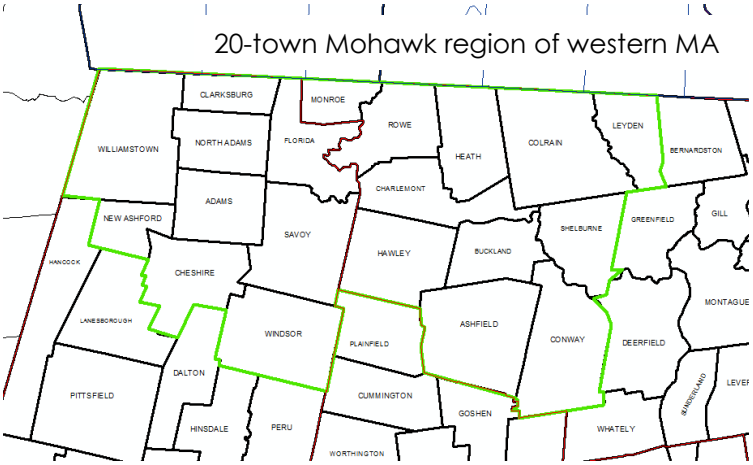
Mohawk Trail Renewable Heating Initiative - Forest Resource Assessment

Project Report from:

Innovative Natural Resource Solutions, LLC

May 19, 2016



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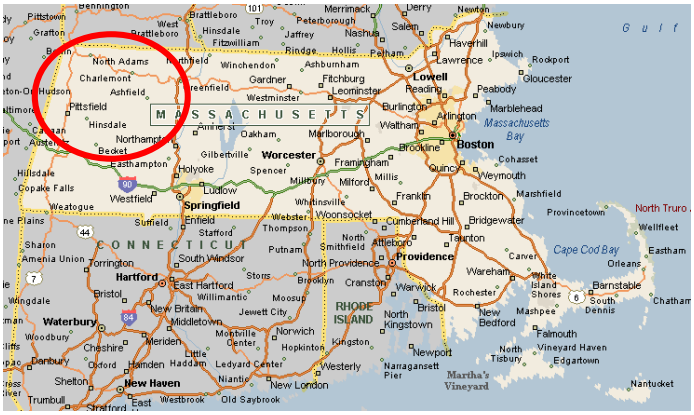
Disclaimer- This report was prepared for the Massachusetts Department of Energy Resources (DOER). Technical research was carried out by Innovative Natural Resource Solutions, LLC with funding provided under RFR-ENE-2015-027. The findings and recommendations are those of the technical consultants and do not represent the official views of the DOER.

This report is commissioned by the DOER as part of its mandate to develop and implement policies and programs aimed at ensuring the adequacy, security, diversity, and cost-effectiveness of the Commonwealth's energy supply to create a clean, affordable and resilient energy future. Funding for this report was provided by DOER from Alternative Compliance Payments collected per 225 CMR 15.00, promulgated pursuant to M.G.L. c. 25A, § 11F.

Executive Summary

The Mohawk Forest Resource Assessment, part of a larger project – the Mohawk Trail Renewable Heat Initiative (MTRHI) – was designed to primarily do one thing: determine if there is enough low-grade forest-sourced wood fuel to sustainably supply a hypothetical new wood pellet manufacturing mill in the 20-town northwestern Massachusetts Mohawk region. This project is part of a larger effort to encourage more use of local wood fuel to heat buildings in the region, thereby reducing use of fossil fuel use and bolstering economic potential of woodlands in the region.



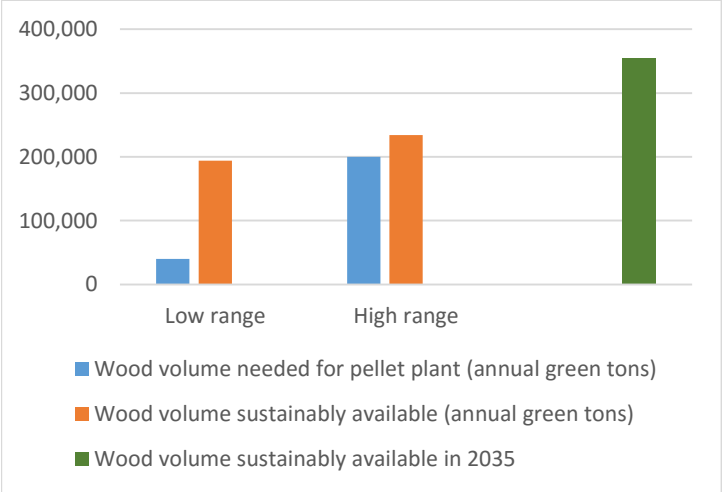
Area of analyses – approximate northwestern Massachusetts 20-town Mohawk trail region

Innovative Natural Resource Solutions, LLC (INRS), a northeastern U.S. based consulting firm, conducted this assessment. It researched, reviewed and analyzed data from several major sources including:

- the USDA Forest Service's national Forest Inventory and Analysis (FIA) dataset;
- the Northern Forest Biomass Project Evaluator modeling program;
- urban wood and wood manufacturing mill wood residues;
- Massachusetts Chapter 61 lands with forest stewardship plans;
- Massachusetts Chapter 132 Forest Cutting Plan data;
- INRS's decades of knowledge and experience about wood availability.

If a wood pellet manufacturing plant is built in the region, we make the presumption that the mill would be sized in the range of mills currently operating in the northeast U.S – with pellet output production of 20,000 to 100,000 tons per year. The actual size would be determined with business planning at a later date.

In addition to wood pellets, another important wood fuel of interest in the region is refined semi-dry wood chips. Production of refined semi-dry wood chips is projected to be modest – 5,000 -10,000 tons/year.



The conclusion of the many analyses of this Assessment is that there is more than ample wood feedstock that can sustainably supply a wood pellet mill and semi-dry chips in the region. Today, we conservatively estimate that there are between 193,000 and 234,000 tons of low-grade wood material from the privately owned forests of the region available annually to supply such a facility. This feedstock availability will increase over the next 20 years because the forest is growing well in excess of what is being harvested today and projected to be harvested in the future.

This region is blessed with ample standing forest resources as a result of light timber harvesting pressure, and productive forest ecosystems. Should a wood pellet manufacturing mill be built, the additional draw of wood resource from these forests can be done sustainably and could result in an improved forest resource that continues to grow well in excess of harvesting, resulting in a continuing increase in the standing forest wood volume over time.

Currently, there appears to be inadequate logging infrastructure within the region to supply a new wood pellet manufacturing facility, should one be sited within the region.

1. Introduction

The Mohawk Forest Resource Assessment is part of a larger project – the Mohawk Trail Renewable Heat Initiative (MTRHI) – which is designed to evaluate the economic development potential of extensive privately owned woodlands in western Massachusetts. MTRHI is a partnership of the Massachusetts Executive Office of Energy and Environmental Affairs, Franklin Regional Council of Governments (FRCOG), Berkshire Regional Planning Commission (BRPC), Franklin Land Trust (FLT) and the Massachusetts Department of Energy Resources (MA DOER). The MTRHI effort is planning on contracting for a series of research and analysis projects, namely:

- Regional Forest Resource Assessment;
- Quantify the Carbon Balance of the Regions Forests and Potential Air Quality Impacts;
- Market Analysis and Development;
- Development of a Wood Pellet Manufacturing, Storage and Distribution Business Plan;
- Regional Economic Impact Study.

This report is for the first effort, the Regional Resource Assessment. MA DOER has contracted with Innovative Natural Resource Solutions, LLC (INRS) to complete the assessment. The purpose of the Regional Forest Resource Assessment is to gain an understanding of the availability of low-grade wood resources that could be used for wood pellet manufacturing and production of semi-dry refined wood chips in the northwestern Massachusetts 20-town region[1] that includes: Ashfield, Buckland, Charlemont, Colrain, Conway, Hawley, Heath, Leyden, Monroe, Rowe, and Shelburne in Franklin County, and Adams, Cheshire, Clarksburg, Florida, New Ashford, North Adams, Savoy, Williamstown, and Windsor in Berkshire County. The intent of the MTRHI, assuming sufficient wood resources are available, is to encourage more use of local wood fuel to heat buildings in the region, thereby reducing use of fossil fuel use and bolstering economic potential of woodlands in the region.

Research for this report was completed in the second half of 2015. The report will be supplemented with presentations in the region and a webinar, to be held in the first half of 2016.

[1] Note: subsequent to the completion of this study, a 21st town, Peru, was added to the overall project. Because the approximate 20-town area included an area larger than the 20-towns by about a town's acreage, no changes were made to these analyses and the results are still valid.

2. Forest Inventory and Analysis data

The USDA Forest Service has maintained a national forest inventory program – the Forest Inventory & Analysis (FIA) – since the early 1950s. This system of on-the-ground forest measurement plots in forests throughout the U.S. is the most robust national data set on the number of trees, tree volume, trends and many other forest and tree information that exists. This dataset is constantly updated through a rolling re-measurement of plot trees and vegetation on a roughly 6 year cycle. This Resource Assessment relies heavily on this data set to draw its key conclusions.

A. 20 Town analysis - Using the USDA Forest Inventory & Analysis (FIA) database[i], INRS determined the growth and loss (harvest) for a region that approximates the towns[ii], shown in orange in Figure 1. INRS used the most recent complete FIA information for Massachusetts, with data collected from 2009 through 2014[iii].

Figure 1. Area of Analysis (approximate), as a Proxy for Selected Towns

The sampled FIA plots in this region represent roughly 536,000 acres of land and water. Of this, over 420,000 acres – or 78% - is classified as "timberland" - acres physically and legally capable of producing commercial timber crops[iv]. The remainder of this assessment is restricted to timberland, and does not include any land where timber harvesting is not legally allowed.

An important note, the 20-town political boundaries include approximately 345,451 acres of surface area. The acreage of our analysis is larger because it includes area slightly beyond the political boundaries of the 20 communities to accommodate the location of the fixed on-the-ground measurement plots of the Forest Inventory and Analysis system and because each plot represents a certain amount of surrounding land (see Figure 2).

Figure 2. 20-town region (green) vs. FIA data polygon (pink)

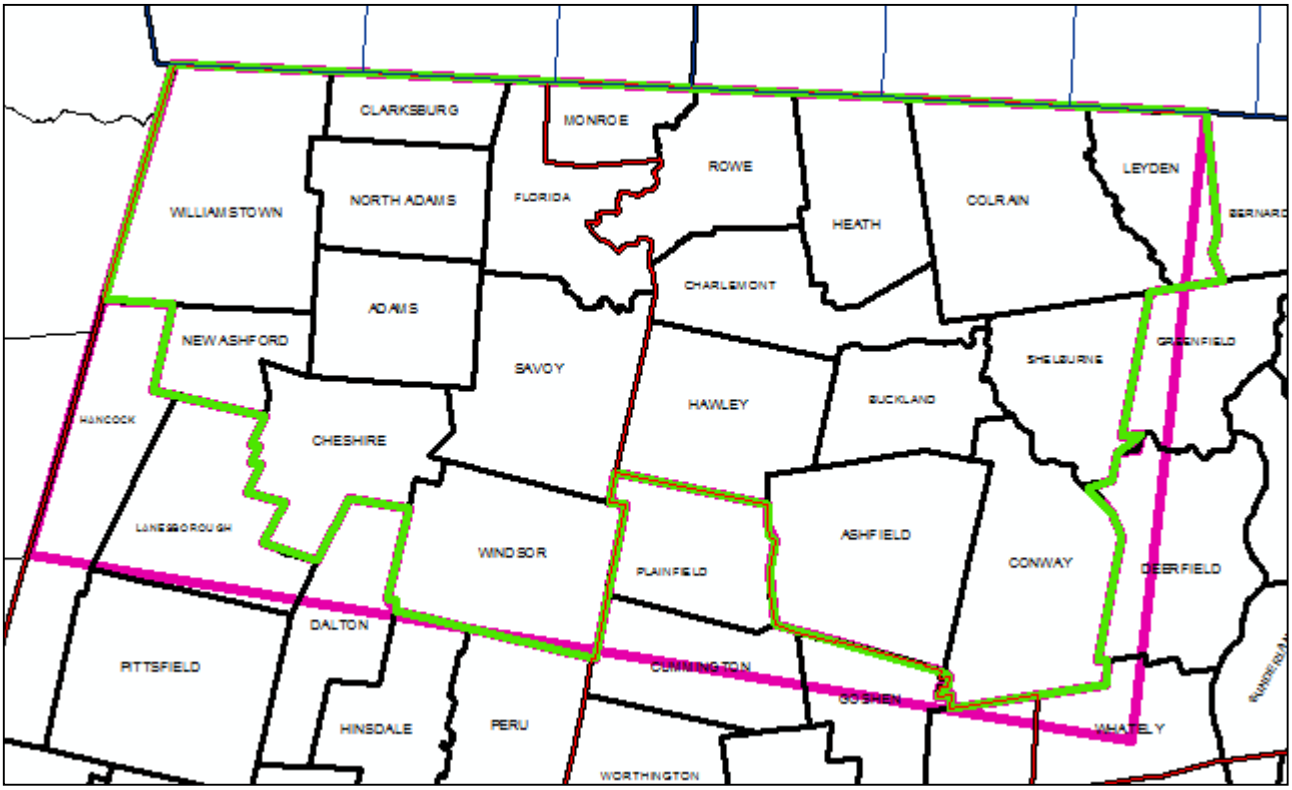
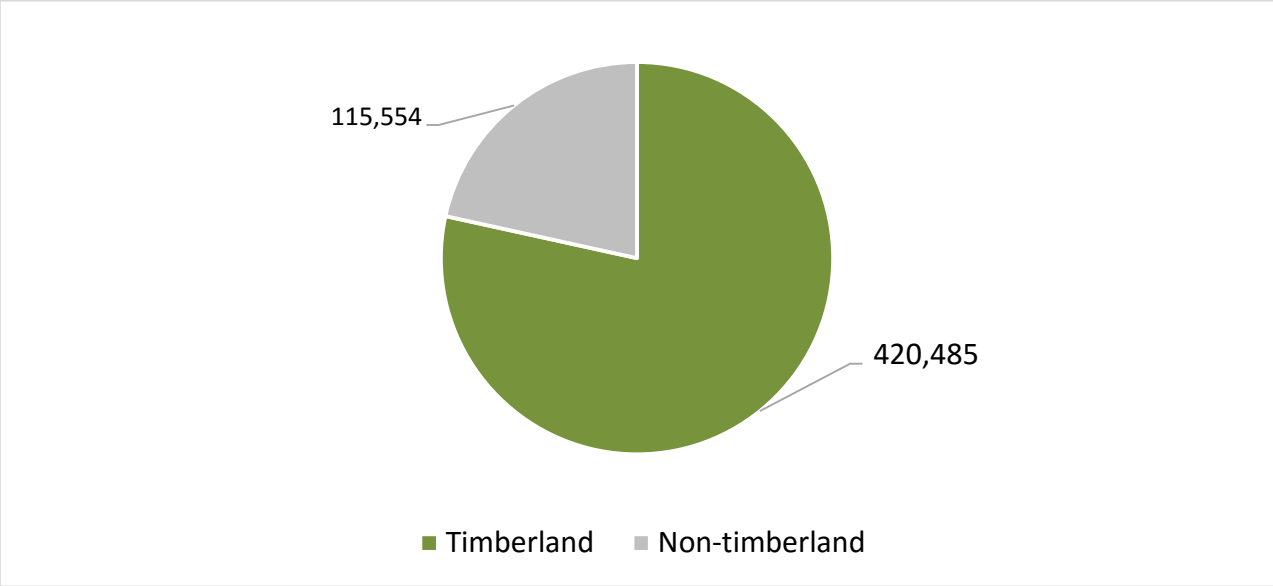


Figure 3. Classification of Land in the Region (acres)



Of the over 420,000 acres of timberland represented by these FIA plots, an estimated 73% is in private ownership. The remainder is publicly owned, by either state or municipal owners. There is no federal timberland ownership in the Region. This assessment focuses exclusively on private land in the region, and makes the conservative assumption that no wood fiber is available from public lands[v].

Figure 4. Timberland Ownership in the Region (acres)

With all large markets in place and operating, for privately owned timberland in the region, annual growth of low-grade (non-sawtimber) wood exceeds harvest by roughly 174,000 green tons per year.

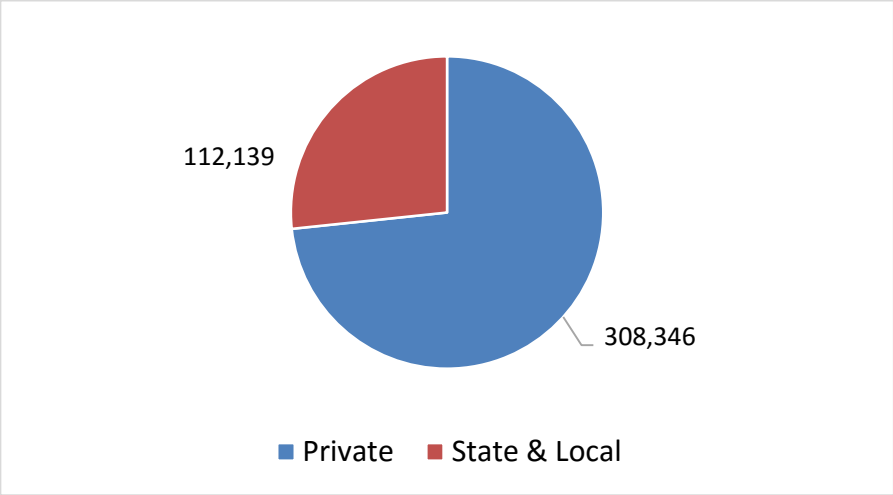


Table 1. Standing Timber, Growth and Removals for Region (estimated)

	Softwood	Hardwood	Total
	green tons/yr		
Growing Stock			
• **all**	5,927,239	17,084,561	23,011,800
• **sawlog**	5,885,290	10,297,407	16,182,697
• **non sawlog**	41,949	6,787,155	6,829,103
Growth			
• **all**	162,304	238,351	400,655
• **sawtimber**	62,351	118,790	181,141
• **non sawlog**	99,953	119,561	219,514
Removals			
• **all**[2]	-	58,083	58,083
• **sawtimber**	-	12,455	12,455
• **non sawlog**	-	45,628	45,628
Growth less			
• **all**	162,304	180,268	342,572
• **sawtimber**	62,351	106,335	168,686
• **non sawlog**	99,953	73,933	173,886

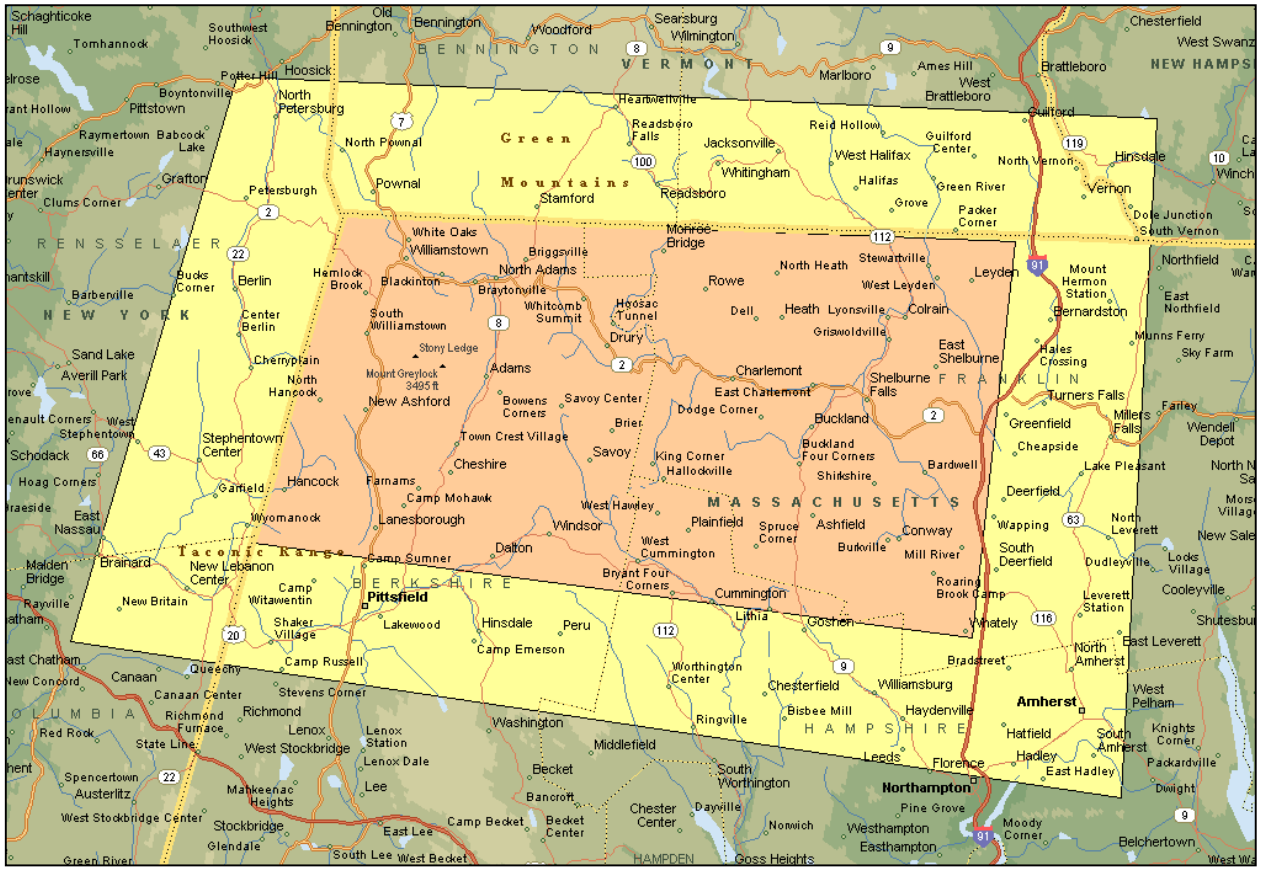
[2] FIA data is based on what occurs on a series of fixed diameter plots in the forest. The fact that no harvest was noted indicates that no trees within the fixed plots that were on softwood identified forest were harvested during the 6 year period of data collection for the FIA plots.

The FIA only measures the roundwood portion of the tree, not tops, branches, or other parts potentially suitable for biomass fuel - but the tops, branches and other tree parts (residues) volume is estimated within the FIA dataset. Not all of these residues are appropriate for manufacturing wood pellets, and not all residue can be efficiently and economically utilized. When the additional 19,000 green tons of "residues" are included from the FIA data, INRS estimates that low-grade material exceeds harvest levels by over 193,000 green tons per year[vi].

	Softwood	Hardwood	Total
		green tons/yr	
Growth less Removals (non –sawtimber)	99,953	73,933	173,886
Residue	-	19,167	+ 19,167
All Low-Grade			193,054

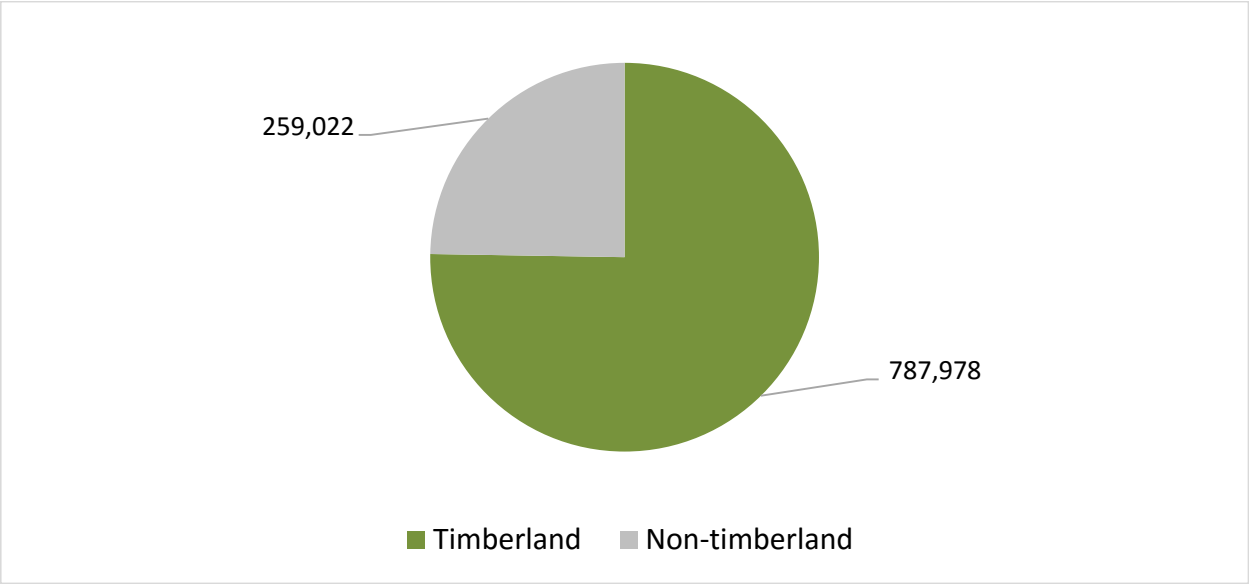
B. 20 Town plus surrounding towns analysis – Using the FIA database, INRS determined the growth and loss (harvest) for a region that approximates the towns, shown in orange in Figure 4, and a buffer around them (shown in yellow) to take into account the import of wood from outside of the prescribed towns. This area better approximates "real world" movement of wood to market. Again, INRS used the most recent complete FIA information for Massachusetts, Vermont, New York and New Hampshire with data collected from 2009 through 2014.

Figure 5. Expanded Area of Analysis (approximate)



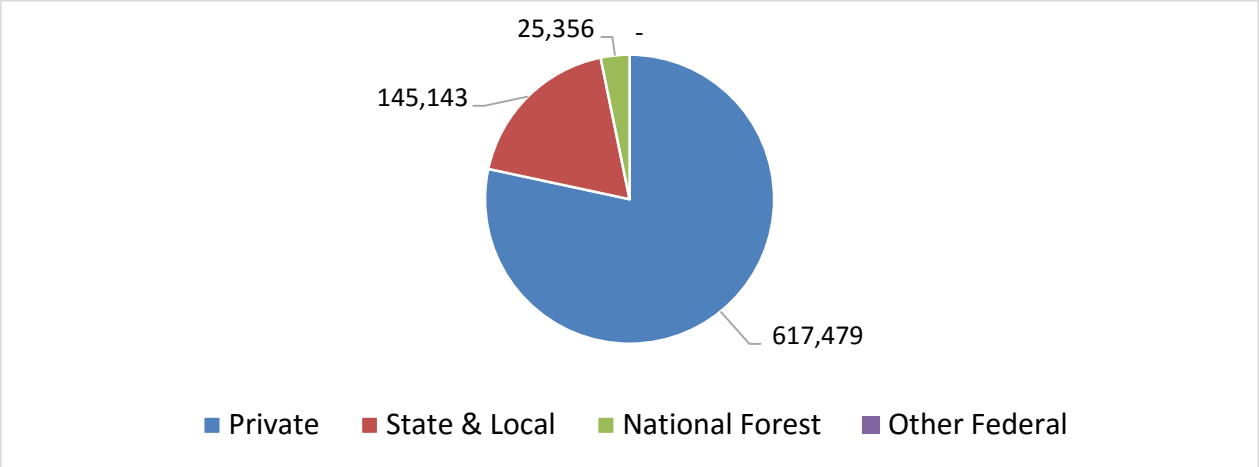
In this region, the sampled FIA plots represent an estimated 1,047,000 acres of land and water. Of this, nearly 788,000 acres – or 75% - is classified as "timberland" - acres physically and legally capable of producing commercial timber crops. As with the 20 town region, the remainder of this assessment is restricted to timberland, and does not include any land where timber harvesting is not legally allowed.

Figure 6. Classification of Land in the Expanded Region (acres)



Of the nearly 788,000 acres of timberland within the region, an estimated 78% is in private ownership. The remainder is publicly owned, by either state and municipal owners or the USDA Forest Service. This assessment focuses exclusively on private land in the region, and makes the conservative assumption that no wood fiber is available from public lands.

Figure 7. Timberland Ownership in the Expanded Region (acres)



With all existing large markets in place and operating, for privately owned timberland in the region, annual growth of low-grade (non-sawtimber) wood exceeds harvest by over 384,000 green tons per year.

Table 2. Standing Timber, Growth and Removals for Expanded Region (estimated)

	Softwood	Hardwood	Total
		green tons/yr	
Growing Stock			
• **all**	13,519,354	32,903,737	46,423,091
• **sawlog**	10,578,849	19,933,187	30,512,036
• **non sawlog**	2,940,505	12,970,549	15,911,055
Growth			
• **all**	334,236	651,228	985,464
• **sawtimber**	130,416	287,958	418,374
• **non-sawtimber**	203,820	363,270	567,090
Removals			
• **all**	64,976	193,806	258,782
• **sawtimber**	21,494	54,378	75,873
• **non-sawtimber**	43,481	139,428	182,909
Growth less Removals			
• **all**	269,260	457,422	726,682
• **sawtimber**	108,922	233,580	342,502
• **non-sawtimber**	160,338	223,842	384,180

As described above, the tree residues volume is estimated using information from the FIA dataset. Not all residues provide high enough quality feedstock to manufacture for premium grade wood pellets, and not all residue can be efficiently and economically captured. When the additional 82,000 green tons of residues are included, INRS estimates that low-grade material available exceeds harvest levels by nearly 466,000 green tons per year.

	Softwood	Hardwood	Total
		green tons/yr	
Growth less Removals (non – sawtimber) Residue	160,338	223,842	384,180
	18,193	63,956	82,149
All Low-Grade			466,330

3. Northern Forest Biomass Project Evaluator model

A future look at the forests of the Mohawk Region

As with the FIA analysis in Section 2 above, an analysis was conducted for the 20 town Mohawk trail region and larger area including surrounding towns in Massachusetts, New Hampshire, Vermont and New York using the Northern Forest Biomass Project Evaluator (BPE) model[vii]. The BPE model runs also use the FIA dataset for a region that approximates the towns, shown in orange in Figure 7. The 20 town plus surrounding town area is seen in Figure 4 above. As with the FIA analysis, the BPE model used the most recent complete FIA information for Massachusetts, with data collected from 2009 through 2014.

Figure 8. Area of Analysis (approximate), as a Proxy for Selected Towns

The Biomass Project Evaluator (BPE) model was created by INRS on behalf of the North East *State* Foresters Association through grant support from the USDA Forest Service. The BPE tool is intended to be used as a decision support tool for analyses of wood supply under different conditions for a geographic area, including the supply of low-grade wood for energy projects. Using FIA data as its core dataset, BPE estimates available timber volumes for a specific geographic area based on a series of parameters. The tool's interface allows for nearly infinite different model runs. For this project, we have chosen a small number of likely potential futures given certain parameter choices further described in the next section.

A. 20 town region BPE model runs

The power of the BPE model is its ability to project possible forest future scenarios using varying assumptions. All four scenarios outlined below are conservative in that they do not include any public land and they further discount 52 % of the private timberland remaining for various factors (see Appendix for details). These are conservative assumptions as with the FIA analysis above and, hence, the available biomass material in the current year is comparable to the FIA section results. All scenarios here look at the next 20 years. We have chosen to conduct four "runs" of the model for the 20 town region, representing a wide range of possible futures.

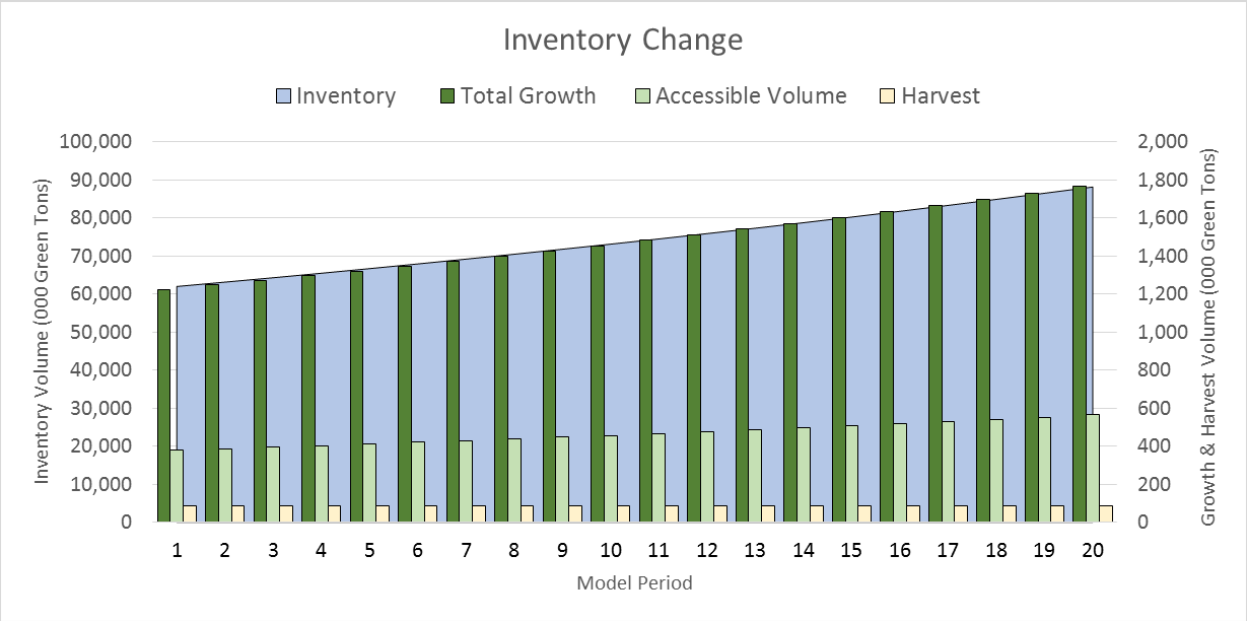
Run 1: The constant run – this is the "business as usual" run and assumes that wood use and growth and mortality of trees from the Region will continue at the same levels as are experienced today. The land acreage available for timber harvesting with this run is as follows.

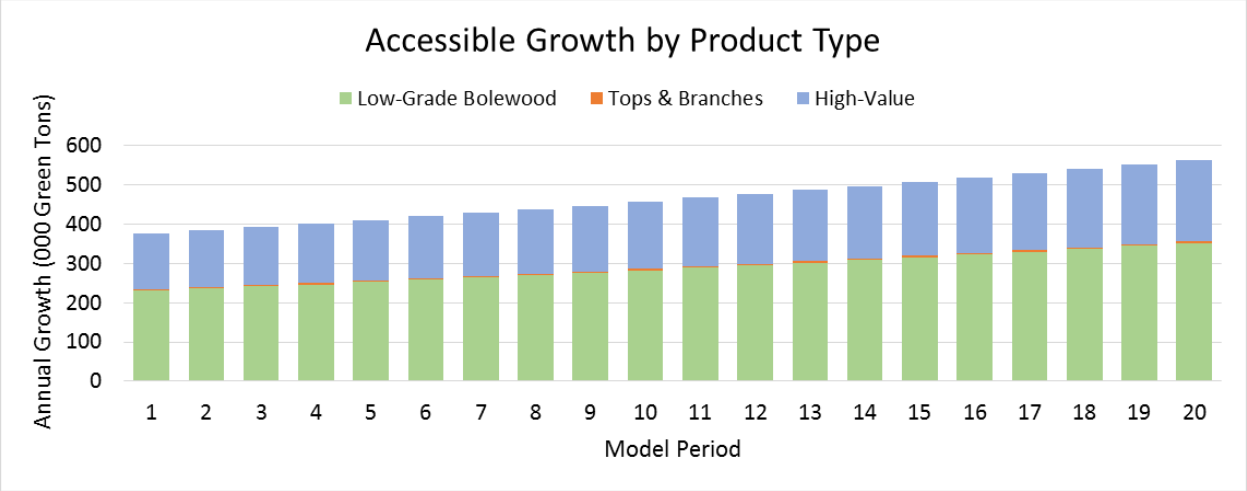
Table 3.

Ownership Category	Total Acres of Timberland	Accessible Acres		
Federal	0.00	0.00		
State	99,689.42	0.00		
Municipal	12,452.80	0.00		
Corporate	15,417.76	13,875.98		
Farm	6,167.10	3,083.55		
Other Private:				
Parcels 1-50acres	86,031.10	43,015.55		Net Accessible Timberland:
Parcels 50+acres	200,739.22	140,517.46		
Total:	**420,497.40**	**200,492.54**	→	**190,467.91**
			Percent Discount:	54.7%

In Figure 9 below, the results of model run are shown graphically.

Figure 9. BPE model run 1 results – business as usual





Available woody biomass for energy in year 2015 – 234,000 green tons

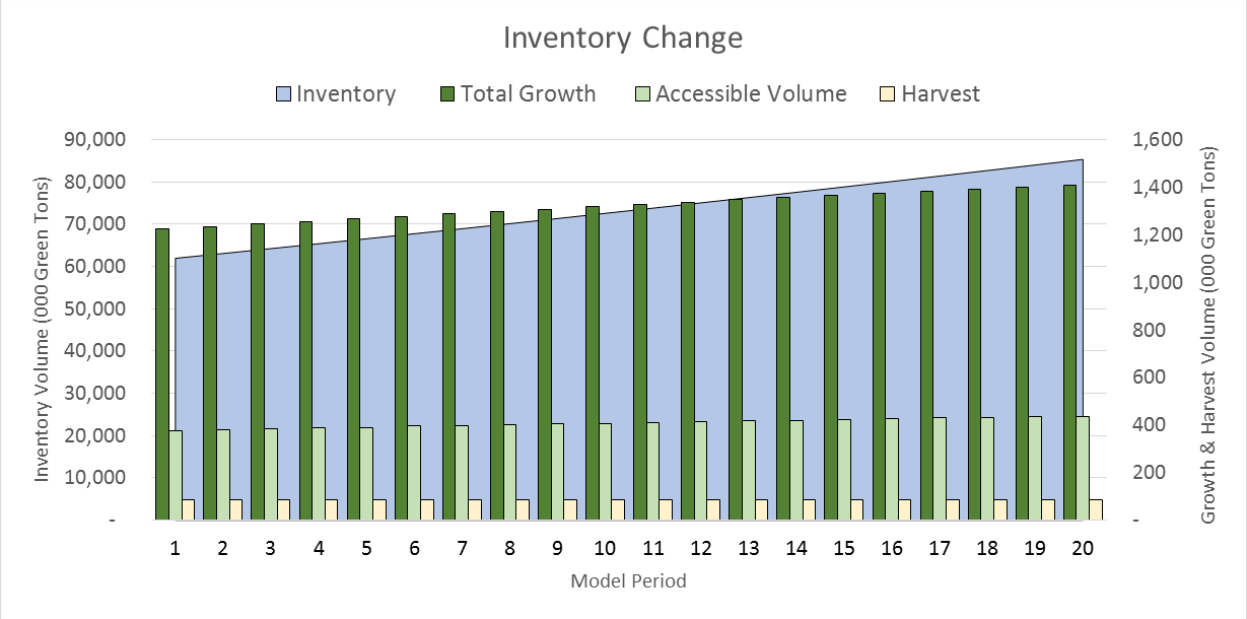
Available woody biomass for energy in year 2035 – 355,000 green tons

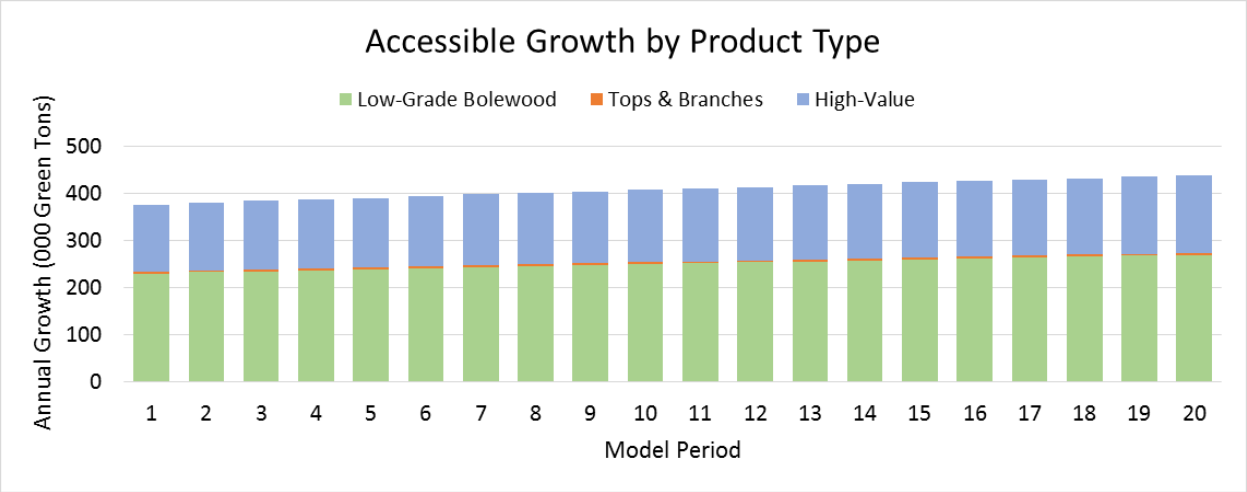
Run 2: Reduced growth run – this is the pessimistic run and assumes that wood use remains constant but that forest growth is reduced by 1 % per year (compounded) over the run period. This choice reflects factors such as insects and diseases (hemlock wooly adelgid, emerald ash borer) or invasive plants and their possible future effects on forest growth. The land acreage available for timber harvesting with this run are the same as Run 1 above.

Table 4.

Ownership Category	Total Acres of Timberland	Accessible Acres		
Federal	0.00	0.00		
State	99,689.42	0.00		
Municipal	12,452.80	0.00		
Corporate	15,417.76	13,875.98		
Farm	6,167.10	3,083.55		
Other Private:				
Parcels 1-50acres	86,031.10	43,015.55		Net Accessible Timberland:
Parcels 50+acres	200,739.22	140,517.46		
Total:	**420,497.40**	**200,492.54**	→	**190,467.91**
			Percent Discount:	54.7%

Figure 10. BPE model run 2 results – reduced growth - pessimistic





Accessible[3] woody biomass for energy in year 2015 – 234,000 green tons

Accessible woody biomass for energy in year 2035 – 273,000 green tons

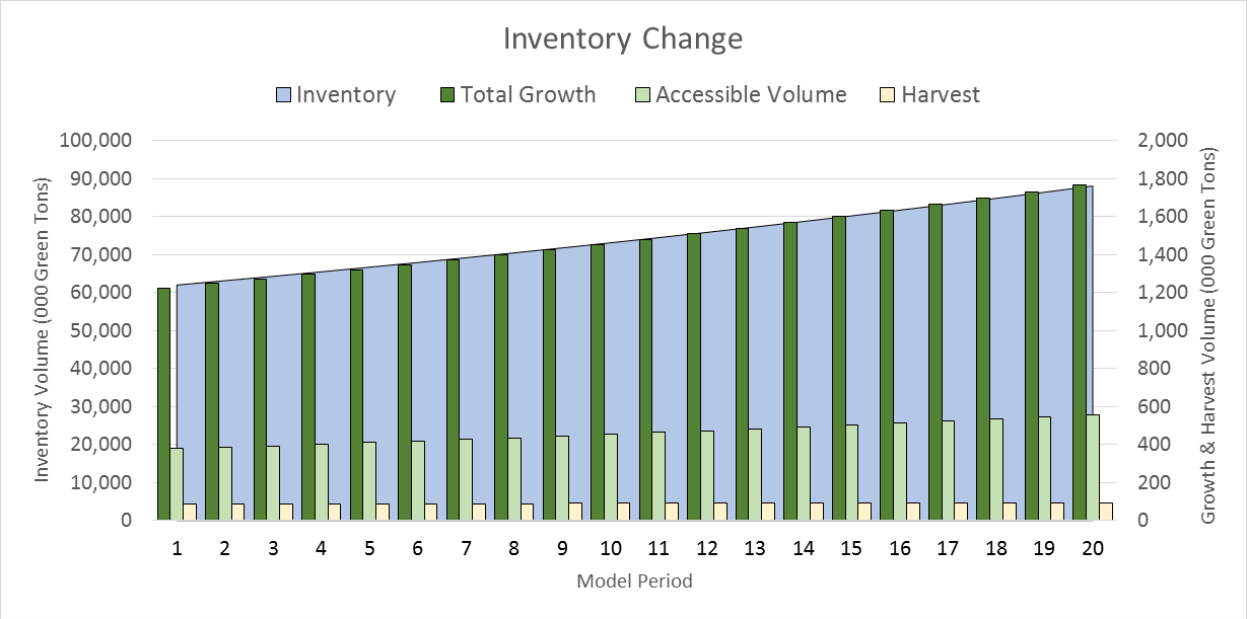
Run 3: Increased demand run – This is a run that assumes an annual increase of .5 % wood use (compounded) in the Region while keeping growth and mortality at current levels and reducing forest land available by 10% for the Region. The land acreage available for timber harvesting with this run is the same as Run 1 & 2 above for the start of the run and then is reduced by 10% beginning in year 2 of the 20 year model run.

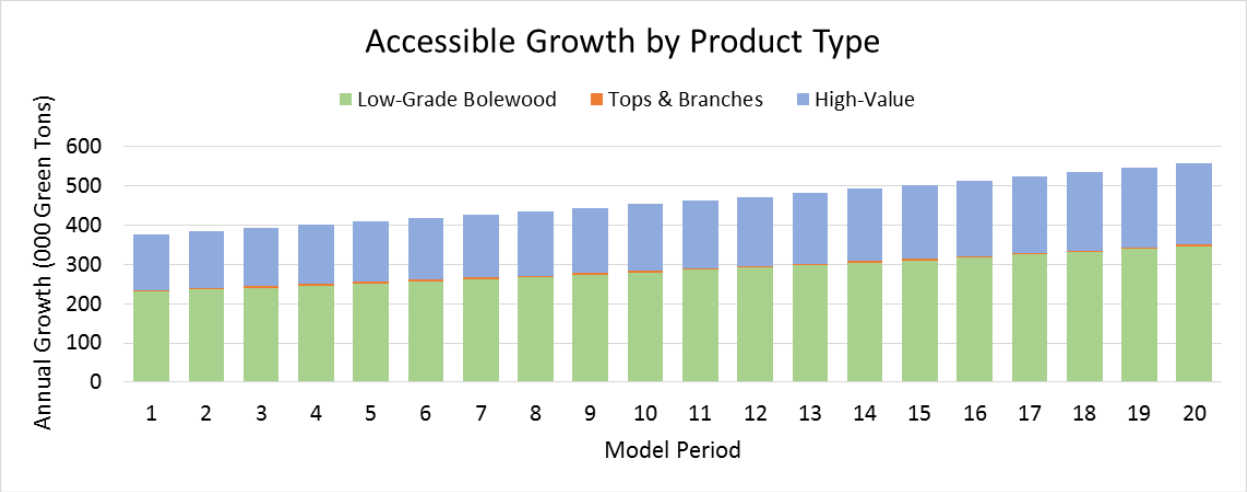
[3] The words accessible and available are interchangeable for the purposes of this report.

Table 5.

Ownership Category	Total Acres of Timberland	Accessible Acres	
Federal	0.00	0.00	
State	99,689.42	0.00	
Municipal	12,452.80	0.00	
Corporate	15,417.76	13,875.98	
Farm	6,167.10	3,083.55	
Other Private:			
Parcels 1-50acres	86,031.10	43,015.55	Net Accessible Timberland:
Parcels 50+acres	200,739.22	140,517.46	
Total:	**420,497.40**	**200,492.54** →	**190,467.91**
		Percent Discount:	54.7%

Figure 11. BPE model run 3 results – increased demand





Available woody biomass for energy in year 2015 – 234,000 green tons

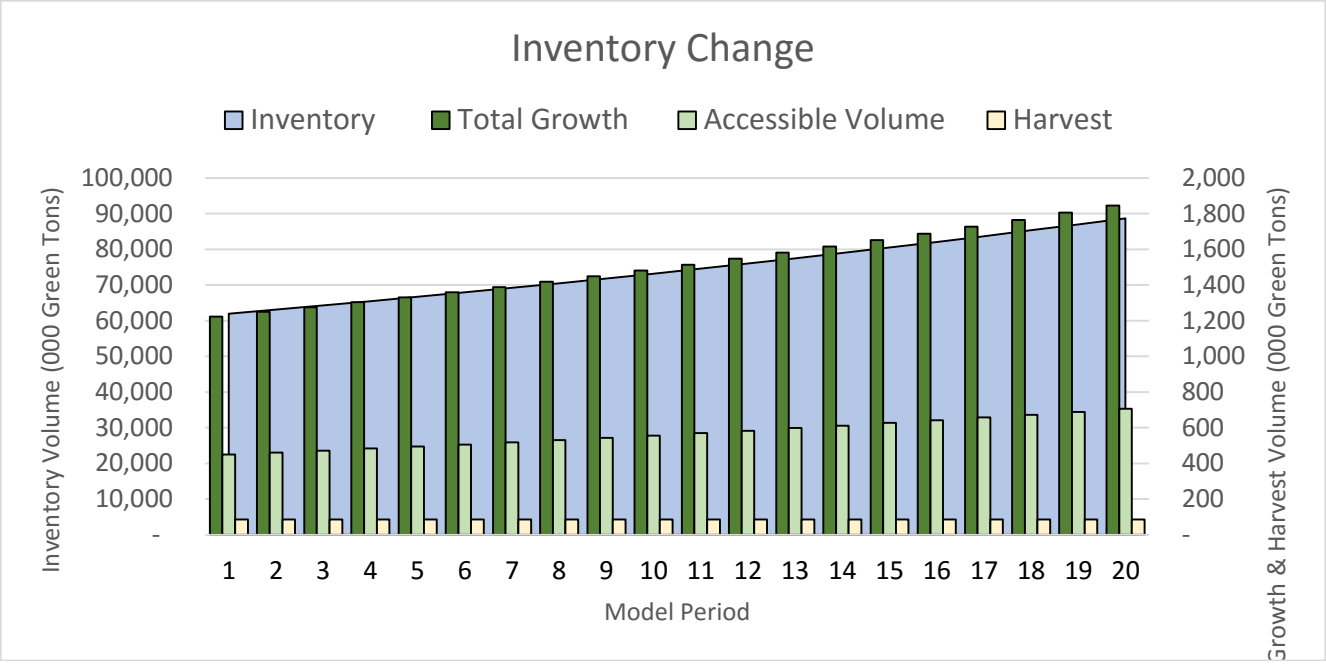
Available woody biomass for energy in year 2035 – 349,000 green tons

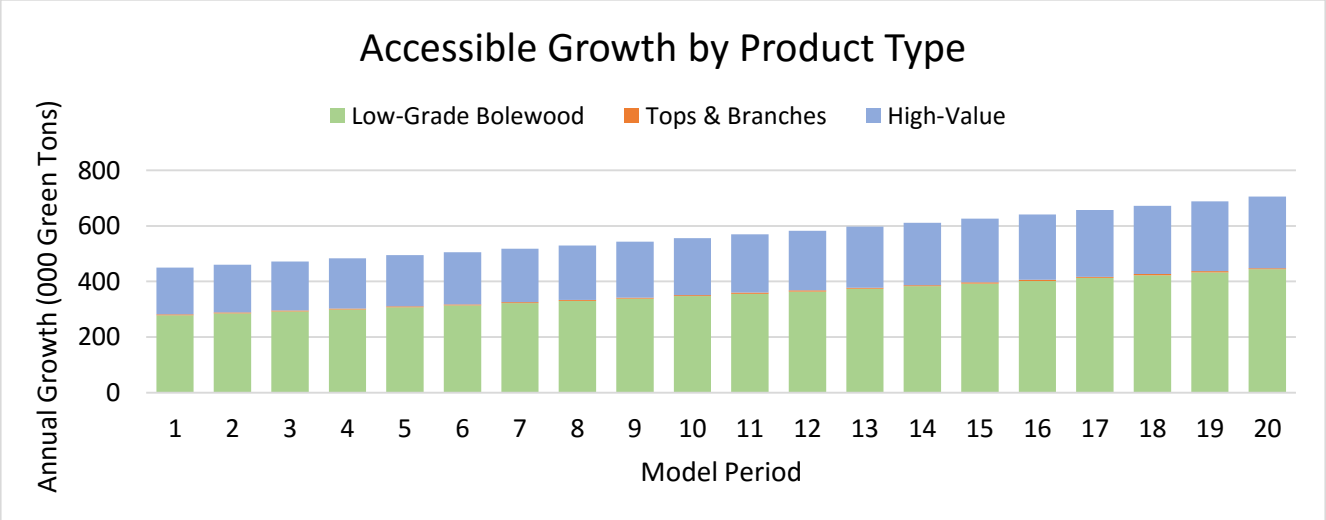
Run 4: Increased forest growth run – This is a run that assumes an annual forest growth increase of .2 % (compounded) in the Region while keeping harvest and mortality at current levels. The land acreage available for timber harvesting with this run is the same as Run 1, 2 & 3 above for the run. This model run projection was chosen because early signs of climate change indicate that the forests of the northeast U.S. are increasing their annual growth due to the longer growing seasons being experienced as compared to 50 years ago.

Table 6

Ownership Category	Total Acres of Timberland	Accessible Acres	
Federal	0.00	0.00	
State	99,689.42	0.00	
Municipal	12,452.80	0.00	
Corporate	15,417.76	13,875.98	
Farm	6,167.10	3,083.55	
Other Private:			
Parcels 1-50acres	86,031.10	43,015.55	Net Accessible Timberland:
Parcels 50+acres	200,739.22	140,517.46	
Total:	**420,497.40**	**200,492.54** →	**190,467.91**
		Percent Discount:	54.7%

Figure 12. BPE model run 4 results – increased forest growth





Available woody biomass for energy in year 2015 – 278,000 green tons

Available woody biomass for energy in year 2035 – 444,000 green tons

B. 20 town plus surrounding towns region BPE model runs

The full run information for these three model runs for the 20 town plus region can be found in Appendix II. The results are:

Constant run (5)

Available woody biomass for energy in year 2015 – 429,000 green tons

Available woody biomass for energy in year 2035 – 714,000 green tons

Reduced growth run (6)

Available woody biomass for energy in year 2015 – 429,000 green tons

Available woody biomass for energy in year 2035 – 695,000 green tons

Increased demand run (7)

Available woody biomass for energy in year 2015 – 429,000 green tons

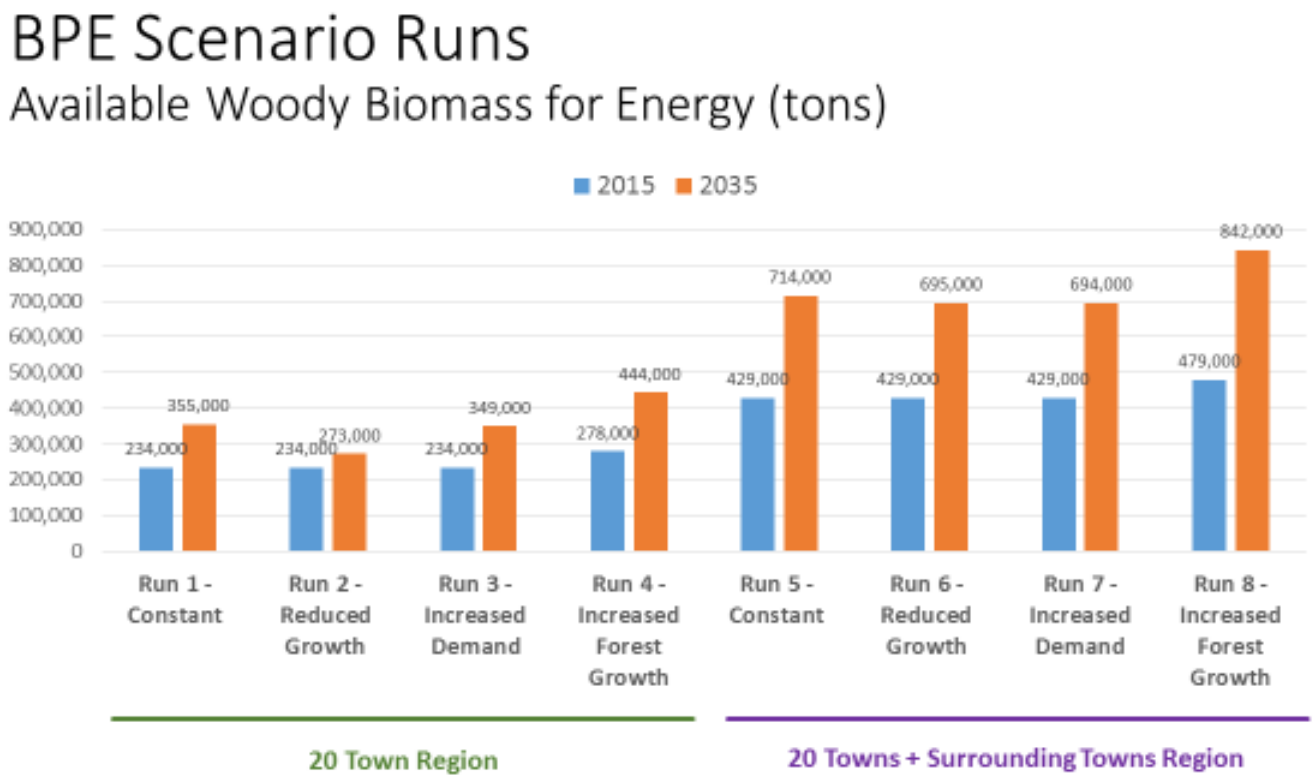
Available woody biomass for energy in year 2035 – 694,000 green tons

Increased forest growth run (8)

Available woody biomass for energy in year 2015 – 479,000 green tons

Available woody biomass for energy in year 2035 – 842,000 green tons

Figure 13. A Summary of BPE model runs



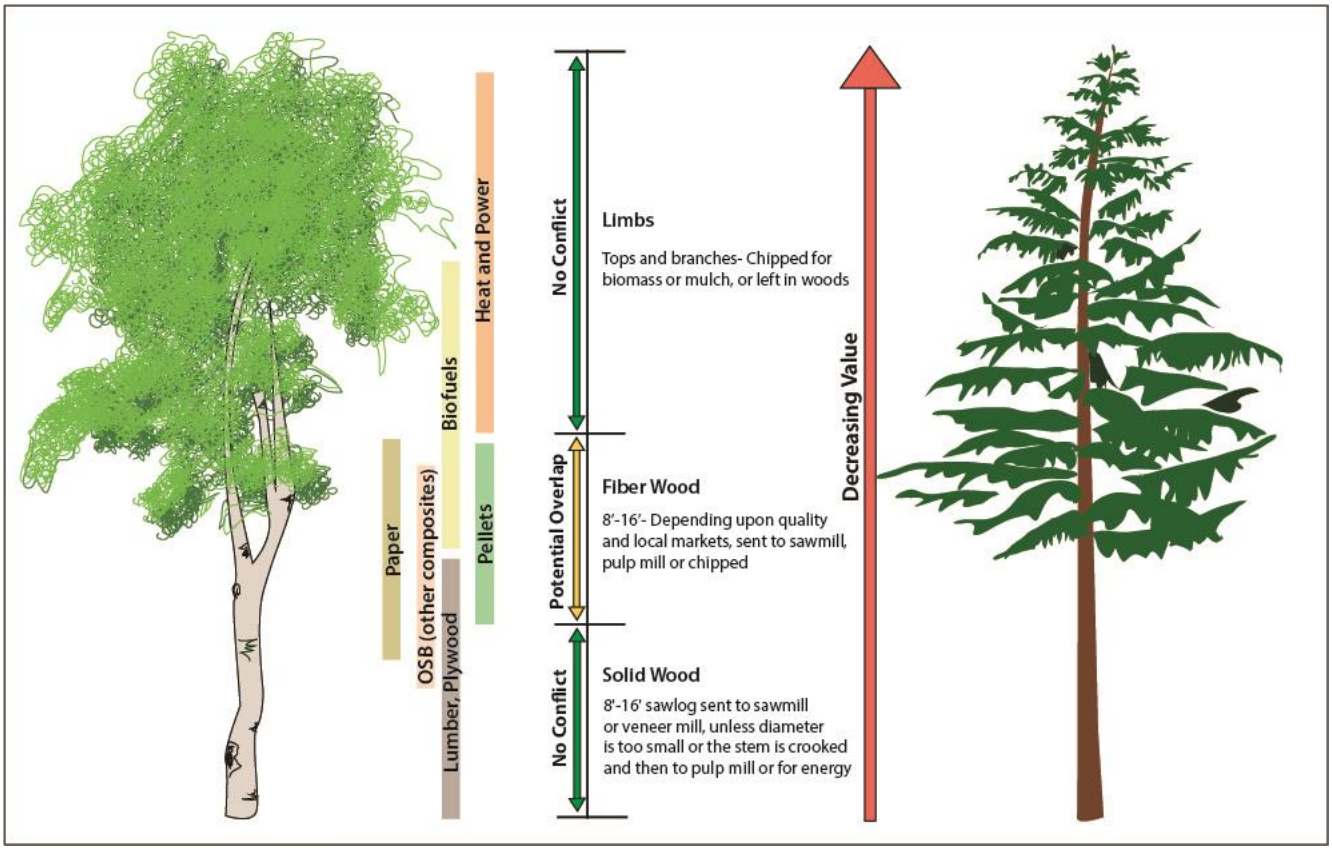
4. Other sources of feedstock for wood heat and cost curves

Forests in Massachusetts and the northeast U.S. produce a range of wood products from harvested timber:

- higher-value materials such as sawlogs (used to produce solid wood products such as boards or 2x4s) and veneer (highest value sawlog used to make plywood);
- mid-value products such as pulpwood (used to make paper products at pulp mills) and log length firewood (processed into chunk firewood – the kind you put in your woodstove which is generally hardwood species in the northeast);
- lower-value bolewood for wood heat or pellets (roundwood portion of the tree often chipped in the woods) and the lowest value product, whole-tree chips for power plants.

Figure 14 shows this forest product mix organized into several categories.

Figure 14



In addition to sourcing woody biomass directly from forest harvesting operations, a pellet or other low-quality woody feedstock facility may also be able to source some of its wood

feedstock from mill residue (sawmill or other solid wood manufacturing plant) and urban wood sources.

A. Urban Wood

One possible source of feedstock for any project is "urban wood", or wood derived from activities such as land clearing, tree services, wood from yard tree pruning and right-or-way maintenance. This wood is harvested for reasons other than producing forest products or woodland management – it is a result of some other goal.

Urban wood generation is particularly difficult to estimate, but the National Renewable Energy Laboratory has developed a tool[viii], using population and other factors, in order to estimate the annual generation of urban wood. That data[ix], kept at the county level, is presented below.

Figure 15. Urban Wood Generation by County (estimated)

Using this information and knowledge of the Mohawk Region, INRS estimates that roughly 12,400 green tons of urban wood is generated annually in the 20 town area. When including the surrounding towns as we did with FIA and BPE estimates in the

earlier sections of this report, an additional 21,800 green tons are estimated to be available, for a total of roughly 34,200 green tons of wood annually.

There could be a unique event that causes a temporary increase in the availability of urban wood, such as the development of a new pipeline corridor or a hurricane hitting the area. Such one-time events are not considered in the numbers above, and while they would provide high volumes of wood for a short period, they are by definition not sources that provide a sustained level of feedstock.

It is important to note that there are a number of possible complications with urban wood that can make it a challenge to utilize in wood pellet manufacturing (or as any other low-quality wood feedstock input):

- Urban wood is often generated in very small individual quantities, and aggregation can add significant cost;
- The generators of urban wood are often focused on achieving a goal other than wood utilization (for example, getting a lot cleared quickly so that construction activities can start) and as such do not take the time to produce wood to certain market specifications;
- A range of species and quality can be generated, which can complicate sorting or species selection for wood pellet production, which requires stringent wood cleanliness/quality specifications;
- Much of the wood produced is chipped or ground with the bark on and often tops and branches for ease of handling; this is generally not a suitable feedstock for the production of quality pellets due to the excess bark as well as the difficulty in handling and processing the material through the plant system due to a lack of uniform size.

While urban wood certainly exists in the region, INRS suggests that for the reasons above that no volume be relied upon as part of the core supply of a wood pellet manufacturing operation.

B. Sawmill Residue

When sawmills cut cylindrical logs into rectangular boards, residue--including bark, sawdust, and mill chips--is produced. While residue generation varies by species and mill equipment, generally a log in a sawmill produces 60 to 70% of useful timber as boards, 20 to 30% as wood chips, and 10% as sawdust[x]. Due to high concentrations of wood from the outside of the tree, which carries water from the roots to the leaves, sawmill residues are generally high in moisture, often higher than 50%.

Figure 16. Sawmill Residue Production

Sawmill residue, while a possible wood pellet feedstock, has other potential uses. Bark is often sold for landscaping uses, sawdust is sold for animal bedding, and sawmill chips are often sold to pulp mills, or for playground chips. It is highly unusual for sawmills to have an excess of residual material.

In the 20-town Mohawk Region, there is one sawmill that generates a meaningful and collectable volume of sawmill residue. Roberts Brothers Lumber Company, Inc.[xi], located in Ashfield, generates roughly 125 green tons of clean mill residue weekly, 60% of which is chips and the remainder of which is sawdust[xii]. On an annual basis, this is roughly 6,000 green tons of material that may be well suited for wood pellet manufacturing. All of this material currently is sold to other markets, including pellet manufacturing and community-scale biomass heating. Additionally, Roberts Brothers Lumber Company has a plan to install a combined heat and power biomass gasifier, which could utilize some of this material for on-site electricity and heat generation.

There are a few other mills in adjacent towns to the 20-town region, including Cersosimo Lumber Co. mill and Allard Lumber in Brattleboro, VT.

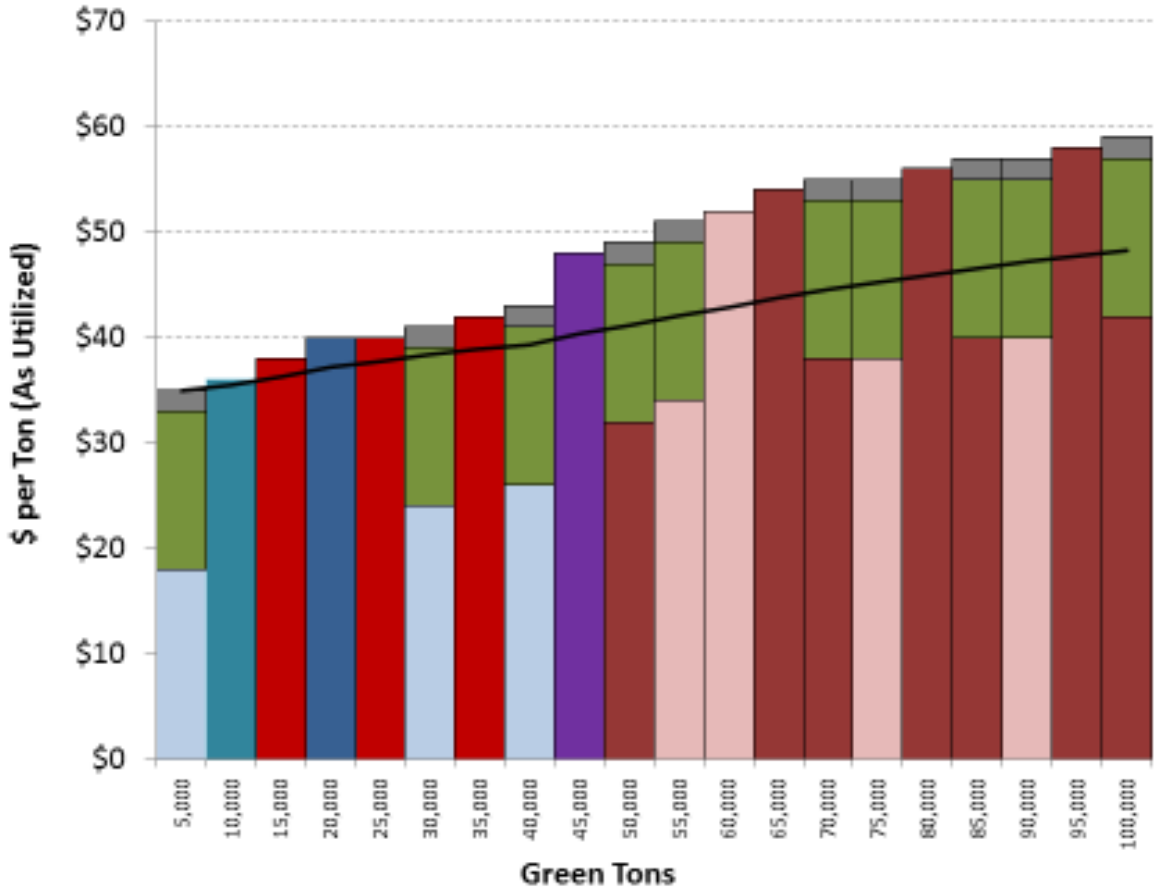
Any new market for their residues closer to these and other sawmills than existing markets will certainly be in a competitive position to secure some of the residues from these mill operations owing to more favorable trucking economics. We recognize that the residues currently produced at these mills already have market options. With this in mind and for the purposes of this analysis, we assume that up to 5,000 tons of mill residue material may be available to a wood pellet mill developed in the Mohawk region.

C. Cost Curves

A wood pellet facility in the Mohawk region would be expected to utilize feedstock in a number of forms, including roundwood (low-grade stems delivered in whole form), debarked (clean) chips, and some bole chips with the bark on the wood. Bole chips, which contain some bark, are a financially attractive feedstock but have higher ash content than debarked material and must be blended with other higher value material to make a premium wood pellet; for this reason the volume of bole chips is limited in the cost curve below. Accounting for existing regional markets and the forest resource in the region, INRS projects a facility that uses a blend of hardwood and softwood feedstocks.

Based upon current wood prices in the region and neighboring areas, combined with modelling and INRS' experience in the forest industry, the cost curve chart and accompanying table below (Figure 17 & Table 7) shows a range of products and the incremental (bar) and average (line) price per green ton of feedstock *as utilized* at a wood pellet manufacturing facility. Bole chips and clean chips (which are debarked) arrive at the facility ready to use. Roundwood needs additional processing (estimated here at $15 per green ton), and some loss associated with shrinkage (loss of material in the debarking process, estimated here at $2 per ton).

Figure 17 Cost curve for feedstock at MA wood pellet manufacturing plant



Softwood Roundwood
Softwood Bole Chips
Softwood Clean Chips
Hardwood Roundwood
Hardwood Bole Chips
Hardwood Clean Chips
Mill Residue
Debarking / Chipping
Shrinkage

Legend

Table 7 Cost curve data for feedstock at MA wood pellet manufacturing plant

Tons	Wood Cost	Processing	Shrinkage	Total Price	Running Average Price	Feedstock Type
5,000	$ 18.00	$ 15.00	$ 2.00	$ 35.00	$ 35.00	SW RW
10,000	$ 36.00			$ 36.00	$ 35.50	SW Bole Chips
15,000	$ 38.00			$ 38.00	$ 36.33	HW Bole Chips
20,000	$ 40.00			$ 40.00	$ 37.25	SW Clean Chips
25,000	$ 40.00			$ 40.00	$ 37.80	HW Bole Chips
30,000	$ 24.00	$ 15.00	$ 2.00	$ 41.00	$ 38.33	SW RW
35,000	$ 42.00			$ 42.00	$ 38.86	HW Bole Chips
40,000	$ 26.00	$ 15.00	$ 2.00	$ 43.00	$ 39.38	SW RW
45,000	$ 48.00			$ 48.00	$ 40.33	Mill Residue
50,000	$ 32.00	$ 15.00	$ 2.00	$ 49.00	$ 41.20	HW RW
55,000	$ 34.00	$ 15.00	$ 2.00	$ 51.00	$ 42.09	HW RW
60,000	$ 52.00			$ 52.00	$ 42.92	HW Clean Chips
65,000	$ 54.00			$ 54.00	$ 43.77	HW Clean Chips
70,000	$ 38.00	$ 15.00	$ 2.00	$ 55.00	$ 44.57	HW RW
75,000	$ 38.00	$ 15.00	$ 2.00	$ 55.00	$ 45.27	HW RW
80,000	$ 56.00			$ 56.00	$ 45.94	HW Clean Chips
85,000	$ 40.00	$ 15.00	$ 2.00	$ 57.00	$ 46.59	HW RW
90,000	$ 40.00	$ 15.00	$ 2.00	$ 57.00	$ 47.17	HW RW
95,000	$ 58.00			$ 58.00	$ 47.74	HW Clean Chips
100,000	$ 42.00	$ 15.00	$ 2.00	$ 59.00	$ 48.30	HW RW

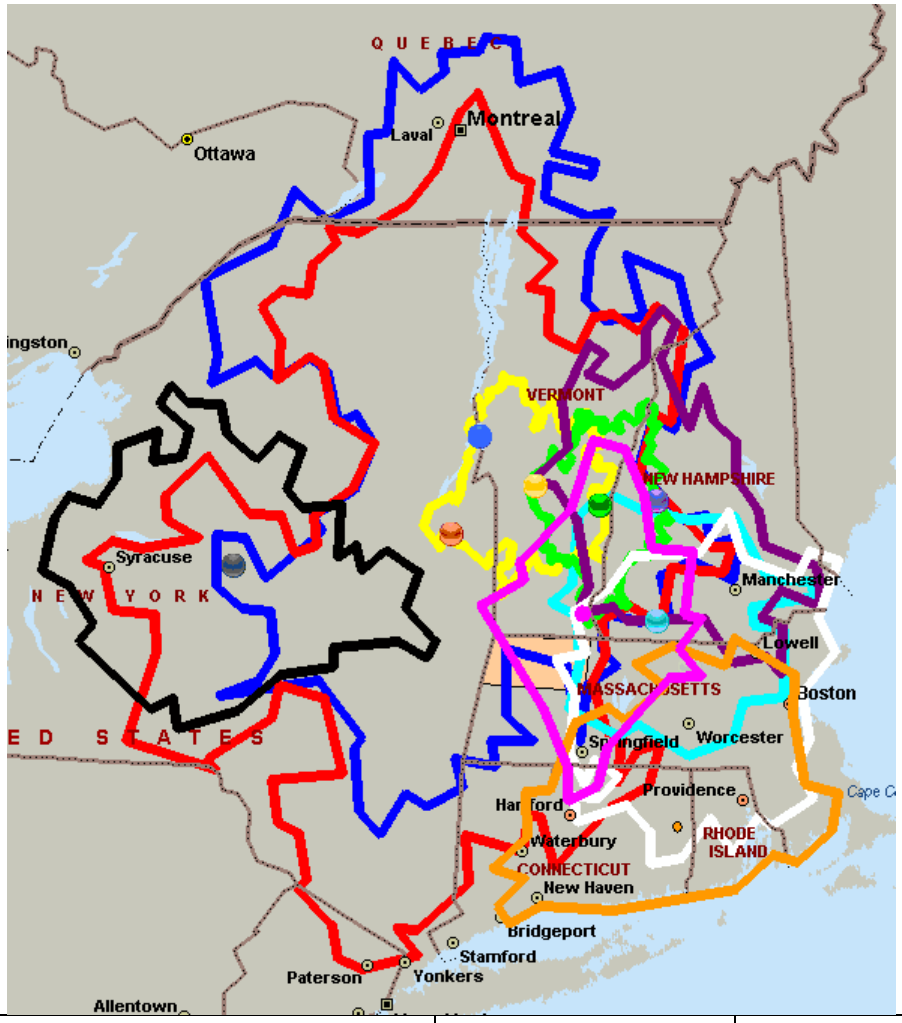
D. Major Users of Low-Grade

Major users of low-grade forest product material in the greater Mohawk region reach far from the facility location in order to secure the woody feedstock needed to supply those facilities. Figure 18 shows the web of estimated procurement areas for these facilities, many of which cross over and through the Mohawk region. It is important to keep this in mind when thinking about competition for sources of low-value woody material for a new wood pellet manufacturing facility in the region, should one be constructed.

Figure 18

Major Users of Low-Grade Wood Proximate to Mohawk Region

Estimated Annual Wood Use and Assumed Procurement Drive Time Shown



Color	Facility	Wood Use (g tons, est.)	Drive Time (min., est.)
	Renewable Fuels of Vermont	38,000	60
	Springfield Power	200,000	90
	New England Wood Pellet - Jaffrey, NH	200,000	90
	Finch Paper	690,000	180
	International Paper -Ticonderoga	1,500,000	180
	Vermont Wood Pellet	40,000	60
	Pinetree Power – Fitchburg	225,000	90
	New England Wood Pellet – Schuyler, NY	200,000	90
	Plainfield Renewable Energy	~220,000 (clean only)	90
	Cersosimo – Low Grade Chip Yard	50,000	75

5. MA Chapter 61 lands and Chapter 132 harvests

In order to add to the forest data developed from FIA and other sources and described in the previous sections of this report, the Mohawk Forest Resource Assessment project includes an analysis of Chapter 61 lands and Chapter 132 Forest Cutting Plan data. These analyses are intended to further understand the role of Chapter 61 forest lands – where a licensed forester has developed a forest management (stewardship) plan – on forestry and low-grade wood availability in the region. On these lands, it is assumed that projected harvests and actual harvests are being conducted in a sustainable manner and, with the data from all the lands and harvests in the 20-town region, we hope to gain some additional insight into what might be available to harvest on these lands among other useful information.

Our analyses for these lands and harvests are focused on understanding how much low-grade timber volume is projected to be harvested from Chapter 61 lands in the 20-town region based on the stewardship plans for these properties. Additionally, understanding how much volume was harvested from the Chapter 61 properties based on the Chapter 132 Forest Cutting Plans is also a desired outcome.

INRS obtained the Chapter 61 and 132 Access file datasets from the MA Department of Conservation and Recreation. After analyzing the data from the Access datasets, several shortcomings were identified although INRS believes some useful data and information can be drawn from these datasets.

The first major challenge found with Chapter 61 property data is that very few planned practices – where planned harvest acres and volumes are identified – are for years beyond 2015. Without most of the property plans showing projected practices beyond 2015, the Chapter 61 data does not provide any useful information for this analysis.

Chapter 132 data on Forest Cutting Plan timber harvest levels are available for the 20 town area Chapter 61 lands – these are a subset of all of the Cutting Plans. Unfortunately, there is no way to link the Chapter 61 individual properties with individual Forest Cutting Plans in the Chapter 132 dataset, thereby allowing a direct comparison of planned timber harvest volumes as set forth in Forest Cutting Plans with the planned stewardship practices as identified in Chapter 61 Stewardship Plans.

Lastly, we are reminded that the Chapter 132 Forest Cutting Plan data are estimates only since they are filed prior to harvests from estimates made of proposed harvest volumes. No "actual" harvest volumes are available from these permitted harvests.

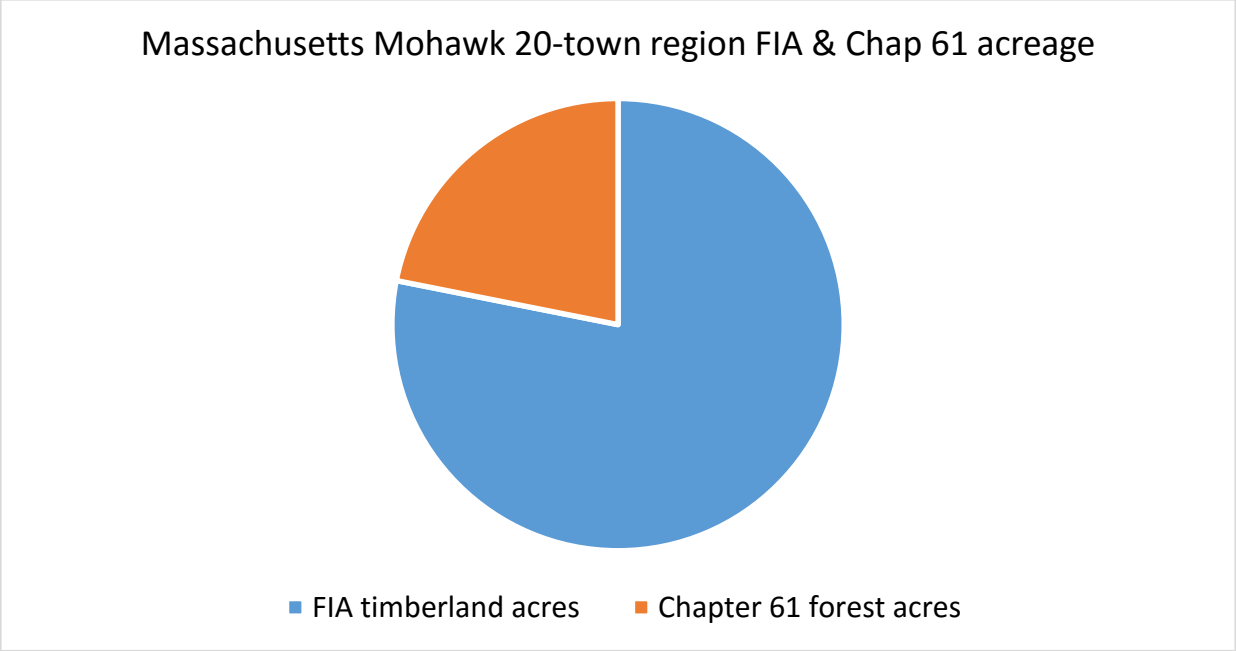
A. Chapter 61

Despite these data challenges, Chapter 61 data may provide some useful information or at least provide an understanding of whether these lands might or might not play a significant role in supplying future low-grade wood fuel for the region.

Forest acreage

In this 20-town area, 91,885 acres of forestland[xiii] are enrolled in Chapter 61, representing approximately 22% of the forest in the region (Figure 19). Of these acres, 56,978 acres are (or were) proposed for some forest harvest in the stewardship plans although the period of years these acres are (or were) proposed for harvest is not known.

Figure 19



Timber Volume proposed for harvest

The Chapter 61 dataset includes several categories of data about prospective timber harvesting on these lands. The stewardship plans include proposed future harvests with estimates of harvest volumes. The challenge with the plans and the

data, as discussed earlier in this section, is that there are either no specific years attached to the proposed harvest volumes or the years attached are in the past or partially in the past. As a result, the potential harvest volumes are neither helpful in terms of actual amounts, since they are merely proposed and not actual, and their likelihood cannot be ascertained by year.

Combined for the 20-town region, the volumes represented for future harvest are:

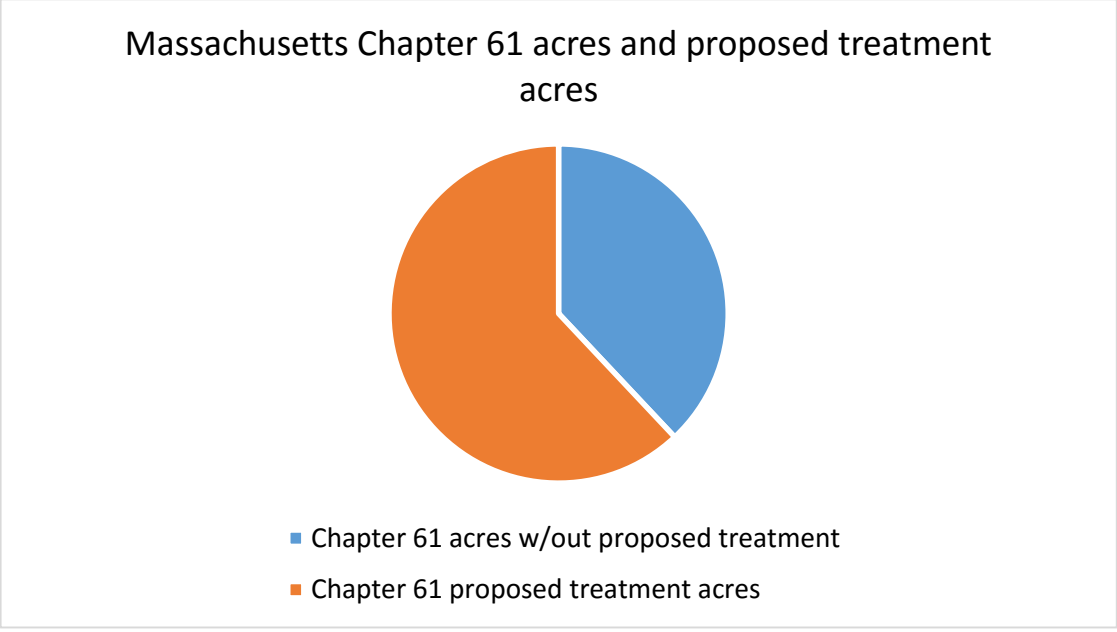
- Sawtimber – 17.18 million board feet
- Low-quality – 94,582 cords

These volumes are intended to be harvested on a total of 56,978 treatment acres so they represent:

- 301.6 board feet per acre
- 1.65 cords per acre.

A better metric to understand how Chapter 61 harvests might be helpful to this project is to look at the projected harvest volume data on a yearly output basis. Chapter 61 plans are developed for a 10 year period. As a result, for the Chapter 61 lands in the 20 town region, harvest volumes of low quality wood are projected to be 9,458 cords or an estimated 23,645 tons per year.

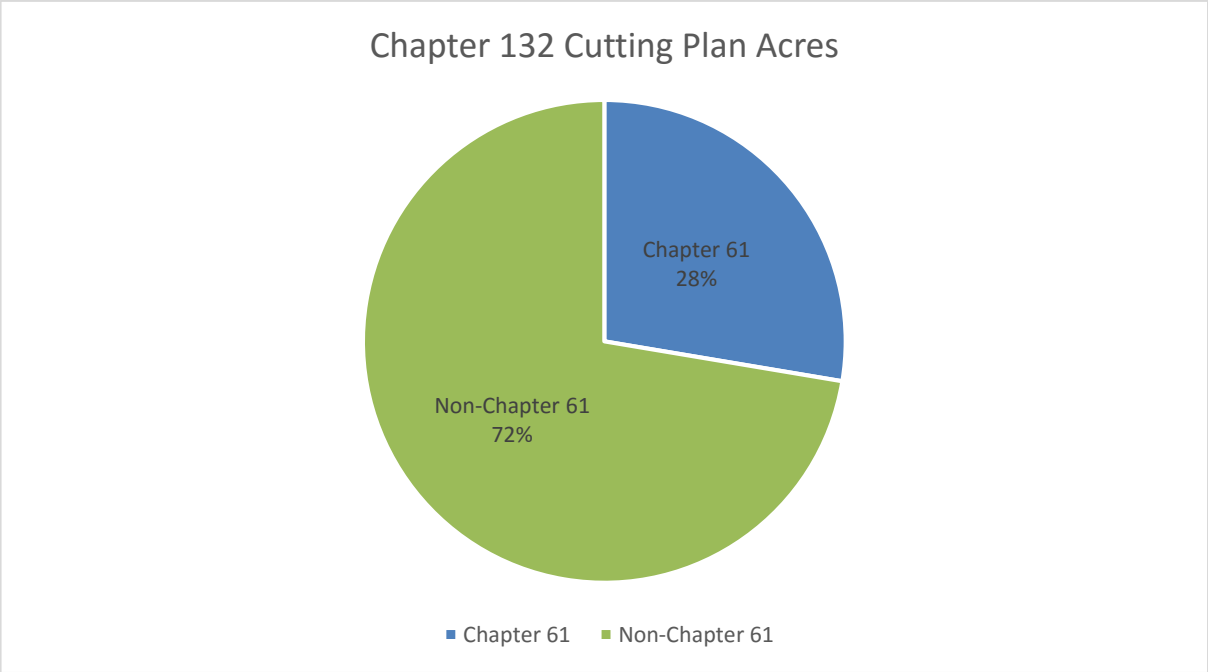
Figure 20



B. Chapter 132 – Chapter 61 vs non-Chapter 61 lands

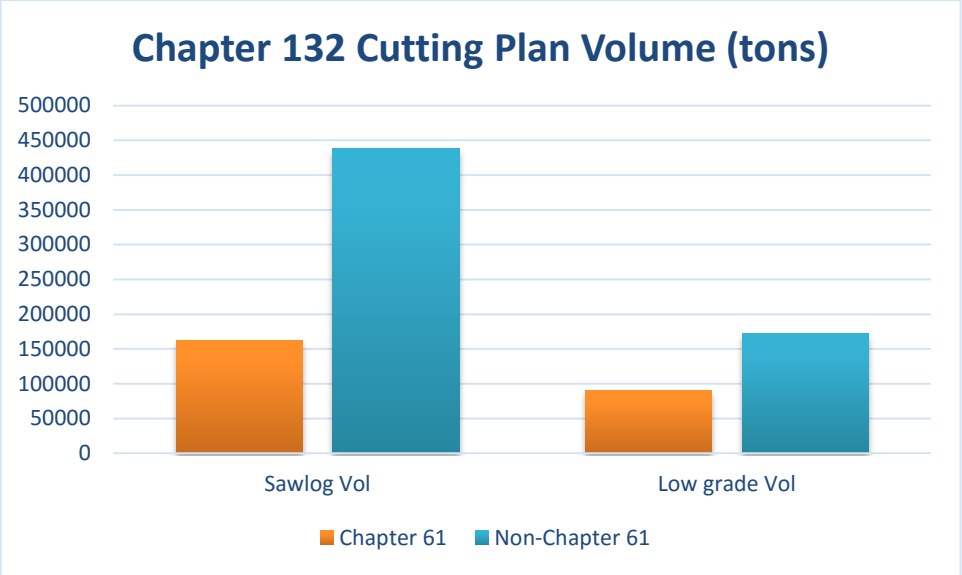
Chapter 132 Forest Cutting Plan information covers the period from 2001 to mid-2015. While it is not possible to link individual Chapter 61 properties to Forest Cutting Plan data, there is still useful information that can be gleaned for the 20-town area. The data show that considerable timber harvesting is taking place on forest lands other than those enrolled in Chapter 61. Of the harvest area identified for Cutting Plans filed, Chapter 61 lands have 15,581 acres while non-Chapter 61 cutting areas totaled 40,782 acres (Figure 21) for the period up to mid-2015.

Figure 21



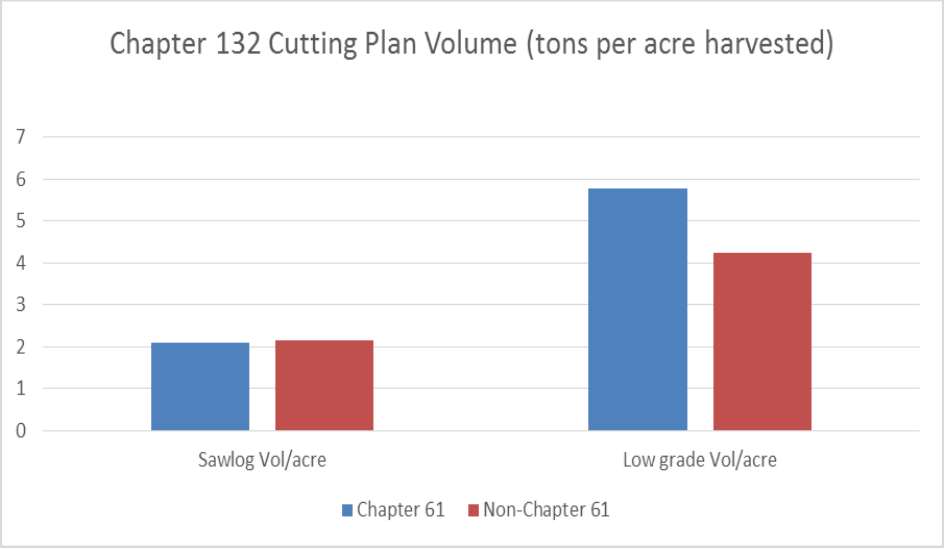
Sawlog volume harvested on Chapter 61 lands total 32.5 million board feet. Non-Chapter 61 sawlog volume harvested was 87.7 million board feet. Low grade pulpwood/firewood/chips harvested on Chapter 61 lands was 90,000 tons while on non-Chapter 61 lands 173,000 tons. These data are summarized in Figure 22.

Figure 22



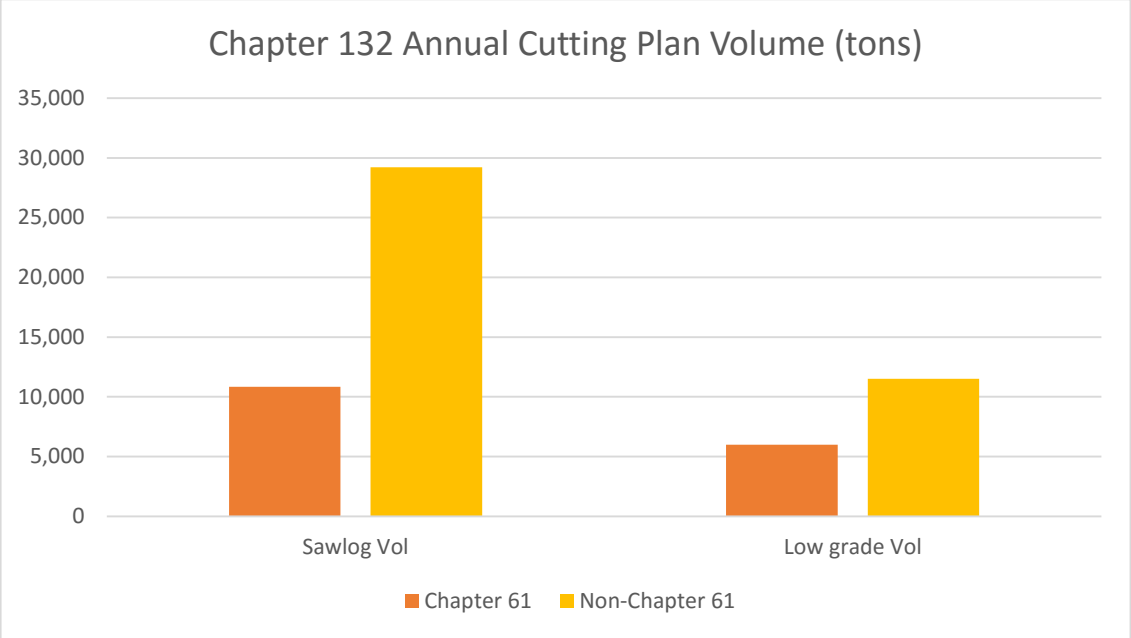
A more useful metric to compare Chapter 61 vs non-Chapter 61 land cutting plan volumes is on a per acre basis. In Figure 23, cutting plans showed that about the same amount of sawlog volume per acre was harvested on Chapter 61 vs non-Chapter 61 lands. For low-grade volume (primarily firewood, but also pulpwood and chips), Chapter 61 lands had more harvested per acre than did non-Chapter 61 lands.

Figure 23



One last useful comparison is of annual cutting plan volumes from Chapter 61 and non-Chapter 61 lands (Figure 24). In reviewing this chart, it is important to remember that the non-Chapter 61 acres account for 72% of the lands harvested on (Figure 21).

Figure 24



C. Chapter 132 – Long-term vs. short-term harvesting

Under the Chapter 132 Forest Cutting Plans, one of two boxes must be checked to denote whether the harvest was for long-term forestry purposes or for short-term purposes. The language in the Cutting Plan form reads:

Long-term Forest Management

Long-term Forest Management means the planned management of the forest to achieve one or more of the following objectives: produce immediate and maximize long-term income from harvesting activity, maintain or enhance wildlife habitat, improve recreational opportunities, protect soil and water quality, or produce forest specialty products such as maple syrup.

This strategy employs the science and art of forestry to help you manage your property to achieve multiple objectives, preserve future management options, and maximize economic return.

Short-term Harvest

Short-term Harvest means the selection of trees for cutting based on the economic value of individual trees which commonly results in a residual forest stand dominated by poor quality trees and low value species. While this strategy produces immediate income and meets the ***minimum*** *standards of the act, it does little to improve the future condition of the forest. A Short-Term harvest can limit future income and management options by:*

- *Removing trees before they reach economic maturity*
- *Leaving little value for future harvests*
- *Retaining slow growing or poor quality trees*
- *Removing mostly large diameter or high value species (such as oak) that could act as a seed source for growing future high quality trees or provide food for wildlife.*

Given these different purposes for the proposed timber harvest when the Cutting Plan is filed, it could be expected that the harvesting prescription would lead to different outcomes depending on whether it was a short or long-term harvest.

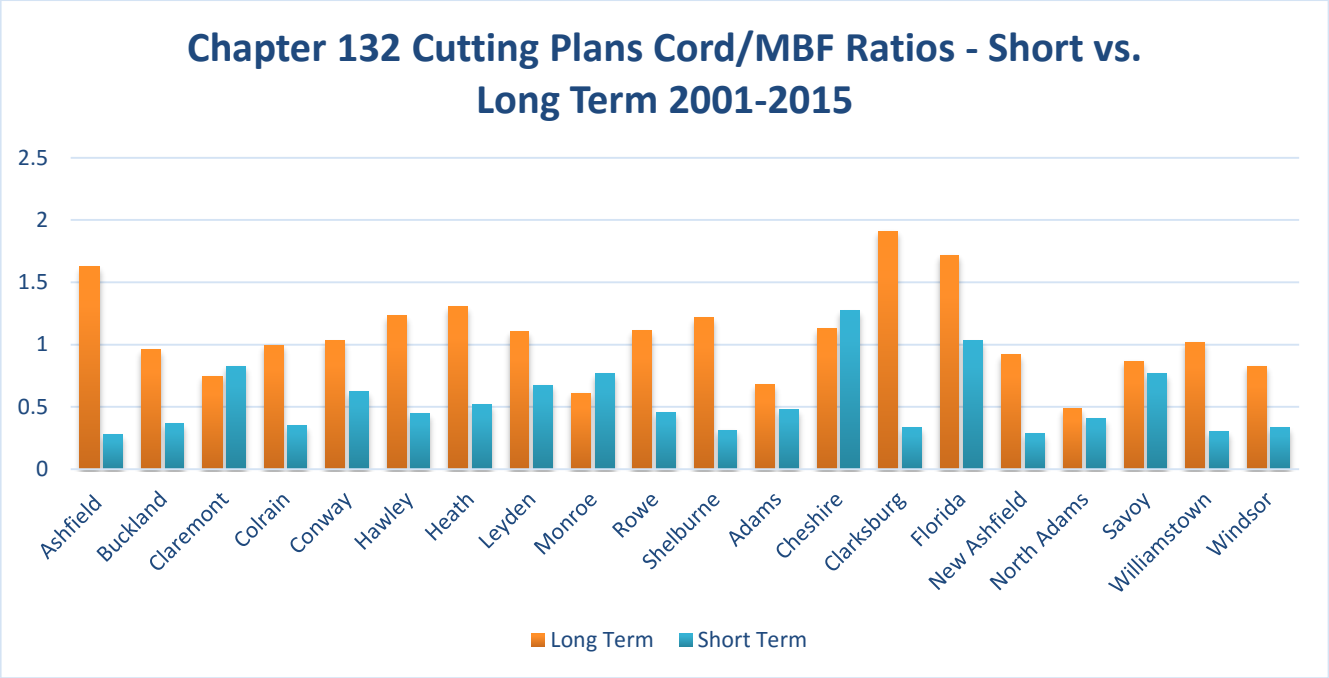
Table 7 below lists the number of cutting plans by town from which the Figure 25 data is derived.

Table 8 Number of Chapter 132 Cutting Plans by Town for 2001-2015

	# Chap 132 Cutting Plans
Ashfield	88
Buckland	50
Claremont	70
Colrain	71
Conway	112
Hawley	69
Heath	75
Leyden	45
Monroe	20
Rowe	29
Shelburne	60
Adams	21
Cheshire	19
Clarksburg	15
Florida	22
New Ashfield	26
North Adams	21
Savoy	62
Williamstown	105
Windsor	69

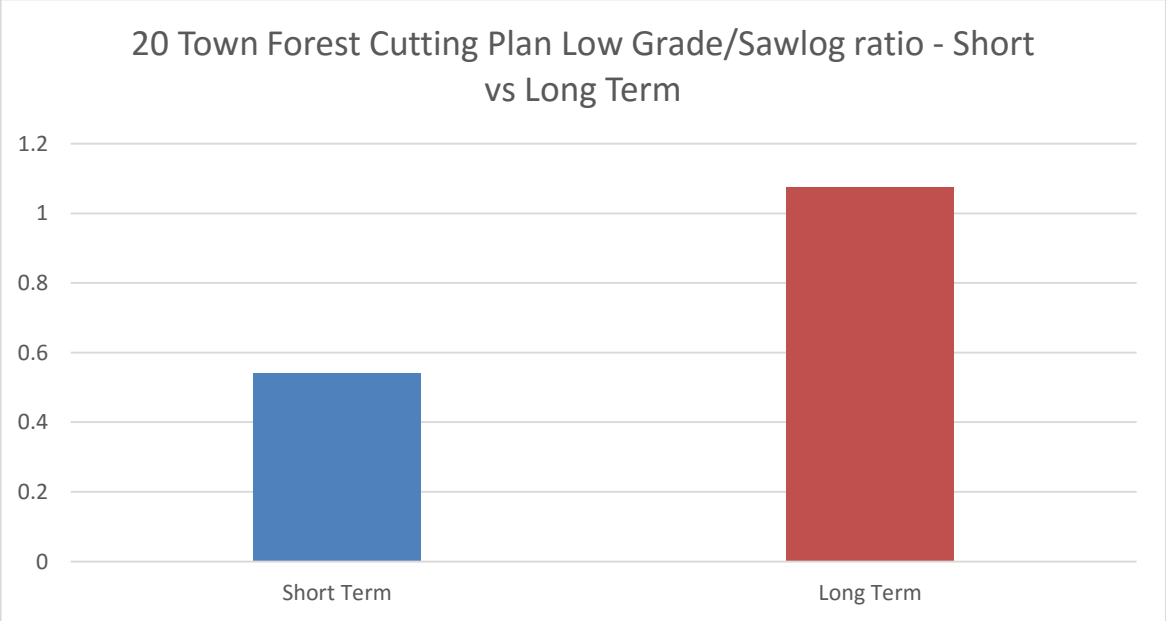
In Figure 25 below we see a town by town comparison of ratios of low-grade volume (cords) to sawlog (thousand board feet) volume. In all but a few towns, the data show that short term harvests result in more sawlog volume being harvested than low-grade wood volume, as a ratio of the two (taller orange columns mean more low grade timber harvested)[xiv].

Figure 25



This same data summarized for the 20 town region is included in Figure 26.

Figure 26



Similar analyses have been done statewide by MA DCR. Figure 27 shows results of those analyses (done for the Forest Cutting Plan data up to 2011).

Figure 27 MA Statewide comparison of long vs. short term cutting plan harvest data

Long-Term vs. Short-Term

Years	2003 -2005		2006-2008		2009 -2011	
	LT	ST	LT	ST	LT	ST
%of plans	70	30	81	19	87	13
Ratio Cd/MBF	1.2	.45	1.98	.71	2.06	.88

dcr Massachusetts

Source: Jennifer Fish, MA Dept. of Conservation and Recreation

6. Siting a wood pellet mill in Mohawk area

Wood pellet manufacturing is a capital intensive, relatively low operating margin type of wood product manufacturing. Profitable wood pellet manufacturing depends on a careful optimization of several factors:

a. Close proximity to sufficient quality and quantity of wood feedstock to source the plant as cost effectively as possible;
b. Close proximity to market demand for full output of plant that will enable the plant to run at or close to capacity throughout the year;
c. Well designed and engineered plant and equipment to minimize downtime, and a design capacity for which there will be demand for 100% of the output within 2-3 years after the plant comes on line;
d. Close proximity to an efficient highway transportation network;
e. Sufficient working capital to allow owner to operate at capacity through extended periods of inventory build, such as during non-heating months or unusually warm winters;
f. A supportive community and appropriately-zoned land, preferably with no nearby residential development, and access to reliable three-phase electric power.

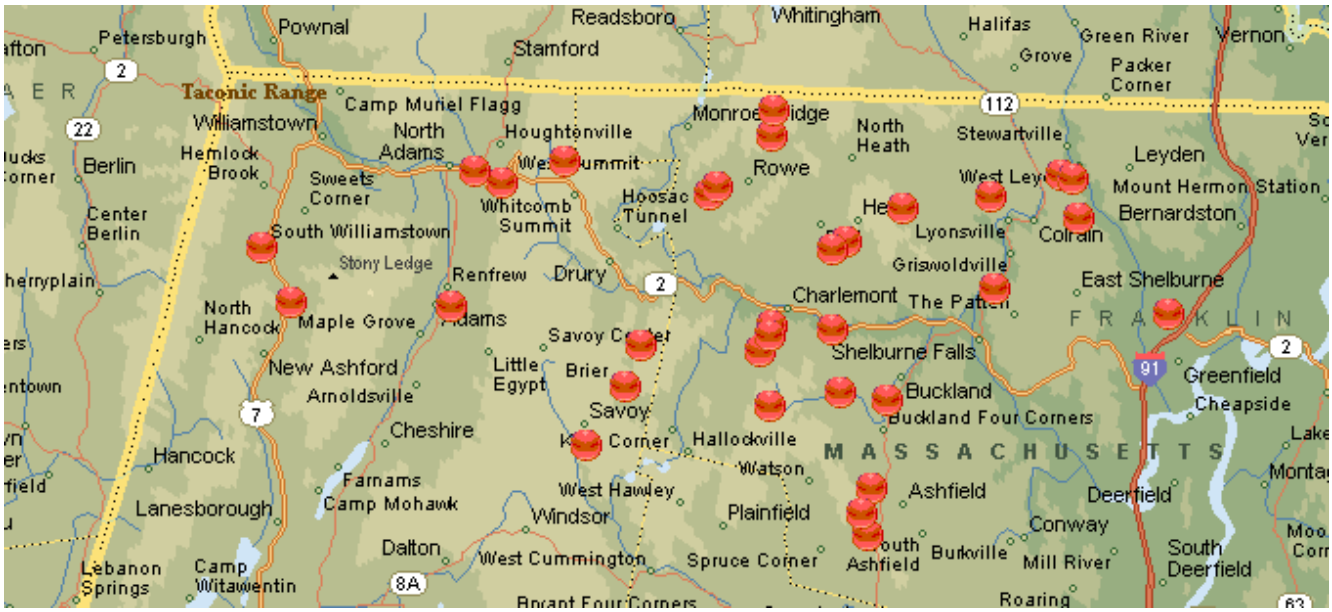
It is not the purpose of this report to examine all of these factors in detail. INRS[xv] has been asked to provide a projection of the capacity of wood pellet manufacturing that could feasibly be installed in the region and the suitability of the region to manufacture wood pellets including evaluating existing forest based infrastructure and workforce to provide required feedstock.

A. Supply Dynamics for Sustainable Wood Feedstock for a Mohawk Region Wood Pellet Plant

We know from sections 2 and 3 of this report that the privately owned forests of the 20 town Mohawk study region can, today, conservatively source between 193,000 and 234,000 green tons of low-grade hardwood and softwood roundwood per year on a sustainable basis. We know that primary and secondary wood product residues as pellet feedstock are limited within this region, with only one sawmill and few small secondary manufacturers (e.g furniture, cabinetry, millwork) within the 20 town Mohawk study area. We know that urban waste wood is also very limited in supply in this region and difficult to obtain in the quality necessary for premium grade pellet manufacturing.

Thus it is likely that any wood pellet plant operating within the Mohawk study region will rely heavily on feedstock derived directly from forest harvesting operations. The Massachusetts database of licensed timber harvesters[4] (2014) identifies 35 licensed timber harvesters whose business address is within the 20-town Mohawk study region. Larger logging contractors, particularly those with mechanized felling, forwarding and chipping capability, are not well represented among these 35. Smaller logging contractors collectively represent a larger percentage of the logging workforce and capacity within the study area.

Figure 28 Licensed Timber Harvesters within the 20-Town Mohawk Region (2014)



Outside of the study area in Massachusetts, and adjacent in Vermont and New Hampshire, there is a larger population of logging contractors who serve existing low grade markets, such as those documented in Figure 17. Many contractors within north-central Massachusetts, southern VT and southern NH are within economic trucking distance of the study area, and may operate from time to time in the study area. The most notable existing commercial-scale low grade markets within a 70 mile trucking distance to the study area are (again, Figure 16) Cersosimo Lumber Company's chip yard in Vernon, VT (roundwood, 35 miles to Charlemont[xvi]); New England Wood Pellet's facility in Jaffrey NH (chips, 61 miles to Charlemont); and the Pinetree biomass electric facility in Fitchburg (chips, 68 miles to Charlemont).

[4] http://www.mass.gov/eea/docs/dcr/stewardship/forestry/service/thl-directory-march2014.pdf

Individual firewood processors also represent some demand on low grade wood resources but there exists no definitive information on the amount of low grade roundwood these processors purchase each year. Thus logging contractors have a variety of markets available to them, and trucking distance to these markets is an important factor in whether the market represents a viable option or not. A pellet manufacturer in the Mohawk study region may be able to provide competitive pricing to certain suppliers by virtue of closer proximity to end market than is currently provided by other existing markets.

B. A Mohawk Region Pellet Plant in Relation to Sustainable Wood Supply

We are assuming that should a wood pellet plant be developed in the Mohawk region, that it would be sized within the range of plants operating within the northeast U.S. – between 20,000 – 100,000 tons of wood pellet output annually. A plant in this size range would include the following design elements:

a. Paved woodyard sufficient to inventory delivered roundwood and chips of at least 10,000 tons. This is at least 1.5 acres. Rolling stock: front end loader with log grapple and chip bucket. Truck scale for verifying weight of delivered roundwood, chips and outgoing bulk pellet shipments;
b. Stationary debarking and chipping capability, hard-wired with electric service, for processing roundwood into clean micro-chips as pellet feedstock;
c. A wood-fueled burner and rotary kiln or other dryer of sufficient capacity to process at least 125 tons of green wood feedstock dried to +/-10% moisture content per day, seven days per week. This system would require a MA DEP natural minor source air permit;
d. A pelletizing capability built around at least two (2) ring die pellet mills capable of operating at up to 3 tons per hour each. Redundancy in pellet mills is essential so that the plant can continue to operate at partial output during periods when one of the mills experiences scheduled or unscheduled down time;
e. Ability to ship finished product either in 40 lb bags, larger bulk containers, or by bulk truck through a top loading silo - with inventory storage silo of at least 200-300 tons. Covered storage capable of protecting at least 2,000 bagged tons from rain or snow.

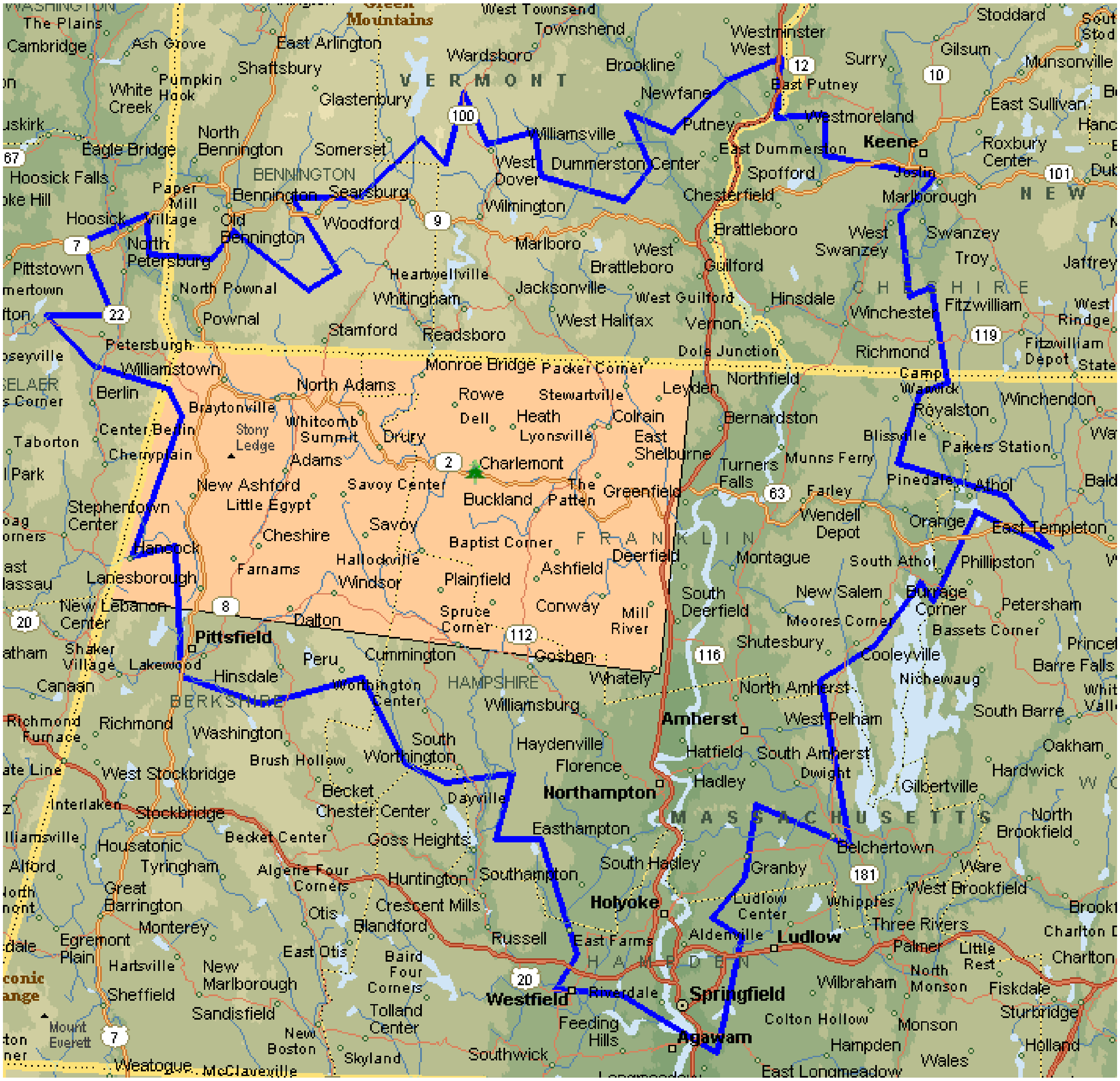
A plant in this size range will require wood feedstock of 40,000 to 200,000 tons per year, either in the form of roundwood delivered to the plant woodyard, chips delivered by self-unloading trailer from primary wood product manufacturing suppliers, or chips delivered by self-unloading trailer from in-woods operations (either flail-debarked or bark-on bole chips). Ideally this can be a blend of hardwood and

softwood, with production taking full advantage of the range of tree species native to Mohawk region forests.

The ratio of wood feedstock to finished pellet product is about 2:1 due to the moisture content reduction (from about 40-50% to 5% in finished product) and percentage of wood that is used to fuel the burner for heat to dehydrate wood to the appropriate moisture content for pelletizing. Wood quality is essential in the production of wood pellets that will meet a premium grade standard. Bark must be removed from roundwood and only a small percentage of bark-on chips can be tolerated and still stay within quality parameters, especially ash content.

A wood pellet manufacturing plant, NY

Figure 29 Likely wood procurement area for a hypothetical wood pellet plant in Charlemont area



C. Procurement Strategy for Mohawk Region Pellet Plant

In our judgment, it is imperative that a pellet plant have the capability of processing roundwood so that the market is open to the widest possible array of small and large logging contractors and suppliers, and so that private forest landowners and

sustainable forest management benefit directly from access to low grade markets. The alternative would be for the plant developer to co-locate with an existing wood processing yard that has a debarking and chipping capability. INRS has been unable to determine if such a yard exists within the study area. Another alternative may be to co-locate with the one existing sawmill within the study area, Robert Brothers Lumber Company in Ashfield.

A hypothetical procurement strategy to secure the amount of roundwood or roundwood chips necessary for a new wood pellet of the size range of mills in the northeast might be comprised of the following elements:

Table 98

Description of Supplier	Number	Type of feedstock
Large mechanized fully integrated contractor: Feller/buncher, grapple skidder(s), flail debarker, chipper, livefloor chip van(s), tri-axle with pup trailer	3 -6	Flail debarked chips and roundwood
Medium mechanized cut to length contractor: feller/buncher, forwarder, grapple skidder, chipper, livefloor van, tri-axle with pup trailer	3 -6	Bark-on bole chips and roundwood
Small conventional logging contractor: forwarder/cable skidder, tri-axle with pup trailer	15 -20	roundwood
Miscellaneous tree service/municipal road crew wood that meets high quality specification	6 - 10	
Mill residues	2-4	Clean mill chips and sawdust
TOTAL		**Plant using 40,000 – 200,000 green tons of wood feedstock per year**

Lastly, we can expect between 20 and 30 employees hired if a pellet plant is built, depending on the size and between 30 and 60 job equivalents increased in the logging and trucking sectors.

D. Role of MA DOER in Providing Possible Assistance to Build Logging Capacity to Serve Mohawk Pellet Plant

The logging capacity necessary to supply a potential wood pellet plant in the region does not currently exist within the study area, but does exist within a 60-75 mile procurement radius of a plant centrally located within the study region. It would take time and capital investment for the logging infrastructure to respond to the existence of this new market. To the extent that the Massachusetts Department of Energy Resources may be considering incentives for new pellet manufacturing, it may also want to consider incentives to help, simultaneously, develop logging capacity to serve such a new market. This could include capital grants toward investment in flail debarkers, high capacity micro-chippers, forwarders and livefloor trailers – all essential to the production of high quality roundwood and roundwood chips. It could also include grants toward the development of one or more roundwood concentration yards, where mobile flail debarking and chipping could be brought in periodically to process roundwood for trucking to the pellet plant.

E. Refined, Semi-Dry Chips as a Viable Alternative to Pellets in the Mohawk Region

This report has evaluated the potential of the Mohawk study region to sustainably supply low grade wood feedstock for a hypothetical "community scale" wood pellet manufacturing plant.

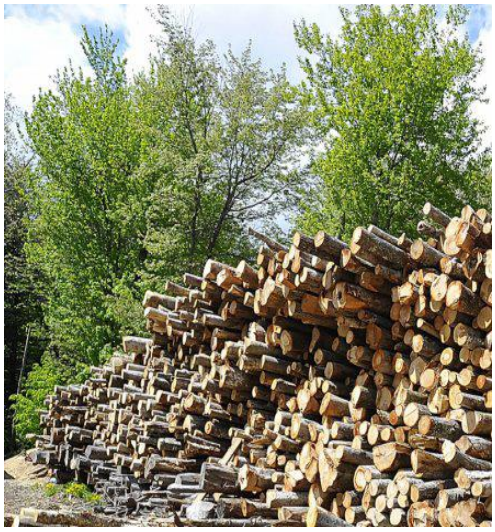
In western Europe, Scandinavia, and more recently in other New England states, semi-dry, refined wood chips and boilers specifically engineered to utilize this refined wood fuel have seen market interest[xvii]. If the objective of MA DOER is to utilize low grade wood in the Mohawk region toward high efficiency, clean commercial and institutional heating, it may be prudent to explore the development of semi-dry refined chips as an alternative to pellet fuel or in addition to pellets.

About Refined/Semi-Dry Wood Chips

Refined/Semi-Dry Wood Chips, or "RDCs" are chips that meet a tight size and moisture content specification - generally <1.5" in any two dimensions, and <30% moisture content by weight. Modern wood chipping equipment cannot consistently meet this size specification, and thus screening of both overs (>1.5") and fines (<1/4") may be necessary and desirable to mitigate the potential for bridging and auger jams, and to optimize combustion. Hardwood species common to the northeast have ambient moisture content of 35-50%, depending on species and time of year.

The semi-dry moisture content of RDCs is achieved either by air-drying of roundwood, or active drying by exposure of green chips to heated air flow.

Active drying requires a significant investment in infrastructure; whereas, air drying only requires time, yard space to inventory roundwood with good air flow, solar exposure, and careful attention to both species and handling. Air drying utilizes solar energy, while active drying utilizes an input of thermal energy from some other fuel. It is necessary to screen and dry chips in order to utilize them in boilers that are specifically engineered for a refined chip that meets a tight size and moisture specification. In so doing, these boilers can achieve higher combustion efficiencies that perform closer to wood pellet boilers. Some boiler manufacturers offer systems that can utilize both wood pellets and RDCs (e.g. Froling, Viessmann), and these systems are operating in numerous locations in the northeast.



Roundwood being air-dried for semi-dry chips

Elements of a Supply Chain to Produce RDCs for the Mohawk Region

The elements of the supply chain for RDCs include forest landowners; foresters; loggers/truckers; inventory yard, processing and storage; access to a truck scale; and truck transportation to end consumer. RDCs have an advantage over pellets in that they can be produced at a fraction of the sizable multi-million dollar investment required for pellet manufacturing. They have the disadvantage that they can only be used in larger boilers typically in commercial, municipal or institutional scaled buildings, and not residential boilers. However, at this scale, boiler cost is roughly the same as for pellet (though fuel storage may cost more), but operating cost in $/MMBTU heat output is considerably lower.

7. Logging and Trucking Infrastructure in study area

Having loggers who are capable and equipped to provide a consistent and affordable volume of wood is critical to any forest product manufacturer. INRS evaluated the logging infrastructure within the 20 town area, and based upon findings of this work recommends that building the base of suppliers is a necessary task before any new manufacturer utilizing low grade wood is established in the region.

Survey of Loggers

Innovative Natural Resource Solutions LLC used the *Massachusetts Department of Conservation and Recreation Harvester License Report*, available online[5], in order to identify 35 loggers that lived in the 20 towns that comprise the Mohawk region. All identified loggers were sent a postcard alerting them to expect a call to briefly discuss existing supply infrastructure in the region (see Appendix III). Following the arrival of the card, INRS made at least three attempts to contact each of the identified loggers via phone. Of the 35 licensed harvesters identified as living in the region, 10 were successfully contacted (29%), and 8 are currently working as loggers (either full or part time).

Survey Questions

INRS developed a script to make certain that all surveys of loggers were conducted in a consistent manner. The questions, available in Appendix IV, sought information on a range of topics, including:

- Equipment currently used in the logging operation;
- Volume of wood currently produced (including the current range of products);
- Additional or diverted volume available to a new potential market at a specific price point (for both hardwood and softwood);
- Any need for new equipment;
- Interest in possible grant or other financial support for new equipment;
- Other information that the logger believed would be valuable.

Survey Results

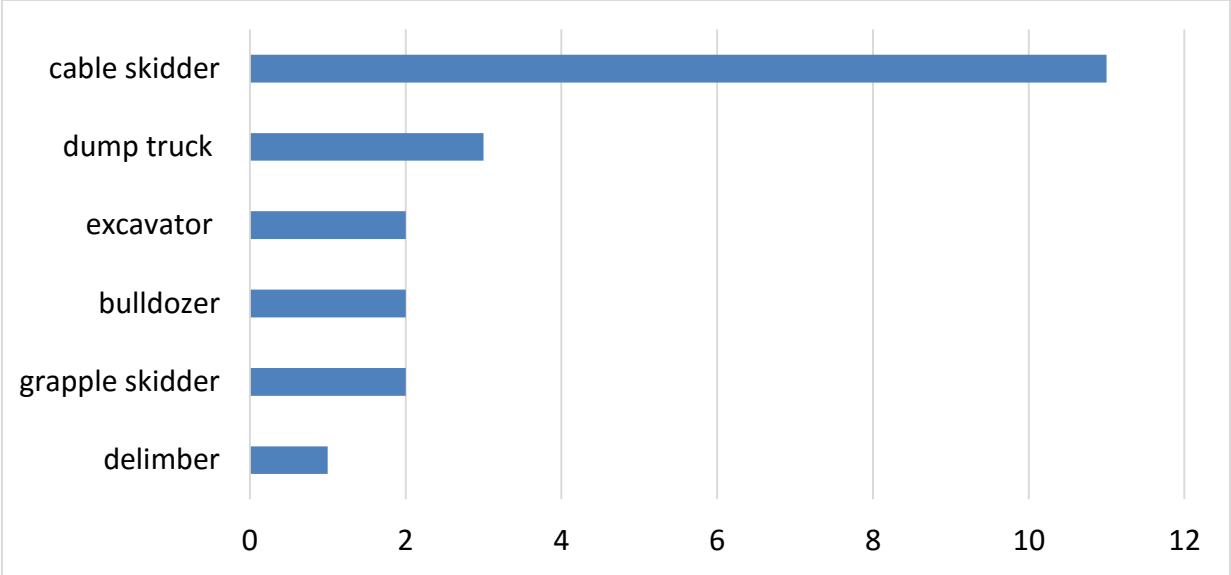
Based only upon those loggers INRS was able to speak with (which may represent the most productive and active loggers in the region), the following is known about logging production in the region:

[5] http://www.mass.gov/eea/docs/dcr/stewardship/forestry/service/thl-directory-2016-jan.pdf

- The annual production of the group is estimated at 50,000 green tons per year
- If a manufacturer located in the region utilizing low grade wood, they could expect from these suppliers short-term procurement availability of approximately:
    - 10,000 green tons of hardwood, and
    - 11,000 green tons of softwood

There is, of course, additional harvesting capacity in the region and adjacent to the region that INRS was unable to reach; these additional suppliers would add to the totals above.

Based upon those individuals and firms that INRS was able to speak with, the primary logging equipment is cable skidders (used in conjunction with chainsaws for hand felling of trees). Only two firms that INRS was able to reach have a mechanized harvesting capability.



In addition to discussing current capabilities, loggers in the region offered the following comments:

- The region needs to move toward more mechanized harvesting, increasing production and logger safety;
- The region would benefit from a focused logger training program (Maine program noted as a successful model); and
- "We desperately need a new market for low-grade wood".

Conclusions

The group of loggers that INRS was able to reach, operating in the 20-town Mohawk region does not have sufficient production capacity to supply a manufacturing facility with a procurement need of +/- 50,000 green tons of wood. Securing larger volumes would require either:

- Securing supply from loggers outside of the 20-town region; or
- Building new supply infrastructure, either by recruiting new or expanding existing logging operations to the region; or
- A combination of the two.

8. Analysis and Conclusion

The goal of this Forest Resource Assessment is to gain an understanding of the availability of low-grade wood resources that could be used for wood pellet manufacturing and also the production of semi-dry refined wood chips in the northwestern Massachusetts 20-town Mohawk region. The intent of the overall Mohawk project, as articulated in the introduction and assuming sufficient wood resources are available, is to encourage more use of local wood fuel to heat buildings in the region, thereby reducing use of fossil fuel use and bolstering economic potential of woodlands in the region.

To develop a conclusion to answer the question of whether enough wood feedstock is available for the region's needs, INRS used the following sources of data to analyze:

- the USDA Forest Service's national Forest Inventory and Analysis (FIA) dataset;
- the Northern Forest Biomass Project Evaluator modeling program;
- urban wood and wood manufacturing mill wood residues;
- Massachusetts Chapter 61 lands with forest stewardship plans;
- Massachusetts Chapter 132 Forest Cutting Plan data;
- INRS's decades of knowledge and experience about wood availability.

While all of the sources cited above were useful in our analyses, ultimately we chose to rely most heavily on the USDA Forest Service's FIA dataset. This dataset has been collected and maintained since the 1950s, and is the most complete, robust and reliable available. Further, since we decided that a wood pellet plant sited in this region would rely mostly on forest-derived wood feedstock for its raw material, the FIA dataset is the best and, really, only choice for forest data for this region.

With the assumption made in section 6 of this report that a wood pellet manufacturing facility proposed for this geographic region would be in the size range typical of plants in the northeast that use anywhere from 40,000 to 200,000 green tons of raw-material feedstock annually, the FIA data clearly shows that there is an adequate amount of forest-derived material that would be available on a sustainable basis. Using conservative assumptions, we determined that, today, there are between 193,000 and 234,000 tons available sustainably per year. This is woody material not being harvested currently. Since some of this grade of wood material is currently being harvested from the forest each year and being sent to other markets in the region (see Figure 17), we believe, assuming a new wood pellet plant would pay market rates for woody feedstock, that a portion of the material already being harvested for other markets would be diverted to this new market within the 20-town region. We have no way of knowing how much wood volume this might represent

but no matter how much, it would be in addition to what we project is sustainably available and stated above. In 2035, there will be between 355,000 to 842,000 tons available annually (depending on the procurement area). This large increase is simply because the forests of the region are projected to grow so much more wood each year compared to harvesting and mortality of trees.

In addition to the adequate availability of wood resources for a pellet plant feedstock, there is ample wood resource to also (or instead of) supply the emerging semi-dry wood chip market for heating buildings.

At present, there appears to be inadequate logging infrastructure within the 20-town region to supply a new wood pellet plant, should one be developed in the region.

Lastly, to facilitate proper forest management and provide forest landowners with economic incentive to keep land as forests, a low-grade wood market is sorely needed in this part of Massachusetts and the region. There are few nearby markets as evidenced in Figure 16. Such a market would enable the economic removal of low quality timber from the forest to improve the remaining standing timber for higher sawlog and veneer markets – and thus providing more money to the forest landowner over the long-term in return for being a good steward.

The primary purpose of this resource assessment is to determine if a new wood pellet plant would be able to operate sustainably on available forest-derived feedstock, should one be built in the 20-town Mohawk region. From the many data sources consulted, INRS concludes that such a wood using facility can obtain a sustainable supply of wood fuel from the forests of the 20-town and nearby surrounding areas, supplemented by a small amount of wood-using mill residues.

Appendix I

BPE Model run assumptions (all runs have these assumptions plus additional ones described in narrative)

Scenario Name: ohawk small run 1 pessimist

General

% of total standing bolewood volume that is low grade:	65%
% of total sawtimber harvest that is high-value (sawlog quality):	50%
% of tops and limbs inventory that is suitable/sustainable to extract for chipping:	75%

Private Timberland Ownership Proportions

% Corporate	5.0%		
% Farm	2.0%		
% Other Private	93.0%	% Other Private: 1-50acre parcels	30.0%
		% Other Private: 50+acre parcels	70.0%

Physical Factors Limiting Access

Slope	1.0%
Elevation	1.0%
Wetlands	0.5%
Distance to Roads	1.0%
Deer Yards	0.0%
Stream Buffers	1.0%
Easements	0.5%
Other	0.0%
Total % Physically Inaccessible Acres:	**5.00%**

Ownership Impact on Accessibility

Federal	0.0%
State	0.0%
Municipal	0.0%
Farmer	50.0%
Corporate	90.0%
Private Parcels 1-50 acres	50.0%
Private Parcels 50+ acres	70.0%

Appendix II

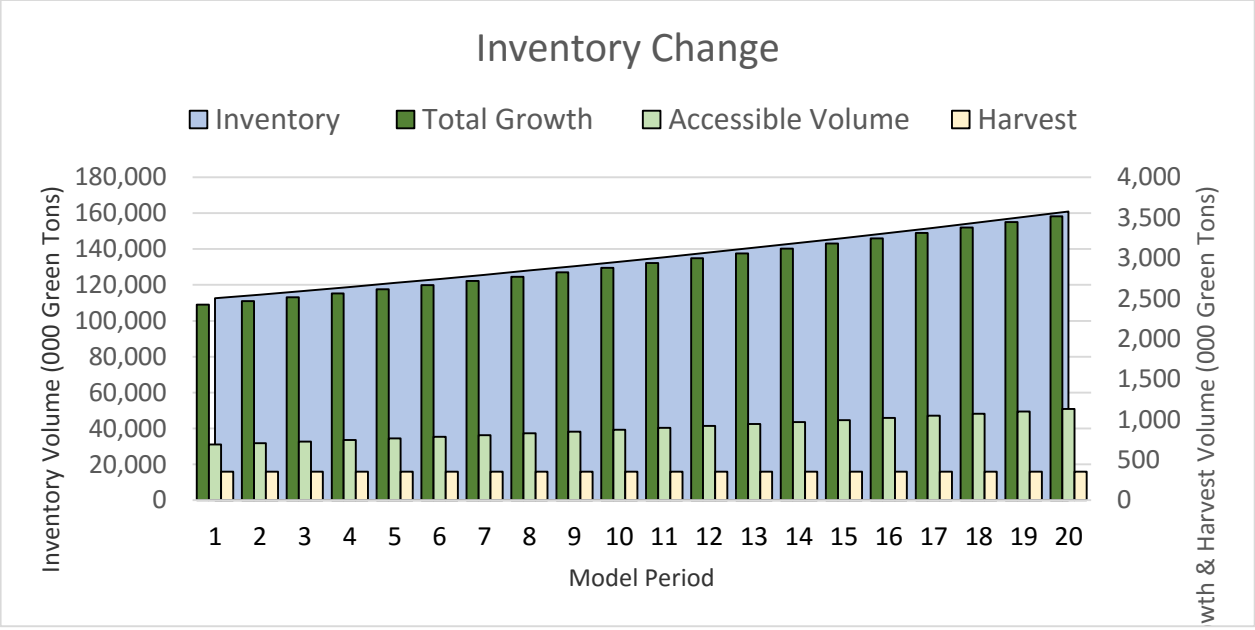
B. 20 town plus surrounding towns region BPE model runs

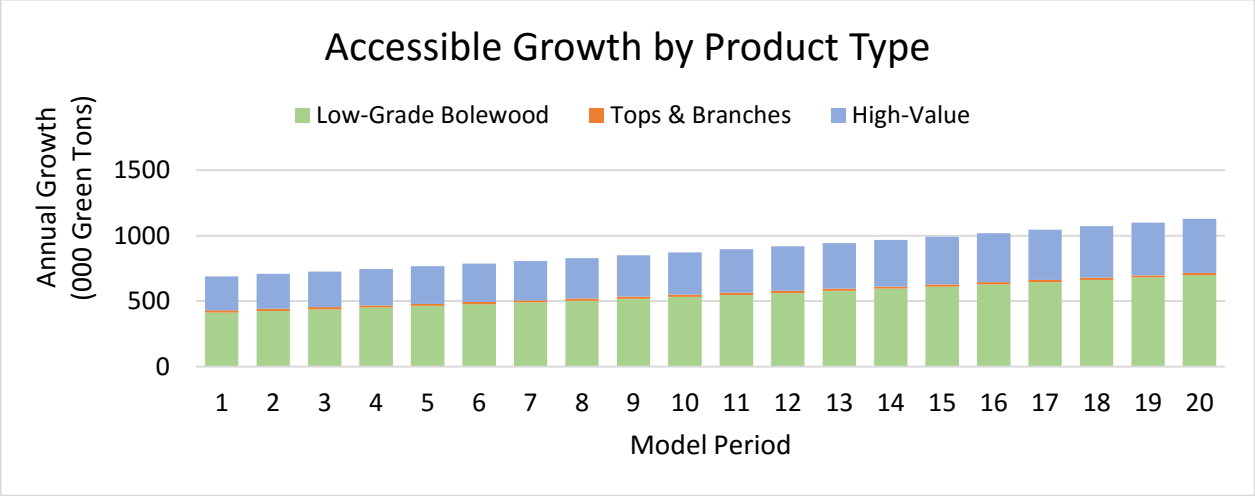
Run 5: The constant run – this is the "business as usual" run and assumes that wood use from the Region will continue at the same levels as are experienced today and that growth and mortality of trees will continue as today. The land acreage available for timber harvesting with this run is as follows.

Table A1.

Ownership Category	Total Acres of Timberland	Accessible Acres	
Federal	25,356.75	0.00	
State	126,467.73	0.00	
Municipal	18,679.20	0.00	
Corporate	30,874.80	27,787.32	
Farm	12,349.92	6,174.96	
Other Private:			
Parcels 1-50acres	172,281.36	86,140.68	Net Accessible Timberland:
Parcels 50+acres	401,989.84	281,392.89	
Total:	**787,999.60**	**401,495.84** →	**381,421.05**
		Percent Discount:	51.6%

Figure A1. BPE model run 5 results – business as usual (large area)



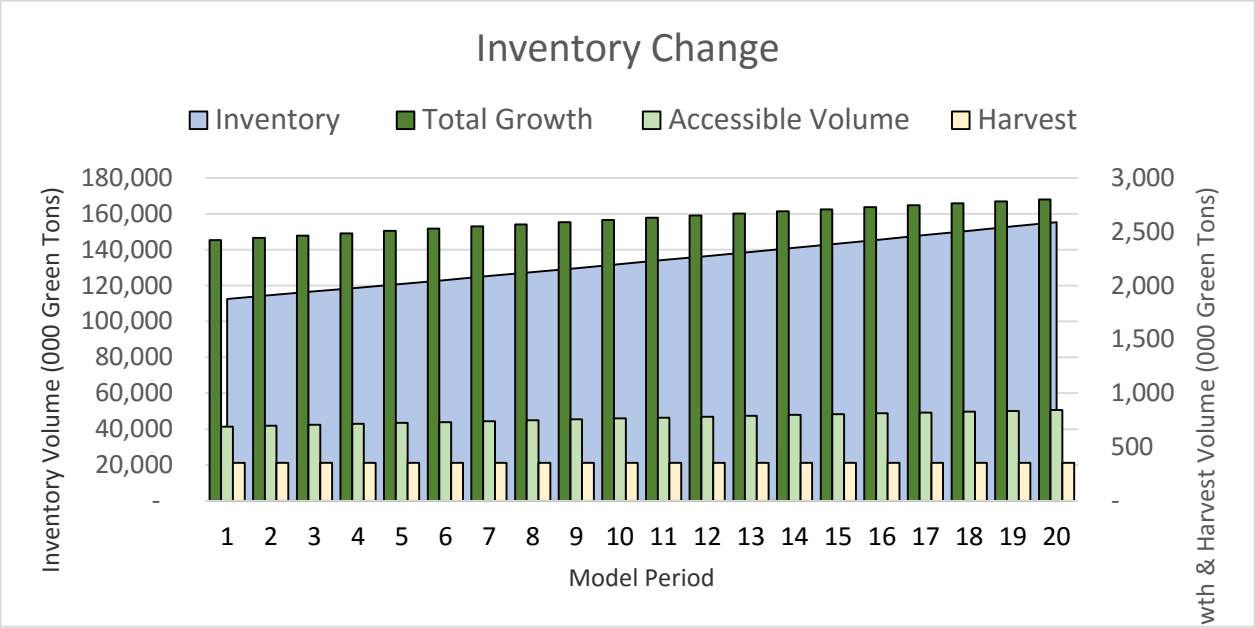


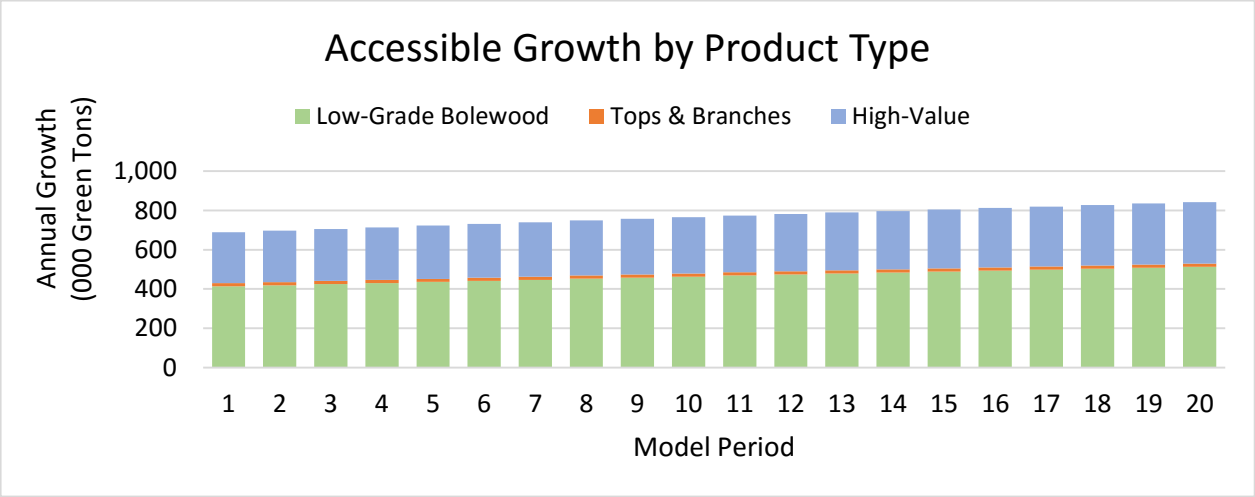
Available woody biomass for energy in year 2015 – 429,000 green tons

Available woody biomass for energy in year 2035 – 714,000 green tons

Run 6: Reduced growth run – this is the pessimistic run and assumes that wood use remains constant but that forest growth is reduced by 1 % per year over the run period. This choice reflects factors such as insects and diseases (hemlock wooly adelgid, emerald ash borer) or invasive plants and their possible future effects on forest growth. The land acreage available for timber harvesting with this run is the same as Run 4 above.

Figure A2. BPE model run 5 results – pessimistic (large area)



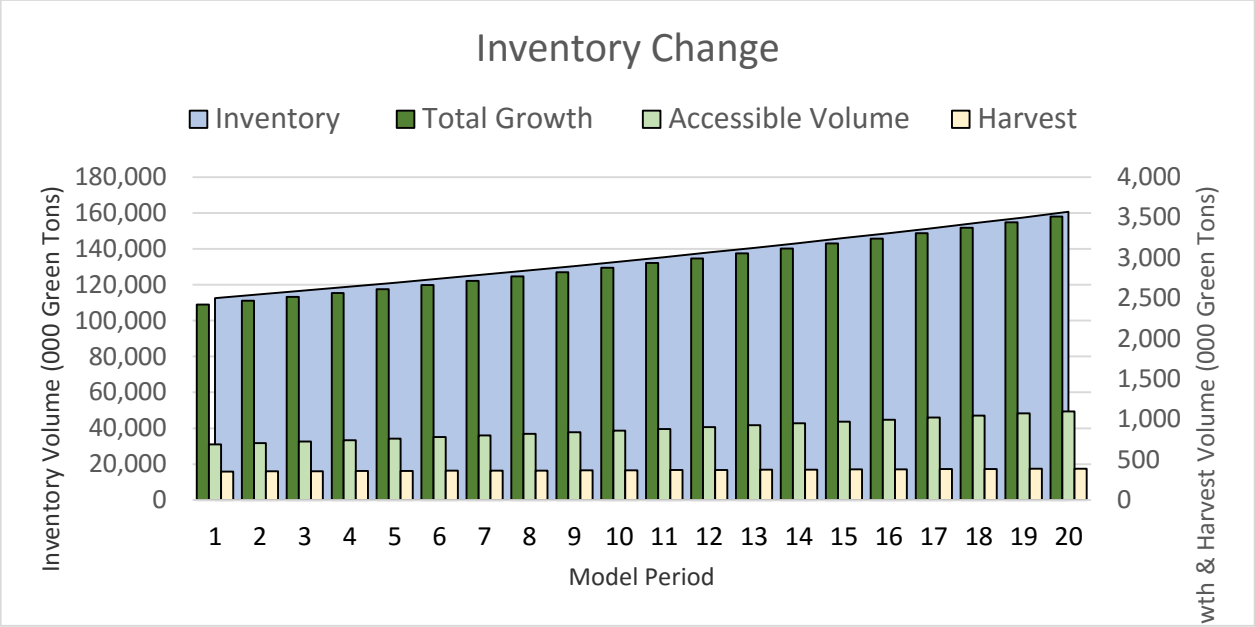


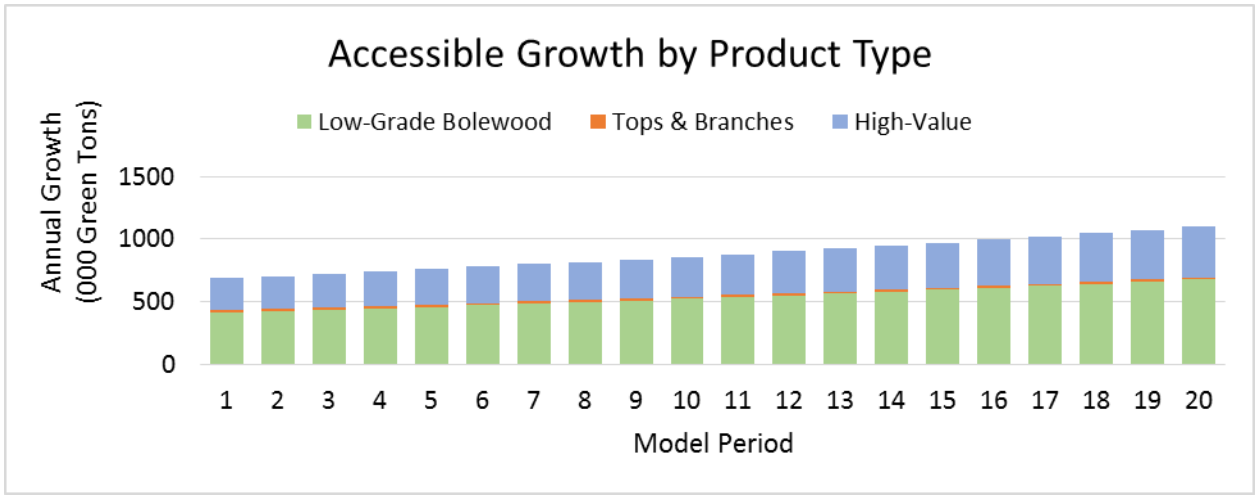
Available woody biomass for energy in year 2015 – 429,000 green tons

Available woody biomass for energy in year 2035 – 695,000 green tons

Run 7: Increased demand run – This is a run that assumes an annual increase of .5 % wood use in the Region while keeping growth and mortality at current levels and reducing forest land available by 10% for the Region. The land acreage available for timber harvesting with this run is the same as Run 4 & 5 above for the start of the run and then is reduced by 10% beginning in year 2 of the 20 year model run.

Figure A3. BPE model run 7 results – increased demand (large area)





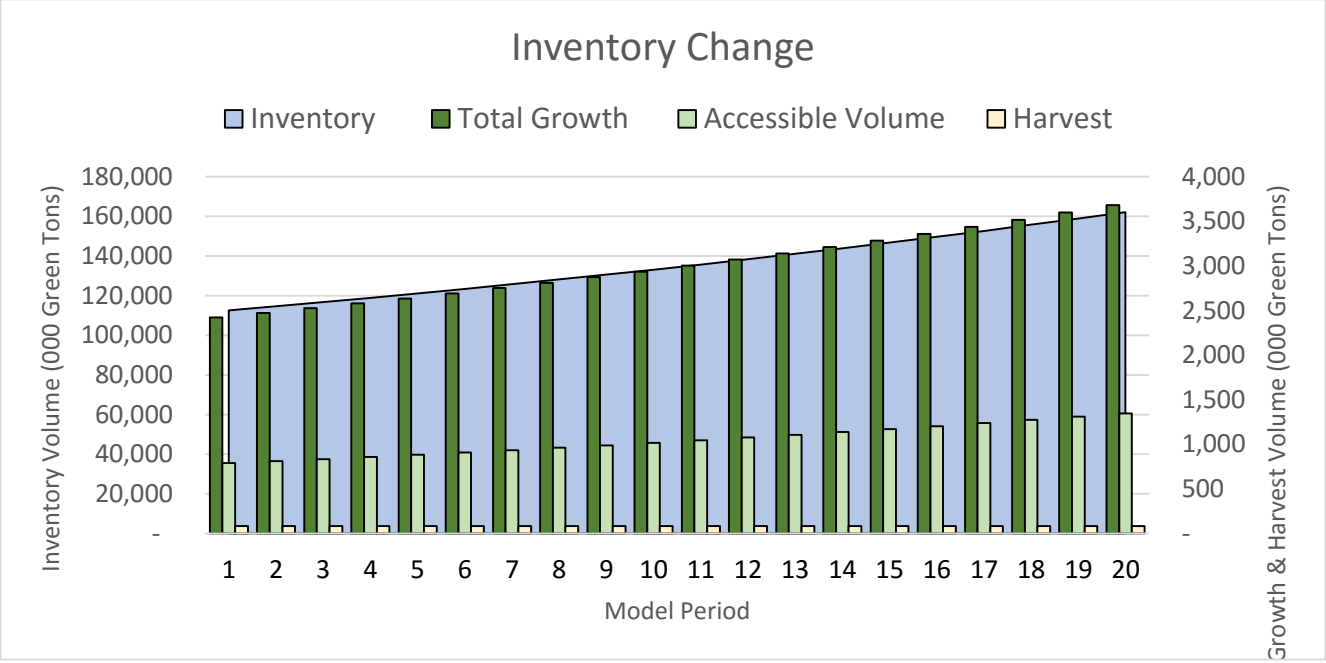
Available woody biomass for energy in year 2015 – 429,000 green tons

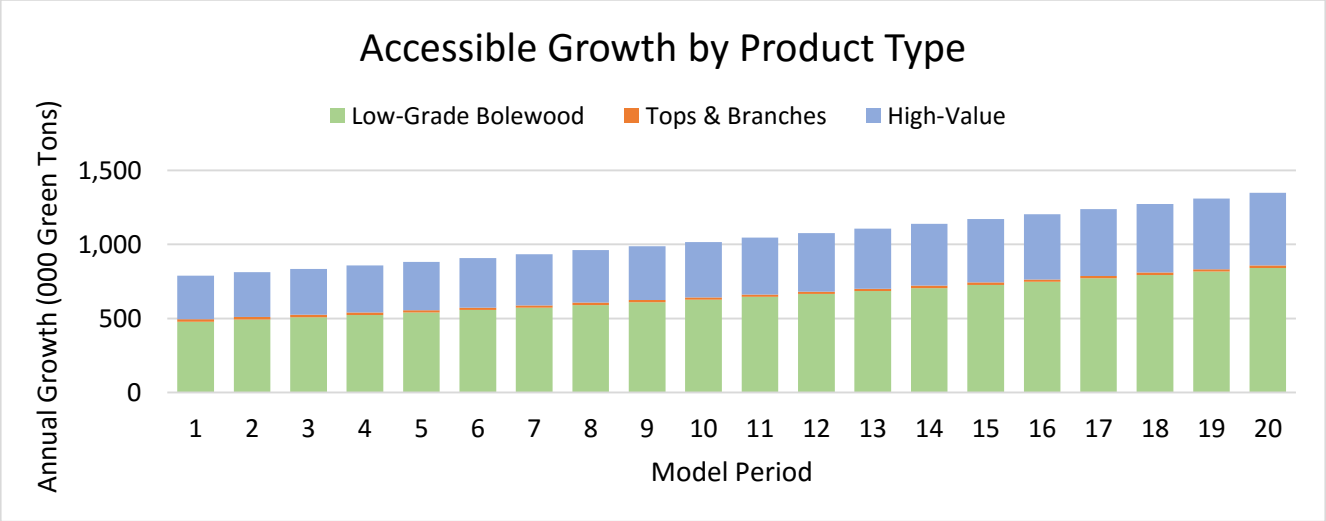
Available woody biomass for energy in year 2035 – 694,000 green tons

Run 8: Increased forest growth run – This is a run that assumes an annual forest growth increase of .2 % (compounded) in the Region while keeping harvest and mortality at current levels. The land acreage available for timber harvesting with this run is the same as Run 1 &

2 above for the run. This model run projection was chosen because early signs of climate change indicate that the forests of the northeast U.S. are increasing their annual growth due to the longer growing seasons being experienced as compared to 50 years ago.

Figure A4. BPE model run 8 results – increased forest growth (large area)





Appendix III Postcard sent to Licensed Harvesters

Evaluating a New Market for Low-Grade Wood

Innovative Natural Resource Solutions LLC (INRS) is evaluating a new market for low-grade wood in the northwestern region of Massachusetts. As part of that effort, we are evaluating the opportunities for logging firms operating in the region to supply volume.

You can expect a call from INRS to discuss this effort. I hope you will be willing to take 5 – 10 minutes to help us understand the existing supply opportunities in the region. If you would prefer, you can call the number below at any time.

Innovative Natural Resource Solutions LLC

Phone 207-233-9910, kingsley@inrsllc.com

www.inrsllc.com

Project being conducted for the MA Department of Energy Resources

Appendix IV Survey Questions for Logger interviews

Questions for MA DOER Infrastructure v1

- Calling as part of a project for MA DOER looking wood supply in northwestern Massachusetts
- I have a few quick questions, will take about 5 minutes
- All responses will be aggregated together – we will not use any information that identifies you are your firm – our real interest is what loggers in the region can do, not what your firm can do.
-

Name	
Company	
Date / Time	
Interviewed by	
Are you currently a logger?	
What type of equipment do you currently have?	
What volume of wood do you currently produce, and what range of products - (make sure to get units and time)	
If a new market was established in northwestern Massachusetts and was paying: - $24 per ton for "pulp grade" softwood roundwood - $38 per ton for "pulp grade" hardwood roundwood Would you be interested, and if yes, How much volume would you be able to provide?	
In order to supply this much volume, would you need to add equipment or people to your crew? If yes, what would you want to add?	
Would financial assistance from the state, either in the form of grants or low/no interest loans or loan guarantees for this equipment be of interest to you	
Do you have a truck that can haul roundwood, and if so what is its capacity (tons)?	
Who else should I talk to about this?	
Anything else you would like to add?	

Endnotes

[i] USDA Forest Service EVALIDator 4.01, http://fiatools.fs.fed.us/Evalidator401/tmattribute.jsp
[ii] The standard ways to access FIA data is by selecting entire counties or a radius around a point as the unit of analysis. Because of the towns considered as part of this project, INRS worked with the USDA Forest Service to identify individual sampled plots within a specified area, and used these plots to estimate the growth, harvest, standing timber, and land ownership in the region.
[iii] USDA Forest Service data is presented in cubic feet. INRS calculated green tons assuming 85 cubic feet of solid wood per cord, and that a green cord of wood weighs 2.6 tons for hardwood and 2.3 tons for softwood.
[iv] FIA definition of "timberland" is "Forest land that is producing or capable of producing in excess of 20 cubic feet per acre (1.4 cubic meters per ha) per year of wood at culmination of mean annual increment (MAI). Timberland excludes reserved forest lands." http://socrates.lv-hrc.nevada.edu/fia/ab/issues/pending/glossary/Glossary_5_30_06.pdf
[v] While some timber is harvested on state lands in the 20-town region, we have chosen not to include these lands because only a small percentage of the state lands is managed (Woodland category) and our interest in this report is to be as conservative as possible with the results.
[vi] Not all of this materially is necessarily available to the market.
[vii] The Northern Forest Biomass Project Evaluator model was development by Innovative Natural Resource Solutions, LLC for the North East *State* Foresters Association. A working version can be found at www.nefainfo.org.
[vii] A. Milbrandt. A Geographic Perspective on the Current Biomass Resource Availability in the United States. National Renewable Energy Laboratory, Technical Report NREL/TP-560-39181. Prepared under Task No. HY55.2200. December 2005.
[vii] http://en.openei.org/w/images/f/f0/Biomass.png
[vii] Wakefield, E., *PyNe Workshop Report*. In: *ThermalNet*. Issue 04. June 2007.
[vii] http://www.robertsbrotherslumberandlogging.com/
[vii] Personal communication with Lenny Roberts, December 9, 2015.
[vii] A. Milbrandt. A Geographic Perspective on the Current Biomass Resource Availability in the United States. National Renewable Energy Laboratory, Technical Report NREL/TP-560-39181. Prepared under Task No. HY55.2200. December 2005.
[vii] http://en.openei.org/w/images/f/f0/Biomass.png
[vii] Wakefield, E., *PyNe Workshop Report*. In: *ThermalNet*. Issue 04. June 2007.
[vii] Given the modest number of plans in some towns, INRS cautions against drawing conclusions about forest management on a town-by-town level based on this data.
[viii] A. Milbrandt. A Geographic Perspective on the Current Biomass Resource Availability in the United States. National Renewable Energy Laboratory, Technical Report NREL/TP-560-39181. Prepared under Task No. HY55.2200. December 2005.
[ix] http://en.openei.org/w/images/f/f0/Biomass.png
[x] Wakefield, E., *PyNe Workshop Report*. In: *ThermalNet*. Issue 04. June 2007.

[xiii] In the Franklin and Berkshire County area of Massachusetts, forestland acre and timberland acreage are virtually the same. We offer a further reminder here that our FIA analysis area is slightly larger than the actual area of the 20-town region because FIA data is not available strictly within individual town boundaries.

[xv] Disclosure: one of the principals of Innovative Natural Resource Solutions LLC worked for a wood pellet manufacturer in the region, and retains a working relationship with that firm.
[xvi] Charlemont is used as a proxy for the middle of the region (from a transportation standpoint). No independent evaluation has been made of the correct location for plant siting.
[xvii] Disclosure: Innovative Natural Resource Solutions LLC is a partner in a New Hampshire firm, Innovative Wood Fuels,that produces and supplies semi-dry wood chips to customers in that state.

Sources:

A. Milbrandt. A Geographic Perspective on the Current Biomass Resource Availability in the United States. National Renewable Energy Laboratory, Technical Report NREL/TP-560-39181. Prepared under Task No. HY55.2200. December 2005.

GIS data – courtesy of many sources including: MA Office of GIS, GRANIT, Vermont Center for Geographic Information, New York State GIS Clearinghouse and U.S. Geological Survey

Northern Forest Biomass Project Evaluator – www.nefainfo.org

Massachusetts Chapter 61 data – Massachusetts Department of Conservation and Recreation

Massachusetts Chapter 132 data – Massachusetts Department of Conservation and Recreation

Personal communications - Jennifer Fish – Massachusetts Department of Conservation and Recreation (numerous from August – December 2015).

Personal communication - Lenny Roberts, December 9, 2015.

Telephone Survey, April and May 2016 – many loggers and truckers in Mohawk region

USDA Forest Service – Forest Inventory and Analysis data - http://www.fia.fs.fed.us/tools-data/

Wakefield, E., *PyNe Workshop Report*. In: *ThermalNet*. Issue 04. June 2007.http://www.robertsbrotherslumberandlogging.com/

Wood pellet and other large user data – Innovative Natural Resource Solutions, LLC