

# 2005-2008 Forest Harvest Summary for Selected Towns in Addison and Washington Counties, Vermont



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## 1. Purpose

In the face of uncertain fossil fuel prices and concerns about climate change, many people are viewing Vermont's forests as a valuable renewable and carbon neutral energy resource. Increased use of Vermont's forests could help to foster local economic and cultural development, while encouraging responsible stewardship of our forestlands.

This report was compiled to help enable such development and stewardship through better knowledge of forest harvest volumes. As part of the Community Biomass Project<sup>1</sup>, this study aimed to identify existing levels of wood harvests in selected Vermont towns from 2005 to 2008. The ultimate goal of the study is to improve understanding of local wood fuel supplies and inform community decision making regarding the increased role for wood and biomass fuels in the local energy system. The study contributes to the Community Biomass Project's larger goal of seeking to improve local energy systems in the Northeast according to community-supported principles of sustainable production, efficient use, local sourcing, and fair access (SELF).

The study focuses on the towns of Bristol, Lincoln, Monkton, New Haven and Starksboro in NE Addison County, and Fayston, Moretown, Waitsfield and Warren in Washington County (the "Mad River Valley"), as sites where initiatives for community-based wood energy are already underway and in need of wood supply data.

## 2. Highlights

- This report summarizes 2005-2008 harvest data for private lands enrolled in the Use Value Appraisal Program ("current use") and all public lands within the nine-town project boundaries. Note: harvesting from non UVA-enrolled private lands is not reflected in this analysis due to lack of data and makes these findings a systematic underestimate of total harvesting activity.
- Average annual harvest from focal Addison towns was 160.5 MCF/yr (5,095 gt/yr; 2,140 cords/yr); from focal Washington towns was 321.0 MCF/yr (10,190 gt/yr; 4,280 cords/yr); from all focal towns combined was 481.5 MCF/yr (15,286 gt/yr; 6,420 cords/yr).
- Focal Washington towns harvested 67% of the 2005-2008 cumulative harvest volume, with focal Addison towns producing the remaining 33%.
- Of the 2005-2008 cumulative harvest volume for all focal towns, 60% was sawtimber (reported in board feet) and 40% was low-grade wood (reported in cords or tons).
- Average annual harvest of low-grade wood (cordwood and chips) from focal Addison towns was 966 cords/yr (2,318 gt/yr); from focal Washington towns was 1,599 cords/yr (3,838 gt/yr); from all focal towns combined was 2,565 cords/yr (6,156 gt/yr).
- Existing average annual low-grade wood harvest is approximately 4-11% of the projected low-grade wood supply (based on growth models and landbase) grown annually on the sustainably harvestable landbase within the focal towns.

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<sup>1</sup> A partnership between the University of Vermont, Vermont Family Forests and the Northern Forest Alliance. Funded by the Northern States Research Cooperative, USDA Forest Service.

- The overwhelming majority of harvest came from private lands, with 94% from private UVA enrolled lands, roughly 3% each from state and federal lands, and none from town lands.
- Focal Addison and Washington County towns could potentially heat (primary space heating) 6% and 14% of their households, respectively, with their existing average annual low-grade harvest volumes. (Based on an average consumption of 4.3 cords/household/yr (UVM Wood Heating Consumption Survey 2009). Note: this does not consider current competing uses for low-grade wood.)
- Projected low-grade wood growth from the focal areas could provide an annually available, sustainably harvestable heating fuel with a potential to heat 64-138% of homes in focal Addison towns and 126-305% of homes in focal Washington towns.

**Table I. Summary of Harvest Highlights.** All numbers based on 2005-2008 annual averages.

	NE Addison towns			Washington towns			All towns combined		
	MCF/yr	gt/yr	cords/yr	MCF/yr	gt/yr	cords/yr	MCF/yr	gt/yr	cords/yr
Average annual harvest- (all wood)	160.5	5,095	2,140	321.0	10,190	4,280	481.5	15,286	6,420
Low-grade wood (cordwood and chips)	72.5	2,318	966	119.9	3,838	1,599	192.4	6,156	2,565
% of homes heatable from harvested low-grade wood	6%			14%			9%		
% of homes heatable from all sustainably harvestable biomass	64-138%			126-305%			89-205%		

### 3. Methods

This report summarizes available harvest data from 2005 to 2008 from public and privately owned lands. Lands include federal (Green Mountain National Forest), state, town, and private UVA-enrolled<sup>2</sup> lands within the nine-town project area in Addison (Bristol, Lincoln, Monkton, New Haven, and Starksboro) and Washington counties (Fayston, Moretown, Waitsfield, and

<sup>2</sup> According to the Vermont Division of Forestry, “the **Use Value Appraisal (UVA) Program**, also called “Current Use” or “Land Use,” enables landowners who practice long-term forest management to have their enrolled land appraised for property taxes based on its value for forestry, rather than its fair market value. When land is enrolled, the State attaches a **permanent lien** to the deed.... To be enrolled, forestland must have an approved, forest management plan updated at ten year intervals.” ([http://www.vtfor.org/resource/for\\_forres\\_useapp.cfm](http://www.vtfor.org/resource/for_forres_useapp.cfm)).

Warren), Vermont. Harvest data for non-UVA enrolled private lands were not readily available and are not reflected in this study. Other missing data are discussed in Appendix B.1.

All data were gathered from existing sources at various agencies as listed in Appendix A. UVA lands harvest data was compiled from Forest Management Activity Reports filed by landowners; Appendix B.2 discusses the challenges of this data source. Public lands harvest data was compiled from unpublished records kept by the relevant personnel (Appendix A). National Forest data in particular presented a challenge to understand at the desired local scale, see Appendix B.3-4 for details.

Summarizing harvest data requires converting among different reporting units (e.g. board feet, cords, etc.), and this can be a source of error as explained at length in Appendix B.3. Unit definitions and conversions used in this report are as follows.

<b>Unit</b>	<b>Definition</b>
MCF	1000 solid cubic feet of wood
MBF	1000 board feet
Cord	4ft x 4ft x 8ft stack of wood, 128 ft <sup>3</sup> with air spaces, here 75 solid ft <sup>3</sup> of wood
Green ton	2000 pounds green wood

#### **Conversion Factors**

0.146 MCF/MBF

0.075 MCF/cord

0.0315 MCF/green ton

1.9 cords/MBF

2.4 green tons/ cord

Source: National Carbon Offset Coalition Inc. or derived there from.

For growth volume modeling and sustainably harvestable land base estimation methods see Lapin and Rodgers (2009).

Household data for energy analysis were calculated from 2007 town populations divided by 2000 population/household data from the US Census.

## **4. Local Supply Chain**

Major components to the wood products supply chain in the project area include foresters, loggers and haulers, mills, processors, and log brokers, and consumers big and small.

Numerous foresters, loggers and haulers operate in the project area. Their numbers are difficult to assess precisely due to the diversity of scales, specialties, and service regions for these businesses. Logging operators span the gamut from one-person, part-time, horse logging operators to fully mechanized, multi-personnel, wide-ranging operations. Many smaller operators also sustain their businesses with supplemental work in construction, sugaring, or other endeavors.

Wood suppliers include three large mills and wood processors. The three companies, Claire Lathrop's, Tom Lathrop's, and the A. Johnson Company, are located in Bristol. In addition to being processors these companies all have land holdings from which they harvest regularly. Although outside the study area, Canopy Timber Alternatives is a concentration yard and log broker serving the area from the nearby town of Middlebury. Other such yards and smaller, regional mills are important components of the supply chain as well.

Major wood fuel consumers in the project area include Mt. Abraham Union High School (Bristol), Harwood Union High School (Duxbury, just over the Moretown line) and the kiln operations of A. Johnson Company. Outside the study area, numerous other schools and institutions, including Middlebury College, the Burlington Electric Department McNeil Generating Plant, and the State Office Complex in Waterbury, constitute other major wood fuel consumers in the region. The paper industry (Ticonderoga mill in New York) also competes for some of the same wood resources. The remainder of wood fuel demand comes from small and residential scale consumers. Some portion of the locally harvested wood enters global and Canadian wood products markets in log and other various processed forms, though this is significantly less true of low-grade (fuel) wood.

## **5. Harvest Summary**

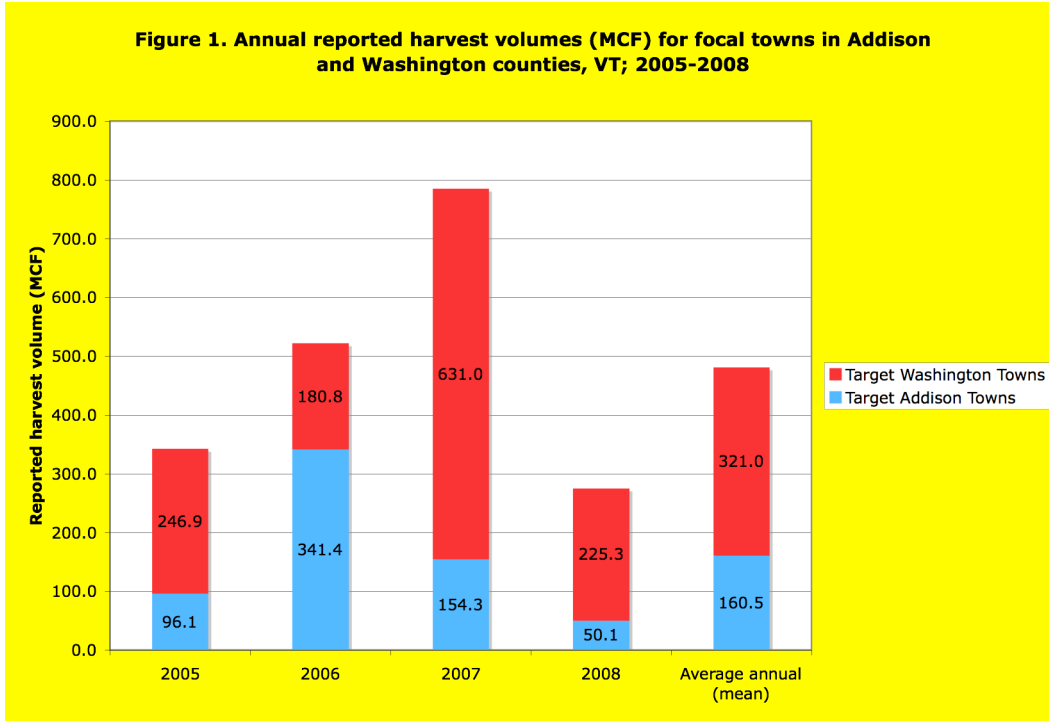
### ***Harvest volumes by land base***

#### **Total harvest volumes**

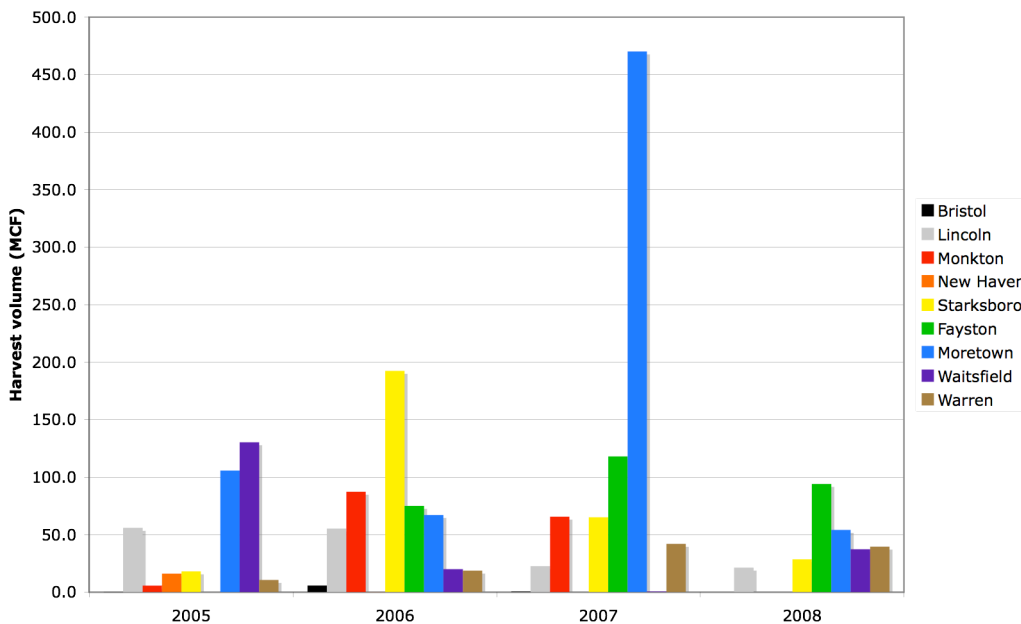
Total annual reported harvest volumes ranged from 275.4 to 785.3 MCF/year (Fig. 1) for the entire project area with a four-year total of 1925.9 MCF (Table 1) and an average (mean) annual harvest volume of 481.5 MCF (6420 cords). The focal Addison towns' average annual harvest was 160.5 MCF (2140 cords), while focal Washington towns averaged 321.0 MCF/year (4280 cords). The National Association of Home Builders estimates a 2,000 square foot new home requires about 2 MCF of framing lumber, so these annual volumes are roughly equivalent to the framing material for 240 new homes per year for the entire project area, or 80 homes/year in Addison, and 160 homes/year in Washington towns. (Note: much of the harvested wood is not suitable for framing lumber, but the intent here is to aid visualizing the quantities.) According to the Vermont Forest Resource Harvest Summary (Vermont Department of Forests Parks and Recreation 2006) the average annual total harvest for all of Vermont for 2005-2006 was 54,354 MCF (724,720 cords), thus average annual harvests from the entire project area account for 0.9% of the statewide total, with focal Addison towns contributing 0.3% and focal Washington towns contributing 0.6%. More recent statewide data is not yet available.

While total harvest volumes show a large increase from 2005 to 2007, 2008 data do not continue this trend. Harvest volumes grouped by county show no consistent year-to-year trends, though Washington towns cumulatively harvested more volume than Addison towns in three of the four years and harvested 67% of the four-year total volume (Table C.1. – see Appendix C). Town level harvest shows some trends: of the five Addison towns, Bristol and New Haven generally harvested the least wood volume; and of the four Washington towns, Warren harvested the least in aggregate, though annual trends were not consistent (Fig. 2).

It should be noted that all harvest estimates presented herein are systematic underestimates of total harvesting within the project area due to the lack of harvest data from non UVA-enrolled private lands. This data gap may be significant since surveys in the Addison towns indicate that half of non UVA-enrolled landowners harvest firewood from their property (Susannah McCandless pers. comm.).



**Figure 2. Annual harvest volumes (all wood) by town**





Of the total harvest volume for all years (1,926 MCF; 61,138 green tons) 40% (770 MCF; 24,455 gt) was reported as low-grade wood (cordwood and chips) and 60% (1,156 MCF; 36,683 gt) was reported as sawtimber (Table 1). On a county basis, Washington harvested slightly more (63%) of its wood as sawtimber, and Addison harvested slightly less (55%); the reverse is true for low-grade wood.

**Table 1. 2005-2008 Total wood harvest volumes (MCF and green tons) and percent sawtimber versus low-grade (cordwood and chips) wood.**

<b>Year</b>	<b>County</b>	<b>% Sawtimber</b>	<b>% Low-grade wood</b>	<b>Total Volume (MCF)</b>	<b>Total Volume (green tons)</b>
2005	Addison	51%	49%	96	3051
2005	Washington	62%	38%	247	7837
2005	Combined	59%	41%	343	10888
2006	Addison	55%	45%	341	10839
2006	Washington	71%	29%	181	5738
2006	Combined	61%	39%	522	16577
2007	Addison	58%	42%	154	4898
2007	Washington	65%	35%	631	20031
2007	Combined	64%	36%	785	24929
2008	Addison	52%	48%	50	1590
2008	Washington	49%	51%	225	7154
2008	Combined	50%	50%	275	8744
<b>2005-08</b>	<b>Addison</b>	<b>55%</b>	<b>45%</b>	<b>642</b>	<b>20378</b>
<b>2005-08</b>	<b>Washington</b>	<b>63%</b>	<b>37%</b>	<b>1284</b>	<b>40760</b>
<b>2005-08</b>	<b>Combined</b>	<b>60%</b>	<b>40%</b>	<b>1926</b>	<b>61138</b>

### Potential harvest volumes

Average annual total and low-grade wood harvest volumes are compared to modeling results in Table 2. Modeled annual growth volumes are taken from Lapin and Rodgers (2009) and are determined by multiplying the land base suitable for sustainable harvesting within the project area (37,900 acres Addison; 50,270 acres Washington) by an annual growth rate (1.2-2.9 gt/ac/yr; 0.5-1.2 cords/ac/yr) and a percent of low-quality wood (58%). Different growth rates arise from different management assumptions (intensive vs. unmanaged) and different source data. The difference between the 58% low-grade proportion of growth and the 40% low-grade proportion of current harvests (Table 1) may be explained by the current economics of low-grade wood extraction, ie. the current market value of low-grade products is insufficient to justify extracting all of them from the woods. This may indicate a broad average of 18% of low-grade wood being left in the forest by current harvesting. The comparison of modeled growth volumes to existing harvests shows average annual low-grade harvest to be roughly 4-11% of the low-grade wood supply grown annually depending on which land base and model is chosen.

Sherman's growth model is based on an average annual growth rate (2.9gt/ac/yr) for whole tree biomass, which is significantly higher than silvicultural growth rates used for timber in the

region. It is included here to provide a range of estimates, but we suggest that the low growth rate model (1.2 gt/ac/yr) is more realistic and ecologically sustainable.

**Table 2. Comparison of average (mean) annual harvest volumes (green tons/yr) to modeled annual low-quality wood growth volumes on lands capable of sustainable harvest within the project woodshed(s).** All model volumes from Lapin and Rodgers (2009), alternate scenarios and methodology are explained therein.

<b>Land base</b>	<b>Average annual total volume harvested (gt/yr)</b>	<b>Average annual low grade volume harvested (gt/yr)</b>	<b>Leak et al's (1987) unmanaged growth model; 58% low quality wood (gt/yr)</b>	<b>Leak et al's (1987) intensively managed growth model; 58% low quality wood (gt/yr)</b>	<b>Sherman's (2007) growth model; 58% low quality wood (gt/yr)</b>
<b>Addison (5 Towns)</b>	5094	2301	26,380	37,372	57,157
<b>Washington (4 Towns)</b>	10190	3807	34,990	49,569	84,560
<b>Combined (9 towns)</b>	15284	6108	61,370	86,941	141,717

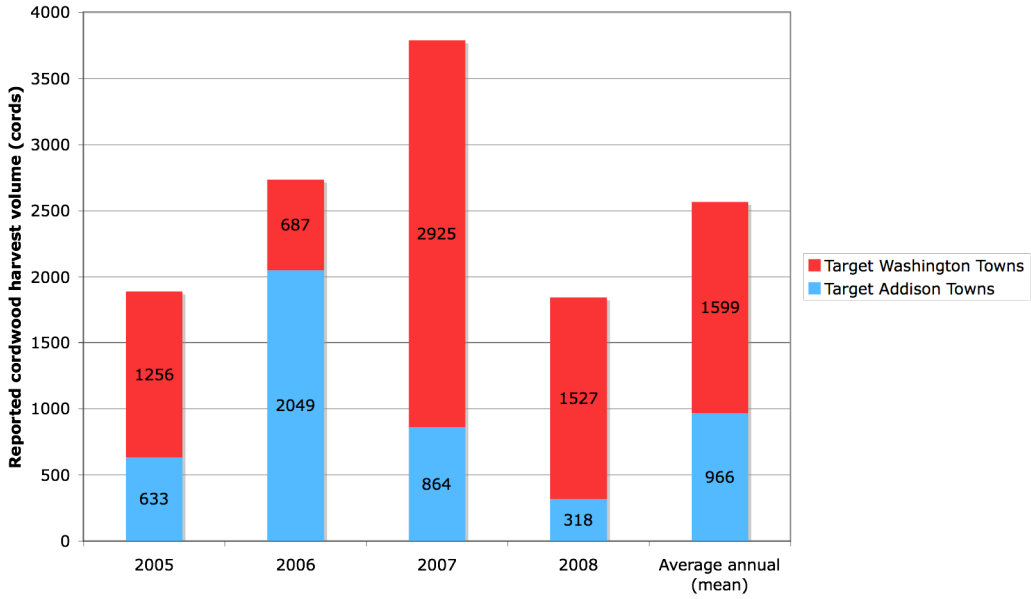
### Total cordwood harvest

Total annual cordwood harvest (soft and hardwood) ranged from 1845 to 3790 cords/ year (Fig. 3) for the entire project area with a four-year total volume of 10,260 cords. Average annual cordwood harvest was 2565 cords for the entire project area, 966 cords for the focal Addison towns, and 1599 cords for the focal Washington towns. Washington towns harvested 62% (6396 cords) of the four-year total cordwood volume (Appendix C Table C.2.). There were no clear year-to-year trends.

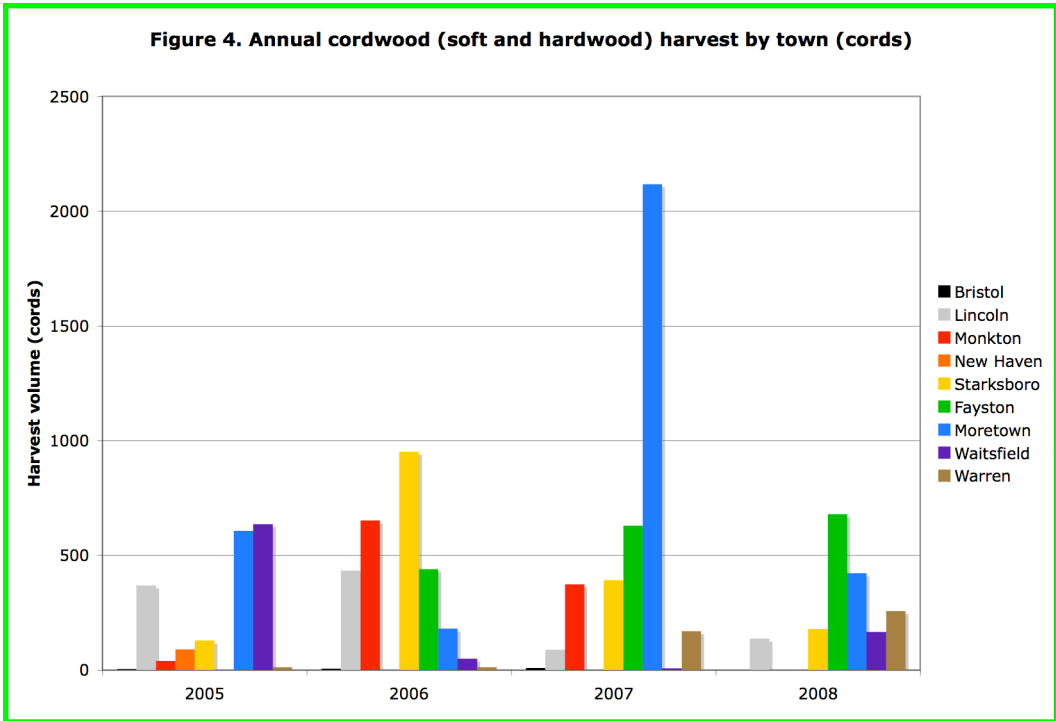
According to the Vermont Forest Resource Harvest Summary (Vermont Department of Forests Parks and Recreation 2006) total combined pulpwood and chip fuel harvests for *all* towns in Addison and Washington Counties in 2006 were 1,597 and 10,302 cords, respectively. Cordwood (including chips) harvest for 2006 in *focal* Addison and Washington towns accounts for 128%<sup>3</sup> and 6.7% of the respective county-wide harvest totals. At the town level year-to-year trends were minimal as well (Fig. 4). Among focal Addison towns, Bristol and New Haven had generally low harvest, while Starksboro had the greatest four-year harvest at 43% of Addison total (1654 cords). Among focal Washington towns Moretown had the greatest four-year harvest at 52% of Washington total (3330 cords).

<sup>3</sup> The Addison number clearly indicates some incongruence in these comparisons since the focal towns cannot have harvested more than the entire county; it's possible that some wood categories (especially cordwood that went to firewood) were not included in the statewide data or that some harvest was missed as data were gathered from different sources.

**Figure 3. Annual reported harvest of cordwood (soft and hardwood) from focal towns in Addison and Washington counties, VT; 2005-2008**



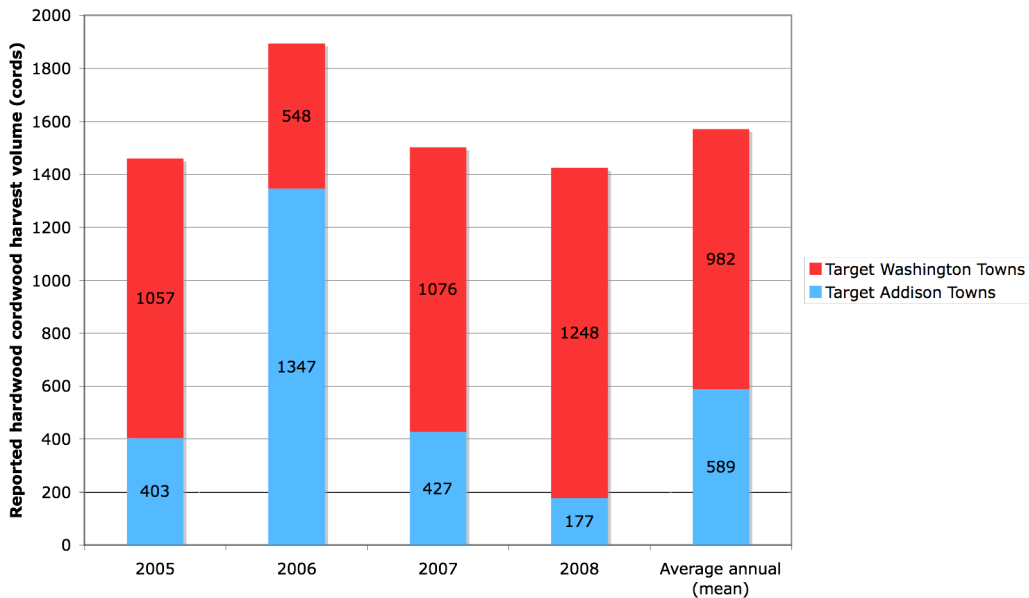
**Figure 4. Annual cordwood (soft and hardwood) harvest by town (cords)**



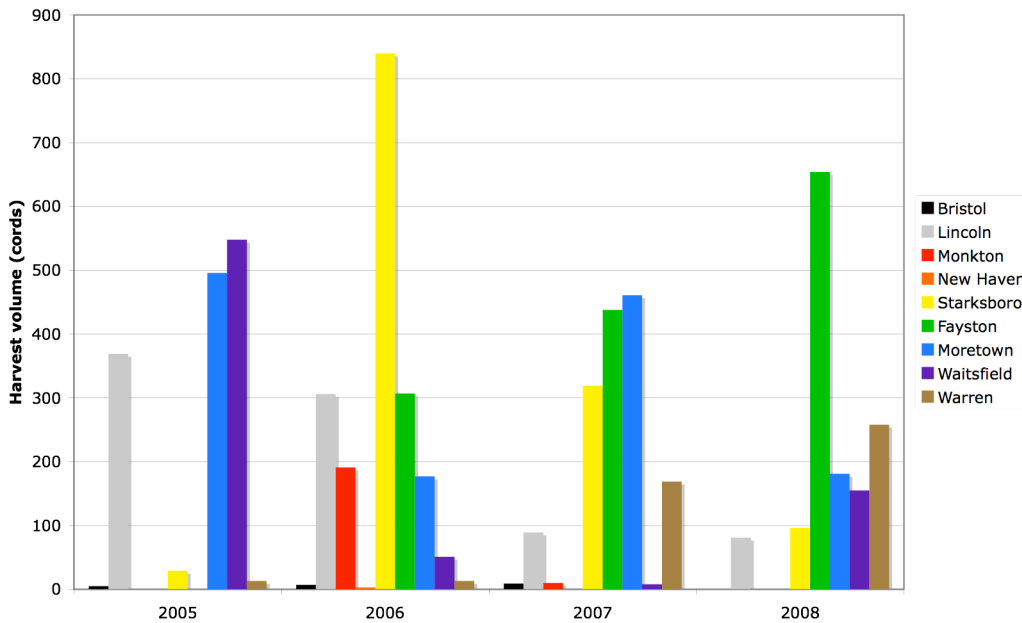
## Hardwood cordwood harvest

Total annual hardwood cordwood harvest ranged from 1425 to 1895 cords/year (Fig.5) for the entire project area with a four-year total volume of 6,283 cords. Average annual hardwood cordwood harvest was 1571 cords for the entire project area, 589 cords for the focal Addison towns, and 982 cords for the focal Washington towns. Washington towns harvested 63% (3929 cords) of the four-year total hardwood cordwood volume. Again, there were no clear year-to-year trends, though Washington towns harvested more than Addison towns in three of four years. It is noteworthy that hardwood cordwood harvest seems to display more stability than other types of wood products in aggregate. The reason for this is not clear. At the town level year-to-year trends were minimal (Fig.6), though among Addison towns Bristol and New Haven had generally low harvest while Starksboro had the greatest four-year harvest at 55% of Addison total (1284 cords). Among Washington towns Fayston and Moretown had the greatest four-year harvests at 36% and 33% of Washington total (1399 and 1315 cords, respectively).

**Figure 5. Annual reported hardwood cordwood harvest volumes for focal towns in Addison and Washington counties, VT; 2005-2008**



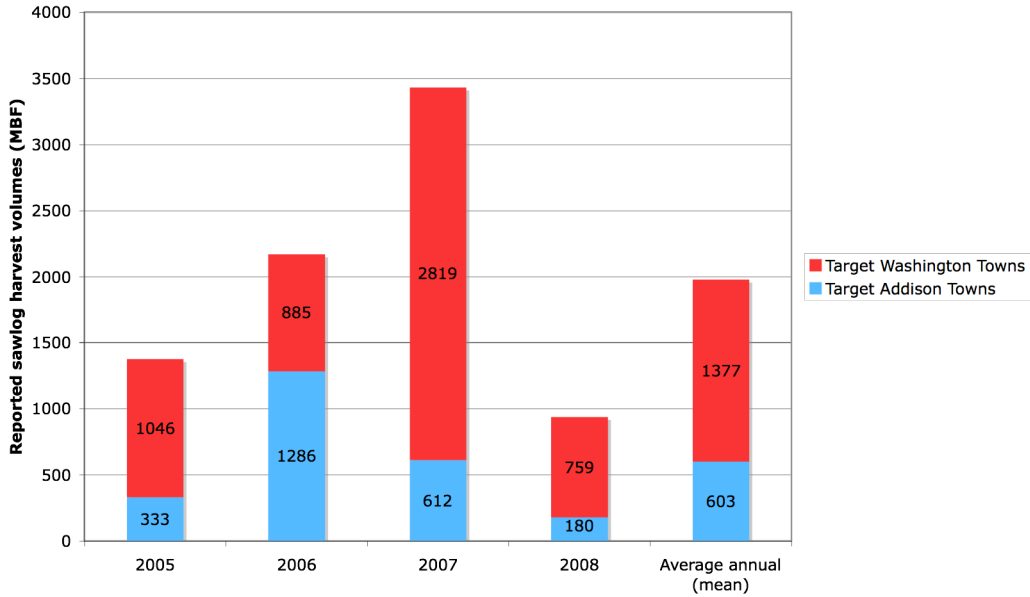
**Figure 6. Annual hardwood cordwood harvest by town (cords)**



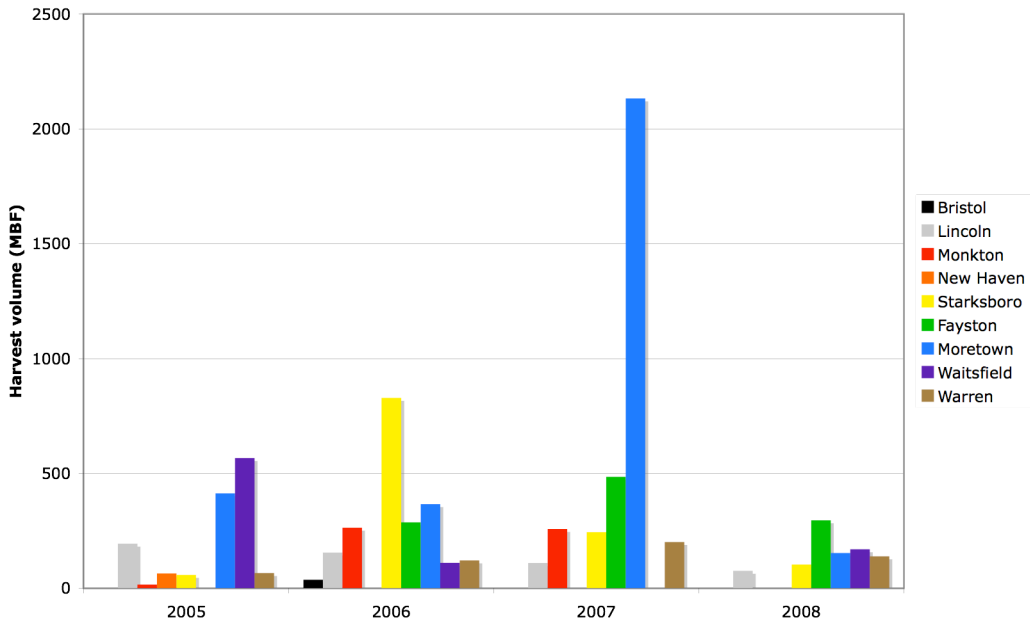
### Total sawtimber harvest

Total annual harvest of sawtimber alone ranged from 939 to 3431 MBF/year (Fig.7) for the entire project area and the four-year total harvest was 7919 MBF. Average annual sawlog harvest was 1980 MBF (3,962 cords) for the entire project area, 603 MBF (1,146 cords) for the focal Addison towns, and 1377 MBF (2,616 cords) for the focal Washington towns. As noted above, a 2,000 square foot new home requires about 2 MCF or 14 MBF of framing lumber, so these annual volumes are roughly equivalent to the framing material for 141 new homes per year for the entire project area, or 43 homes/year in Addison, and 98 homes/year in Washington towns. Washington towns harvested 70% (5509 MBF) of the four-year total sawtimber volume. There were no clear year-to-year trends. According to the Vermont Forest Resource Harvest Summary (Vermont Department of Forests Parks and Recreation 2006) total sawtimber harvests for *all* towns in Addison and Washington counties in 2006 were 7,632 and 7,339 MBF (13,944 cords), respectively. Sawtimber harvest for 2006 in *focal* Addison and Washington towns accounts for 11.6% and 17.6% of the respective county-wide harvest totals. At the town level year-to-year trends were minimal (Fig.8), though among Addison towns, Bristol and New Haven had generally low harvest while Starksboro had the greatest four-year harvest at 51% of Addison total (1235 MBF). Among Washington towns, Moretown had the greatest four-year harvest at 56% of Washington total (3066 MBF).

**Figure 7. Annual reported sawlog harvest volumes (MBF) for focal towns in Addison and Washington counties, VT; 2005-2008**



**Figure 8. Annual sawtimber harvest by town (MBF)**

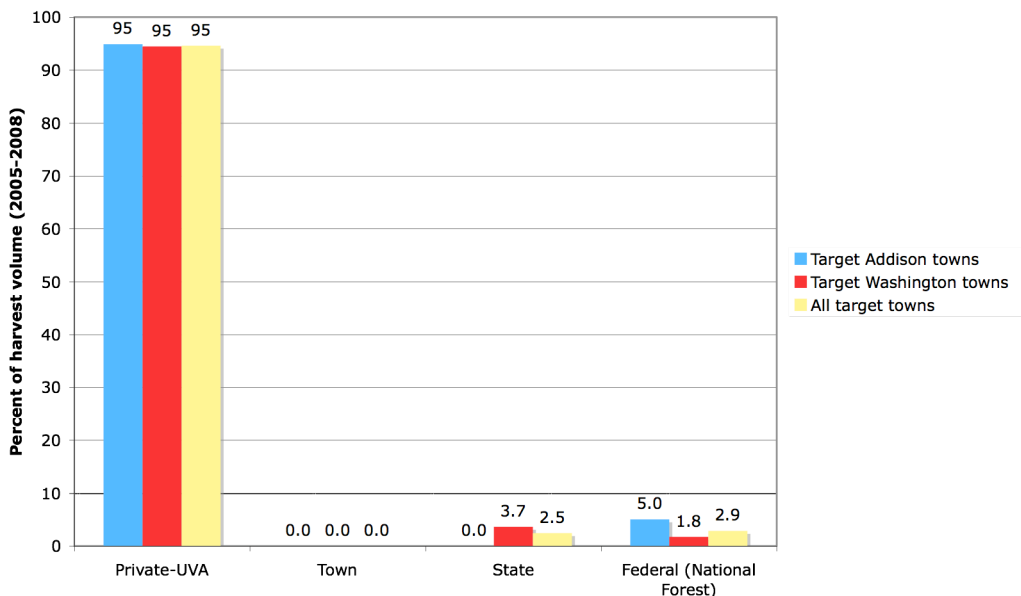


### ***Harvest volumes by land ownership***

Analysis of harvest volumes by land ownership shows the overwhelming majority of harvesting occurs on private lands. Overall, public lands accounted for only 5.4% of the harvest volume (less than 3% each from state and federal lands, none from town lands); the remaining 94.6% came from private UVA-enrolled lands (Fig. 9). Harvest volumes from non-UVA enrolled land

(not available for this analysis) would even further exaggerate this trend. The trend was consistent across years and varied slightly depending on how the data are aggregated. The lowest proportional private lands harvest (78%) occurred among the focal Washington towns in 2005, otherwise annual- and county-aggregated private land harvests generally comprised over 90% of the total harvest. This trend holds for cordwood and sawtimber as well, when considered separately (see Appendix C.5-16 for details). While this trend appears stable, some shift toward harvest on Federal lands may occur as the US Forest Service substantially increases its harvesting in the relevant portions of the Green Mountain National Forest through the Natural Turnpike Project over the next five to ten years. It should also be noted that using town boundaries for this analysis does not give an entirely accurate picture of the harvest from the regional “woodshed”, which is more defined by topography, and transportation/processing infrastructure (e.g. roads and mills) than it is by political boundaries. This is especially relevant to harvesting from large blocks of national forest that span town boundaries (see Appendix B.3).

**Figure 9. Percent of cumulative harvest volumes 2005-2008 by land ownership type**



### ***The energy value of harvested wood***

While it is not possible to determine which portion of the harvested wood has been consumed as fuel (firewood, chips, pellets) from these data, it is useful to consider how much heating energy the harvested wood represents. There are many complicating factors involved in estimating energy content and home heating value from wood volumes (including tree species, moisture content, combustion efficiency, home weatherization, etc.) so the following are estimates at best. However, many of these variables are integrated by using actual wood consumption data for Vermont households. Two sources of this information are available: the Vermont Residential Fuelwood Assessment (Department of Public Service 2000) estimated 11.5 green tons/household/yr (4.8 cords/household/yr) average wood use for primary space heating; the

UVM Wood Heating Consumption Survey<sup>4</sup> (2008 data) estimates 10.3 green tons/household/yr (4.3 cords/household/yr). The latter figure is used for this analysis because it is more recent (reflecting efficiency/weatherization improvements) and specific to our project area. Focal Addison and Washington towns could heat (primary space heating) 12% and 37% of their households, respectively, with the existing average annual *total* harvest volumes from their land bases (Table 3). Since it is unlikely that fuelwood prices will justify using high quality sawlogs for fuel Table 3 also shows household heating potential from low-grade (all cordwood and chips) wood only and from hardwood cordwood alone (softwoods are not generally used for home heating in New England). Existing average annual *low-grade* harvest provides potential heating for 6% and 14% of focal Addison and Washington County homes, respectively. Existing average annual *hardwood cordwood* harvest provides potential heating for 3% and 8% of focal Addison and Washington County homes, respectively. While these current supplies offer potential heat to modest, though significant, percentages of the homes in the focal communities, much greater fuelwood supply may be possible. Table 3 also shows potential home heating values for annual wood growth volumes from three models presented by Lapin and Rodgers (2009) report. Modeled annual growth volumes are taken from Lapin and Rodgers (2009) and are determined by multiplying the land base suitable for sustainable harvesting within the project area (37,900 acres Addison; 50,270 acres Washington) by an annual growth rate (1.2-2.9 gt/ac/yr; 0.5-1.2 cords/ac/yr) and a percent of low-quality wood (58%). Different growth rates arise from different management assumptions (intensive vs. unmanaged) and different source data. These models suggest annually available sustainable heating fuel from the project area (low-grade wood only) with a potential to heat 64-138% of focal Addison County households and 126-305% of focal Washington County households.

As noted previously there is dispute over the appropriateness of the modeled growth rates this analysis is based on, and other lines of evidence, including the judgment of many forest professionals, suggests the lower estimates are likely to be most realistic. This view is emphasized and explained in greater detail in Lapin and Rodgers (2009).

It is important also to note that these are rough projections and that the available wood volume for potential household heating may be reduced by several factors including: user preferences among wood types (soft vs. hardwood), institutional consumption of wood chips for biomass heating, other competing uses for low-grade wood (pulp, etc.), and the economics of viably extracting low-grade products from the forest. Large chip users for biomass heating in the immediate area include Middlebury College and Mt. Abraham Union High School for Addison County and Harwood Union High School for Washington County. Consumption by these facilities would reduce the household heating potentials in Table 3 by 313 homes or 7.8% of homes for focal Addison towns and 87 homes or 3.2% of homes for focal Washington towns<sup>5</sup> if their fuels were harvested solely from the project area (see footnote for Middlebury exception). Comparison to Table 3 values indicates this institutional consumption already exceeds existing

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<sup>4</sup> This survey was conducted in early 2009 as part of the Community Biomass Project and covered the same 9-town project area as this report. General survey results are not yet published.

<sup>5</sup> Consumption figures used as follows. Middlebury College: 2,323gt/yr (proportion of their 22,000gt/yr consumption (Biocycle 2008) based on the 37,900 acre portion of their woodshed in the focal towns (Vermont Family Forests Biomass Assessment Team 2004)); Mt. Abraham High School: 900gt/yr (Wedge personal communication 2009); Harwood Union High School 900gt/yr (Holden personal communication 2009).



local low-grade wood harvest totals for focal Addison towns (at least from the land base covered by this report). Other factors may further reduce the potential for household heating, but this full fuel availability analysis is beyond the scope of this report.

**Table 3. Household heating potential of average harvest volumes and modeled sustainably harvestable growth volumes (low-quality wood only).** Calculated based on estimated 10.3 green tons/household/yr (4.3 cords/household/yr) average wood use for primary space heating as found by the UVM Wood Heating Consumption Survey (unpublished data). Household data calculated from 2007 population and 2000 population/household (US Census Bureau 2000).

	<b>Average annual total harvest</b>			<b>Average annual low-grade harvest</b>		
<b>Land base</b>	<b>Volume (gt/yr)</b>	<b>Household heating potential (# households)</b>	<b>Potential % of households</b>	<b>Volume (gt/yr)</b>	<b>Household heating potential (# households)</b>	<b>Potential % of households</b>
<b>Addison (5 Towns)</b>	5094	495	12%	2301	223	6%
<b>Washington (4 Towns)</b>	10190	989	37%	3807	370	14%
<b>Combined (9 towns)</b>	15284	1484	22%	6108	593	9%
	<b>Avg. annual hardwood cordwood harvest</b>			<b>Leak et al's (1987) avg. annual unmanaged growth model; 58% low quality wood scenario</b>		
<b>Land base</b>	<b>Volume (gt/yr)</b>	<b>Household heating potential (# households)</b>	<b>Potential % of households</b>	<b>Volume (gt/yr)</b>	<b>Household heating potential (# households)</b>	<b>Potential % of households</b>
<b>Addison (5 Towns)</b>	1412	137	3%	26,380	2561	64%
<b>Washington (4 Towns)</b>	2357	229	8%	34,990	3397	126%
<b>Combined (9 towns)</b>	3770	366	5%	61,370	5958	89%
	<b>Leak et al's (1987) avg. annual intensively managed growth model; 58% low quality wood scenario</b>			<b>Sherman's (2007) avg. annual growth model; 58% low quality wood scenario</b>		
<b>Land base</b>	<b>Volume (gt/yr)</b>	<b>Household heating potential (# households)</b>	<b>Potential % of households</b>	<b>Volume (gt/yr)</b>	<b>Household heating potential (# households)</b>	<b>Potential % of households</b>
<b>Addison (5 Towns)</b>	37,372	3628	90%	57,157	5549	138%
<b>Washington (4 Towns)</b>	49,569	4813	179%	84,560	8210	305%
<b>Combined (9 towns)</b>	86,941	8441	126%	141,717	13759	205%

## 6. References

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- Vermont Department of Forests Parks and Recreation. 2006. Vermont Forest Harves [www.vtfor.org/util/for\\_utilize\\_harvsumm.cfm](http://www.vtfor.org/util/for_utilize_harvsumm.cfm).
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## 7. Appendix A. Data Sources

<b>Landbase</b>	<b>Contact</b>
Federal lands-	
Green Mountain National Forest	Chris Casey, Middlebury office, Lead Forester 388.4362x115;
	Bill Peterson, Rutland office, Forest Management Team Leader, 747.6758
State lands-	
Addison Co.	Gary Sawyer, Essex office State Lands Forester, 879.5682
State lands-	
Washington Co.	Diana Frederick, Barre Office, State Land Forester, 476.0174
	Chris Olson, Addison County Forester, 800-956-1125;
Town lands-	David Brynn, Vermont Family Forests, for Bristol & Lincoln Town forests;
Addison Co.	Robert Turner, 453.2171, for Starksboro Town forest
Town lands-	Russ Barret, Washington County Forester, 476.0172
Washington Co.	<Russ.Barrett@state.vt.us>
UVA-Private lands	
Addison Co.	Chris Olson, Addison County Forester, 388.4969x13, 800-956-1125, <Chris.Olson@state.vt.us>
UVA-Private lands	
Washington Co.	Russ Barret, Washington County Forester, 476.0172 <Russ.Barrett@state.vt.us>

## **8. Appendix B. Sources of Error**

### ***B.1 Missing data***

Complete harvest data for UVA enrolled private lands was not obtainable for 2005 in Addison County due to a change in filing practices accompanying a change in personnel. These records may exist but were not found in this data gathering effort. UVA harvest data for Addison County, all years, is lacking harvest volumes from A. Johnson Company, who consider their UVA harvest data proprietary information.

There is also a systematic omission of harvest data for non-UVA private lands since this data is not systematically tracked and compiled.

### ***B.2 Interpretation and reporting problems***

Interpretation and reporting problems arise with the use of Forest Management Activity (FMA) Reports (formerly known as Conformance Reports) to compile and track UVA harvest data. There are two main sources of error associated with these reports. The first is that although UVA program landowners are required to file a FMA reports following any year with management activities, not all landowners comply with this requirement and enforcement is not practical, thus it is likely that some harvest on UVA enrolled lands goes unreported and is missing from this report. The second source of error in FMA reports arises simply from issues of interpreting landowner handwriting, which is not always highly legible, leading to possible errors in compiling harvest data. A further issue is encountered when analysis by wood type (ie. softwood vs. hardwood) is desired since landowner reports do not always separate these. The data compiler then is forced to decide (often from a mixed list of species) which category to assign harvested volumes to; this may be fairly accurate if the County Forester is compiling the data and is familiar with the general composition of the property, but this is not always the case.

### ***B.3 Converting from reported units***

Other sources of error come from converting data from its originally reported units, both units of wood and in some cases units of land. Reported wood volumes used for this analysis were in MBF, cords, green tons (chips), and MCF. Conversion factors between these units vary depending on numerous factors (including bole diameter, bole quality/grade, bole taper, moisture content, region of the county, and species), thus no set of conversions would be perfect for the level of specificity of these data. The conversion factors used for this analysis are listed in the Methods and were selected as an internally consistent set of conversions that closely approximate “rules of thumb” in this region.

National Forest harvest data was reported in land units that did not match the study boundaries (town lines) used in this project. To overcome this incongruence these harvest volumes were attributed proportionally to the harvested acreage within our study boundaries. That is, the total harvest volumes were divided by the total acreage harvested, yielding a per acre harvest volume

that was then multiplied by the harvested acreage within our study boundary. While the harvested volume was not actually distributed evenly over the entire harvest unit, there was no other unbiased way to keep the data boundaries of the study congruent.

#### ***B.4 Other data considerations***

The National Forest data obtained for this study was based on timber cruise volume estimates for the timber sale contract, rather than on actual harvested volumes (this data was not available). Actual harvested volumes may have differed from cruise estimates. Additionally timber sale contract volumes are subject to Forest Service rules governing the official Limits of Merchantability. In some situations loggers may be able to market wood that is beyond official Limits of Merchantability (usually smaller in diameter or lower in quality) leading to further departures from cruise estimated volumes used in the timber sale contract. In some cases this volume increase can be as high as 10-15%.

Additional imprecision in the National Forest data presented here results from it being reported in aggregate over the time span 2005-2007. This is due to all the relevant harvest occurring under one timber sale contract and being harvested over a period of three years, with no annual harvest volumes available. This total harvest volume was divided evenly over the three years for the purposes of this study.

## 9. Appendix C. Summary Data Tables

**Table C.1. Total reported volumes harvested (MCF). Includes all reported wood regardless of reporting units and product type.**

Land area	2005	2006	2007	2008	Total (2005- 2008)	% of Total
<b>Bristol</b>	*0.4	5.9	0.7	0.0	<b>*7.0</b>	<b>0%</b>
<b>Lincoln</b>	*56.0	55.4	22.7	21.4	<b>*155.5</b>	<b>8%</b>
<b>Monkton</b>	*5.3	87.4	65.7	0.0	<b>*158.4</b>	<b>8%</b>
<b>New Haven</b>	*16.2	0.2	0.0	0.0	<b>*16.4</b>	<b>1%</b>
<b>Starksboro</b>	*18.1	192.5	65.2	28.6	<b>*304.4</b>	<b>16%</b>
<b>Fayston</b>	0.0	75.0	118.1	94.2	<b>287.3</b>	<b>15%</b>
<b>Moretown</b>	105.8	67.1	470.3	54.2	<b>697.4</b>	<b>36%</b>
<b>Waitsfield</b>	130.4	20.0	0.6	37.3	<b>188.3</b>	<b>10%</b>
<b>Warren</b>	10.6	18.7	42.1	39.6	<b>111.0</b>	<b>6%</b>
<b>Addison (5 Towns)</b>	*96.1	341.4	154.3	50.1	<b>*641.9</b>	<b>33%</b>
<b>Washington (4 Towns)</b>	246.9	180.8	631.0	225.3	<b>1284.0</b>	<b>67%</b>
<b>All (9) Towns</b>	<b>*343.0</b>	<b>522.2</b>	<b>785.3</b>	<b>275.4</b>	<b>*1925.9</b>	<b>100%</b>

**Table C.2. Total reported cordwood harvested (cords) by land area. Includes all soft- and hardwood reported in cords or chip tons (2.4 green tons/cord).**

Land area	2005	2006	2007	2008	Total (2005- 2008)	% of Total
<b>Bristol</b>	*5	7	9	0	<b>*21</b>	<b>0%</b>
<b>Lincoln</b>	*369	**434	89	138	<b>*1030</b>	<b>10%</b>
<b>Monkton</b>	*40	652	374	0	<b>*1066</b>	<b>10%</b>
<b>New Haven</b>	*90	3	0	0	<b>*93</b>	<b>1%</b>
<b>Starksboro</b>	*129	953	**392	180	<b>*1654</b>	<b>16%</b>
<b>Fayston</b>	0	441	630	680	<b>1751</b>	<b>17%</b>
<b>Moretown</b>	607	182	2118	423	<b>3330</b>	<b>32%</b>
<b>Waitsfield</b>	636	51	8	166	<b>861</b>	<b>8%</b>
<b>Warren</b>	13	13	169	258	<b>454</b>	<b>4%</b>
<b>Addison (5 Towns)</b>	*633	2049	864	318	<b>*3864</b>	<b>38%</b>
<b>Washington (4 Towns)</b>	1256	687	2925	1527	<b>6396</b>	<b>62%</b>
<b>All (9) Towns</b>	<b>*1889</b>	<b>2736</b>	<b>3790</b>	<b>1845</b>	<b>*10260</b>	<b>100%</b>

**Table C.3. Total reported hardwood cordwood harvested (cords). Includes only hardwood reported in cords or chip tons (2.4 green tons/cord).**

Land Area	2005	2006	2007	2008	Total (2005- 2008)	% of Total
<b>Bristol</b>	*5	7	9	0	<b>*21</b>	<b>0%</b>
<b>Lincoln</b>	*369	**306	89	81	<b>*845</b>	<b>13%</b>
<b>Monkton</b>	*0	191	10	0	<b>*201</b>	<b>3%</b>
<b>New Haven</b>	*0	3	0	0	<b>*3</b>	<b>0%</b>
<b>Starksboro</b>	*29	840	319	96	<b>*1284</b>	<b>20%</b>
<b>Fayston</b>	0	307	438	654	<b>1399</b>	<b>22%</b>
<b>Moretown</b>	496	177	461	181	<b>1315</b>	<b>21%</b>
<b>Waitsfield</b>	548	51	8	155	<b>762</b>	<b>12%</b>
<b>Warren</b>	13	13	169	258	<b>453</b>	<b>7%</b>
<b>Addison (5 Towns)</b>	*403	**1347	427	177	<b>*2354</b>	<b>37%</b>
<b>Washington (4 Towns)</b>	1057	548	1076	1248	<b>3929</b>	<b>63%</b>
<b>All (9) Towns</b>	<b>*1460</b>	<b>1895</b>	<b>1503</b>	<b>1425</b>	<b>*6283</b>	<b>100%</b>

**Table C.4. Total reported board feet harvested (MBF). Includes all soft- and hardwood reported in board feet.**

Land Area	2005	2006	2007	2008	Total (2005- 2008)	% of Total
<b>Bristol</b>	*0	37	0	0	<b>*37</b>	<b>0%</b>
<b>Lincoln</b>	*194	156	110	76	<b>*536</b>	<b>7%</b>
<b>Monkton</b>	*16	264	258	0	<b>*538</b>	<b>7%</b>
<b>New Haven</b>	*65	0	0	0	<b>*65</b>	<b>1%</b>
<b>Starksboro</b>	*58	829	245	104	<b>*1235</b>	<b>16%</b>
<b>Fayston</b>	0	287	485	296	<b>1068</b>	<b>13%</b>
<b>Moretown</b>	413	366	2133	154	<b>3066</b>	<b>39%</b>
<b>Waitsfield</b>	567	111	0	170	<b>848</b>	<b>11%</b>
<b>Warren</b>	66	121	201	139	<b>527</b>	<b>7%</b>
<b>Addison (5 Towns)</b>	*333	1286	612	180	<b>*2411</b>	<b>30%</b>
<b>Washington (4 Towns)</b>	1046	885	2819	759	<b>5509</b>	<b>70%</b>
<b>All (9) Towns</b>	<b>*1379</b>	<b>2171</b>	<b>3431</b>	<b>939</b>	<b>*7919</b>	<b>100%</b>

**Table C.5. Total reported volume of wood harvested (2005-2008) by land ownership and town cluster (MCF).**

<b>Ownership</b>	<b>Addison (5 Towns)</b>	<b>Washington (4 Towns)</b>	<b>Combined (9 Towns) Total</b>	<b>% of Combined Total</b>
<b>Private-UVA</b>	*610	1214	<b>*1824</b>	<b>95%</b>
<b>Town</b>	0	0	<b>0</b>	<b>0%</b>
<b>State</b>	0	47	<b>47</b>	<b>2%</b>
<b>Federal (National Forest)</b>	32	23	<b>55</b>	<b>3%</b>
<b>Total</b>	<b>*642</b>	<b>1284</b>	<b>*1926</b>	<b>100%</b>

**Table C.6. Total reported volume of wood harvested by land ownership, town-cluster, and year (MCF).**

<b>Ownership</b>	<b>Addison (5 Towns)</b>				<b>Washington (4 Towns)</b>			
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>Private-UVA</b>	*85.3	330.7	143.5	50.1	192.1	173.2	623.4	225.3
<b>Town</b>	0	0	0	0	0	0	0	0
<b>State</b>	0	0	0	0	47.2	0	0	0
<b>Federal (National Forest)</b>	10.8	10.8	10.8	0	7.6	7.6	7.6	0
<b>Total</b>	<b>*96.1</b>	<b>341.5</b>	<b>154.3</b>	<b>50.1</b>	<b>246.9</b>	<b>180.8</b>	<b>631</b>	<b>225.3</b>

**Table C.7. Total reported volume of wood harvested in all focal Addison and Washington County towns by land ownership and year (MCF).**

<b>Ownership</b>	<b>All Towns</b>				
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>Total</b>
<b>Private-UVA</b>	*277.4	503.9	766.9	275.4	<b>*1823.6</b>
<b>Town</b>	0	0	0	0	<b>0.0</b>
<b>State</b>	47.2	0	0	0	<b>47.2</b>
<b>Federal (National Forest)</b>	18.4	18.4	18.4	0	<b>55.2</b>
<b>Total</b>	<b>*342.9</b>	<b>522.2</b>	<b>785.2</b>	<b>275.4</b>	<b>*1926.0</b>



**Table C.8. Total reported cordwood harvested from 2005-2008 by land ownership and town cluster (cords).**

<b>Ownership</b>	<b>Addison (5 Town)</b>	<b>Washington (4 Town)</b>	<b>Combined (9 Towns) Total</b>	<b>% of Combined Total</b>
<b>Private-UVA</b>	*3807	6039	<b>*9846</b>	<b>96%</b>
<b>Town</b>	0	0	<b>0</b>	<b>0%</b>
<b>State</b>	0	317	<b>317</b>	<b>3%</b>
<b>Federal (National Forest)</b>	57	40	<b>97</b>	<b>1%</b>
<b>Total</b>	<b>*3864</b>	<b>6396</b>	<b>*10260</b>	<b>100%</b>

**Table C.9. Total reported cordwood harvested by land ownership, town-cluster, and year (cords).**

<b>Ownership</b>	<b>Addison (5 Towns)</b>				<b>Washington (4 Towns)</b>			
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>Private-UVA</b>	*614	**2030	**845	318	926	674	2912	1527
<b>Town</b>	0	0	0	0	0	0	0	0
<b>State</b>	0	0	0	0	317	0	0	0
<b>Federal (National Forest)</b>	19	19	19	0	13	13	13	0
<b>Total</b>	<b>*633</b>	<b>2049</b>	<b>864</b>	<b>318</b>	<b>1256</b>	<b>687</b>	<b>2925</b>	<b>1527</b>

**Table C.10. Total reported cordwood harvested in all focal Addison and Washington County towns by land ownership and year (cords).**

<b>Ownership</b>	<b>All Towns</b>				
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>Total</b>
<b>Private-UVA</b>	*1540	**2704	**3757	1845	<b>*9846</b>
<b>Town</b>	0	0	0	0	<b>0</b>
<b>State</b>	317	0	0	0	<b>317</b>
<b>Federal (National Forest)</b>	32	32	32	0	<b>97</b>
<b>Total</b>	<b>*1889</b>	<b>2736</b>	<b>3790</b>	<b>1845</b>	<b>*10260</b>

**Table C.11. Total reported hardwood cordwood harvested from 2005-2008 by land ownership and town cluster (cords).**

<b>Ownership</b>	<b>Addison (5 Town)</b>	<b>Washington (4 Town)</b>	<b>Combined (9 Towns) Total</b>	<b>% of Combined Total</b>
<b>Private-UVA</b>	*2297	3577	<b>*5874</b>	<b>93%</b>
<b>Town</b>	0	0	<b>0</b>	<b>0%</b>
<b>State</b>	0	313	<b>313</b>	<b>5%</b>
<b>Federal (National Forest)</b>	57	40	<b>97</b>	<b>2%</b>
<b>Total</b>	<b>*2354</b>	<b>3930</b>	<b>*6284</b>	<b>100%</b>

**Table C.12. Total reported hardwood cordwood harvested by land ownership, town-cluster, and year (cords).**

<b>Ownership</b>	<b>Addison (5 Towns)</b>				<b>Washington (4 Towns)</b>			
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>Private-UVA</b>	*384	1328	408	177	731	535	1063	1248
<b>Town</b>	0	0	0	0	0	0	0	0
<b>State</b>	0	0	0	0	313	0	0	0
<b>Federal (National Forest)</b>	19	19	19	0	13	13	13	0
<b>Total</b>	<b>*403</b>	<b>1347</b>	<b>427</b>	<b>177</b>	<b>1057</b>	<b>548</b>	<b>1076</b>	<b>1248</b>

**Table C.13. Total reported hardwood cordwood harvested in all focal Addison and Washington County towns by land ownership and year (cords).**

<b>Ownership</b>	<b>All Towns</b>				
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>Total</b>
<b>Private-UVA</b>	*1115	1863	1471	1425	<b>*5874</b>
<b>Town</b>	0	0	0	0	<b>0</b>
<b>State</b>	313	0	0	0	<b>313</b>
<b>Federal (National Forest)</b>	32	32	32	0	<b>97</b>
<b>Total</b>	<b>*1460</b>	<b>1895</b>	<b>1503</b>	<b>1425</b>	<b>*6284</b>

**Table C.14. Total reported board feet harvested from 2005-2008 by land ownership and town-cluster (MBF).**

<b>Ownership</b>	<b>Addison (5 Town)</b>	<b>Washington (4 Town)</b>	<b>Combined (9 Towns) Total</b>	<b>% of Combined Total</b>
<b>Private-UVA</b>	*2219	5213	<b>*7432</b>	<b>94%</b>
<b>Town</b>	0	0	<b>0</b>	<b>0%</b>
<b>State</b>	0	161	<b>161</b>	<b>2%</b>
<b>Federal (National Forest)</b>	192	135	<b>327</b>	<b>4%</b>
<b>Total</b>	<b>*2411</b>	<b>5509</b>	<b>*7919</b>	<b>100%</b>

**Table C.15. Total reported board feet harvested by land ownership, town-cluster, and year (MBF).**

<b>Ownership</b>	<b>Addison (5 Towns)</b>				<b>Washington (4 Towns)</b>			
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>
<b>Private-UVA</b>	*269	1222	548	180	840	840	2774	759
<b>Town</b>	0	0	0	0	0	0	0	0
<b>State</b>	0	0	0	0	161	0	0	0
<b>Federal (National Forest)</b>	64	64	64	0	45	45	45	0
<b>Total</b>	<b>*333</b>	<b>1286</b>	<b>612</b>	<b>180</b>	<b>1046</b>	<b>885</b>	<b>2819</b>	<b>759</b>

**Table C.16. Total reported board feet harvested in all focal Addison and Washington County towns by land ownership and year (MBF).**

<b>Ownership</b>	<b>All Towns</b>				
	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>Total</b>
<b>Private-UVA</b>	*1109	2062	3322	939	<b>*7432</b>
<b>Town</b>	0	0	0	0	<b>0</b>
<b>State</b>	161	0	0	0	<b>161</b>
<b>Federal (National Forest)</b>	109	109	109	0	<b>327</b>
<b>Total</b>	<b>*1379</b>	<b>2171</b>	<b>3431</b>	<b>939</b>	<b>*7919</b>

\*Indicates incomplete data set, missing some 2005 UVA data, see Section 6.1.

\*\*Includes wood reported as chip tons.