An Analysis of Mill Frequency and Sediment Load in Vermont with Emphasis on Bennington, Caledonia, and Chittenden Counties

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Abstract

In this paper, we have quantified mid-nineteenth century mills in the towns of Bennington, Caledonia, and Chittenden counties of Vermont. This data was compared with population density and relative topography to interpret the landscapes preferable for mills to operate. We found more mills were located in steeper, less populated terrain because steeper terrain has higher river energy. Less mills were located in the valley, where river energy is decreased and population density is increased. We also examined sites of old mills to look for sediment deposits typical of damming and noted human impact on landscape change. We observed drastic changes in the course of the Browns River in Jericho, believed to be related to removal of dams.

Introduction

In the mid 1800's logging and milling were among the most important economic activities in Vermont. (Grover, 1998) At most mills, the energy of the river was harnessed by damming it and directing the water through a narrow channel, allowing it to turn a wheel or turbine, which supplies energy for the mill. Mills can be used in production of a variety of products, including timber, flour, animal feed, tanning, paper, and cotton, among other things. (Bellis, 2003) Our work quantifies the number of mills in three Vermont counties, and relates this number to the surrounding landscape. Because high river energy is necessary in order for a mill to run successfully, a higher frequency of mills is expected in areas with higher average slope.

Damming a river directly affects the surrounding landscape, most noticeably through ponding at the base of the dam. As the natural course of the river changes, the rate of sediment transfer changes as well. When a river is dammed, fine grain sediment builds at the base of the dam, in the still pond water. Also, with increased deforestation, such as the extensive period of logging in Vermont in the middle to late 1800's, an increased load of sediment runoff can be expected. (Jennings, 2003) Increased deposits of fine grained sediments can therefore be expected in stream cut banks located behind former mill sites. (Merritts, 2003)

Methods

We began by examining Walling's maps published between 1856 and 1858. (Figure 1). These maps cover the entire state of Vermont and display topography, residential areas, as well as sites of factories and mills. Three counties were selected according to differing topography and map availability. Chittenden County, Bennington County and Caledonia County were selected because of geographic separation, and differing topography. (Figure 2) We copied the maps for each of the individual towns

within the county, and examined the waterways of each town carefully. Whenever a mill was found, it was highlighted. Once all mills were highlighted, they were sorted by county and type and put onto an Excel spreadsheet. For each town, the number of mills was divided by the area of the town, in order to obtain average mills per square kilometer. We also looked at the relief from highest to lowest points to see if this impacted mill frequency. Also, we used Vermont Census data for the 1850's published by Arnold (1980) in order to obtain population density data to relate to mill frequency.

Next, we explored five sites where mills once existed. Once a site was found, we looked for deposits created by dams, and river incisions that would reveal levels of fine grained sediment typical of a dammed river. Out of the 350 mills in the three counties, we examined four former mill sites, and the site of one preserved mill. In particular, we examined the still existing Old Red Mill in Jericho, and the sites of two other former mills upstream on the Browns River, inside Old Mill Park. The Old Red Mill proved to be a good reference for how most of the other mills would have operated. We had a chance to explore the interior of the mill, and note the functions of each component. Also, river outcrops were examined in order to look for sediment loads that could be related to Vermont's period of rapid deforestation.

Data

We counted a total of 350 mills between the three counties examined. Bennington had 142, with a frequency of about 0.03 per square kilometer. Caledonia had 133, also with a frequency of about 0.03 per square kilometer. Chittenden had 75, with a frequency of about 0.02 per square kilometer. (Table 1) Population density was greatest in Chittenden, at about 7.6 people per square kilometer. Caledonia had about 5.1, and Bennington around 4. (Figure 3)

In the field, all of the mills we visited were built on bedrock stream channels, with seemingly little sediment built up behind where the dam would have been. The sediment we did encounter was primarily fine sand. Also, off of Mill Road in Jericho, we noticed a dramatic difference between the current stream path and the path of the Brown's River documented on the Walling's map. Two mills had existed in this spot, and we believe that the removal of the dam could have allowed the river to take it's natural course, rather than the redirected course it took when the mill existed. In the older map, the water was channeled in a straight line, while current maps display an S-shaped course rather than a straight line. (Figure 4) The abundance of mills that existed in this small stretch of land leads us to believe that the removal of the dams impacted course of the river

Discussion

Results showed an abundance of mills located in environments with steeper terrain and higher frequency of mountains. The valleys, such as the city of Burlington, contained a relatively low frequency of river powered mills. These results support the fact that a high-energy river is necessary for a mill to perform efficiently. Population seems to have an inverse relationship to mill frequency, as people tend to congregate in vallies and next to major waterways more than in hilly regions. Examining average relief per county was not as helpful as we had wished, mainly because Chittenden County the highest and lowest elevation. Therefore it was hard to draw a solid relationship between relief and amount of mills because we noted far more mills in the more mountainous terrain near Mt. Mansfield than we did in the valley. Separating the counties and counting amount of mills at certain elevations would have been more helpful.

As of 1992, 255 mills remained in all of Vermont, with only 30 in the three counties we examined. (De Geus, 1992) Removal of the damming structures used to harness the energy of the river has definitely led to a change in river flow. This can be

seen on the Brown's River upstream from the Old Red Mill on Mill Road in Jericho. In this area, the flow of the river is drastically S-shaped, while it was once a relatively straight channeled flow from one mill to the next. (Figure 4) We believe that this is a result of the destruction of the mill dams in this area, which is indicative of the impact humans can have on landscape change.

Comparing the results of this study to those of Merritts and Walter, it is important to note that many of the areas we examined were rivers on top of bedrock. Lack of sediment in certain areas prevented us from locating cross sections with distinct layers of increased sediment runoff due to deforestation. More investigation of these sites, as well as finding other sites more preferable to this aspect of the study likely would display layers of increased sedimentation during the latter half of the 19th century.

Summary

Although once quite prominent in the hills of Vermont, most old mills were eventually replaced by steam mills, and later by electricity. (Bellis, 2003) Lower regions, where population was higher, had fewer mills. Sediment once trapped behind the many dams along most of Vermont's rivers has mostly been washed downstream, though certain areas still display evidence of the past. Construction and destruction of dams has impacted these sites, displaying the effect humans can have on the environment. Today, few of the old mills that still exist maintain their original function. However, studying old mill sites can aid the understanding of past environments and methods used to harvest nature's energy.

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FIGURE 1

Figure 1. (Walling's Map) Walling's map of Woodford, VT, 1856. Woodford was home to 25 mills at this time, 20 of which were saw mills (marked with orange). It has the highest mill frequency of all towns studied, at about one mill per five square kilometers.

Figure 2

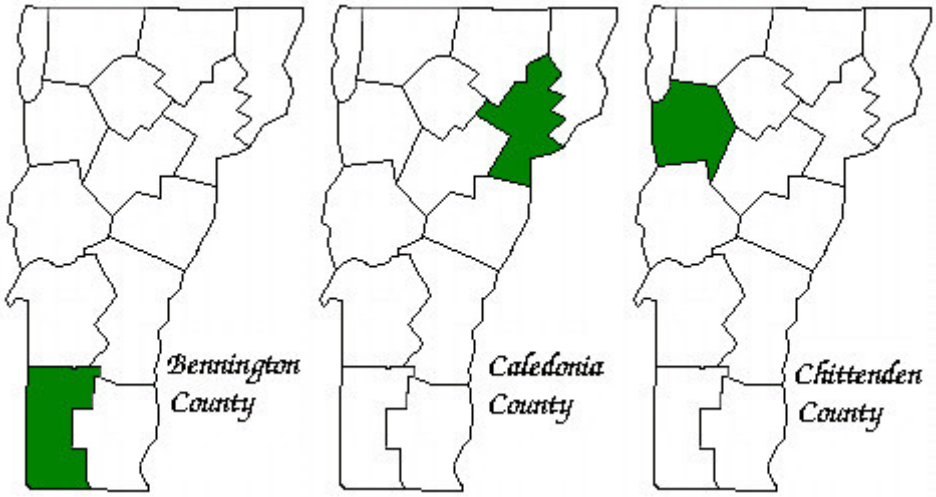

Figure 2 (Counties Selected) Three Vermont Counties were selected because of their differing geographic location and topography.

FIGURE 3

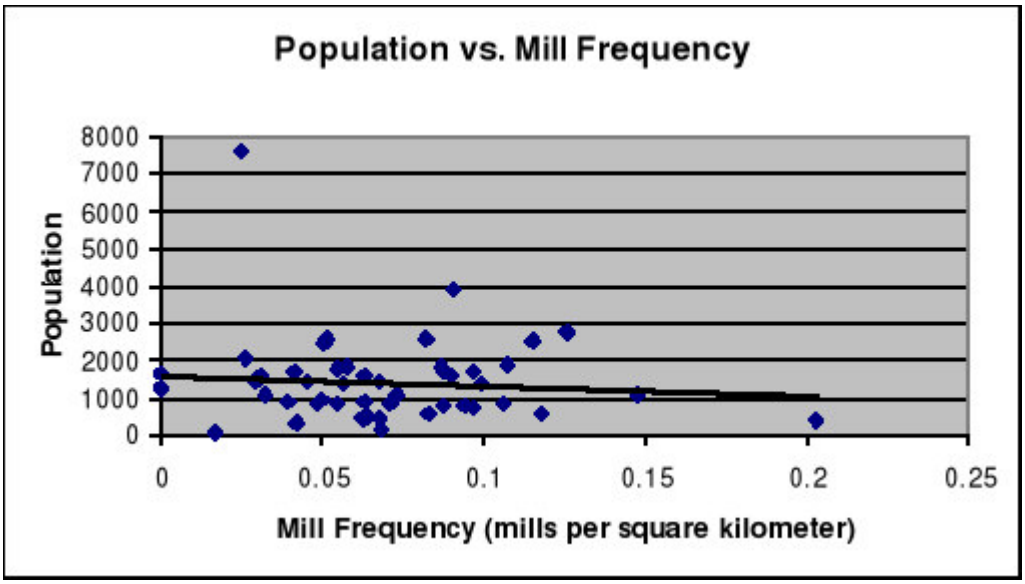

Figure 3 (Mill frequency vs. Population) This graph displays the inverse relationship between mill frequency and populations. The more people that live in an area, the less mills are likely to be found.

FIGURE 4

Figure 4 (1857 vs. 1996) Maps of Jericho in 1857 (Walling's, 1857) and in 1996 (VT Atlas). Note the radical difference in the path of Brown's River and the new S-shaped course the Browns River takes

TABLE 1.A Bennington

BENNINGTON
(total relief = 3280)

	Saw Mills	Grist Mills	Paper Mills	Ocher Mills	Flax Mills	Oil Mills	Total	
Arlington	5	2				1		8
Bennington	3	1	5				1	10
Dorset	11	1						12
Glastenbury	2							2
Landgrove	1							1
Manchester	5	1						6
Peru	8							8
Pownal	4	1						5
Readsboro	8	2						10
Ruppert	4	1						5
Sandgate	5	1						6
Searsburg	4							4
Shaftsbury	7	2	1			2		12
Stamford	9							9
Sunderland	7	1						8
Winhall	11							11
Woodford	20			4			1	25
Total	114	13	6	4	3	2		142

Area (sq. km)	Mills/sq. km	Population	People/sq. km
109.92	0.0727802	1084	
110.05	0.09086779	3923	
123.93	0.09682885	1700	
115.2	0.01736111	52	
23.62	0.042337	337	
109.5	0.05479452	1782	
96.84	0.08261049	567	
121.03	0.04131207	1742	
94.46	0.10586492	857	
155.5	0.03215434	1101	
109.3	0.05489478	850	
58.53	0.06834102	201	
111.76	0.10737294	1896	
102.56	0.08775351	833	
118.1	0.0677392	479	
113.96	0.0965251	762	
123.28	0.2027904	423	
4655.63	0.03050071	18589	3.99280012

TABLE 1.B Caledonia

CALEDONIA
(Total Relief
=2760)

	Saw Mills	Grist Mills	Woolen Mills	Oil Mills	Total	Area (sq. km)
Barnet	8	4	1		13	112.85
Burke	10	3			13	88.22
Danville	10	2	1		13	158.38
Goshen Gore	2				2	
Groton	7	1	1		9	142.45
Hardwick	9	1			10	100.73
Kirby	4				4	62.93
Lyndon	7	1		1	9	103.08
Newark	5	1			6	96.35
Peacham	4	2	1		7	123.54
Ryegate	6				6	95.31
St Johnsbury	10	1	1		12	95.31
Sheffield	8				8	84.95
Sutton	5				5	99.46
Walden	7	1			4	101
Waterford	6	1			7	102.82
Wheelock	4	1			5	103.08
Total	112	19	5	1	133	4326.5

Mills/sq. km	Population	People/sq. km
0.11519716	2521	
0.14735888	1103	
0.08208107	2577	
0.06318006	895	
0.09927529	1402	
0.06356269	509	
0.08731083	1752	
0.06227296	434	
0.05666181	1377	
0.06295247	1606	
0.12590494	2758	
0.09417304	797	
0.05027147	1001	
0.03960396	910	
0.06808014	1412	
0.04850601	855	
0.03074078	22124	5.11360222

TABLE 1.C Chittenden

CHITTENDEN
(Total relief = 4298)

	Saw Mills	Grist Mills	Woolen Mills	Paper Mills	Total	Area (sq. km)	Mills/sq. km	Population	People/sq. km
Bolton	13				13	110.33	0.11782833	602	
Burlington	1				1	40.15	0.0249066	7585	
Charlotte	3	1			4	130.64	0.03061849	1634	
Colchester	3				3	58.63	0.05116834	2575	
Essex	2	1		1	4	151.85	0.02634178	2052	
Hinesburg	2	3	1		6	103.91	0.05774228	1834	
Huntington	6	1			7	98.8	0.0708502	885	
Jericho	5	2	1		8	91.82	0.08712699	1837	
Milton	5	1	1	1	8	157.7	0.05072923	2451	
Richmond	3	1			4	87.73	0.04559444	1453	
Shelburne	1	1			2	116.27	0.01720134	127	
St George					0	14.37	0	1257	
Underhill	11	1			12	133.13	0.09013746	1599	
Westford	2	1			3	101.76	0.02948113	1458	
Williston					0	79.51	0	1669	
Total	57	13	3	2	75	3824.39	0.01961097	29018	7.58761528