Working Paper

Northeast Forest Fire Compact Project

Vermont's Fire History 1908-2010:

Initial observations

Zero Draft

LCI Oct 2, 2011

This note is an initial summary of key data on Vermont fire history. We reach back into history for several reasons. First, it is useful to see whether major fire years are synchronous or not, and if so to associate those with weather conditions to the extent we can. Second, the history can five clues to important associations with weather that might not be evident from a short period of records. Analyzing this kind of information is subject to the usual caveats; especially for the older data completeness and accuracy of coverage cannot always be assured. For example, it is easy to finds in the literature widely differing estimates of the area for the same fire! Most importantly must take care in making casual extrapolations to the future. Ultimately we hope to analyze circumstances surrounding the very largest fires in the region, and hope to use the annual fire occurrence data to identify years when those occurred.

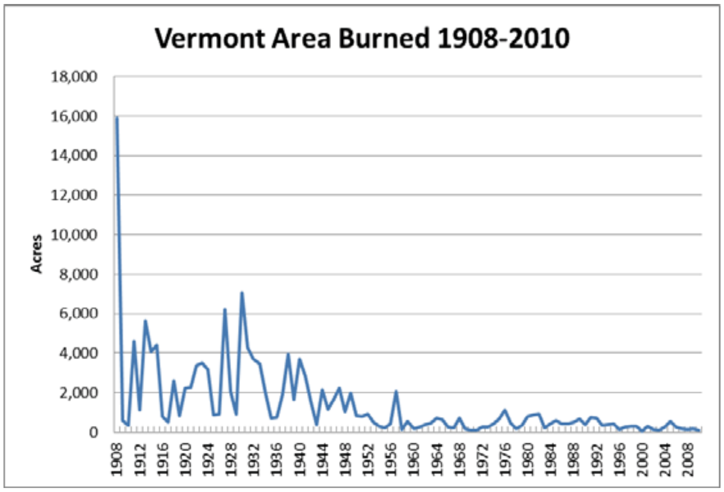
We would observe that as a policy matter, the number of acres burned annually may not be a sensible way to discuss policy. A year is an arbitrary unit of time. Would it make more sense to think in terms of area burned per decade or even longer, given resource and property values involved? Also, in this research we are searching for general empirical regularities to the extent they can be observed, but our purpose is not to develop methods for prediction.

The data used here come from two sources: first, an unpublished paper by Richburn and Patterson for the US Forest Service that compiled extensive detail to 1998, and second, official USFS summaries, based on state submissions, for years 1999-2010. In all of our work, we are at the moment giving no attention to costs, estimated damages, or damages to structures.

Based on this information, 1908 was an extreme fire year, followed by pulses of fires in the early teens and late 20's to early 30's (Fig 1). A further pulse occurred in the early 40's. From 1944-48, a somewhat jagged decline to about 1960 took place. In contrast to other states, 1947 was an unremarkable year, though 1957 strands out. After that year, in only one year did area burned exceed 1000 acres again (1976), and in most years it was below 500 acres. Over the entire period, an estimated 141,000 acres burned. Especially in earlier years, a portion of this area was likely not forest but pasture or brushland.

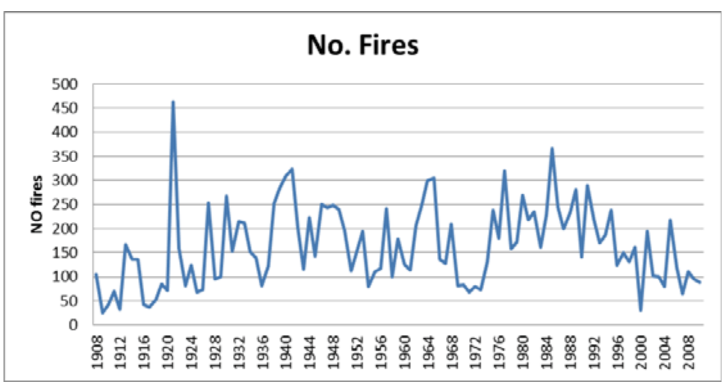
In **further work** we will standardize area burned to the total area of forest in Vermont, which may yield an improved picture. Further, we may be able to draw conclusions from the county data compiled by Richburn and Patterson.

Figure 1.



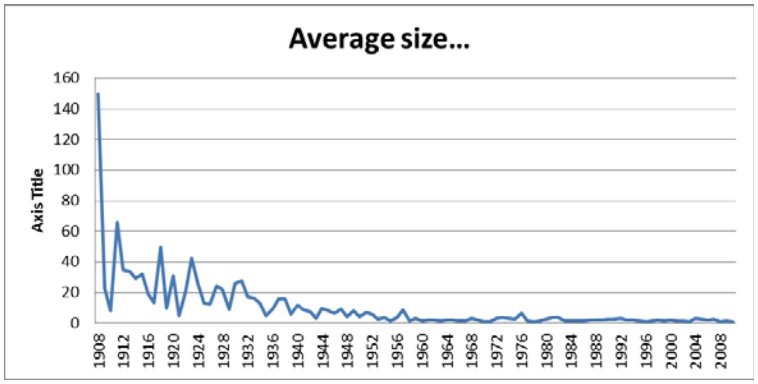
After the 1920 spike, fire numbers moved in a wide band between 100 and 300 fires per year (Fig 2). They showed a spike consistent with effects of the early 60's drought, but even then fire numbers did not exceed their 1940 peak. An early 70's trough was followed by a jagged rebound to a mid 80's peak and then a decline to very low levels.

Figure 2.



Over this period, average area burned per fire declined dramatically, reflecting several factors but surely due in large part to improved detection and initial attack (Fig 3). After 1960, average fire sizes larger than 2 acres were unusual. Averages are not the whole story, though, as we see below.

Figure 3.



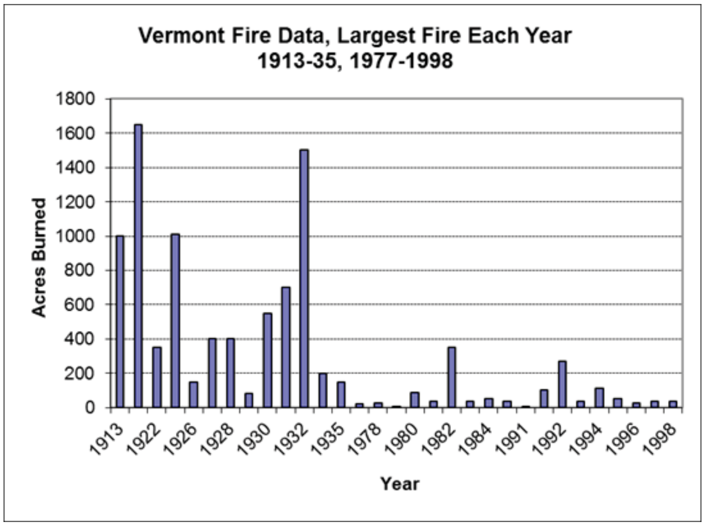
Defining subperiods for analysis is challenging. Simply doing this by decades has the merit of clarity, and avoids making judgments about complicated factors that may affect fire history (Table 1). When we later analyze return periods and extreme values this problem will need to be confronted. We do not have a final view on this issue yet. But averaging by decade does not make the problem go away, as some of the decadal averages are affected by extreme individual years.

Table 1.

Average annual area burned and fire size by Decade				
Decade	# fires	total acres	Ave. acres	Ave. acres per fire
1910-1919	804	24951	2,495	31
1920-1929	1493	25504	2,550	17
1930-1939	1879	29459	2,946	16
1940-1949	2300	18703	1,870	8
1950-1959	1486	6737	674	5
1960-1969	1856	3978	398	2
1970-1979	1507	3899	390	3
1980-1989	2439	5840	584	2
1990-1999	1816	4017	402	2
2000 - 2010	1204	2205	200	2
note: totals/aves for 11 yrs in last "decade".				

Richburn and Patterson's compilation gives us a long run of data for the largest fires, something we have not been able to find for any other state, and which resources will not allow us to compile anew from primary documents. Despite its gaps, it hints that heavy fire years often involve fires of unusual size. From 1977 to 1998, there were only 2 fires exceeding 200 acres.

(Will try to update to present)



The skewness of area burned stands out when the fire years are ranked. It is clear that a large portion of total area burned over the period occurred in a small number of years. The pattern of skewness persists when pre 1946 years are dropped from the analysis, only the level changes.

Figure 4.

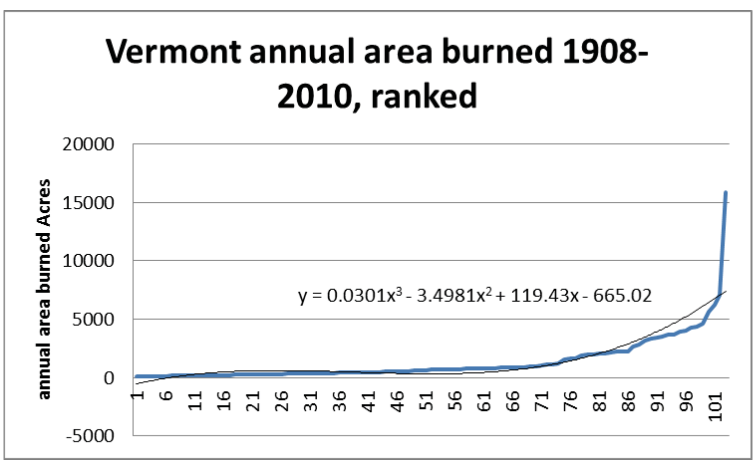
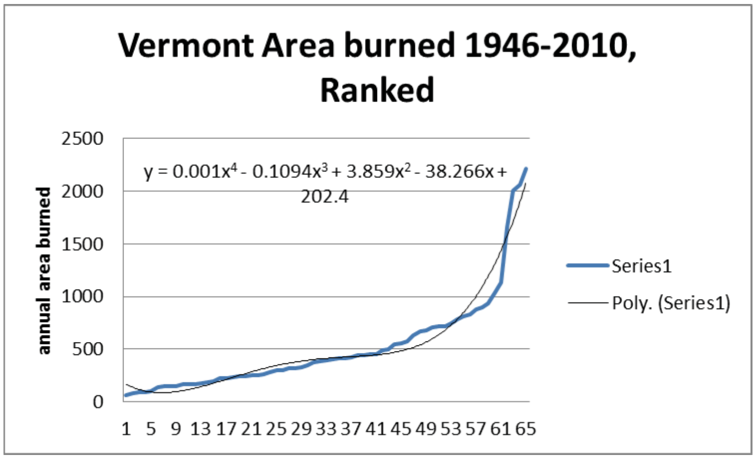


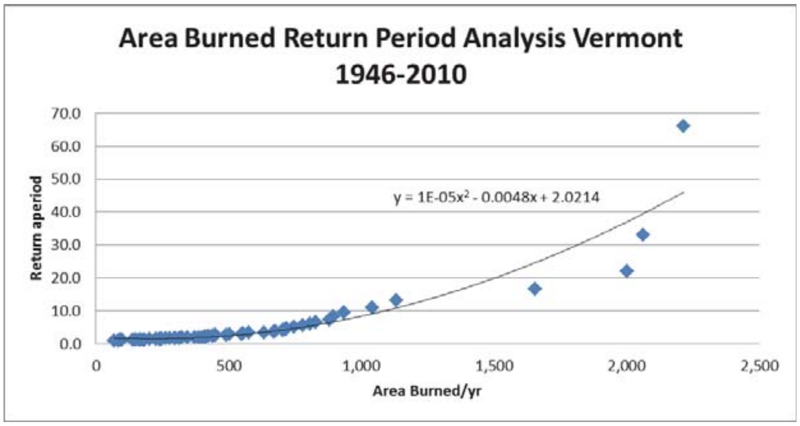
Figure 5.



Using only years 1946 to present, we performed a rudimentary return period analysis. This uses a concept familiar in analyzing longterm flood risks. It brings the problem of defining a suitable data period to the fore. It is not easy to see an objective basis for choosing the beginning of this data period. One would not recommend analyzing hurricane risks in New England by starting in 1939, simply on the grounds that 1938 was a long time ago. At the same time, we need to know more as to what kinds of conditions may have changed, and how significantly, since the 1940s, in order to set an initial year for the data period. At the moment, then, this chart is only to suggest the method. The principal point is that one cannot talk of fire risks using averages, but should use some concept such as return periods instead. We think that presenting such an analysis may be of use to decisionmakers. We would porefer to use this method on the largest fires each year (as is done for flood risk), but at present we have very little data on individual fires)

This initial analysis shows that to plan for a return period of 10 years would mean expecting about 1100 acres of area burned to occur once a decade. For 20 years, the figure rises to just above 1500 acres. Both figures significantly exceed recent averages.

Figure 6.



Fire Season

Richburn and Patterson's compilation by months gives us the only example of a longterm trend we have uncovered of a truly longterm dataset on monthly fire occurrence (Table 2) . Even with its gaps, it yields interesting insights. For the years covered, it shows a large increase in March area burned, and a 2X increase in October area burned. This is roughly consistent with statements that fire seasons have been lengthening in the region. At the same time, area burned in June and July has declined. Looking at individual years, there is high variability in these relationships and choice of data periods may influence the comparisons.

(can we update to present?)

Table 2.

Table… Vermont Area Burned by Month, 1913-1998 and 2 subperiods						
	Average of 56 years	Percent	Averages			
			1908-1945	Percent	1946 to 1998*	Percent
January	1.0	0.1	0.8	0.0	1.1	0.2
February	0.7	0.0	0.0	0.0	1.2	0.2
March	67.4	4.2	84.7	2.8	70.2	10.4
April	655.8	40.8	1257.7	42.2	245.5	36.3
May	494.1	30.7	952.3	31.9	174.6	25.8
June	107.6	6.7	216.0	7.2	32.3	4.8
July	21.8	1.4	34.2	1.1	14.3	2.1
August	40.6	2.5	85.8	2.9	10.1	1.5
September	17.0	1.1	26.9	0.9	10.4	1.5
October	139.5	8.7	206.0	6.9	93.3	13.8
November	56.1	3.5	104.3	3.5	23.5	3.5
December	6.4	0.4	13.2	0.4	0.7	0.1
	1608.1		2981.7		677.2	

* 62 to 76 missing

Trends in Fire size distribution and Area Burned since 1984.

The skewed nature of the fire size distribution is illustrated by the cumulative ‘84-2010 data (Table 3). The smallest fires are the most numerous but affect the least amount of area, while the less freq2uent larger fires affect much more area. Over this period, only 6 Class D fires burned an estimated 1,000 acres, or 11% of the cumulative area burned over the period. In fires 10 A and larger, a total of 194 patches, totaling 4800 acres, was affected by fire. These may have been minor ground fires; many were probably not stand-replacing. In the largest fires, unburned islands may have persisted within outer fire perimeters. For at least some of these, effects visible at a later time may have been negligible or very subtle.

Table 3. Vermont Fire size distribution, 1984 to 2010. Source: USFS

NUM	Cum 1984				
	to 2010	PERCENT		In 27 seasons...	
Class A	1,731	39%		10 a & Larger	
Class B	2,496	56%			
Class C	188	4%		194	patches
Class D	6	0%			
Class E	0	0%			
Class F	0	0%			
Class G	0	0%			
TOTAL	4,421	100%			
ACRES					
Class A	234	3%			
Class B	4,281	46%			
Class C	3,793	41%		4843	acres
Class D	1,050	11%			
Class E	0	0%			
Class F	0	0%			
Class G	0	0%			
TOTAL	9,358	100%			

The annual data display significant patterns (Fig 7). Attributing these patterns to specific causes, however, will take some discussion and further analysis and may not yield precise answers. In Fig 7A, the general downtrend in both numbers and area is evident, together with the volatility. In Fig 7b, we can see that some years pass with no large fires at all, and the mix of fires by size can change. Over the period, the number of fires in the middle of the distribution seems to be shrinking considerably. This may be a result of more fires being extinguished before they reach that size. In Fig 7c we can see the importance of the occasional larger fires, and the fact that the smallest fires burn a tiny share of the total area. Fig 7-D reformats the data to show shares of total area burned by fire size classes.

Further analysis of these patterns, and discussion of possible causes for the changes, will be pursued.

Question for experts: can we associate these trends in any meaningful way with changes in fire protection programs?

Fig 7 a-d Vermont fire size distribution 1984-2010

Fig 7-A. Totals. (fix legend)

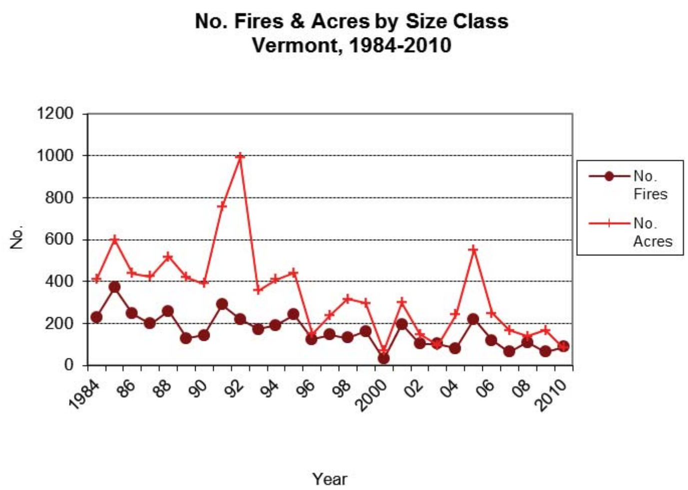


Fig 7-B

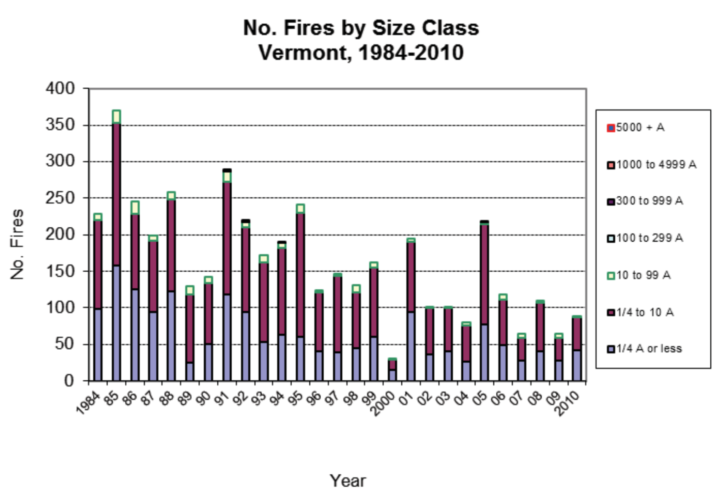


Fig 7-C --absolute numbers

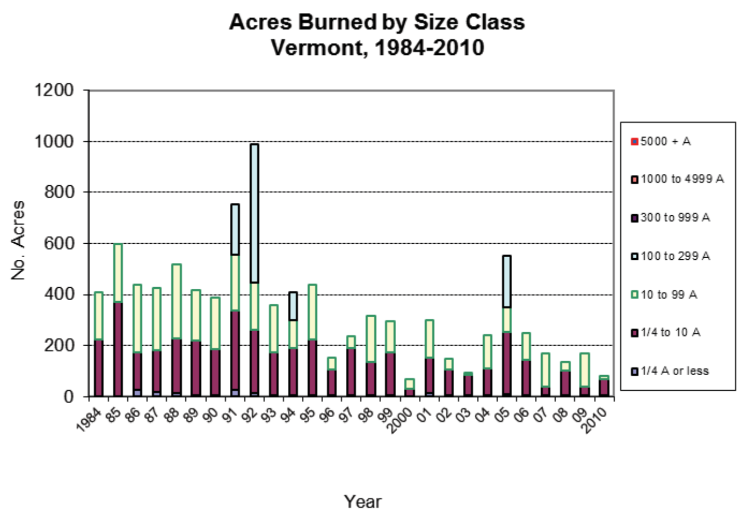
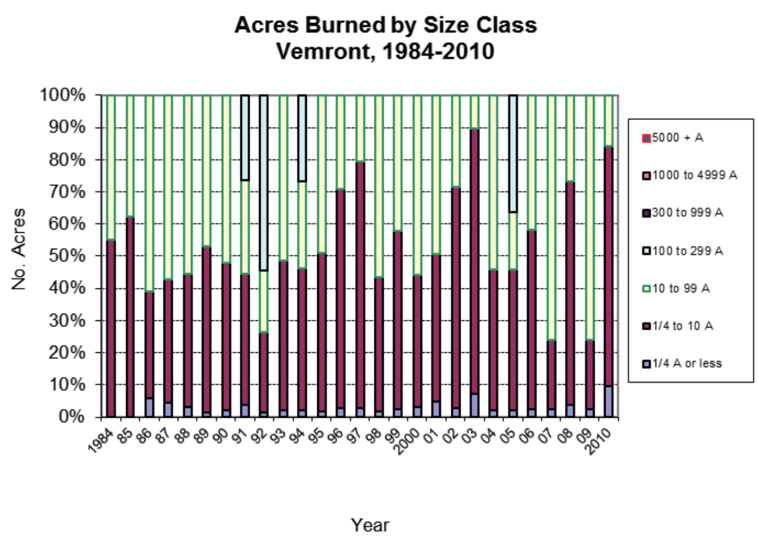


Fig 7-D Percentages of totals



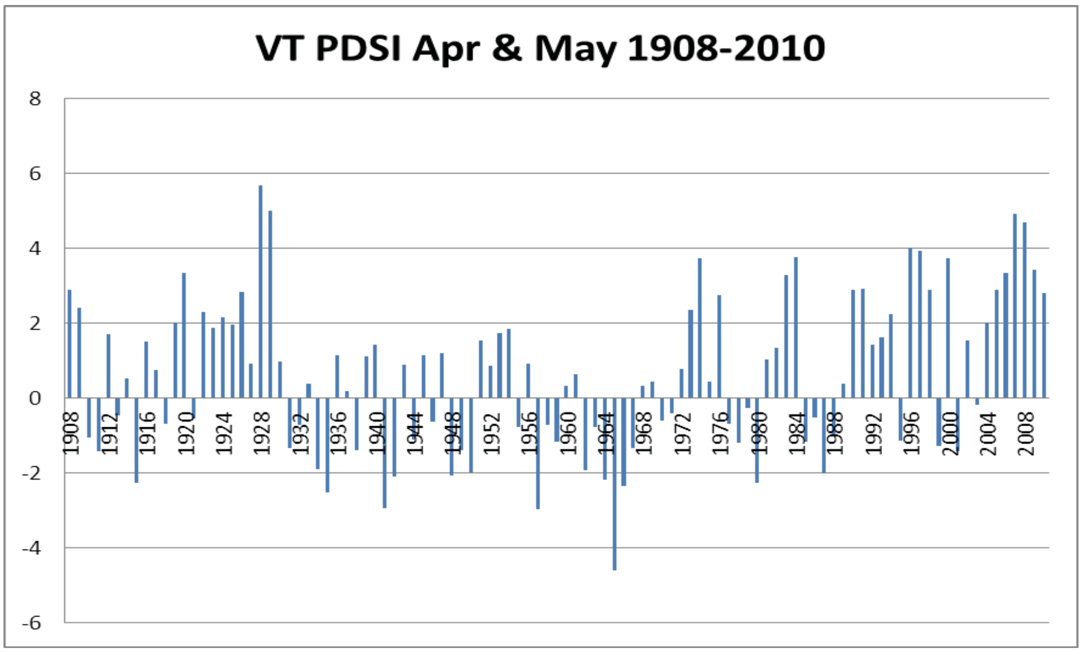
Effects of weather conditions.

Monthly historic weather data from NOAA enable us to examine fire occurrence and compare it with weather conditions in particular months. We hope to do this using Richburn and Patterson's monthly dataset, which at present contains some gaps. Pending a full analysis, we have compared annual area burned to the April May Palmer Drought severity Index (PDSI), relying on the fact that these

2 months include a significant percentage of area burned in a typical year (62% on average for 1946-98). Before 1930, Vermont did not have the frequency of very dry springs that occurred in other areas we have studied so far (Fig. 8). Also, it has experienced no dry springs worse than 2.3 since the mid 60's drought, and in the same years springs were on average wetter by this measure than from the 30's to 1960. The early 60's drought stands out, but as seen above it produced no notable increase in fire activity.

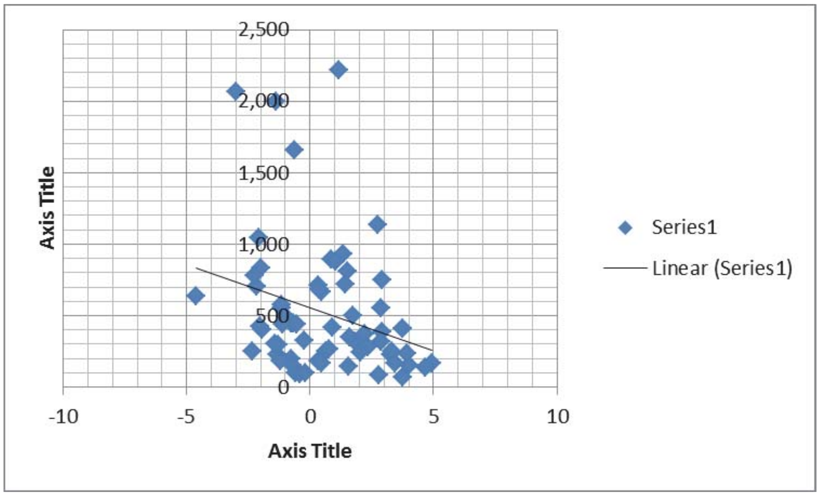
Request for comments: the PDSI is one of several drought indexes available. Is it the most suitable one for this purpose?

Figure 8.



A scatter of annual area burned 1946-2010 vs PDSI for April and May shows a broad trend with a high degree of scatter. The picture is consistent with the view that wetter springs are one factor in area burned, but by no means the only one. If we could analyze also the separet fire seasona with monthly data, and perhaps explore other drought indexes, and obtain windiness data it would surely improve the picture. Likely, though considerable scatter would remain.

Figure 9. PDSI for May and June, 1946-2010 and annual area burned.

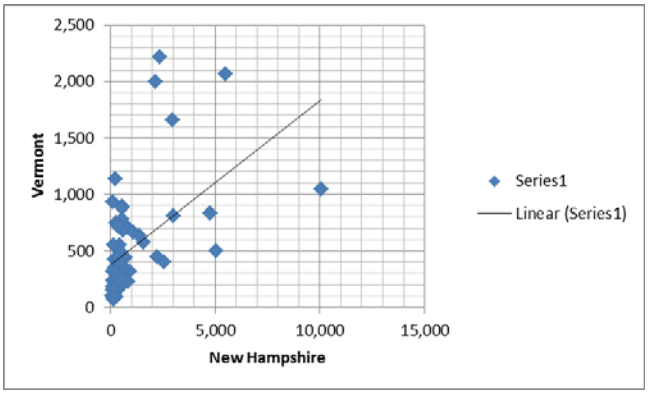


Relation to the Region

The Compact's reason for existence is to enable the sharing of resources among its members. It is then helpful to gain a sense of the extent to which bad fire years are correlated across states or not. The relationship between Vermont and New Hampshire for area burned is not at all tight, but then it may not need to be (Fig 9). What we can see is that when one state has a bad year, the other does as well. In most years, there is no relation at all, and the need for resource sharing does not arise in any case.

(Will compare to NY when we fill in some gaps for NY)

Figure 9. Scatter of Vermont and NH Area burned 1946-2010.



Average for NH 1138; VT 572

Notes on overall fire vulnerability of Vermont forests

Richburn and Patterson and other researchers have drawn conclusions concerning fire rotations and other issues concerned with landscape ecology. They and many others agree that on the whole Vermont forests are virtually "asbestos forests" with extremely long average fire intervals, on the order of 500 to 1000 years. Mann Engstrom and Bubier note that in local areas, the more fireprone forest types have shorter fire return intervals than do the general average upland hardwoods. A study on this subject by Parshall et al used charcoal sediments in lakes but unfortunately for our purposes only included 2 sites in Vermont.

In further work we hope to be able to draw on other data to estimate the areas and locations of those more fire prone types.

Forces affecting Vermont's Fire history

Will seek info. and viewpoints and discuss:

Amount and effectiveness of detection-initial attack programs; prevention activities and pre-suppr. Response times.

Change in lumber/pulp industry activity 9 slash, crews/mach. in woods

Changes in forest, composition, condition, etc.

Longterm trend in RR's, smoking etc.

Yr to yr trends in lightning

Land use changes, less pasture, changes in debris burning in farms, etc.

Drought and weather (e.g. ’38 hurricane, debris, effect on fine fuels). Clearly drought alone does not explain incidence of large fire yrs in VT.   **Wind** is clearly a major factor, but we do not at present have longterm data on windiness to compare with fire experience.

It may prove impossible to reach clear conclusions as to the impact of each factor, but this list should stimulate discussion and suggest additional points.

Literature References

Experts – can you suggest other relevant materials we need to consider?

Mann, D. H. F. B. Engstrom, and J. L. Bubier. 1994.   Fire history and tree recruitment in an uncut New England forest. Quaternary research, 42 (1994): 206-215.

Parshall, J. and D. R. Foster. 2002. Fire on the new England landscape: temporal variation, cultural and environmental controls. J. Biogeography. 29”1305-1317. (fossil charcoal, lake sediment. one study site in VT.)

Richburn, J. A. and W A Patterson. 2001. Fire history of the White and Green Mountain National Forests. Report to White Mountain National Forest. Jan. 31.   48 pp + app. Processed. (copy in author files)