



August 18, 2011

William Beardsley
Commissioner
Maine Department of Conservation
22 State House Station
Augusta, ME 04333-0022

RE: Spruce-fir Resource in the State of Maine

Dear Commissioner:

James W. Sewall Company is pleased to present the following summary of our independent assessment of the spruce/fir resource in the State of Maine. This work was contracted with the Department on July 7th under AdvantageME CT no. 20110714*0195.

SPRUCE/FIR RESOURCE

Executive Summary

The spruce/fir resource appears to have a healthy starting inventory which was roughly in balance between growth and drain over the last five-year inventory cycle. Modeling shows that there is an opportunity over the next twenty years to significantly increase the harvest levels of spruce/fir while still maintaining current levels of total spruce/fir standing inventory. In previous runs of the same model, we demonstrate that spruce/fir standing inventory would build significantly if the harvest levels remained at or below the average levels harvested over the last three years.

Intuitively, this makes sense because a large amount of spruce/fir land was regenerated (as a result of both timber harvesting and the budworm) during the 70s and 80s, and will become merchantable over the next twenty years. This is confirmed by the age class distribution in the most recent FIA inventory with a significant bubble in the acreage in age classes from 16-35 years. The first of these age classes continues to gain merchantability within the twenty year span of the projection.

It appears that there are two opportunities based on our analysis. The short-term opportunity would be to accelerate the harvest from the current three-year low back to the 10-year average (approximately a 15% increase potential). The longer-term opportunity to increase harvest levels comes with the influx of these younger stands over the next twenty years.

Being prudent about future risk, there is always the chance of another spruce budworm (*Choristoneura fumiferana*) infestation or widespread loss to wildfire. We discuss several reasons that we believe this is not the same level of concern it has been in the past.

Study Area

For the purposes of this study we looked at timberlands in the State of Maine excluding federal lands. Private, State and other commercial timberlands are included, resulting in just over 17 million acres of timberland.

Current Estimated Standing Inventory and Growth/Drain

The standing inventory of merchantable spruce/fir growing stock (sawlogs and pulpwood) in the State of Maine is estimated to be 150 million tons.¹ These estimates were derived using the U.S.D.A. Forest Service Forest Inventory and Analysis (FIA) dataset, which was just updated for the measurement of the 2010 panel.² For comparative purposes, this amount of standing inventory represents approximately 37 years of recent average spruce/fir harvest in the State.³

The latest inventory shows an overall State-wide growth/drain ratio of 0.98, which indicates that over the ten-year FIA change period spruce/fir growth was approximately 98% of what was harvested. FIA inventory data estimate the growth of spruce/fir to be 4.7 million tons. FIA drain is estimated to be 4.8 million tons.

Spruce/fir harvest has declined in the State of Maine over the last ten years. The State Wood Processor Report data shows that spruce/fir harvest in the State has decreased over this ten year period by approximately 25%.⁴ Trial fit of a linear regression trend line produces an R² of 0.704.

It is likely with the decreased harvesting pressure on the spruce/fir resource in five of the last six years that actual growth/drain in spruce/fir is now positive. It will take several more cycles of annual inventory for this trend to be reflected in the data.

FUTURE SPRUCE/FIR PROJECTIONS

Total Spruce/fir

Sewall biometricians modeled this same 17 million acres of timberland forward in time for 20 years. Several “runs” were performed to validate the constraints and to assess how the resource reacted under differing harvest and inventory constraints. The data from the model run reported here was configured to optimize the total spruce/fir harvest subject to numerous constraints:

- The starting harvest levels in the model were set to 4.76, with 47% of this being sawlog material (the approximate 10-year average spruce/fir harvest and mix as reported by FIA).
- Sewall allowed the model flexibility after year one to shift the mix between sawlogs and pulpwood.
- The model is constrained to end up with the same amount (or more) of total standing inventory of spruce/fir as it started with.
- Numerous other forest condition constraints as explained in the model assumptions (appendix A)

Results show that the total spruce/fir harvest can be increased in year one to the 10-year historical harvest level of approximately 4.8 million tons estimated from FIA data without adverse effect on standing inventory. Harvest can be further increased to 7.8 million tons by the end of the 20-year period while still maintaining standing inventory of total spruce-fir growing stock at current levels. This

¹ Throughout this report we will express units only in tons. Conversion factors used are: Tons to cords -> divide tons by 2.1; tons to thousands of cubic feet -> divide tons by 24.71; tons to Mbf -> divide tons by 4.2

² FIA data in Maine is collected on a five-year cycle, with roughly one-fifth of the plots being inventoried each year. The data set used included panels from 2006-2010. Change detection (i.e.: growth and drain) is done by comparing plots from one panel year (2010) with the same plots taken five years earlier (2005).

³ The denominator used was the FIA 10-year harvest data as modified by trend analysis using the State Wood Products Report years 2007-2009.

⁴ For purposes of this calculation the three-year average from 2000-2002 was compared to the three-year average of 2007-2009.

reflects an increase of 64% over the period.⁵ The model predicts an average annual harvest level of spruce/fir over the twenty-year period of 5.86 million tons, which is about a 23% increase over the 10-year historical average drain reported by FIA. It is important to remember that the model does not build total standing inventory across the same time period at these harvest levels.⁶

The harvest graph demonstrates that the model selects to hold the harvest level fairly flat until year 2021. This is most likely a function of the model using five-year diameter classes. In the forest, this transitional influx of merchantability would be much smoother than the model depicts.

By Product Class

The model uses slightly modified FIA definitions for product classes, which are not what the industry uses as it purchases fiber (i.e., much of what is classified as pulpwood in FIA can be utilized in high efficiency sawmills). In this study, spruce/fir sawlogs are defined as having proper form, a 9" diameter breast height (dbh), and a top diameter to 4". Pulpwood stems are defined as those with a dbh of 5" to 8.99", plus larger trees that do not have the form to be classified as sawlogs. For purposes of interpreting this report one can think of the pulpwood class as trees suitable for the pulpwood and studwood mills, and of the sawlog category as being sawlog-form trees greater than 9" dbh. Sewall excluded trees classified as "rotten cull" from the analysis.

This run of the model is not constrained to any specific product mix (ratio of sawlog and pulpwood inventory). In doing this, the model selects to harvest a larger amount of pulpwood/studwood volume in the first 10 years and a lesser amount of sawlog volume.

The model is able to increase the pulpwood/studwood harvest at the end of the period to 4.9 million tons/year (a 95% increase) and builds standing inventory levels in this product class by 17%. Average harvest volume over the period is approximately 3.58 million tons, which is roughly 42% higher than the 10-year historical cut in this product class. Much of this is due to the influx of younger age classes that are beginning to show merchantable volume. This can be seen after year 2021 on the harvest graph as the total harvest volume increases, and in the age class distribution graph in the Appendix.

Harvest of sawlog trees averages 2.28 million tons/year over the period, representing a 2% increase over the historical cut. The average harvest at the end of the period is approximately 29% higher than the starting volume, however harvest levels in the first ten years decline to a low of 1.3 million tons, before increasing again. Standing inventory of sawlogs is reduced by 19% over the period, offsetting the increase in pulpwood/studwood standing inventory.

Sewall urges caution when interpreting the data not to focus on product mix changes from year to year. These are a function of the model optimization and are not accurately predictive. What are more instructive are the overall averages and trends that the model demonstrates.

Risks of Natural Disaster

The spruce budworm *Choristoneura fumiferana* (Clemens) is a destructive native insect in the spruce and fir forests of Maine. Periodic outbreaks that may reach epidemic proportions are most often associated with the maturing of balsam fir. Balsam fir is the species most severely damaged by the budworm in the

⁵ For purposes of these comparative calculations, the average of the last five years in the model (years 16-20) are compared with year one.

⁶ In this run of the model, total standing inventory builds by only 2%.

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eastern United States. White, red, and black spruce are also host species and occasional feeding may occur on tamarack, pine, and hemlock.

Budworm outbreaks develop and gain momentum in the northeastern United States when there is a large proportion of mature and over-mature balsam fir in the forest. Management practices including a greater use of balsam fir, regulating age classes to prevent the occurrence of over-mature balsam fir over large areas, and favoring or planting less susceptible species such as spruce make conditions generally unfavorable to the budworm and may materially reduce the risk of an outbreak.

The Maine Forest Service continues to survey spruce budworm population levels and trends in Maine, and monitors the reports from neighboring jurisdictions. While the exact timing, length and magnitude of the next budworm event in Maine is uncertain, it is probable that the budworm will return in numbers large enough to significantly impact the spruce/fir resource. Maine Forest Service entomologists reason that the large quantity of spruce and fir forest approaching maturity can accelerate the conditions leading to an outbreak. Damage can be minimized by keeping the forest healthy and not letting it become over mature, as it did in the 70's and early 80's (last outbreak).

The other potential large loss could come from wildfire. Maine has done a great job of prevention and suppression of forest fires. Historical records indicate that fires frequently consumed 50,000 acres of forest per year, occasionally exceeded 100,000 acres per year, and burned 213,000 acres during the landmark year of 1947. Fire loss since the 1960's is reported as less than 5,000 acres per year and more typically about 1,000 acres, an insignificant amount to include in a statewide analysis.


Both of these risks are partially mitigated by the extensive road system now in place, and by the condition of the forest (younger, more vigorous and more stratified in terms of age class, stand size class, and stocking).

Thank you for the opportunity to offer our services.

Sincerely,



David Edson
President
James W. Sewall Company
State of Maine Licensed Professional Forester 694



Dave Stevens
Vice President
James W. Sewall Company

APPENDIX A: METHODOLOGY AND ASSUMPTIONS

FIA

- 2010 Data Set, including panels from 2006-2010
- Based on timberland area on non-Federal timberlands
- Units are reported in tons. Conversion factors for spruce/fir: 85 cubic feet/cord, 2.1 tons/cord
- Product volumes are as reported by FIA (except S/F)
 - S/F sawtimber is assumed to a 4" top for all sawtimber grade trees. (9"+).
 - In reality studwood would go lower than 9" DBH. All wood less than 9" is assigned to pulpwood.
 - S/F sawtimber estimates are conservative by current market standards.
- Rough cull is included in pulpwood volumes. We make the assumption that these trees could go to the mill.

WPR

- WPR removals based on the Department of Conservation – Maine Forest Service Wood Processor Reports (years 2000-2009).

Growth Modeling (Woodstock yields)

- Plots with BA < 30 square feet are grown using *Fiber*,⁷ using the FIA volumes as the starting inventory volume. Yields based on prior JWS modeling.
- Non- managed plots (not planted and no PCT) grown in *FVS*⁸, using the FIA volumes as the starting inventory volume.
 - Grown 25 years using 5-year cycles.
 - Using trees 1" and larger.
 - Used a mortality multiplier of an additional 4% over FVS mortality model to temper growth rates. (Starting growth rate equals that indicated by 2010 FIA data set.)
- Managed stands grown using *GNYP*⁹ yield tables from prior JWS modeling.

Woodstock parameters

- Objective: maximize S/F cut volume over time.
- Model grown for 25 years. Results reported for first 20. (Done to avoid "end of model funny business" when optimizing.)
- Model constrained to produce "even flow" for key species. In this case even flow is defined as the average range of variability for these species dating back to 1990. The purpose of this constraint is to produce a historical range of variability for wood flows, preventing unrealistic trends. (i.e.: the model unrealistically cuts a whole lot of hardwood in an attempt to maximize S/F production.) Key species variability for this constraint are as follows:
 - Total Cut: 28%
 - Total S/F Cut: 41%
 - Total Pine Cut: 29%
 - Total Hemlock Cut: 50%

⁷ Solomon, Dale S.; Hosmer, Richard A.; Hayslett, Homer T., Jr. 1987. FIBER handbook: a growth model for spruce-fir and northern hardwood types. NE-RP-602. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 19 p

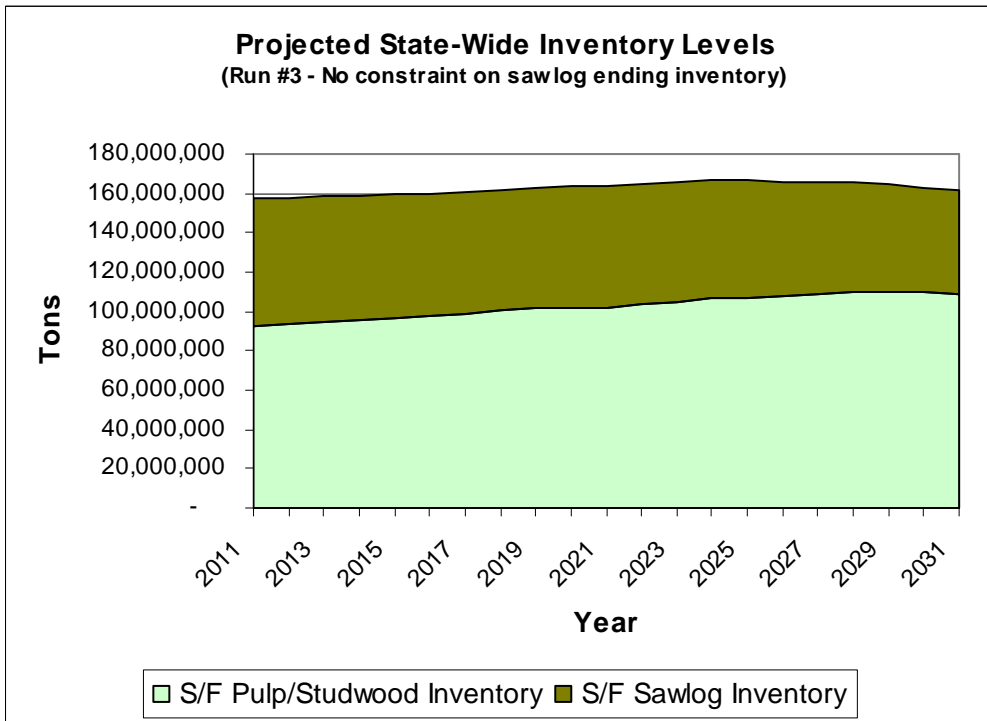
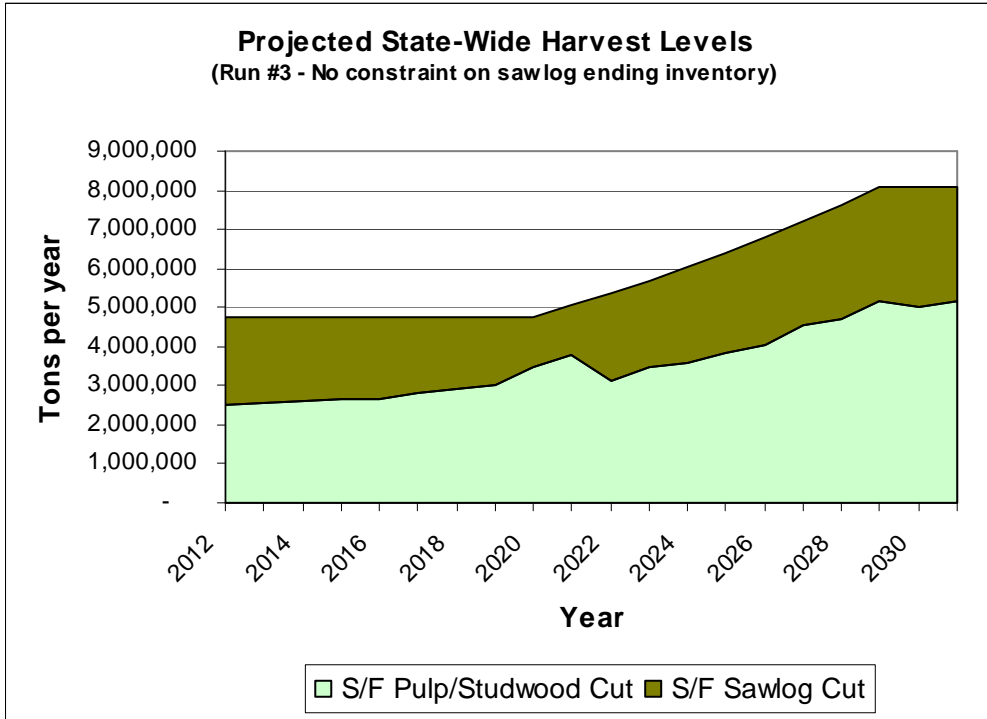
⁸ <http://www.fs.fed.us/fmnc/fvs/description/index.shtml>

⁹ Nova Scotia Growth and Yield Model Version 2. Brad MacPhee, Timothy P. McGrath. Timber Management Group Forest Management Planning Section, Forestry Division, Department of Natural Resources, Nova Scotia Government, Nova Scotia, Canada. Report FOR 2006-3 No. 79

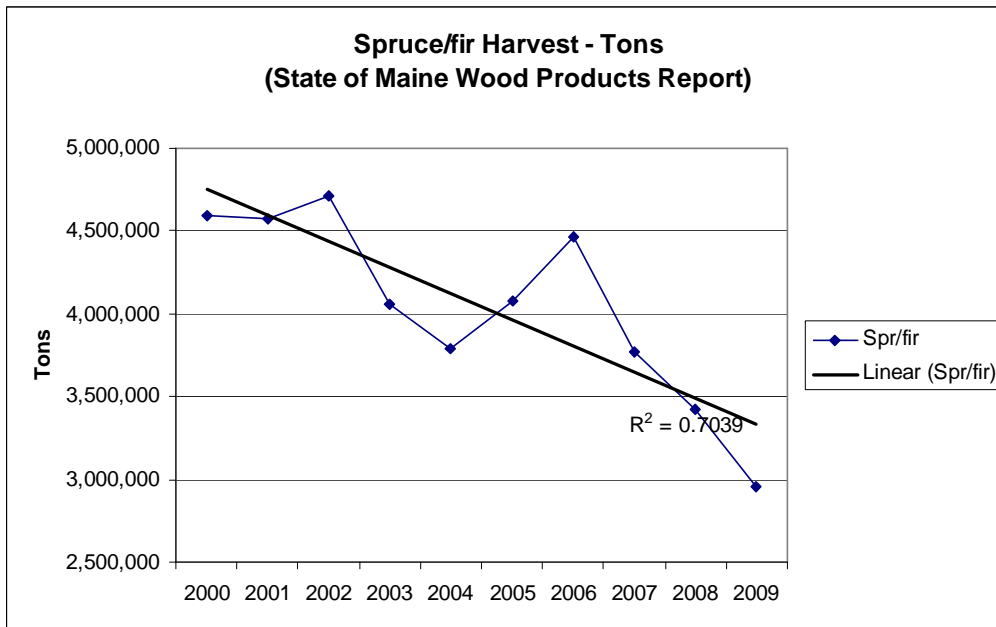
- Total Hardwood Cut: 32%
- Sequential yield constraints on total cut and S/F cut year to year of 6%. Smooths the blocky nature of the even flow constraints. Also mimics the logging infrastructure ability to expand.
- Minimum total harvest may not drop below 392,395,000 cubic feet (about 4.5MM cords). This is the 2009 low-point since 1990. No direct cap on max harvest levels, but inventory constraint prevents liquidation.
- Total inventory must be \geq current inventory starting in year 20.
- S/F total inventory must be \geq current inventory starting in year 20.
- Areas with slopes greater than or equal to 40% are not eligible for harvest.
- 10% of the remaining area is in restricted harvest zones (i.e.: streamside protection zones and others where full harvesting is prohibited.)
 - No clear cutting, planting or other management activities are allowed in these zones.
 - Thinning and shelterwood harvesting only.
 - Not more than 1% of this area can be harvested per year.
- Clearcuts may not exceed 3.2% of the harvest area in any given year. (Based on annual Maine Forest Service (MFS) silvicultural reports.)
- Current planted area based on FIA data.
- Current Pre-Commercial Thinning (PCT) area based on MFS data.
- New planting is limited to 5,000 acres per year. (Based on most recent MFS reports.) TIMO¹⁰s are not managing intensively.
 - 4,000 acres north.
 - 250 acres south.
 - 250 acres west.
 - 500 acres east.
- PCT is limited to 9,000 acres per year. (Based on most recent MFS reports.)
 - 7,200 acres north.
 - 450 acres south.
 - 900 acres west.
 - 450 acres east.
- Herbicide release to produce SW stands is limited to 11,000 acres per year. (Based on most recent MFS reports.)
 - 8,800 acres north.
 - 550 acres south.
 - 1100 acres west.
 - 550 acres east.
- Shelterwood, overstory removal (final shelterwood cut), and commercial thinning areas each may not fluctuate up or down year to year by more than 20%.

¹⁰ Timberland Investment Management Organization (TIMO)

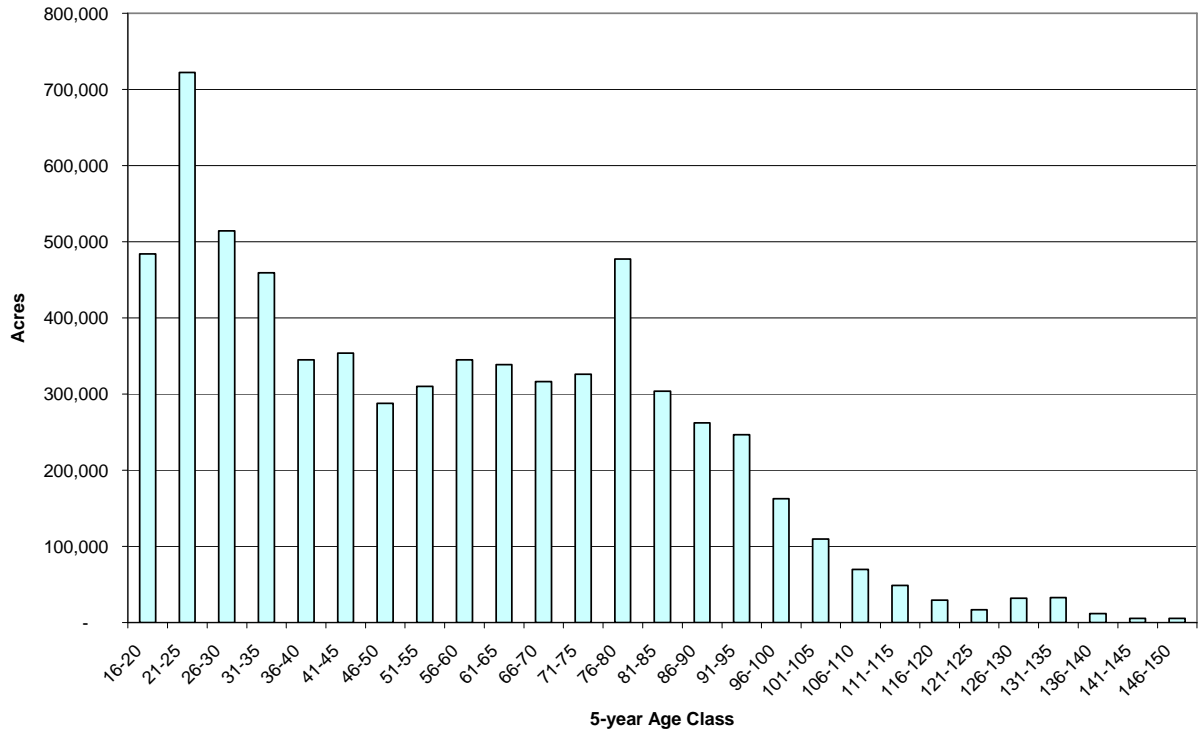
APPENDIX B: GRAPHS AND DATA



Standing Inventory	SF_saw	SF_pulp	SF_Total		Timberland	
County	Cubic Feet (000s)			%	Acres	%
Androscoggin	3,551	6,462	10,013	0.2%	192,251	1.1%
Aroostook	659,346	882,557	1,541,902	25.3%	3,788,663	22.2%
Cumberland	13,711	25,115	38,826	0.6%	376,018	2.2%
Franklin	184,465	234,284	418,749	6.9%	989,291	5.8%
Hancock	221,510	229,368	450,878	7.4%	829,026	4.9%
Kennebec	7,447	23,877	31,324	0.5%	372,917	2.2%
Knox	43,521	53,805	97,326	1.6%	182,172	1.1%
Lincoln	8,013	19,362	27,375	0.4%	197,191	1.2%
Oxford	169,432	168,183	337,615	5.5%	1,177,336	6.9%
Penobscot	218,958	290,024	508,982	8.4%	1,933,462	11.3%
Piscataquis	450,803	553,503	1,004,306	16.5%	2,251,987	13.2%
Sagadahoc	27,559	15,944	43,503	0.7%	105,949	0.6%
Somerset	371,354	519,317	890,672	14.6%	2,326,951	13.6%
Waldo	38,604	63,551	102,155	1.7%	387,241	2.3%
Washington	213,182	358,528	571,710	9.4%	1,463,312	8.6%
York	3,138	9,616	12,754	0.2%	491,127	2.9%
Total	2,634,594	3,453,497	6,088,091	100%	17,064,894	100%



Spruce/Fir Age Class Distribution (from 2010 FIA data set)





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APPENDIX C: SEWALL QUALIFICATIONS

James W. Sewall Company dates back to 1880 and is the oldest forestry and natural resource consulting firm in the Western Hemisphere. We have a long history of working on wood procurement issues for established, greenfield, and proposed forest products mills around the nation. We are the most experienced firm in the nation in the area of timberland investment analysis and forest appraisal, with a reputation for providing the highest quality due diligence and appraisal services both domestically and overseas.

David Edson is the President and one of the principals of Sewall Company. He has been involved in resource studies in the northeast since the early 70s. He managed procurement activities for three biomass facilities in Maine. Dave is a licensed professional forester, and active in industry associations.

David Stevens has deep experience in wood procurement and mill management, having managed Champion's Costigan plant, and built and managed a high-volume, state-of-the-art sawmill for Champion in Florida. Dave has worked at Sewall in organizational effectiveness, as a forest economist, and as Chief Operations Officer. His role in the project was overall project manager.

Tim Mack is a Sr. Biometrician, specializing in forest inventory and forest growth and yield modeling. Prior to joining Sewall, Tim spent 10 years as a forest industry analyst. Since joining Sewall, he has developed an international reputation as a forest biometrician and appraiser, working in native and planted forests around the world. Tim analyzed FIA derived components and did the modeling.