An Economic and Ecological Analysis of: Northern Hardwood Single-Tree Selection Order of Removal Procedures & Red Pine Plantation and Aspen Forest Rotation Ages

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Steigerwaldt Land Services, Inc.

Tomahawk, Wisconsin

Northern Hardwood Single-Tree Selection Order of Removal Procedures

Objectives

- To investigate pre- and post-harvest forest conditions following the Wisconsin Department of Natural Resources (WDNR) Order-of-Removal (OOR) in northern hardwood forests.

- Model alternative harvest scenarios to evaluate the economic and ecological consequences of OOR guidelines.

Key Components

- Forest inventory design.
- Comparison of residual harvest forest conditions between state, county, and private MFL lands.
- Comparison of alternative harvest scenarios' resulting forest structure and timber value to current harvest selection.

Two Project Components

- Native Community Analysis – case study
- Order of Removal Analysis - state, county, and private MFL lands

# Background and Methods: Native Community Analysis

- Native Community Study Area: Fred Luke Road timber sale
- 74 plots
- 1/16th acre merchantable plots with 1/100th acre pre-merch. plots

Native Community Background

"Management activities shall be designed to achieve land management objectives through natural processes and management techniques that mimic those processes whenever possible."

Selected State Forest Native Communities			
Forest	Property Acres (±)	Number of Areas	Estimated Percent of Property Acres
Northern Highland/American Legion	226,000	7 out of 22	20 percent
Flambeau River	88,000	10 out of 21	7 percent
Black River	68,000	12 out of 19	15 percent

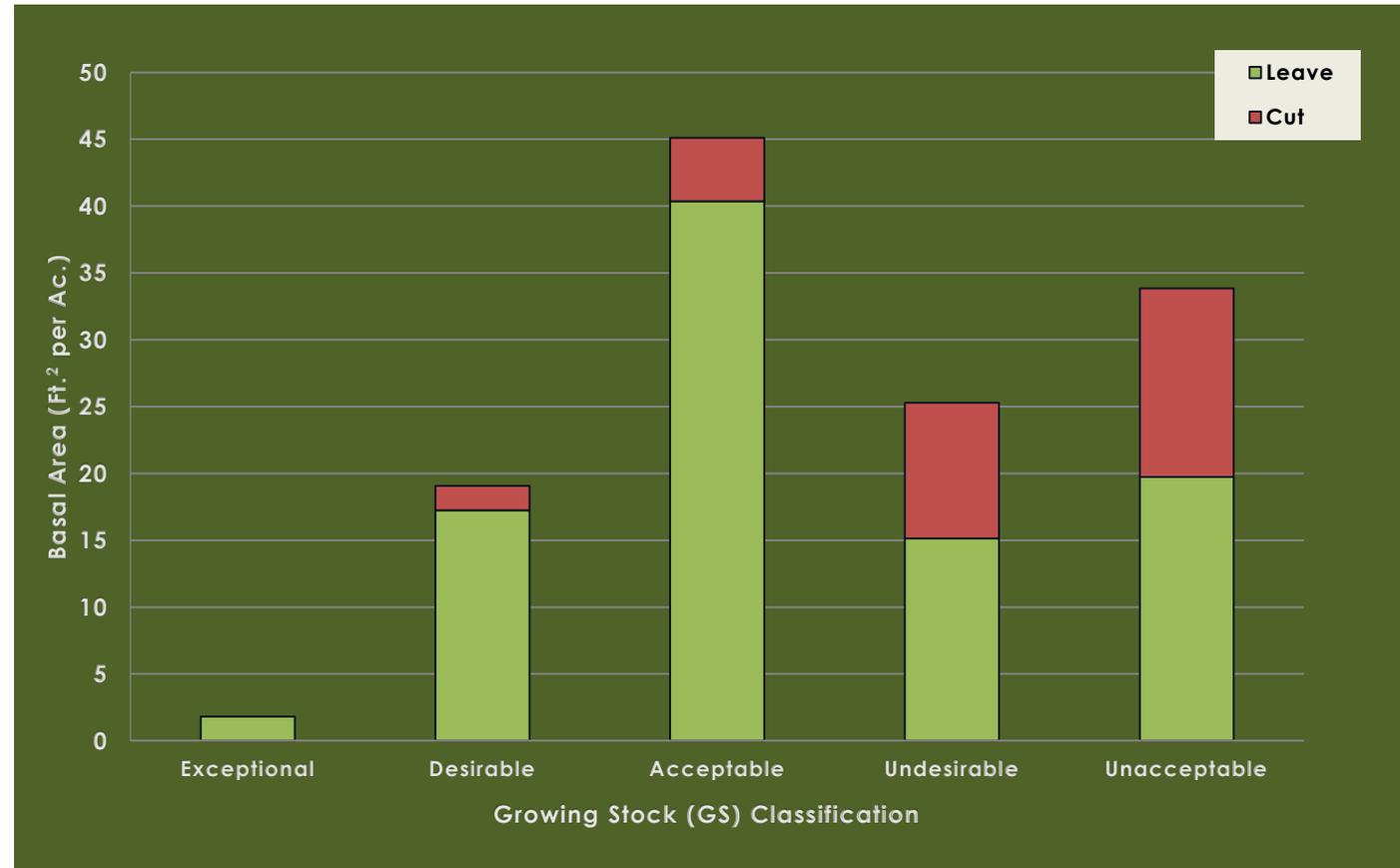# Native Community Analysis: Fred Luke Road Harvest
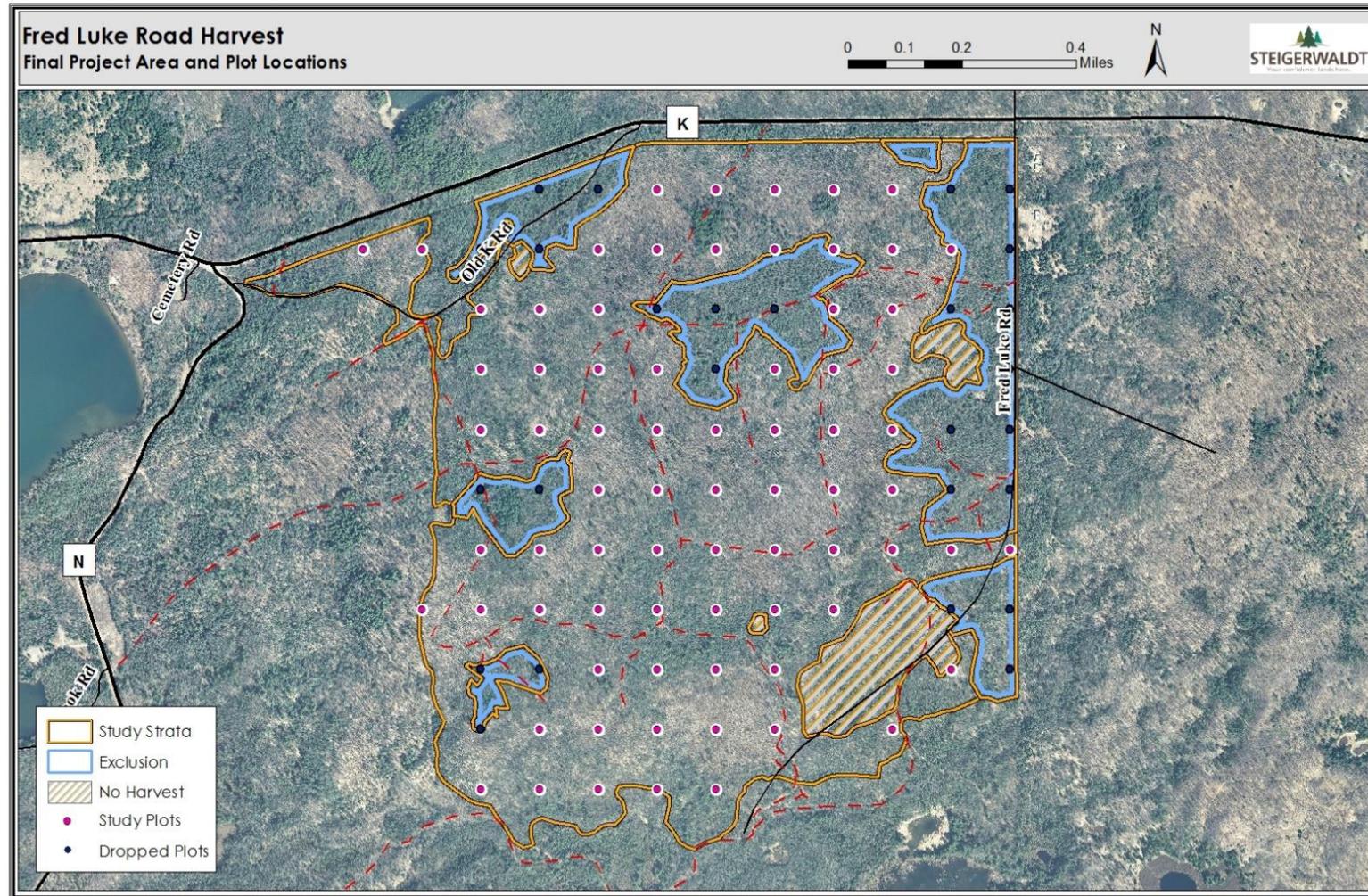
Current Harvest: Native Community Analysis

45 percent of the trees in the 5 to 9-inch DBH classes were selected for removal.
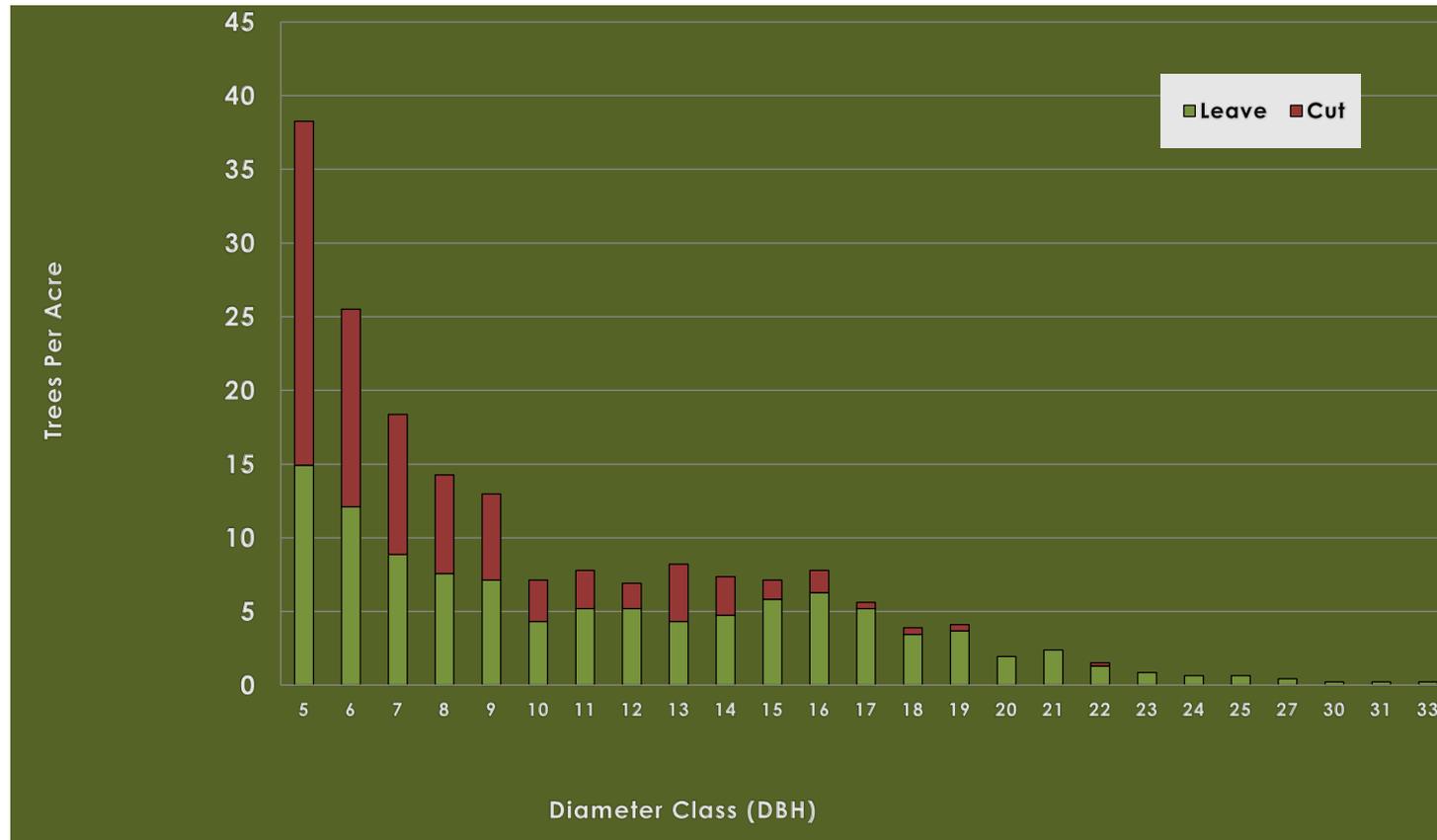
Current Harvest: Native Community Analysis

Lower quality growing stock (GS) was selected for most of the harvest.

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Model Approaches - Alternative Order of Removal Scenarios

- Index 1: Remove Risk – 60 to 65 percent of harvest BA
  - Remove trees in the worst GS classes
  - Additional weight given to sawtimber-sized trees

- Index 2: Remove Mature – 25 percent of harvest BA
  - Scenario 1: >=17 inches DBH
  - Scenario 2: >=19 inches DBH
  - Remove poor GS and top performers, which are likely economically mature

- Index3: Release Crop Trees – 10 to 15 percent of harvest BA
  - Remove trees in close proximity to other growing stock and those of low canopy position with low GS classification

Native Community Analysis: Comparing Alternatives

- Twice as many trees removed from 5- to 10-inch DBH classes in the existing selection.

- Alternative scenarios remove more stocking in the larger size classes.
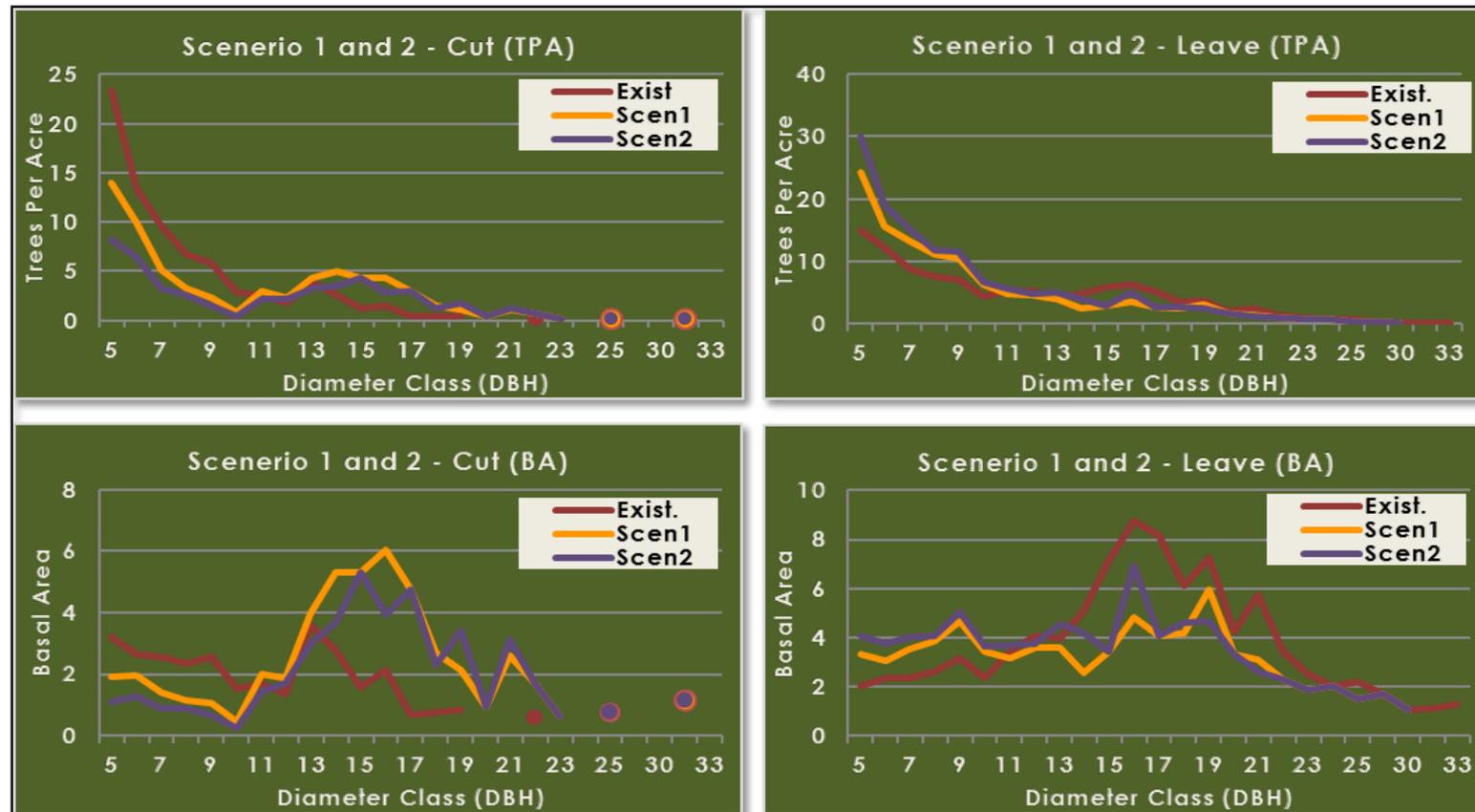
Native Community Analysis: Harvest Results

Native Community Harvest Comparison					
Existing		**Scenario 1**		**Scenario 2**	
Value Per Acre	**Value Per Acre**	**% Dif. From Existing**	**Value Per Acre**	**% Dif. From Existing**	
Cut	$565.43	$1,192.48	110.9%	$1,008.30	78.3%
Leave	$3,225.2	$2,598.1	-19.4%	$2,782.3	-13.7%
Total	$3,790.6	$3,790.6	-	$3,790.6	-
	Pulp (Tons)	**Pulp (Tons)**	**% Dif. From Existing**	**Pulp (Tons)**	**% Dif. From Existing**
Cut	15.6	25.4	63.1%	22.8	46.9%
Leave	39.7	29.9	-24.7%	32.4	-18.4%
Total	55.2	55.2	-	55.2	-
	Sawtimber (MBF)	**Sawtimber (MBF)**	**% Dif. From Existing**	**Sawtimber (MBF)**	**% Dif. From Existing**
Cut	594.6	1399.4	135.4%	1130.6	90.1%
Leave	5293.2	4488.4	-15.2%	4757.2	-10.1%
Total	5887.8	5887.8	-	5887.8	-
	Basal Area (Sq. Ft.)	**Basal Area (Sq. Ft.)**	**% Dif. From Existing**	**Basal Area (Sq. Ft.)**	**% Dif. From Existing**
Cut	30.8	49.7	61.4%	42.9	39.1%
Leave	94.3	75.4	-20.1%	82.2	-12.8%
Total	125.1	125.1	-	125.1	-

Native Community Analysis: Ecological Considerations

- Alternative scenarios focus on removing low GS trees.
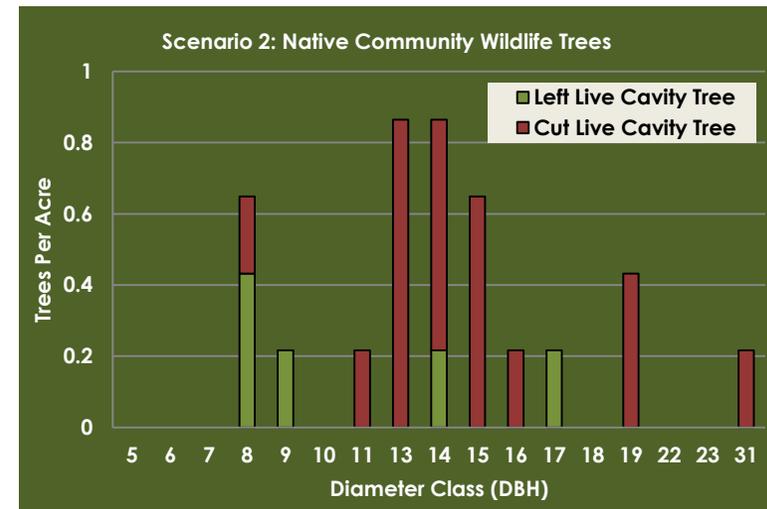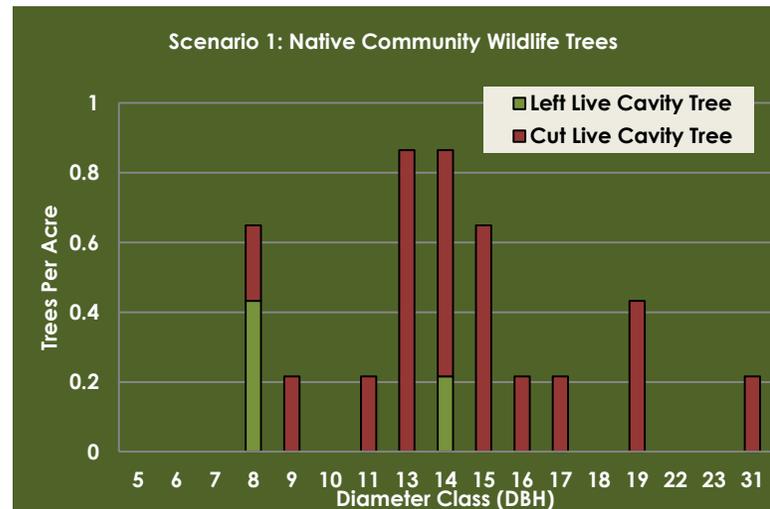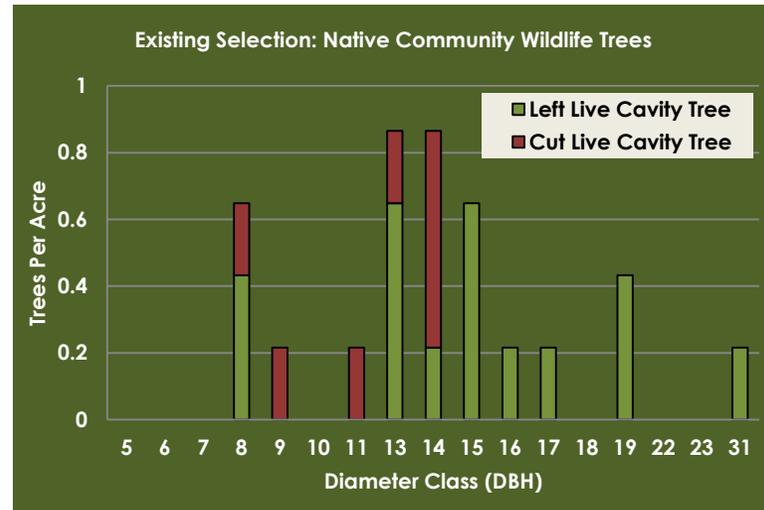
Native Community: Fred Luke Pre-Harvest Condition

Native Community: Fred Luke Existing Harvest, Post-Harvest Condition

Native Community: Fred Luke Scenario 1 Harvest, Post-Harvest Condition

Native Community: Fred Luke Scenario 2 Harvest, Post-Harvest Condition

Native Community Analysis Conclusions

- The alternative scenarios harvested about 15 to 25 percent more BA.

- More trees classified as unacceptable and undesirable were removed in both alternative harvests.

- Compared to the existing harvest, Scenario 1 removed over 3 times more trees in the 14-inch and larger classes.

- Compared to the existing harvest, both scenarios removed about half as much BA in the 5 to 10-inch classes.

- Harvest value increased by ±110 percent and 78 percent for Scenario 1 and 2, respectively.

# Order of Removal Analysis –
State, County, and Private MFL Forests

Methods: Order of Removal Analysis

- Northern hardwood sites on state, county, and private MFL land met the following criteria.
    - Stands 15 acres or larger
    - Sawtimber-sized stands, 11 to 15 and 15+ inch size classes
    - Sale sold after June 1, 2013
    - Marked but not yet cut
- Multi-radial fixed area plots:
    - 1/5th acre only sawtimber sized trees, 1/10th acre merch. timber 5 inches+, 1/100th acre regen. plot
- 8 plots per stand, 10 stands per ownership
- 240 plots total
- Additional 1-acre visualization plots
    - 3 plots per ownership, 9 total

OOR Analysis: Current Conditions

- Most of the stand structures suggest an even-aged forest structure.
- Harvest heavy to smaller size classes.
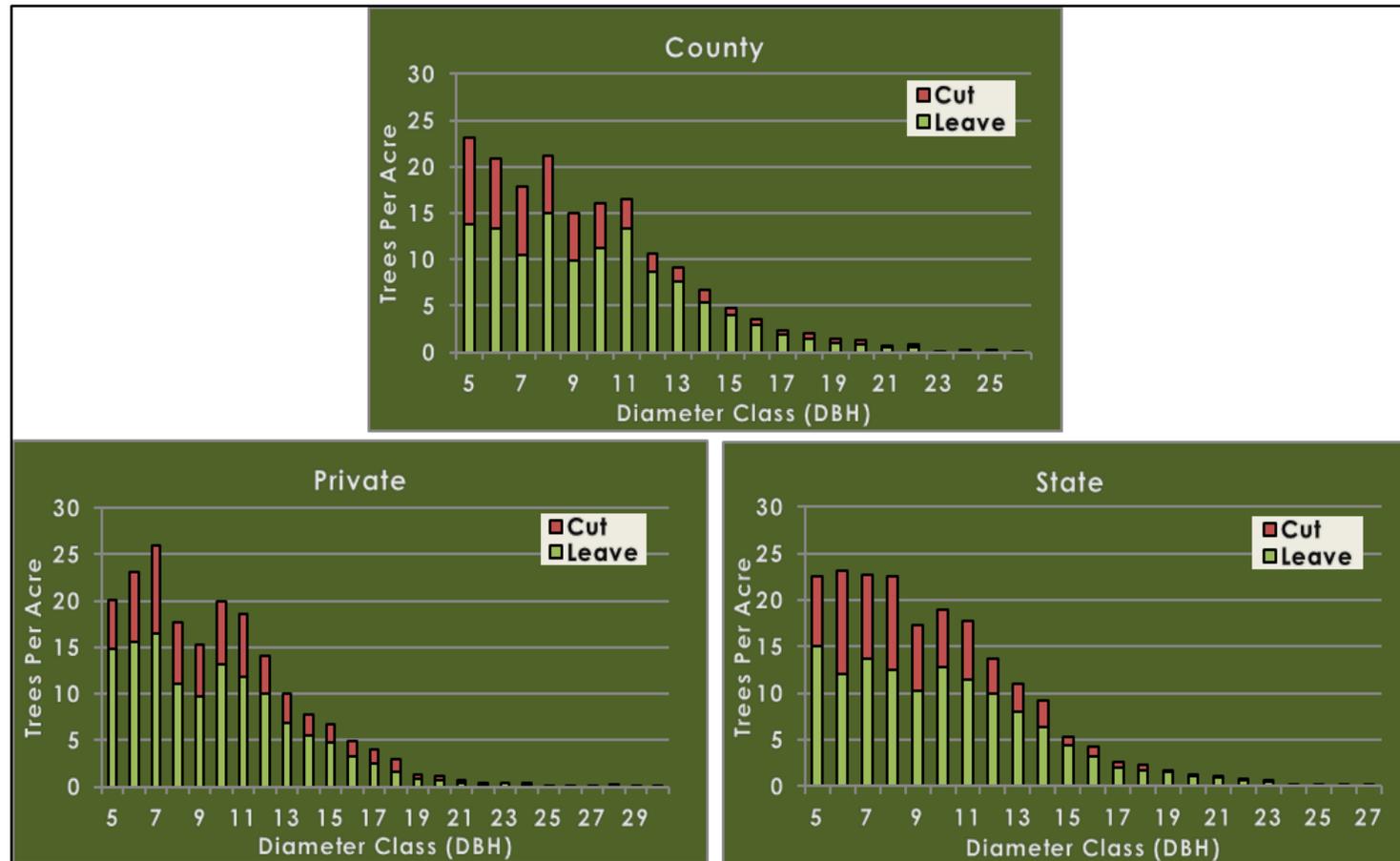
OOR Analysis:
Residual Stocking Statistical Comparison

- Average Residual Basal Areas
  - County = 75.11 sq. f.t
  - Private = 78.96 sq. ft.
  - State = 82.94 sq. ft.

- Residual not statistically across all landowner classes (through ANOVA test)

- Further, using a mean separation test (Tukey HSD test) found no combination of landowner groups to be statistically different as well

Alternative Harvests Results

Alternative harvests removed more unacceptable growing stock.
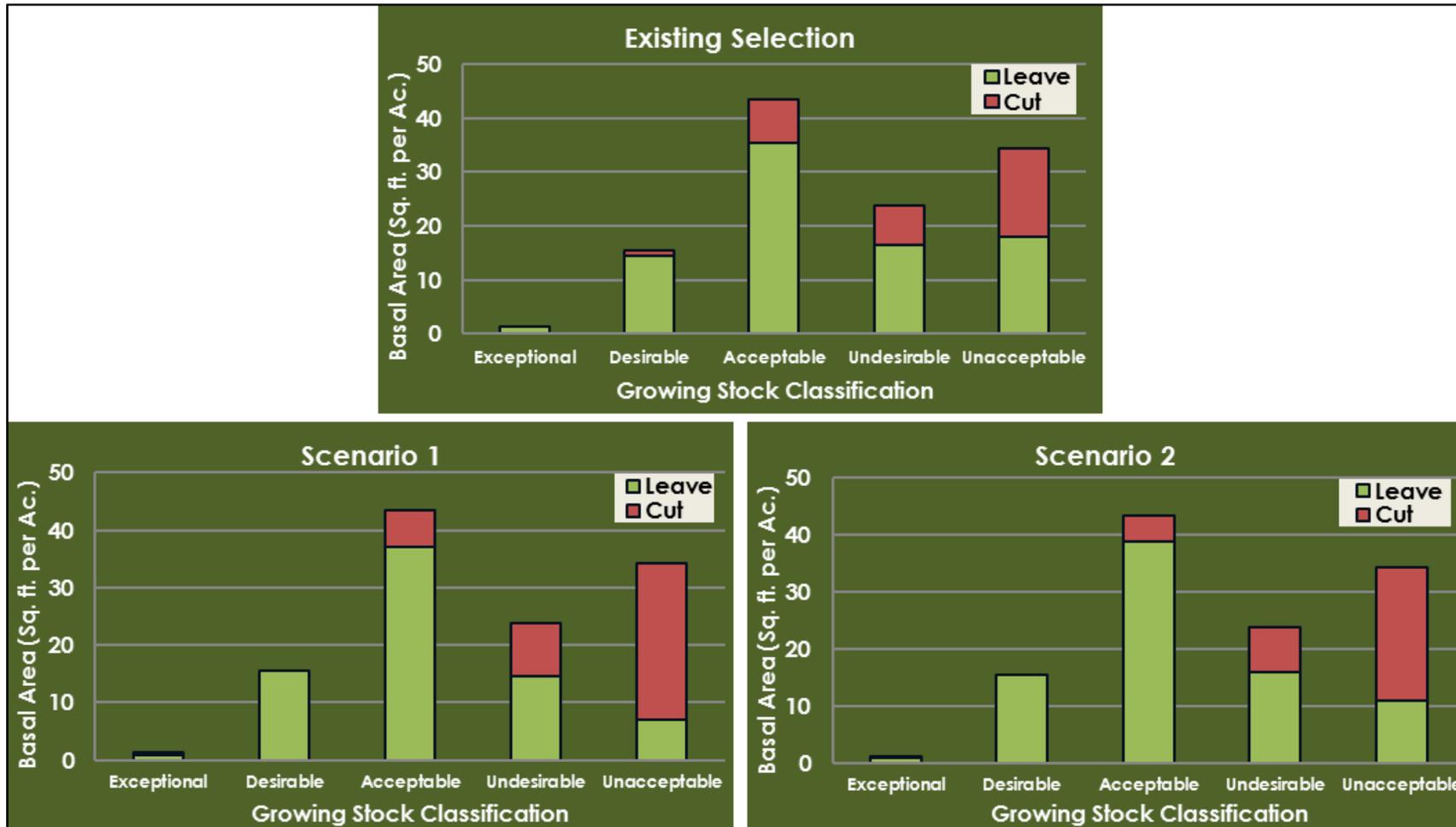
All Ownership Classes Harvest Comparison

- Scenario 1 resulted in an increase in harvest value.
- Scenario 2 had less harvest value and sawtimber harvested.

	Harvest Comparison All Plots				
	Existing	**Scenario 1**		**Scenario 2**	
	Value Per Acre	**Value Per Acre**	**Percent Dif.**	**Value Per Acre**	**Percent Dif.**
Cut	$641.40	$884.80	38.0	$740.60	15.5
Leave	$2,499.70	$2,256.20	-9.7	$2,400.40	-4.0
Total	$3,141.00	$3,141.00	-	$3,141.00	-
	Poletimber (Tons)	**Poletimber (Tons)**	**Percent Dif.**	**Poletimber (Tons)**	**Percent Dif.**
Cut	19.2	26.9	40.2	23.3	21.3
Leave	43.0	35.2	-18.0	38.9	-9.5
Total	62.1	62.1	-	62.1	-
	Sawtimber (MBF)	**Sawtimber (MBF)**	**Percent Dif.**	**Sawtimber (MBF)**	**Percent Dif.**
Cut	885.8	1014.1	14.5	812.4	-8.3
Leave	4366.3	4238.1	-2.9	4439.7	1.7
Total	5252.2	5252.2	-	5252.2	-
	Basal Area (Ft.2)	**Basal Area (Ft.2)**	**Percent Dif.**	**Basal Area (Ft.2)**	**Percent Dif.**
Cut	32.7	43.0	31.64	35.8	9.67
Leave	85.5	75.2	-12.09	82.3	-3.70
Total	118.2	118.2	-	118.2	-

OOR Analysis: Conclusions

- 63 to 77 percent of the existing harvests occur in the 5 to 10-inch DBH classes.

- No statistical difference in post-harvest stocking for all three landowners.

OOR Analysis: Conclusions (Cont.)

- Removals in the smaller size classes decreased, while the harvest in the large size classes increased for the alternative scenarios.

- Removals of low growing stock trees increased for both alternative scenarios.

- Scenario 1 resulted in a 16 to 48 percent increase in "cut" BA.

- Compared to the existing harvest, Scenario 1 resulted in a 46 percent increase in harvest value, on average for the three owners.

- Scenario 2 harvest value increased by only 9 percent on average, with the county forest reporting a 10 percent decrease.

An Economic and Ecological Analysis of:
Red Pine Plantation and Aspen Forest Rotation Ages

Objectives

Evaluate the WDNR rotation age guidelines for red pine plantation and aspen using discounted cash flow principles to identify financially optimal rotation lengths.

Key Components

- Individual Stand Simulation – Land Expectation Value (LEV) analysis for optimum rotation length by species.

- Woodstock Optimization Model – simulating the impact of the presence or absence of mandatory minimum rotation lengths.

Methods

- Data Acquisition: WI tax law program lands and requests to large landowners
- Models:
  - Aspen: Yield system developed by Ek and Brodie (1975)
  - Red Pine: Resinosa model Tim Mack University of Minnesota (2002)
  - Woodstock Optimization Model

Results: Aspen Financially Optimal Rotation Ages

- Based on Land Expectation Value (LEV) and a 5.5 percent discount rate
- Low quality sites (SI 60): 40 years
- Average quality sites (SI 70): 36 years
- High quality sites (SI 80): 33 years

LEV for Aspen on High Quality Sites

Results: Economic Impact of 40 Year Aspen Rotation

- No affect on low quality sites.

- Average quality sites have a decrease in LEV of $4.25 and high quality sites have a decrease of $18.85.

- Across all MFL lands there is a decrease of LEV of $1,710,366.

Summary of Impact - Aspen						
Site Quality	Proportion	Acres	LEV Per Acre	Total LEV	Diminution in LEV Per Acre	Total Diminution in LEV
Low	28 percent	91,220	$ 20.31	$ 1,852,668	$ -	$ -
Average	57percent	185,697	$ 78.75	$ 14,623,629	$ (4.25)	$ (789,212)
High	15 percent	48,868	$ 153.54	$ 7,503,131	$ (18.85)	$ (921,154)
Total	**100 percent**	**325,784**	**$ 73.61**	**$ 23,979,429**	**$ (5.25)**	**$ (1,710,366)**

Results: Red Pine Financially Optimal Rotation Ages

- Based on Soil Expectation Value (SEV) and a 5.5 percent discount rate.

- A shorter 3 thinnings regime produces more value than 60 years with 4 thinnings.

- Low quality sites (SI 62): 54 years

- Average quality sites (SI 65): 50 years
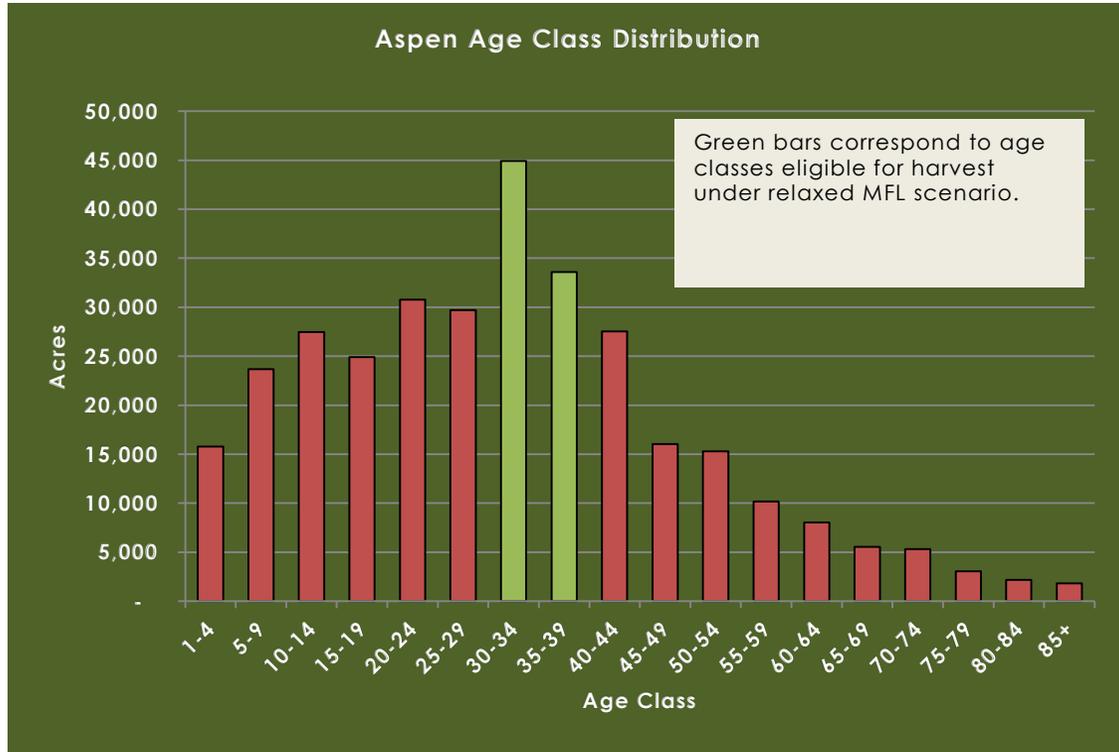
- High quality sites (SI 72): 48 years

Red Pine SEV Results by Site Index			
Result	**Low (62)**	**Avg. (65)**	**High (72)**
Unconstrained, 3-thin Max. SEV	$7.18	$76.22	$120.93
Rotation (Years) at Max. SEV	54	50	48
SEV When Constrained to 60 Years	($2.02)	$63.23	$99.24
Reduction in SEV	($9.20)	($12.99)	($21.69)

Results: Economic Impact of 60 Year Red Pine Rotation

- On the average the 60 year rotation creates a decrease in SEV of $13.97.

- Across all MFL lands this creates a decrease in SEV of $3,505,044.

Red Pine SEV Economic Impact						
Site Quality	Proportion	Acres	Optimal SEV Per Acre	Total SEV	Diminution in SEV Per Acre Due to 60 Years	Total Diminution in SEV
Low	20 percent	50,172	$7.18	$ 360,238	($9.20)	$ (461,586)
Average	60 percent	150,517	$76.22	$ 11,472,421	($12.99)	$ (1,955,218)
High	20 percent	50,172	$120.93	$ 6,067,348	($21.69)	$ (1,088,239)
Total	**100 percent**	**250,862**	$71.35	**$ 17,900,007**	($13.97)	**$ (3,505,044)**

Results: Current "Woodbasket"

Aspen Age Class Distribution

Green bars correspond to age classes eligible for harvest under relaxed MFL scenario.

Red Pine Age Class Distribution

Green bars correspond to age classes eligible for harvest under relaxed MFL scenario.

Conclusion

- Current rotation age guidelines restrict optimal economic timber management.

- Relaxation of the guidelines would increase the potential wood supply.

- Relaxing guidelines would increase present value of future cash flows.