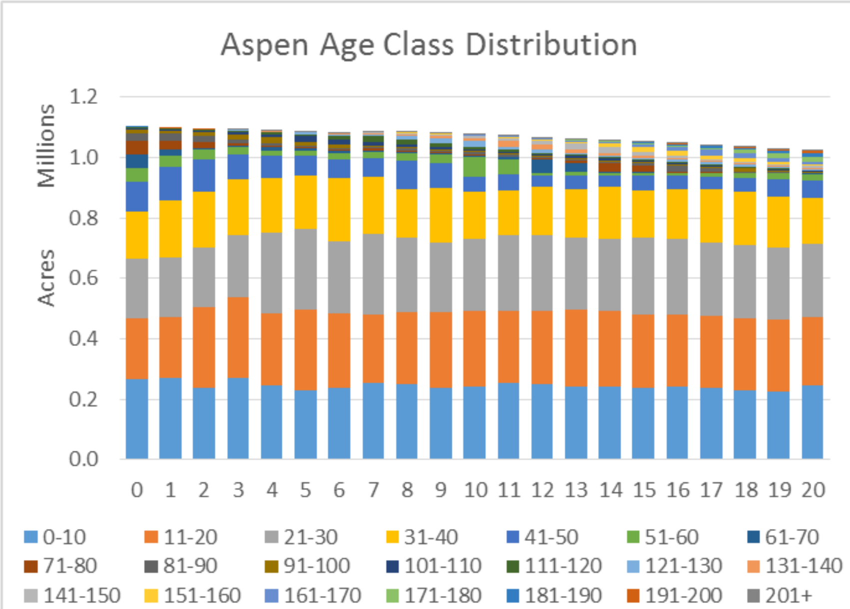

Total Inventory by Planning Area
Cords Millions
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
NMOP
NSU
WSU

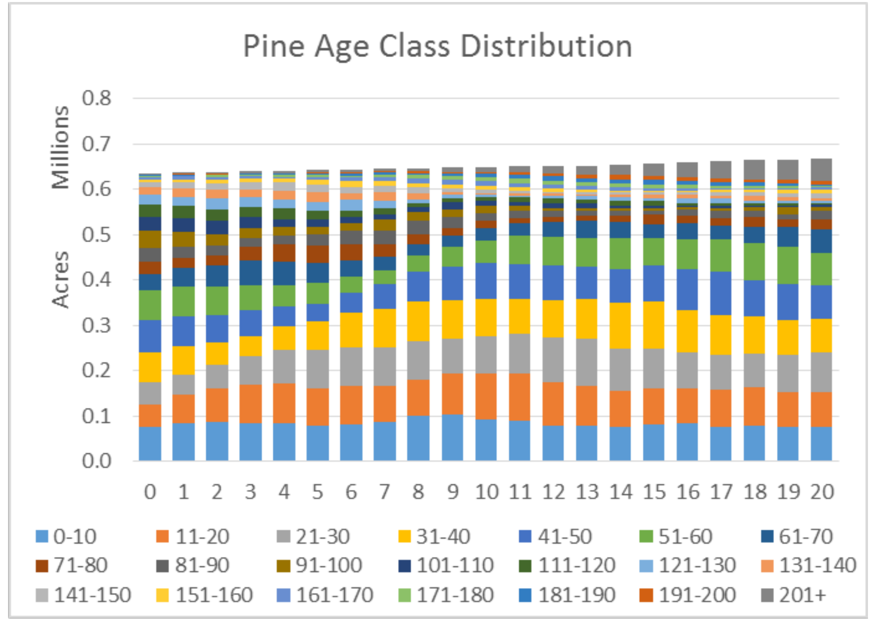

Biodiversity Index by Planning Area
Index
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

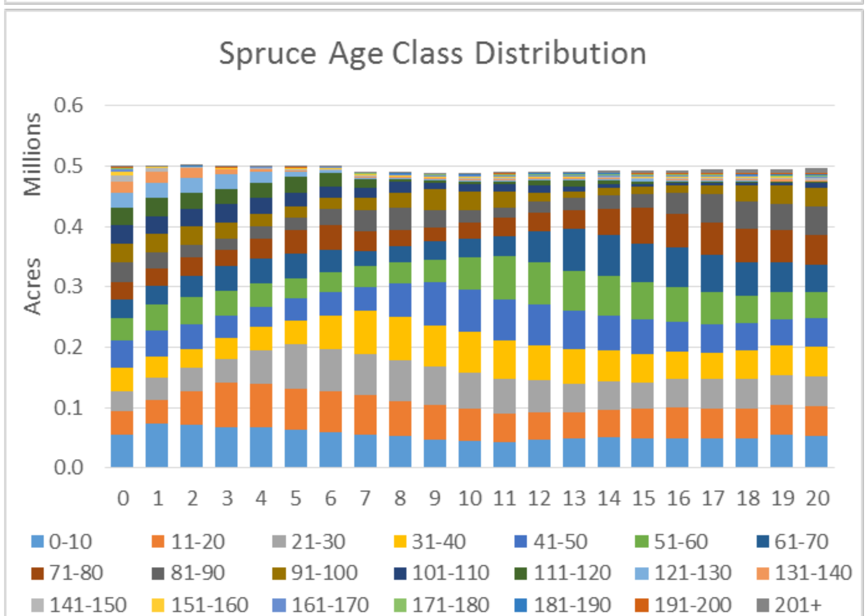

Open Watersheds by Planning Area
Percentage
40
35
30
25
20
15
10
5
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

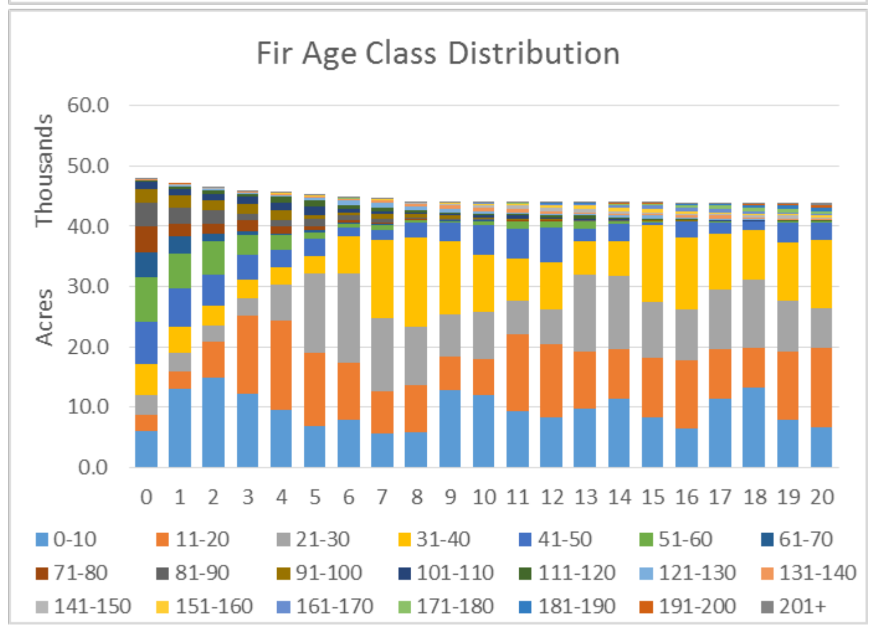

Old Forest Guild by Planning Area
Percentage
100
90
80
70
60
50
40
30
20
10
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU

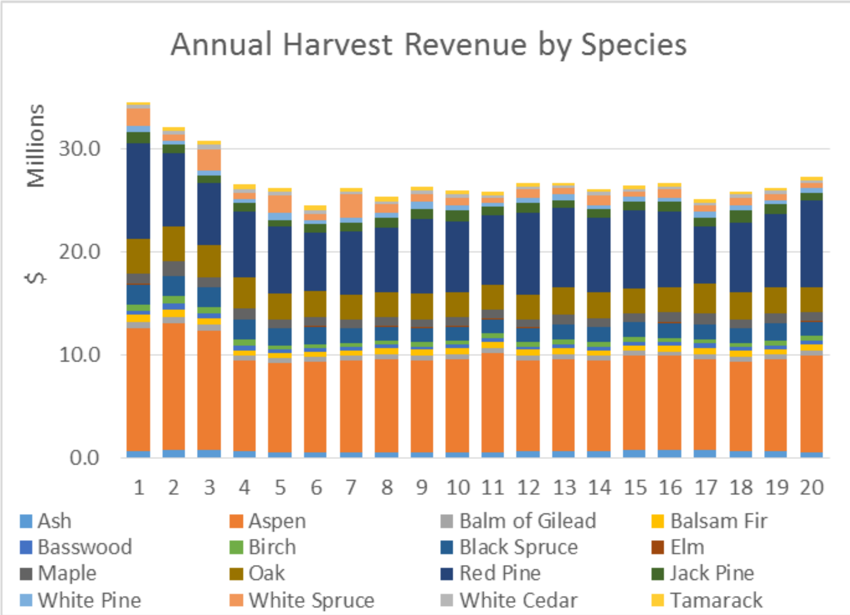

Young Forest Guild by Planning Area
Percentage
20
18
16
14
12
10
8
6
4
2
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
AP
BRP
MNIAM
MDLP
MNOP
NSU
WSU


Aspen Age Class Distribution
Acres
Millions
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

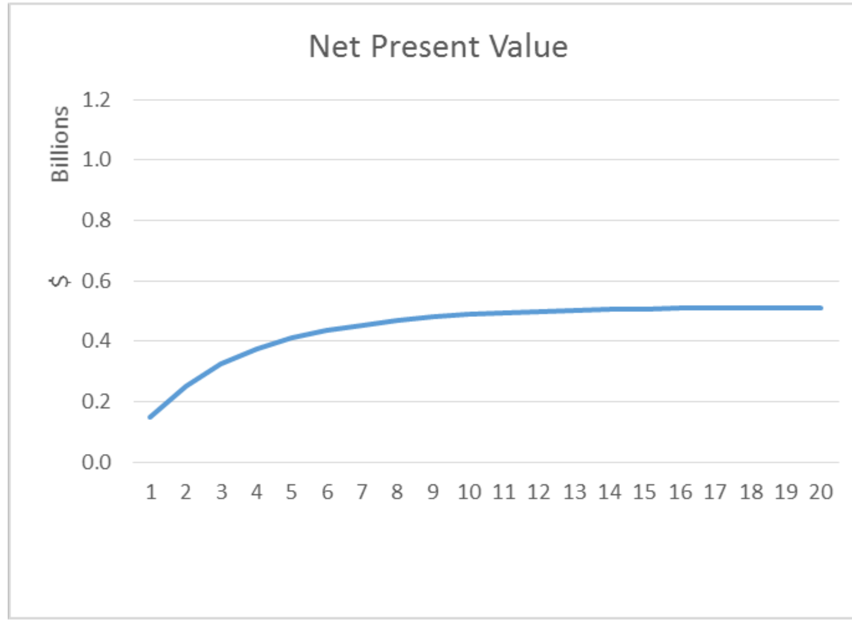

Pine Age Class Distribution
Acres
Millions
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Spruce Age Class Distribution
Acres
Millions
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+


Fir Age Class Distribution
Acres
Thousands
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
0-10 11-20 21-30 31-40 41-50 51-60 61-70
71-80 81-90 91-100 101-110 111-120 121-130 131-140
141-150 151-160 161-170 171-180 181-190 191-200 201+

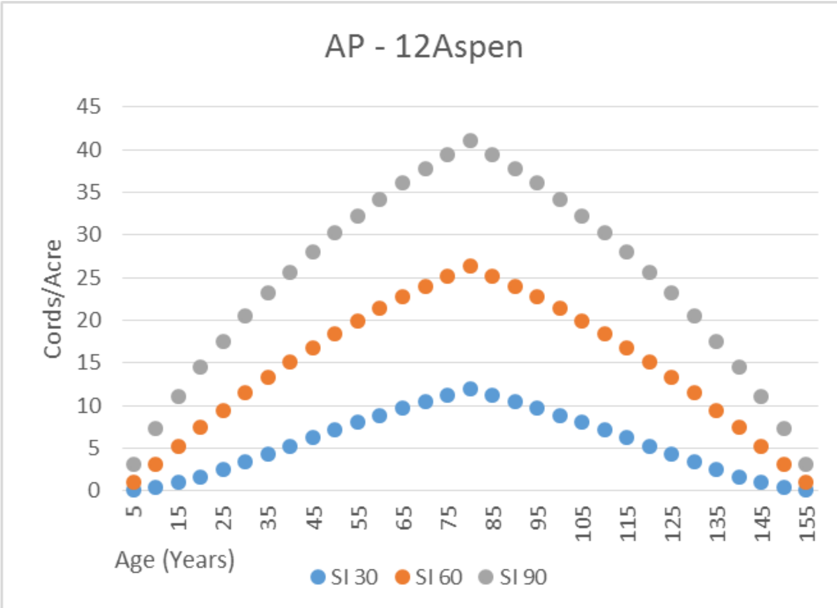


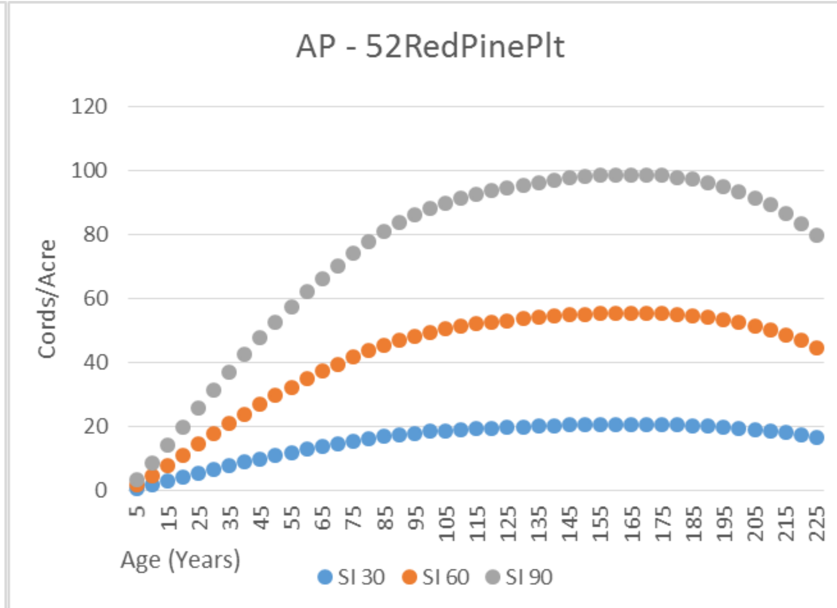
Annual Harvest Revenue by Species
Millions
$
30.0
20.0
10.0
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Ash
Aspen
Balm of Gilead
Balsam Fir
Basswood
Birch
Black Spruce
Elm
Maple
Oak
Red Pine
Jack Pine
White Pine
White Spruce
White Cedar
Tamarack

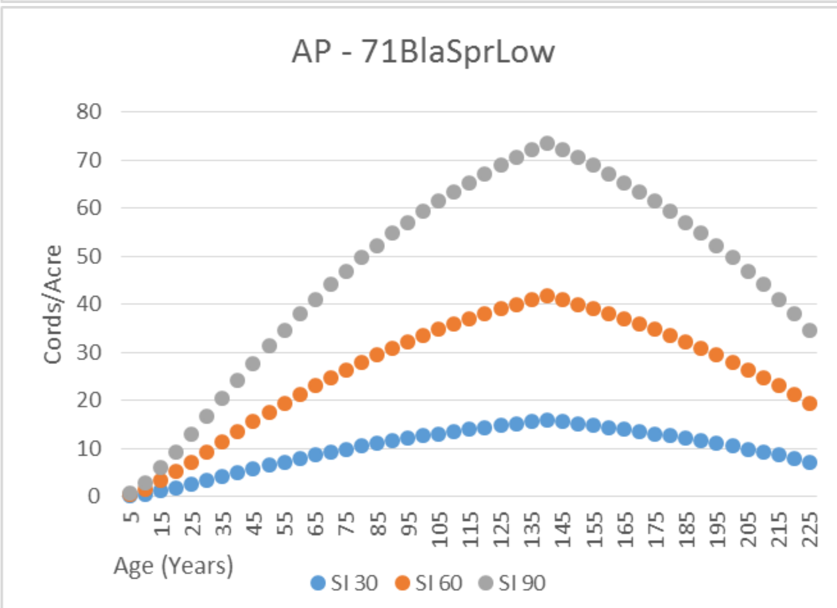


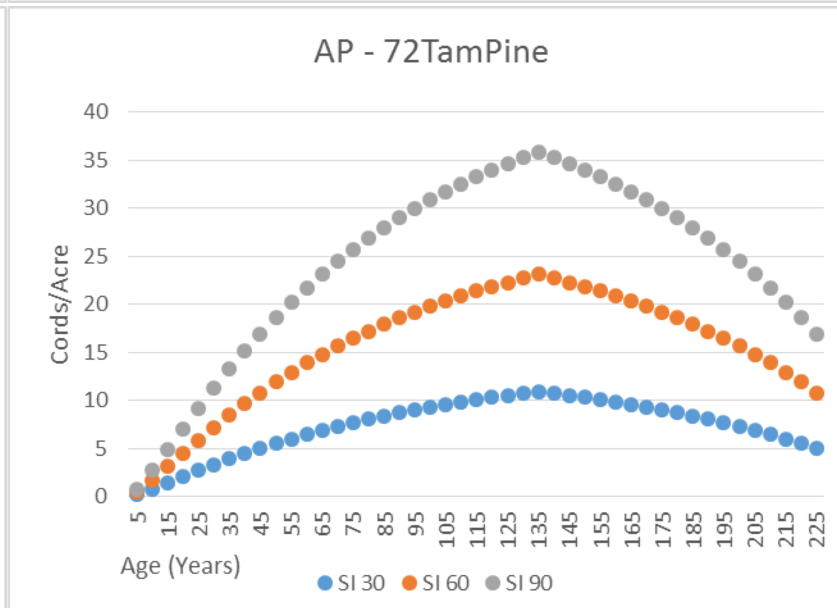
Net Present Value
Billions
$
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

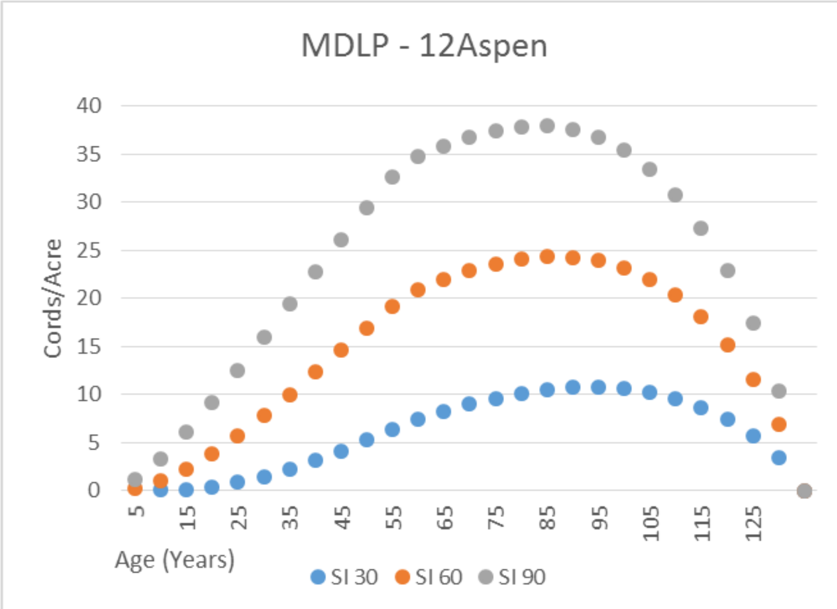
Appendix I: Selected Inventory Yield Tables

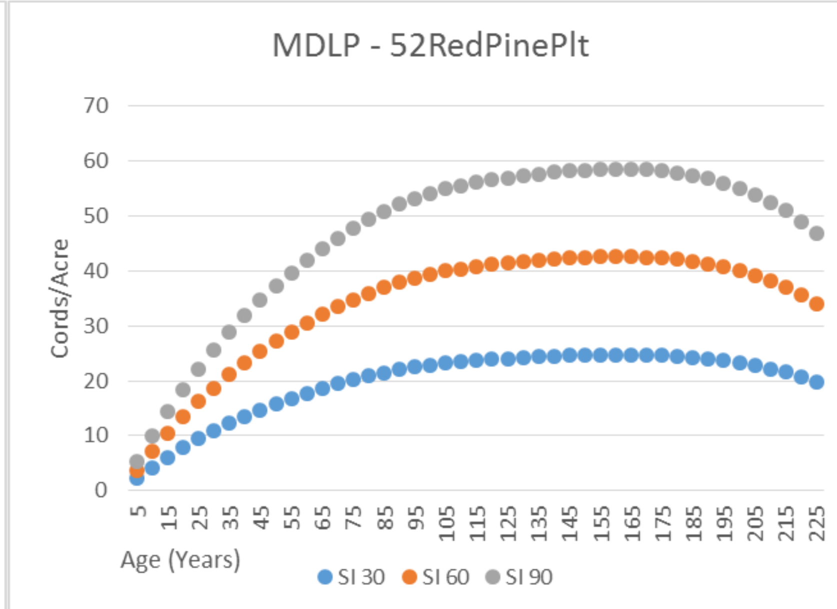


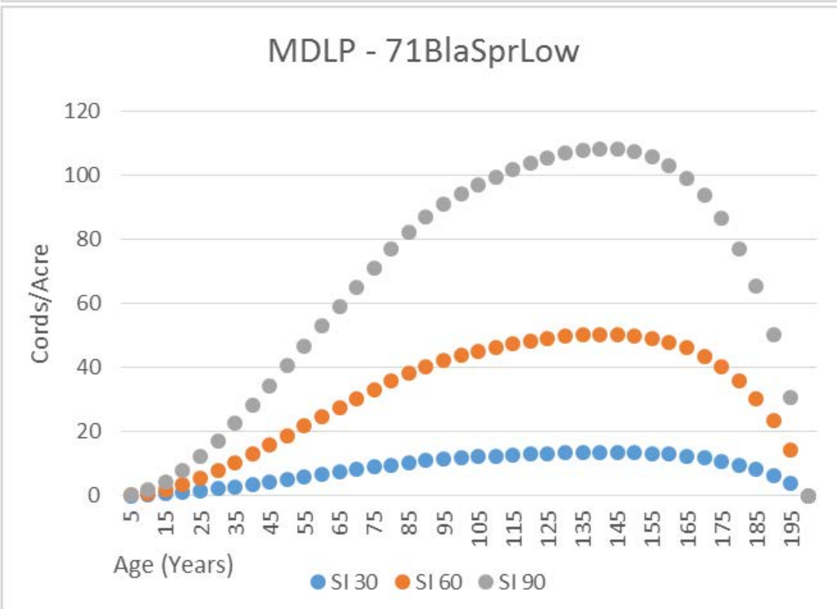


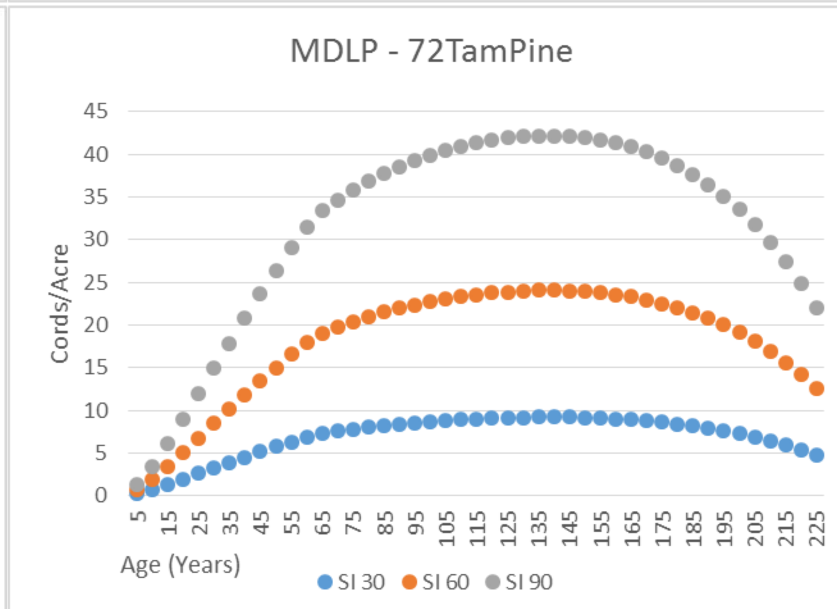


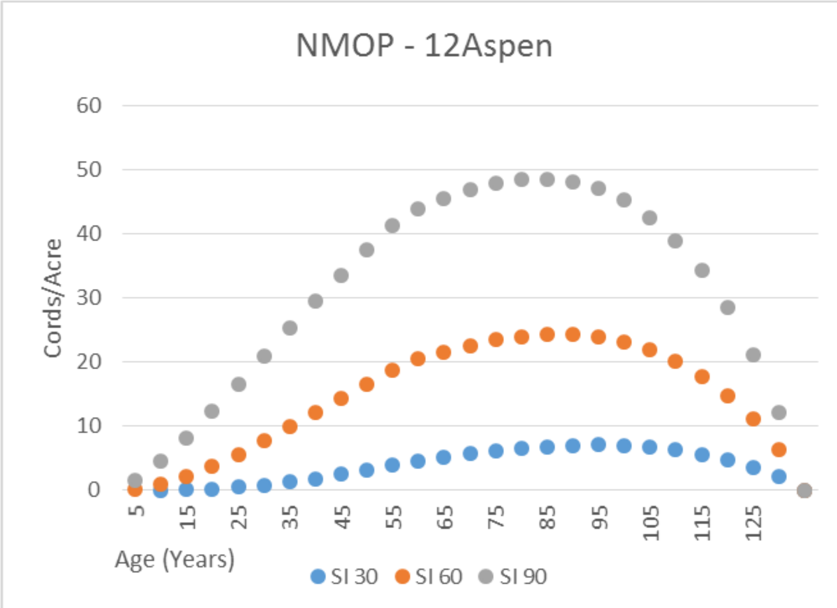


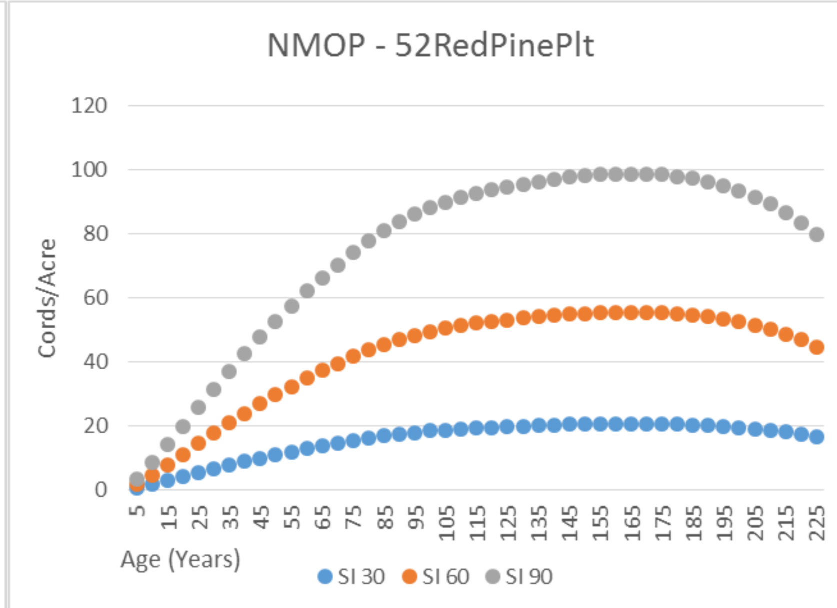

MDLP - 12Aspen
Cords/Acre
40
35
30
25
20
15
10
5
0
5 15 25 35 45 55 65 75 85 95 105 115 125
Age (Years)
SI 30 SI 60 SI 90

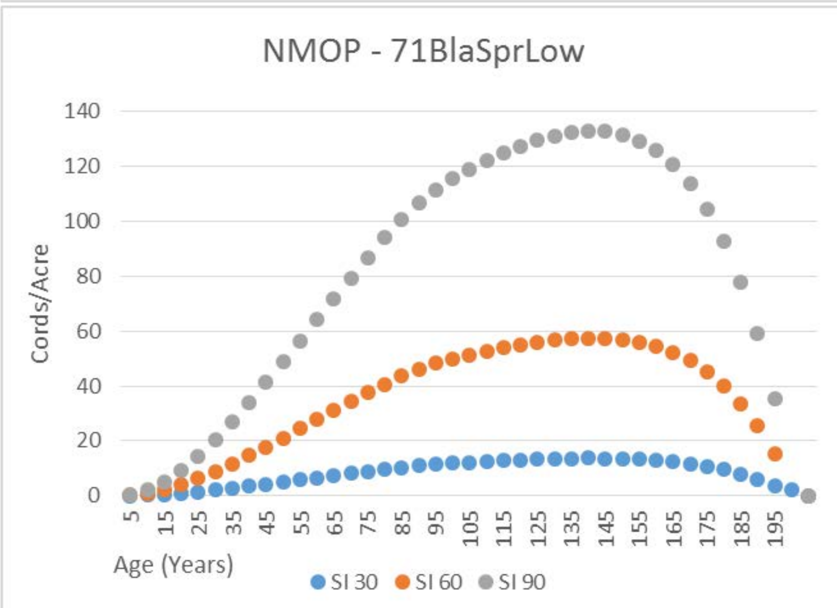

MDLP - 52RedPinePlt
Cords/Acre
70
60
50
40
30
20
10
0
5 15 25 35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195 205 215 225
Age (Years)
SI 30 SI 60 SI 90

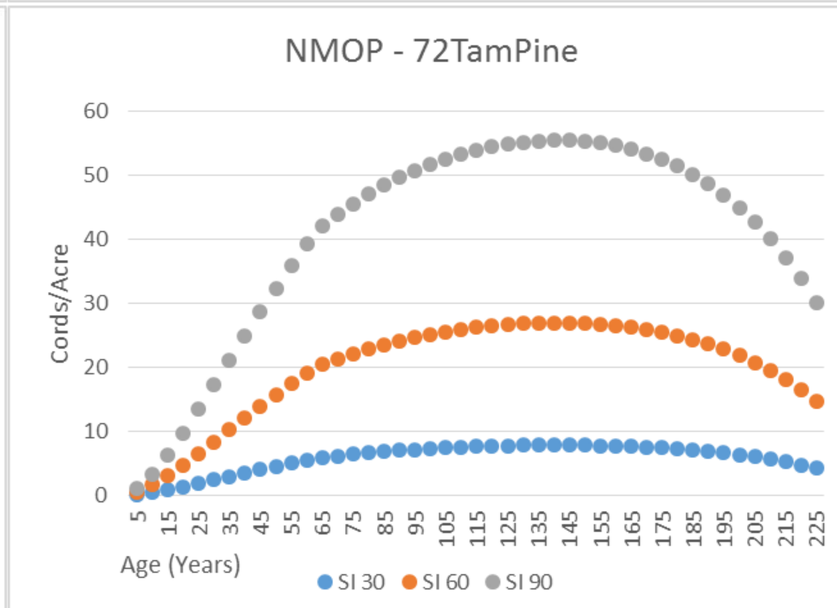

MDLP - 71BlaSprLow
Cords/Acre
120
100
80
60
40
20
0
5 15 25 35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195
Age (Years)
SI 30 SI 60 SI 90

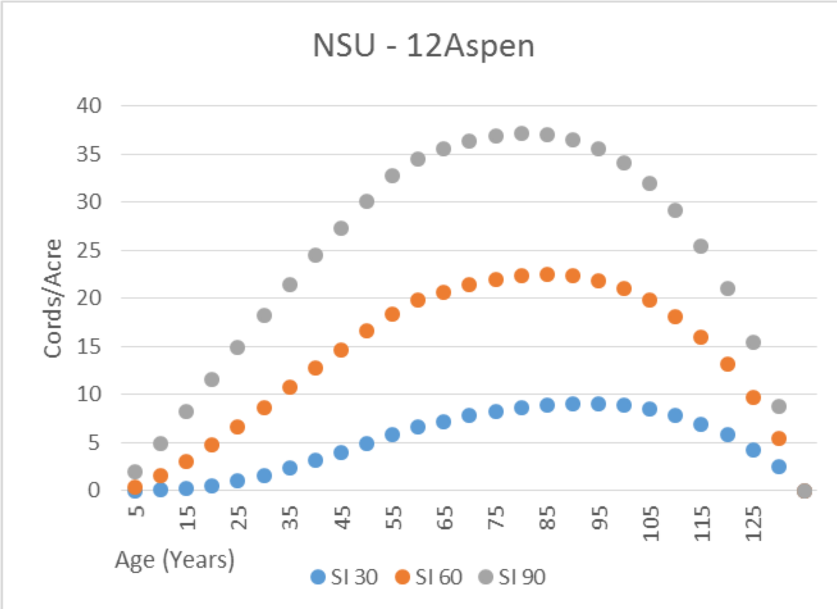

MDLP - 72TamPine
Cords/Acre
45
40
35
30
25
20
15
10
5
0
5 15 25 35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195 205 215 225
Age (Years)
SI 30 SI 60 SI 90

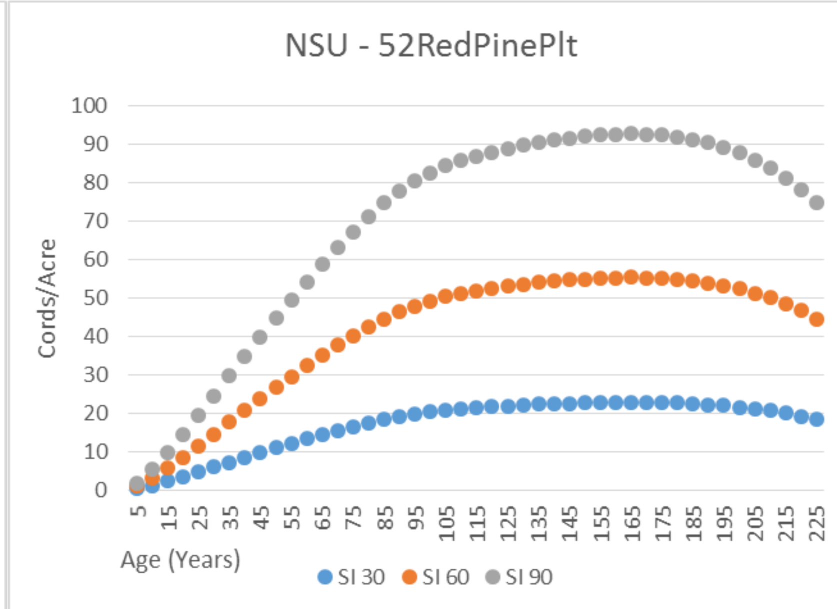

NMOP - 12Aspen
60
50
40
30
20
10
0
Cords/Acre
5
15
25
35
45
55
65
75
85
95
105
115
125
Age (Years)
SI 30
SI 60
SI 90

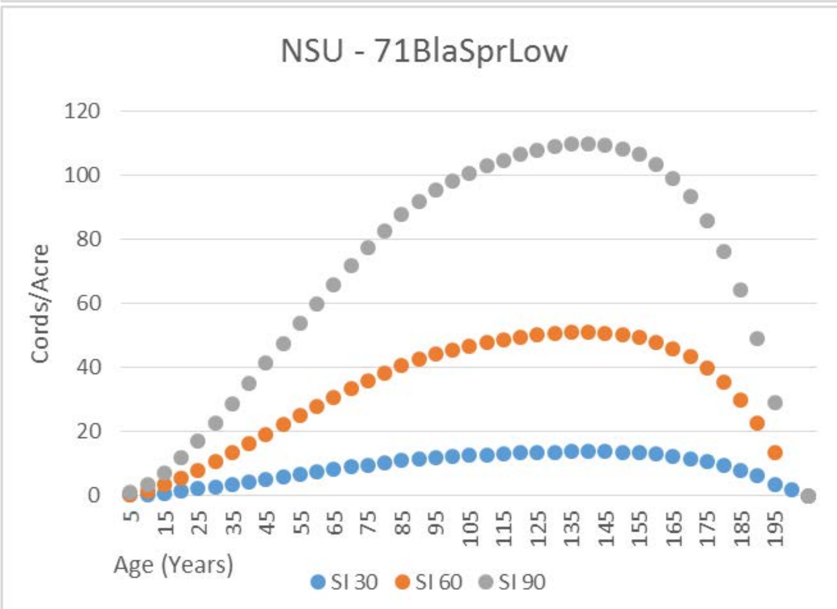

NMOP - 52RedPinePlt
120
100
80
60
40
20
0
Cords/Acre
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
225
Age (Years)
SI 30
SI 60
SI 90

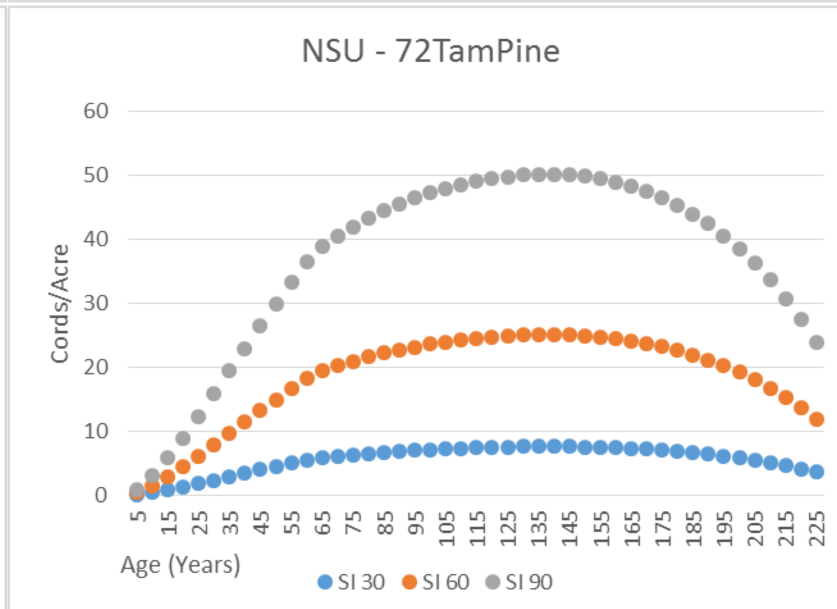

NMOP - 71BlaSprLow
140
120
100
80
60
40
20
0
Cords/Acre
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
Age (Years)
SI 30
SI 60
SI 90

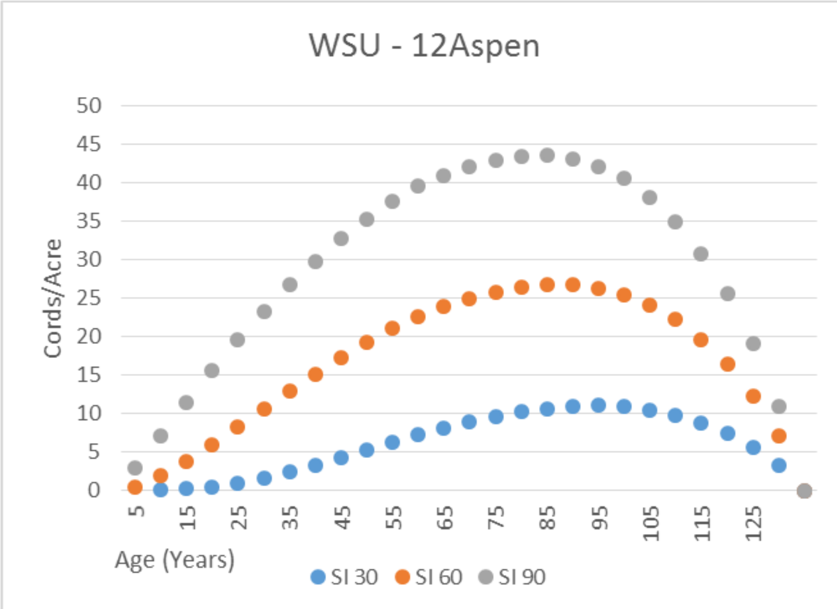

NMOP - 72TamPine
60
50
40
30
20
10
0
Cords/Acre
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
225
Age (Years)
SI 30
SI 60
SI 90

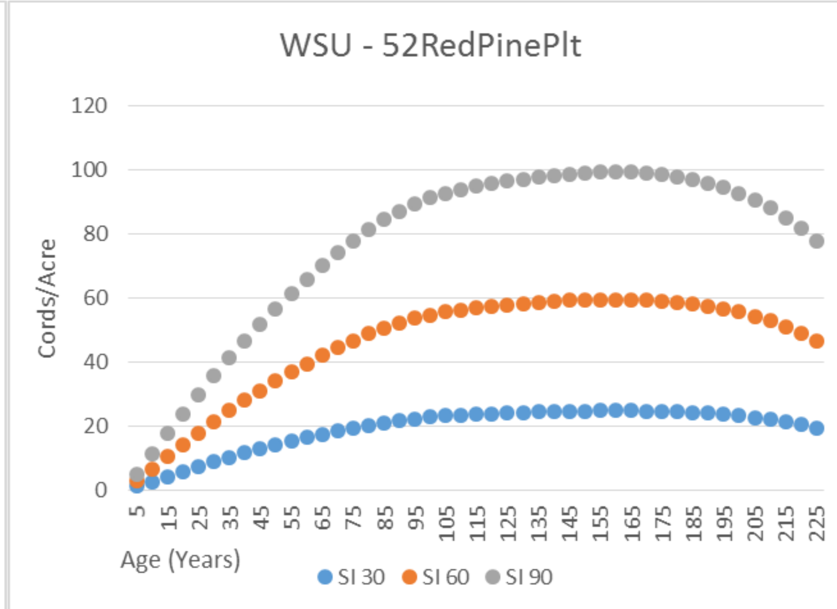

NSU - 12Aspen
Cords/Acre
40
35
30
25
20
15
10
5
0
5
15
25
35
45
55
65
75
85
95
105
115
125
Age (Years)
SI 30
SI 60
SI 90

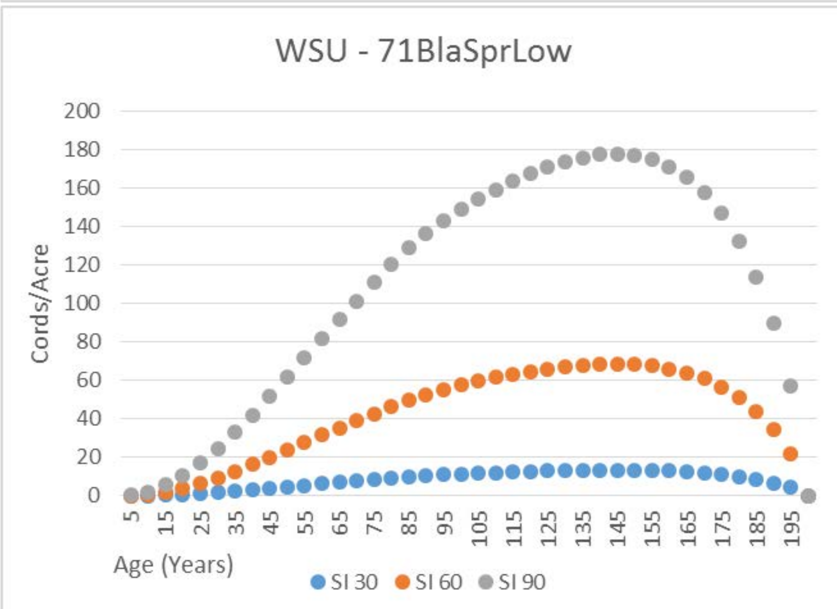

NSU - 52RedPinePlt
Cords/Acre
100
90
80
70
60
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
225
Age (Years)
SI 30
SI 60
SI 90

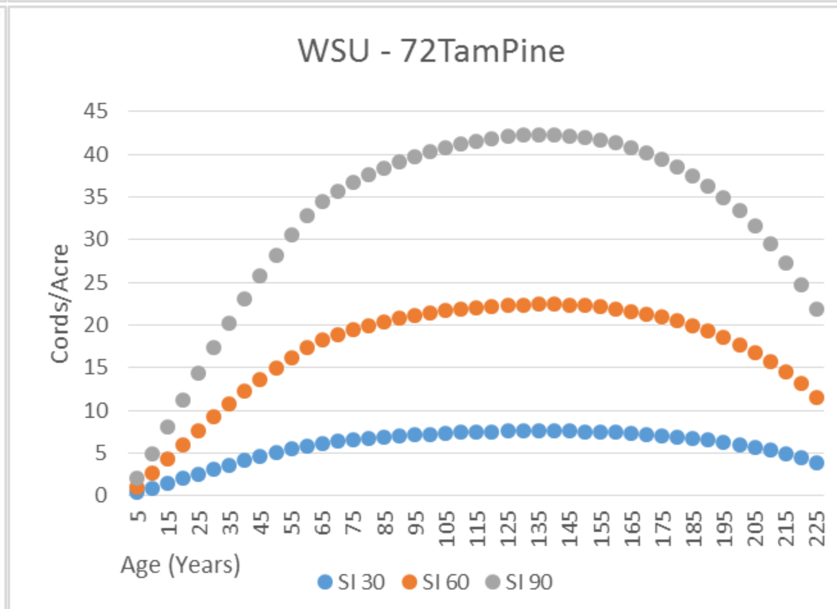

NSU - 71BlaSprLow
Cords/Acre
120
100
80
60
40
20
0
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
Age (Years)
SI 30
SI 60
SI 90


NSU - 72TamPine
Cords/Acre
60
50
40
30
20
10
0
5
15
25
35
45
55
65
75
85
95
105
115
125
135
145
155
165
175
185
195
205
215
225
Age (Years)
SI 30
SI 60
SI 90


WSU - 12Aspen
Cords/Acre
0 5 10 15 20 25 30 35 40 45 50
5 15 25 35 45 55 65 75 85 95 105 115 125
Age (Years)
SI 30 SI 60 SI 90


WSU - 52RedPinePlt
Cords/Acre
0 20 40 60 80 100 120
5 15 25 35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195 205 215 225
Age (Years)
SI 30 SI 60 SI 90


WSU - 71BlaSprLow
Cords/Acre
0 20 40 60 80 100 120 140 160 180 200
5 15 25 35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195
Age (Years)
SI 30 SI 60 SI 90


WSU - 72TamPine
Cords/Acre
0 5 10 15 20 25 30 35 40 45
5 15 25 35 45 55 65 75 85 95 105 115 125 135 145 155 165 175 185 195 205 215 225
Age (Years)
SI 30 SI 60 SI 90

Appendix J: Species Mix by Cover Type Data

The MN DNR yield tables represent stand-level basal area and volume by cover type and planning area, but many cover types have a mixed species composition. Accurate calculations of timber value strongly depend on knowledge of constituent species (Schuler 2004[14] Christensen and Peet 1981[15]), but this information is not explicitly available from the yield tables. Rather than build species-level yield tables, MN DNR used species composition from FIA data corresponding to SFRMPs, mapping the finer spatial scale of FIA composition assessments onto the more coarse scale of the FIM dataset.

The total volumes for each plot and each species' volume are tallied, then each species' total is divided by the plot totals, producing a percentage species occupies. This percentage is applied to the yield table. For example, if an aspen cover-type stand typically has on average 74% of its volume from aspen then 74% of the total estimated stand volume from the yield curve is assumed to come from aspen species, while the other 24% may come from other species such as spruce or other hardwoods in the proportion of volume they occupy.

As stated previously, species composition varies as a stand ages, however, stands nearing harvest are of most interest. Species compositions are developed for stands nearing normal rotation age (NRA) or the economic rotation ages (ERA) used by the DNR. This analysis used a minimum age for a plot to be included in species compositions, to be within 5-10 years of normal rotation age. In addition to the near rotation age species compositions, another set of species compositions was developed for NSU, NMOP, MDLP, and WSU. For these sections—aspen, black spruce, oak, northern hardwoods, and natural red pine cover types—species compositions were developed for three different age periods starting at age 0 and going 30-50 years beyond normal rotation age depending on cover-type. This was done to improve composition resolution through time in these major cover types before harvest, as well as after a potential harvest period to have greater resolution of potential species mixes in the standing and harvest inventory.

The MN DNR uses empirical yield tables, meaning future yields mirror those observed in historical stands of comparable site index from a similar geographic area (Leary, 1991[16]). Forest planning models can be more accurate if stand-level yields are calculated from growth models that use inventory-derived tree lists as their input. With this approach, planners avoid assuming that future stands will have the same species composition, size class distribution, and spatial configuration as those historical stands that

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[14] Schuler, Thomas M. "Fifty years of partial harvesting in a mixed mesophytic forest: composition and productivity." *Canadian Journal of Forest Research* 34.5 (2004): 985-997.

[15] Christensen, Norman L., and Robert K. Peet. "Secondary forest succession on the North Carolina Piedmont." *Forest succession*. Springer New York, 1981. 230-245.

[16] Leary, R.A. 1991. Near-normal, empirical, and identity yield tables for estimating stand growth. Ca. J. For. Res. 21: 353-362

defined the empirical yield tables. A tradeoff to using individual-based growth models is their requirement of detailed inventory data, as well as existence of a trustworthy model.

Developing growth model yield tables can also be a more expensive process than curve fitting procedures used to generate empirical yield tables. Growth models exist for many regions, e.g. USFS FVS Lake States variant, but may require calibration for specific locations, which is another data-limited step. Although the MN DNR can access FIM and FIA data that could serve as tree lists for model calibration and yield forecasting, we used the existing empirical yield tables to reduce costs and stay on schedule. In the next section, we compare MN DNR yields to yields reported in the literature using sources that reported empirical yields.

Appendix K: Species Composition by Cover Type

NMOP - General Species Composition for Each Cover Type																
Cover Type	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH
Ash	0.0967	0.0224	0.0550	0.0017	-	-	0.0114	0.0361	0.0069	0.0407	0.0444	0.0243	0.0044	0.0204	0.0067	0.6227
Lowland Hardwoods	0.0967	0.0224	0.0550	0.0017	-	-	0.0114	0.0361	0.0069	0.0407	0.0444	0.0243	0.0044	0.0204	0.0067	0.6227
Aspen	0.5723	0.2423	0.0247	0.0028	0.0001	0.0018	0.0134	0.0398	0.0219	0.0145	0.0148	-	0.0068	0.0073	0.0001	0.0372
Birch	0.0945	0.0080	0.2615	-	-	-	0.0315	0.1379	0.2387	0.1241	0.0398	-	-	-	-	0.0641
Balm of Gilead	0.5723	0.2423	0.0247	0.0028	0.0001	0.0018	0.0134	0.0398	0.0219	0.0145	0.0148	-	0.0068	0.0073	0.0001	0.0372
Northern Hardwoods	0.0658	0.0110	0.0789	-	-	-	-	0.0189	-	-	-	0.2333	0.1646	0.0141	0.3159	0.0949
Oak	0.0526	-	0.0174	-	-	-	-	-	-	-	-	0.1299	0.6933	0.0090	0.0508	0.0381
Central Hardwoods	0.0658	0.0110	0.0789	-	-	-	-	0.0189	-	-	-	0.2333	0.1646	0.0141	0.3159	0.0949
White Pine Natural	0.0911	-	0.0629	0.0042	0.5935	0.1499	0.0107	0.0053	-	-	-	0.0419	0.0101	-	0.0281	-
White Pine Planted	0.0911	-	0.0629	0.0042	0.5935	0.1499	0.0107	0.0053	-	-	-	0.0419	0.0101	-	0.0281	-
White Cedar	0.0182	0.0084	0.0414	-	0.0052	0.0350	-	0.0412	0.0502	0.0631	0.7276	-	-	0.0019	0.0021	0.0220
Red Pine-Natural	0.0247	-	0.0181	0.0607	0.0094	0.8455	0.0138	0.0095	0.0050	-	0.0043	-	-	-	-	-
Red Pine-Planted	0.0091	-	0.0003	0.0214	0.0056	0.9586	0.0026	0.0021	0.0001	0.0001	-	-	-	-	-	-
Jack Pine	0.0424	-	0.0268	0.7734	0.0521	0.0112	0.0187	0.0645	0.0079	-	-	-	0.0031	-	-	-
White Spruce-Natural	0.0614	0.0149	0.0258	-	-	-	0.6396	0.0981	0.0047	0.0442	0.0814	-	-	0.0299	-	-
White Spruce-Planted	0.0655	0.0118	0.0021	0.0207	0.0043	0.0094	0.8418	0.0146	0.0178	0.0062	0.0003	-	0.0005	0.0002	-	0.0014
Balsam Fir	0.0938	0.0399	0.0667	-	-	-	0.0505	0.4218	0.0991	0.0101	0.1544	-	-	-	-	0.0634
Black Spruce Lowlands	-	-	-	-	-	-	-	-	0.7783	0.1998	0.0219	-	-	-	-	-
Tamarack	-	-	0.0068	-	-	-	-	0.0020	0.1132	0.7940	0.0819	-	-	-	-	0.0020
Black Spruce Uplands	-	-	-	-	-	-	-	-	0.7783	0.1998	0.0219	-	-	-	-	-

NMOP -Species Composition at Different Age Points																	
Aspen	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-30	0.4773	0.0747	0.0747	0.0124	0.0046	0.0159	0.0220	0.0763	0.0065	0.0021	0.0114	0.0225	0.0608	0.0242	0.0369	0.1155	-
31-60	0.6843	0.0627	0.0165	0.0062	0.0003	0.0205	0.0278	0.0574	0.0072	0.0011	0.0125	0.0212	0.0198	0.0071	0.0189	0.0362	0.0004
61-90	0.6703	0.0534	0.0299	0.0057	-	-	0.0317	0.0387	0.0195	0.0118	0.0172	0.0206	0.0422	0.0013	0.0174	0.0395	0.0004
Oak	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.0584	0.0051	-	0.0356	-	0.0047	-	-	-	-	-	0.2945	0.4663	0.0269	0.0686	0.0400	-
41-80	0.1809	0.0314	0.0618	-	-	-	-	0.0291	-	-	0.0177	0.2891	0.2683	0.0076	0.0442	0.0585	0.0113
81-120	0.0316	-	-	-	-	-	-	0.0192	-	-	-	0.2436	0.5825	0.0008	0.0655	0.0450	0.0113
Black Spruce	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.0154	-	0.0170	-	-	-	0	-	0.5666	0.4011	-	-	-	-	-	-	-
41-80	0.0263	0.0016	0.0238	0.0051	0.0038	0.0011	0.0048	0.0152	0.7489	0.1344	0.0310	-	-	-	0.0013	0.0027	-
81-120	0	-	0.0123	-	-	-	0.0007	0.0061	0.6704	0.2331	0.0769	-	-	-	-	0.0004	-
North. Hard.	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.1735	0.0142	0.0128	-	-	-	-	0.0780	-	-	-	-	0.3174	0.1500	0.1547	0.0994	-
41-80	0.0958	0	-	-	0.0520	-	0.0025	0.0164	-	-	-	0.5300	0.0434	0.0194	0.1875	0.0484	0.0047
81-120	0.0462	-	0.0480	-	-	-	0.0048	0.0211	-	-	-	0.3691	0.1317	0.0082	0.3008	0.0656	0.0047
Red Pine	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-55	0.0450	0.0016	0.0311	0.0484	0.0206	0.7962	0.0169	0.0186	0.0066	-	-	0.0006	0.0076	0.0008	0.0061	-	-
56-111	0.0949	0.0013	0.0296	0.0889	0.0898	0.6324	0.0292	0.0181	0	-	-	-	0.0095	-	0.0056	0.0008	-
112-165	0.1291	-	0.0312	0.0448	-	0.6900	-	0.0859	0.0190	-	-	-	-	-	-	-	-

NSU - General Species Composition for Each Cover Type

Cover Type	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH
Ash	0.0816	0.0303	0.0765	-	0.0132	0.0004	0.0295	0.1011	0.0152	0.0172	0.0593	0.0018	0.0027	0.0022	0.0489	0.5109
Lowland Hardwoods	0.0816	0.0303	0.0765	-	0.0132	0.0004	0.0295	0.1011	0.0152	0.0172	0.0593	0.0018	0.0027	0.0022	0.0489	0.5109
Aspen	0.5659	0.0403	0.0730	0.0082	0.0125	0.0055	0.0487	0.1133	0.0336	0.0054	0.0062	0.0008	0.0012	0.0016	0.0494	0.0311
Birch	0.1368	0.0102	0.4744	0.0117	0.0118	-	0.0422	0.1166	0.0313	0.0083	0.0599	0.0012	0.0012	0.0003	0.0487	0.0401
Balm of Gilead	0.5659	0.0403	0.0730	0.0082	0.0125	0.0055	0.0487	0.1133	0.0336	0.0054	0.0062	0.0008	0.0012	0.0016	0.0494	0.0311
Northern Hardwoods	0.0763	0.0056	0.0830	0.0092	0.0317	-	0.0275	0.0650	0.0042	-	0.0354	0.0471	0.0139	0.0045	0.4885	0.0416
Oak	0.0526	-	0.0174	-	-	-	-	-	-	-	-	0.1299	0.6933	0.0090	0.0508	0.0381
Central Hardwoods	0.0763	0.0056	0.0830	0.0092	0.0317	-	0.0275	0.0650	0.0042	-	0.0354	0.0471	0.0139	0.0045	0.4885	0.0416
White Pine Planted	0.0252	-	0.0058	0.0090	0.0575	0.8551	0.0344	0.0063	0.0018	0.0011	0.0011	-	-	-	0.0011	-
White Pine	0.0342	0.0024	0.0448	0.0277	0.6817	0.0858	0.0509	0.0342	0.0168	-	-	-	0.0024	-	0.0174	0.0013
Red Pine-Natural	0.0906	-	0.0665	0.1223	0.0751	0.5051	0.0589	0.0222	0.0097	-	0.0062	-	0.0021	-	0.0315	-
Red Pine-Planted	0.0252	-	0.0058	0.0090	0.0575	0.8551	0.0344	0.0063	0.0018	0.0011	0.0011	-	-	-	0.0011	-
Jack Pine	0.0846	-	0.0408	0.6475	0.0121	0.0370	0.0209	0.0413	0.1025	-	0.0067	-	-	-	0.0060	-
White Cedar	0.0182	0.0084	0.0414	-	0.0052	0.0350	-	0.0412	0.0502	0.0631	0.7276	-	-	0.0019	0.0021	0.0220
White Spruce-Natural	0.1030	0.0046	0.0178	0.0415	-	0.0363	0.6818	0.0503	0.0520	0.0126	-	-	-	-	-	-
White Spruce-Planted	0.0539	0.0060	0.0171	0.0124	0.0025	0.0458	0.7845	0.0518	0.0092	0.0008	0.0061	-	-	0.0003	0.0063	0.0011
Balsam Fir	0.1540	0.0039	0.0945	0.0131	0.0194	0.0092	0.1053	0.2836	0.2061	0.0116	0.0430	-	-	0.0002	0.0417	0.0126
Black Spruce Lowlands	0.0092	-	0.0199	0.0070	0.0067	0.0039	0.0093	0.0235	0.7606	0.1498	0.0094	-	-	-	-	-
Tamarack	0.0122	-	0.0248	0.0253	-	-	-	0.0359	0.1889	0.6496	0.0530	-	-	-	-	0.0094
Black Spruce Uplands	0.0092	-	0.0199	0.0070	0.0067	0.0039	0.0093	0.0235	0.7606	0.1498	0.0094	-	-	-	-	-

NSU-Species Composition at Different Age Points

Oak	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41-80	-	-	-	-	-	0.0084	0.1962	0.0275	-	-	-	-	0.7343	-	0.0084	0.0122	0.0017
81-120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aspen	**ASP**	**BAG**	**BIR**	**JP**	**WP**	**RP**	**WS**	**BF**	**BS**	**TAM**	**WC**	**BASS**	**OAK**	**ELM**	**MAP**	**ASH**	**other**
0-30	0.4405	0.0141	0.0885	0.0115	0.0380	0.0049	0.0476	0.1398	0.0253	0.0023	0.0462	0.0065	-	0.0024	0.0864	0.0457	0.0004
31-60	0.6604	0.0341	0.0450	0.0065	0.0174	0.0132	0.0363	0.0919	0.0181	0.0016	0.0122	0.0023	0.0002	0.0010	0.0426	0.0155	0.0017
61-90	0.6477	0.0092	0.0757	0.0080	0.0087	0.0041	0.0474	0.1043	0.0257	0.0024	0.0116	0.0004	0.0001	0.0010	0.0068	0.0158	0.0311
Black Spruce	**ASP**	**BAG**	**BIR**	**JP**	**WP**	**RP**	**WS**	**BF**	**BS**	**TAM**	**WC**	**BASS**	**OAK**	**ELM**	**MAP**	**ASH**	**other**
0-40	0.1010	-	0.0429	0.0254	0.0197	0.0263	0.0013	0.1401	0.5313	0.0954	0.0166	-	-	-	-	-	-
41-80	0.0317	-	0.0130	0.0351	0.0190	0.0058	0.0271	0.0398	0.6867	0.1145	0.0233	-	-	-	0.0031	0.0010	-
81-120	0.0053	-	0.0082	0.0017	0.0024	-	0.0010	0.0087	0.8669	0.0894	0.0163	-	-	-	-	-	-
North. Hard.	**ASP**	**BAG**	**BIR**	**JP**	**WP**	**RP**	**WS**	**BF**	**BS**	**TAM**	**WC**	**BASS**	**OAK**	**ELM**	**MAP**	**ASH**	**other**
0-40	0.0696	0.0016	0.0549	0.0012	0.0182	-	0.0129	0.0576	0.0098	-	-	0.0737	0.0014	0.0006	0.6288	0.0308	0.0386
41-80	0.0761	0.0116	0.1320	0.0092	0.0348	-	0.0316	0.0553	0.0135	-	0.0341	0.0448	0.0212	0.0122	0.4822	0.0401	0.0012
81-120	0.0621	-	0.1355	0.0059	-	-	0.0261	0.0426	-	-	0.0327	0.0578	-	-	0.6022	0.0350	-
Red Pine	**ASP**	**BAG**	**BIR**	**JP**	**WP**	**RP**	**WS**	**BF**	**BS**	**TAM**	**WC**	**BASS**	**OAK**	**ELM**	**MAP**	**ASH**	**other**
0-55	0.0628	0.0054	0.0200	0.0664	0.0094	0.7856	0.0099	0.0237	0.0105	0.0008	0.0033	-	0.0003	-	0.0018	-	-
56-111	0.0731	-	0.0602	0.0400	0.1361	0.6011	0.0285	0.0158	0.0155	-	0.0091	-	0.0002	-	0.0200	0.0005	-
112-165	0.0208	-	0.0062	0.0129	0.2170	0.7310	0.0086	-	0.0035	-	-	-	-	-	-	-	-

MDLP - General Species Composition for Each Cover Type																
Cover Type	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH
Ash	0.0400	0.0400	0.0200	-	0.0100	-	-	0.0200	-	-	0.0400	0.0300	0.0300	0.0400	0.2000	0.5100
Lowland Hardwoods	0.0400	0.0400	0.0200	-	0.0100	-	-	0.0200	-	-	0.0400	0.0300	0.0300	0.0400	0.2000	0.5100
Aspen	0.6089	0.0823	0.0468	0.0128	0.0050	0.0058	0.0203	0.0665	0.0116	0.0068	0.0060	0.0087	0.0318	0.0116	0.0337	0.0335
Birch	0.1355	0.0106	0.4005	0.0150	0.0117	0.0106	0.0420	0.1084	0.0376	0.0424	0.0278	0.0069	0.0255	0.0111	0.0505	0.0498
Balm of Gilead	0.6089	0.0823	0.0468	0.0128	0.0050	0.0058	0.0203	0.0665	0.0116	0.0068	0.0060	0.0087	0.0318	0.0116	0.0337	0.0335
Northern Hardwoods	0.0900	0.0300	0.0500	0.0100	0.0100	0.0200	0.0100	0.0200	0.0100	-	-	0.1800	0.1200	0.0300	0.3700	0.0500
Oak	0.0889	0.0028	0.0315	0.0050	0.0042	0.0053	0.0030	0.0023	-	0.0010	0.0002	0.1290	0.5253	0.0378	0.0400	0.0413
Central Hardwoods	0.0900	0.0300	0.0500	0.0100	0.0100	0.0200	0.0100	0.0200	0.0100	-	-	0.1800	0.1200	0.0300	0.3700	0.0500
White Pine Natural	0.0714	0.0017	0.0400	0.0324	0.5554	0.1023	-	0.0321	0.0107	0.0038	-	0.0076	0.0679	0.0002	0.0290	0.0054
White Pine Planted	0.0714	0.0017	0.0400	0.0324	0.5554	0.1023	-	0.0321	0.0107	0.0038	-	0.0076	0.0679	0.0002	0.0290	0.0054
Red Pine-Natural	0.1300	0.0003	0.0520	0.1563	0.0573	0.4889	0.0204	0.0191	0.0062	-	0.0013	0.0008	0.0434	0.0009	0.0187	0.0009
Red Pine-Planted	0.0452	0.0036	0.0154	0.0361	0.0227	0.8178	0.0163	0.0166	0.0050	-	0.0010	0.0005	0.0070	0.0007	0.0083	0.0001
Jack Pine	0.0730	0.0025	0.0299	0.6425	0.0234	0.0720	0.0167	0.0551	0.0565	0.0044	-	-	0.0156	0.0016	0.0021	0.0022
White Spruce-Natural	0.0660	0.0024	0.0445	0.0104	-	0.0213	0.6489	0.1154	0.0198	0.0053	0.0275	0.0002	-	0.0237	0.0025	0.0067
White Spruce-Planted	0.0512	0.0038	0.0184	-	0.0036	0.0048	0.7847	0.0661	0.0062	0.0064	0.0094	0.0055	0.0182	0.0008	0.0093	0.0038
Balsam Fir	0.1116	0.0199	0.0809	0.0098	0.0298	0.0237	0.0678	0.2984	0.1437	0.0850	0.0735	-	0.0053	0.0010	0.0180	0.0629
Black Spruce Lowlands	0.0141	0.0005	0.0121	0.0144	0.0066	0.0031	0.0041	0.0240	0.7088	0.1947	0.0155	-	-	-	0.0012	0.0007
Tamarack	0.0035	0.0013	0.0109	0.0020	0.0042	0.0037	0.0018	0.0092	0.1264	0.7867	0.0408	-	0.0007	-	0.0010	0.0059
White Cedar	0.0182	0.0084	0.0414	-	0.0052	0.0350	-	0.0412	0.0502	0.0631	0.7276	-	-	0.0019	0.0021	0.0220
Black Spruce Uplands	0.0141	0.0005	0.0121	0.0144	0.0066	0.0031	0.0041	0.0240	0.7088	0.1947	0.0155	-	-	-	0.0012	0.0007

WSU-Species Composition at Different Age Points																	
Aspen	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-30	0.4380	0	0.0609	-	-	-	-	0.0165	0.0421	-	-	0.0856	0.1233	0.0158	0.1925	0.0178	0.0076
31-60	0.7200	0.0011	0.0480	0.0006	0.0061	0.0016	0.0054	0.0015	0.0017	-	-	0.0133	0.1077	0.0092	0.0549	0.0187	0.0102
61-90	0.6286	0	0.0881	0	-	-	-	0.0069	-	-	-	0.0020	0.1090	0.0007	0.1474	0.0042	0.0131
Oak	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.0827	-	0.0070	-	-	0.0242	-	-	-	-	-	0.0916	0.7243	0.0122	0.0129	0.0210	0.0241
41-80	0.0790	0.0004	0.0165	-	0.0048	0.0016	0.0010	0.0004	0.0018	-	0.0001	0.1477	0.5474	0.0097	0.0940	0.0823	0.0133
81-120	0.0757	0	-	0.0003	0.0076	-	-	0.0007	-	-	-	0.1579	0.5922	0.0148	0.0669	0.0606	0.0235
Black Spruce	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0	-	-	-	-	-	-	-	-	1.0000	-	-	-	-	-	-	-
41-80	0.0061	-	0.0129	-	0.0336	0.0144	-	-	0.6903	0.2426	-	-	-	-	-	-	-
81-120	0	-	-	-	0.0789	-	-	-	0.8579	0.0632	-	-	-	-	-	-	-
North. Hard.	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.0306	-	0.0476	-	-	-	-	0.0251	-	0.0224	-	0.1924	0.2210	0.0215	0.3905	0.0236	0.0253
41-80	0.1748	0.0003	0.0415	-	-	-	-	0.0064	-	-	-	0.1084	0.2293	0.0075	0.3510	0.0648	0.0160
81-120	0.0757	0.0032	0.0056	-	-	-	0.0106	0.0003	-	-	-	0.2088	0.2812	0.0248	0.3495	0.0319	0.0084
Red Pine	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-55	0.0145	-	0.0110	0.0010	0.0266	0.8856	0.0110	0.0198	0.0010	-	-	-	0.0012	0.0070	-	-	0.0214
56-111	0.3818	0	0.0477	0.1085	0.0033	0.2888	0	-	-	-	-	-	0.1313	0.0137	0.0199	-	-
112-165	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

WSU - General Species Composition for Each Cover Type																
Cover Type	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH
Ash	0.0502	0.0130	0.0234	-	-	-	0.0133	0.0417	-	0.0300	-	0.0420	0.0648	0.0700	0.0625	0.5825
Lowland Hardwoods	0.0502	0.0130	0.0234	-	-	-	0.0133	0.0417	-	0.0300	-	0.0420	0.0648	0.0700	0.0625	0.5825
Aspen	0.6625	0.0230	0.0600	-	-	-	0.0100	0.0300	0.0100	-	-	0.0100	0.0700	0.0120	0.0625	0.0500
Birch	0.2200	-	0.4300	-	0.0200	0.0120	0.0220	0.0900	-	-	-	-	0.0720	-	0.0940	0.0400
Balm of Gilead	0.6625	0.0230	0.0600	-	-	-	0.0100	0.0300	0.0100	-	-	0.0100	0.0700	0.0120	0.0625	0.0500
Northern Hardwoods	0.0800	-	0.0500	-	0.0120	-	-	0.0240	-	-	-	0.1800	0.2130	0.0100	0.3810	0.0500
Offsite Oak	0.0840	-	0.0200	-	-	0.0150	0.0250	-	-	-	-	0.1520	0.5800	0.0120	0.0800	0.0320
Oak	0.0840	-	0.0200	-	-	0.0150	0.0250	-	-	-	-	0.1520	0.5800	0.0120	0.0800	0.0320
Central Hardwoods	0.0900	0.0300	0.0500	0.0100	0.0100	0.0200	0.0100	0.0200	0.0100	-	-	0.1800	0.1200	0.0300	0.3700	0.0500
White Pine Natural	0.0700	-	-	-	0.5900	0.0900	0.0500	-	0.0500	0.0300	-	-	0.0800	-	0.0400	-
White Pine Planted	0.0700	-	-	-	0.5900	0.0900	0.0500	-	0.0500	0.0300	-	-	0.0800	-	0.0400	-
Scotts Pine	-	-	0.0200	0.0600	0.0100	0.8500	0.0100	0.0100	0.0100	-	-	-	0.0300	-	-	-
Red Pine-Natural	-	-	0.0200	0.0600	0.0100	0.8500	0.0100	0.0100	0.0100	-	-	-	0.0300	-	-	-
Red Pine-Planted	-	-	-	0.0300	0.0200	0.9100	0.0100	0.0100	0.0100	-	-	-	0.0100	-	-	-
Jack Pine	0.1400	-	0.0400	0.6200	-	0.1200	-	0.0700	-	-	-	-	0.0100	-	-	-
White Spruce-Natural	0.0900	-	0.0100	-	-	-	0.7800	0.0800	-	0.0400	-	-	-	-	-	-
White Spruce-Planted	0.0800	-	-	0.0100	0.0100	0.0200	0.8500	0.0100	0.0102	-	-	-	0.0100	-	-	-
Balsam Fir	-	-	0.0300	-	0.1700	-	0.0600	0.1000	-	0.3100	-	-	0.0300	0.0400	0.2500	0.0100
Black Spruce Lowlands	-	-	0.0100	-	0.0100	-	-	-	0.6200	0.3600	-	-	-	-	-	-
Tamarack	-	-	-	-	0.0300	-	-	-	0.1500	0.8000	-	-	-	-	0.0100	0.0200
White Cedar	-	0.0100	0.0200	-	0.0100	0.0100	0.0100	0.0300	0.0700	0.0800	0.7500	-	-	-	-	0.0100
Black Spruce Uplands	-	-	0.0100	-	0.0100	-	-	-	0.6200	0.3600	-	-	-	-	-	-

MDLP-Species Compositions at Different Age Points																	
Aspen	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-30	0.5105	0.0352	0.0447	0.0069	0.0206	0.0315	0.0197	0.0376	0.0020	0.0023	0.0074	0.0405	0.0979	0.0180	0.0562	0.0599	0.0089
31-60	0.7233	0.0338	0.0300	0.0070	0.0029	0.0168	0.0100	0.0313	0.0011	0.0020	0.0035	0.0145	0.0471	0.0065	0.0348	0.0342	0.0011
61-90	0.6627	0.0188	0.0471	0.0060	0.0069	0.0104	0.0178	0.0523	0.0067	0.0032	0	0.0261	0.0504	0.0069	0.0107	0.0305	0.0434
Oak	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.0829	0.0008	0.0055	0.0053	0.0134	0.0007	0.0036	0.0113	0	0	0.0355	0.2055	0.5526	0.0074	0.0496	0.0209	0.0050
41-80	0.1539	0.0100	0.0533	0.0104	0.0089	0.0120	0.0055	0.0051	0	0	0	0.1214	0.4612	0.0057	0.0971	0.0515	0.0039
81-120	0.0937	0.0056	0.0403	0.0007	0.0015	0.0091	0.0004	0.0122	0	0	0	0.1300	0.5493	0.0018	0.0905	0.0600	0.0046
Black Spruce	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.0208	-	0.0640	-	0.5344	-	-	0.1583	0.1179	0.1045	-	-	-	-	-	-	0
41-80	0.0266	-	0.0086	0.0100	0.0214	0.0025	-	0.0179	0.6208	0.2381	0.0510	0	-	-	-	0.0004	0.0027
81-120	0.0070	-	-	-	0	-	-	0.0012	0.6132	0.3187	0.0598	-	-	-	-	-	-
North. Hard.	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-40	0.1104	0.0047	0.0289	0	0.0111	0.0171	0.0100	0.0075	0	-	-	0.2622	0.2249	0.0153	0.2674	0.0254	0.0151
41-80	0.1344	0.0026	0.0833	0.0021	0.0143	0.0071	0.0084	0.0218	0.0003	-	0.0024	0.2210	0.1530	0.0030	0.3048	0.0332	0.0085
81-120	0.0622	0.0016	0.0562	0	0.0171	-	0.0014	0.0183	-	-	0.0118	0.2875	0.1262	0.0031	0.3482	0.0517	0.0147
Red Pine	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH	other
0-55	0.1413	0.0024	0.0283	0.1028	0.0327	0.5565	0	0.0025	-	-	-	0.0043	0.0833	0.0044	0.0257	0.0004	0.0155
56-111	0.1098	0	0.0521	0.0561	0.0898	0.6148	0.0041	0.0151	0	-	-	0.0019	0.0408	0.0001	0.0148	0	0.0005
112-165	0	-	0.1607	-	0.0272	0.6424	-	0.0937	0.0028	-	-	-	0.0017	-	0.0716	-	-

Rest of State - General Species Composition for Each Cover Type																
Cover Type	ASP	BAG	BIR	JP	WP	RP	WS	BF	BS	TAM	WC	BASS	OAK	ELM	MAP	ASH
Ash	0.0400	0.0400	0.0200	-	0.0100	-	-	0.0200	-	-	0.0400	0.0300	0.0300	0.0400	0.2000	0.5100
Lowland Hardwoods	0.0400	0.0400	0.0200	-	0.0100	-	-	0.0200	-	-	0.0400	0.0300	0.0300	0.0400	0.2000	0.5100
Aspen	0.6089	0.0823	0.0468	0.0128	0.0050	0.0058	0.0203	0.0665	0.0116	0.0068	0.0060	0.0087	0.0318	0.0116	0.0337	0.0335
Birch	0.1355	0.0106	0.4005	0.0150	0.0117	0.0106	0.0420	0.1084	0.0376	0.0424	0.0278	0.0069	0.0255	0.0111	0.0505	0.0498
Balm of Gilead	0.6089	0.0823	0.0468	0.0128	0.0050	0.0058	0.0203	0.0665	0.0116	0.0068	0.0060	0.0087	0.0318	0.0116	0.0337	0.0335
Northern Hardwoods	0.0900	0.0300	0.0500	0.0100	0.0100	0.0200	0.0100	0.0200	0.0100	-	-	0.1800	0.1200	0.0300	0.3700	0.0500
Oak	0.0889	0.0028	0.0315	0.0050	0.0042	0.0053	0.0030	0.0023	-	0.0010	0.0002	0.1290	0.5253	0.0378	0.0400	0.0413
Central Hardwoods	0.0900	0.0300	0.0500	0.0100	0.0100	0.0200	0.0100	0.0200	0.0100	-	-	0.1800	0.1200	0.0300	0.3700	0.0500
White Pine Natural	0.0714	0.0017	0.0400	0.0324	0.5554	0.1023	-	0.0321	0.0107	0.0038	-	0.0076	0.0679	0.0002	0.0290	0.0054
White Pine Planted	0.0714	0.0017	0.0400	0.0324	0.5554	0.1023	-	0.0321	0.0107	0.0038	-	0.0076	0.0679	0.0002	0.0290	0.0054
Red Pine-Natural	0.1300	0.0003	0.0520	0.1563	0.0573	0.4889	0.0204	0.0191	0.0062	-	0.0013	0.0008	0.0434	0.0009	0.0187	0.0009
Red Pine-Planted	0.0452	0.0036	0.0154	0.0361	0.0227	0.8178	0.0163	0.0166	0.0050	-	0.0010	0.0005	0.0070	0.0007	0.0083	0.0001
Jack Pine	0.0730	0.0025	0.0299	0.6425	0.0234	0.0720	0.0167	0.0551	0.0565	0.0044	-	-	0.0156	0.0016	0.0021	0.0022
White Spruce-Natural	0.0660	0.0024	0.0445	0.0104	-	0.0213	0.6489	0.1154	0.0198	0.0053	0.0275	0.0002	-	0.0237	0.0025	0.0067
White Spruce-Planted	0.0512	0.0038	0.0184	-	0.0036	0.0048	0.7847	0.0661	0.0062	0.0064	0.0094	0.0055	0.0182	0.0008	0.0093	0.0038
Balsam Fir	0.1116	0.0199	0.0809	0.0098	0.0298	0.0237	0.0678	0.2984	0.1437	0.0850	0.0735	-	0.0053	0.0010	0.0180	0.0629
Black Spruce Lowlands	0.0141	0.0005	0.0121	0.0144	0.0066	0.0031	0.0041	0.0240	0.7088	0.1947	0.0155	-	-	-	0.0012	0.0007
Tamarack	0.0035	0.0013	0.0109	0.0020	0.0042	0.0037	0.0018	0.0092	0.1264	0.7867	0.0408	-	0.0007	-	0.0010	0.0059
White Cedar	0.0182	0.0084	0.0414	-	0.0052	0.0350	-	0.0412	0.0502	0.0631	0.7276	-	-	0.0019	0.0021	0.0220
Black Spruce Uplands	0.0141	0.0005	0.0121	0.0144	0.0066	0.0031	0.0041	0.0240	0.7088	0.1947	0.0155	-	-	-	0.0012	0.0007

Appendix L: Regulated Uneven-Age Harvest Volumes

Cover Type	Administrator	Site Index	Regulated Uneven-Age Harvest Volume (Cords/Acre)
01Ash	F	45Minus	5.0
		50	5.3
		55	5.5
		60	5.8
		65	6.0
		70Plus	6.5
	W	45Minus	4.0
		50	4.3
		55	4.5
		60	4.8
		65	5.0
		70Plus	5.5
09LowHrdw	F	45Minus	5.0
		50	5.3
		55	5.5
		60	5.8
		65	6.0
		70Plus	6.5
	W	45Minus	4.0
		50	4.3
		55	4.5
		60	4.8
		65	5.0
		70Plus	5.5
20NorthHrdw	F	45Minus	7.0
		50	7.5
		55	8.0
		60	8.5
		65	9.3
		70	10.0
		75	11.0
		80	12.0
		85	12.0
		90	12.0

Cover Type	Administrator	Site Index	Regulated Uneven-Age Harvest Volume (Cords/Acre)
	W	45Minus	7.0
		50	7.5
		55	8.0
		60	8.5
		65	9.3
		70	10.0
		75	11.0
		80	12.0
		85	12.0
		90	12.0
30oak	F	45Minus	7.0
		50	7.5
		55	7.5
		60	7.8
		65	8.0
		70Plus	9.0
	W	45Minus	6.0
		50	6.5
		55	6.5
		60	6.8
		65	7.0
		70Plus	8.0
40CentHrdw	F	45Minus	7.0
		50	7.5
		55	8.0
		60	8.5
		65	9.3
		70	10.0
		75	11.0
		80	12.0
		85	12.0
		90	12.0
	W	45Minus	6.0
		50	6.5
		55	7.0
		60	7.5
		65	8.3

Cover Type	Administrator	Site Index	Regulated Uneven-Age Harvest Volume (Cords/Acre)
		70	9.0
		75	10.0
		80	11.0
		85	11.0
		90	11.0
51WhiPine & 51WhiPinePlt	F	45Minus	6.0
		50	7.3
		55	7.8
		60	8.3
		65	9.2
		70	10.0
		75	11.0
		80	11.0
		85	11.0
		90	11.0
	W	45Minus	6.0
		50	7.3
		55	7.8
		60	8.3
		65	9.2
		70	10.0
		75	11.0
		80	11.0
		85	11.0
		90	11.0
61WhitSpr	F	All	4.0
	W	All	4.0
73WhiCed	All	All	4.0

Appendix M: Thinning Harvest Volumes

Cover Type	Administrator	Entry	Thinning Volume (Cords/Acre)
01Ash	All	All	10
09LowHrdw	All	All	10
20NorthHrdw	All	All	10
30Oak	All	All	8
40CentHrdw	All	All	10
51WhiPinePlt	F	Thin #1	10
	F	Thin #2	12
	F	Thin #3	15
	F	Thin #4	15
	F	Thin #5	15
	F	Thin #6	15
	W	All	12
52RedPine	F	Thin #1	10
	F	Thin #2	12
	F	Thin #3	15
	F	Thin #4	15
	F	Thin #5	15
	F	Thin #6	15
52RedPinePlt	F	Thin #1	10
	F	Thin #2	12
	F	Thin #3	15
	F	Thin #4	15
	F	Thin #5	15
	F	Thin #6	15
	W	All	12
53JacPine	All	All	10
54ScotPine	All	All	10
61WhitSprPlt	All	All	10
79OffOak	All	All	8

Appendix N: Stumpage Revenue

Species	Harvest Type	Stumpage ($/Cord)		
		AP	BRP	All Other
Aspen	All	$ 3.50	$ 30.00	$ 35.00
Balm of Gilead	All	$ 2.80	$ 20.00	$ 28.00
Birch	All	$ 1.50	$ 23.00	$ 15.00
Basswood	All	$ -	$ 35.00	$ 14.00
Oak	All	$ -	$ 150.00	$ 32.00
Maple	All	$ -	$ 140.00	$ 14.00
Ash	All	$ 1.20	$ 45.00	$ 12.00
Elm	All	$ -	$ 22.00	$ 6.00
Black Walnut	All	$ -	$1,250.00	$ -
Cotton Willow	All	$ -	$ 10.00	$ 5.00
Other Hardwoods	All	$ 1.00	$ 25.00	$ 10.00
Balsam Fir	All	$ 1.80	$ 9.00	$ 18.00
Black Spruce	All	$ 2.40	$ 12.00	$ 24.00
Jack Pine	All	$ -	$ 15.00	$ 30.00
Red Pine	Non Red Pine CT	$ -	$ 29.00	$ 42.00
	Thin Age 30	$ 15.00	$ 15.00	$ 15.00
	Thin Age 35 – 40	$ 25.00	$ 25.00	$ 25.00
	Thin Age 45 – 50	$ 35.00	$ 35.00	$ 35.00
	Thin Age 55+	$ 50.00	$ 50.00	$ 50.00
	CC Age 60	$ 80.00	$ 80.00	$ 80.00
	CC Age 65 – 90	$ 85.00	$ 85.00	$ 85.00
	CC Age 90+	$ 75.00	$ 75.00	$ 75.00
Tamarack		$ 0.60	$ 3.00	$ 6.00
White Pine		$ -	$ 22.00	$ 32.00
White Spruce		$ -	$ 13.00	$ 26.00
White Cedar		$ 0.80	$ 4.00	$ 8.00

Appendix O: Forest-Age Diversity Goals

Planning Area	Forest Type	Age Class			
		1	2	3	4
AP	1	41	41	41	41
	2	20	20	20	20
	3	67	67	67	67
	4	1,415	1,415	1,415	1,415
	5	21,221	21,221	21,221	21,221
	6	465	465	465	465
	7	851	851	851	851
BRP	1	1	1	1	1
	2	693	693	693	693
	3	26	26	26	26
	4	1	1	1	1
	5	345	345	345	345
	6	12,532	12,532	12,532	12,532
	7	2,292	2,292	2,292	2,292
MDLP	1	4,719	4,719	4,719	4,719
	2	15,546	15,546	15,546	15,546
	3	4,406	4,406	4,406	4,406
	4	47,635	47,635	47,635	47,635
	5	86,549	86,549	86,549	86,549
	6	21,819	21,819	21,819	21,819
	7	11,623	11,623	11,623	11,623
MNIAM	1	120	120	120	120
	2	1,052	1,052	1,052	1,052
	3	90	90	90	90
	4	420	420	420	420
	5	2,885	2,885	2,885	2,885
	6	7,605	7,605	7,605	7,605
	7	1,043	1,043	1,043	1,043
NMOP	1	11,849	11,849	11,849	11,849
	2	5,255	5,255	5,255	5,255
	3	8,683	8,683	8,683	8,683
	4	163,618	163,618	163,618	163,618
	5	93,665	93,665	93,665	93,665
	6	767	767	767	767
	7	14,603	14,603	14,603	14,603
NSU	1	9,853	9,853	9,853	9,853
	2	13,488	13,488	13,488	13,488

Planning Area	Forest Type	Age Class			
		1	2	3	4
	3	10,327	10,327	10,327	10,327
	4	28,446	28,446	28,446	28,446
	5	64,825	64,825	64,825	64,825
	6	5,558	5,558	5,558	5,558
	7	4,658	4,658	4,658	4,658
WSU	1	780	780	780	780
	2	2,310	2,310	2,310	2,310
	3	1,063	1,063	1,063	1,063
	4	5,325	5,325	5,325	5,325
	5	31,746	31,746	31,746	31,746
	6	20,903	20,903	20,903	20,903
	7	5,860	5,860	5,860	5,860

Appendix P: NPC Growth Stages Goals

NPC	Growth Stage	Percentage of Acres
APn80	0-55	30
APn80	55-205	70
APn81	0-55	38
APn81	55+	62
FDc12	0-55	76
FDc12	55-115	22
FDc12	115+	2
FDc23	0-55	73
FDc23	55-75	18
FDc23	75-155	8
FDc23	155+	1
FDc24	0-55	71
FDc24	55-75	18
FDc24	75-155	10
FDc24	155-195	1
FDc24	195+	0
FDc25	0-55	40
FDc25	55-135	57
FDc25	135+	3
FDc34	0-55	47
FDc34	55-95	31
FDc34	95-135	13
FDc34	135-175	3
FDc34	175+	6
FDn12	0-55	61
FDn12	55-75	17
FDn12	75-195	20
FDn12	195+	2
FDn22	0-55	59
FDn22	55-75	16
FDn22	75-115	14
FDn22	115+	11
FDn32	0-55	57
FDn32	55-95	25
FDn32	95+	18
FDn33	0-35	14

NPC	Growth Stage	Percentage of Acres
FDn33	35-55	27
FDn33	55-125	44
FDn33	125+	15
FDn43	0-35	17
FDn43	35-55	30
FDn43	55-95	31
FDn43	95-115	5
FDn43	115+	17
FDs27	0-55	19
FDs27	55+	81
FDs37	0-75	79
FDs37	75+	21
FDs38	0-55	26
FDs38	55-135	72
FDs38	135+	2
FDw24	0-35	69
FDw24	35+	31
FDw34	0-35	64
FDw34	35+	36
FDw44	0-35	69
FDw44	35+	31
FFn57	0-55	31
FFn57	55-95	45
FFn57	95+	24
FFs59	0-35	7
FFs59	35-155	85
FFs59	155+	8
FPn62	0-55	14
FPn62	55+	86
FPn63	0-55	11
FPn63	55-115	36
FPn63	115+	53
FPn71	0-55	27
FPn71	55+	73
FPn72	0-55	13
FPn72	55+	87
FPn81	0-55	34
FPn81	55+	66
FPn82	0-55	23

NPC	Growth Stage	Percentage of Acres
FPn82	55+	77
FPs63	0-55	19
FPs63	55+	81
FPw63	0-55	27
FPw63	55+	73
MHc26	0-35	21
MHc26	35-55	31
MHc26	55-135	45
MHc26	135+	3
MHc36	0-35	7
MHc36	35-95	75
MHc36	95+	18
MHc37	0-55	40
MHc37	55-135	57
MHc37	135+	3
MHc47	0-55	23
MHc47	55-155	73
MHc47	155+	4
MHn35	0-55	39
MHn35	55-95	51
MHn35	95-205	8
MHn35	205-295	1
MHn35	295+	1
MHn44	0-35	24
MHn44	35-95	60
MHn44	95-195	14
MHn44	195+	2
MHn45	0-75	29
MHn45	75-95	16
MHn45	95-155	38
MHn45	155-195	3
MHn45	195+	14
MHn46	0-35	17
MHn46	35-95	68
MHn46	95+	15
MHn47	0-55	34
MHn47	55-75	31
MHn47	75-195	32
MHn47	195+	3

NPC	Growth Stage	Percentage of Acres
MHs37	0-55	24
MHs37	55-95	60
MHs37	95+	16
MHs38	0-35	7
MHs38	35-75	35
MHs38	75+	58
MHs39	0-35	4
MHs39	35-75	50
MHs39	75+	46
MHs49	0-55	18
MHs49	55+	82
WFn53	0-55	32
WFn53	55-75	10
WFn53	75-105	34
WFn53	105-155	15
WFn53	155+	9
WFn55	0-75	54
WFn55	75-195	43
WFn55	195+	3
WFn64	0-75	55
WFn64	75-135	35
WFn64	135+	10
WFs57	0-55	18
WFs57	55+	82
WFw54	0-55	52
WFw54	55-105	21
WFw54	105+	27

Appendix Q: Map of MN DNR Planning Areas