Historic Wildfire Research in Southeastern Idaho

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Abstract: The goal of this project was to create and analyze wildfire areas that occurred on BLM land in eastern Snake River Plan between 1939-1997. We began with hand drawn wildfire maps and digitized them using standard heads-up digitizing techniques. Our Area Of Concern was southeast Idaho which includes Pocatello and Idaho Falls. We then analyzed the size of fire areas, proportion of vegetation types burned, fire frequency, and fire intervals. These problems were solved using raster grid and vector polygon methods. The results show an overall decreasing trend in acres burned from 1939-1997. Problems associated with decreasing fire acreage are discussed.

Keywords: GIS, fires, BLM, Idaho.

Introduction: This internship was a cooperation between Idaho State University's (ISU) GIS Center and the Bureau of Land Management (BLM). The primary task was to complete a data conversion project that would result in a topologically correct, minimally attributed fire polygon history layer for use in current and future fire management planning, resource allocation planning, and numerous resource/land management planning and implementation efforts. The study area was the BLM east zone fire dispatch area which includes Idaho Falls and Pocatello, Idaho (Fig. 1).

The study area covers approximately 450 1:24000 scale quadrangles in southeast Idaho. Some areas are largely private or under state or other federal agency management, which precluded ISU/BLM from obtaining historic fire information. Since the 1940's BLM fire history data has been traditionally mapped using a 40-acre minimum, on standard Township/Range grids drawn to 1/4 sections. In the 1970's, this mapping effort changed. Using Global Positioning System (GPS) data recorders fire polygons were mapped to ≥10 acres.

This study included digitizing and attributing the polygon layer using existing paper maps from the archives of the Idaho Falls Fire Management Office. After building the polygons, we attributed them with a single unique "fire number" as found on the original fire map documentation. All wildfire reports from 1939-1997 containing hand drawn maps of the burned areas were included in this study.

Tasks:

1. Use heads-up digitizing to create fire coverages that occurred on BLM land in southeastern Idaho from 1939-1997.
2. Determine the percent of BLM land burned within dispatch area during the time from 1939 to 1997.
3. Determine the percent of BLM land burned within dispatch area during each decade.
4. Determine those areas that were burned >1X during this time period. Determine the total area burned >1X, and those areas burned >2X and >3X.
5. Determine the proportion of vegetation types on BLM land (using existing GAP analysis vegetation data).
6. Determine the vegetation types burned ≥1X.
7. Determine if the vegetation types burned ≥1X were also burned in proportion to their availability on the landscape.
8. Using the areas that burned >1X, determine the mean and median fire interval.

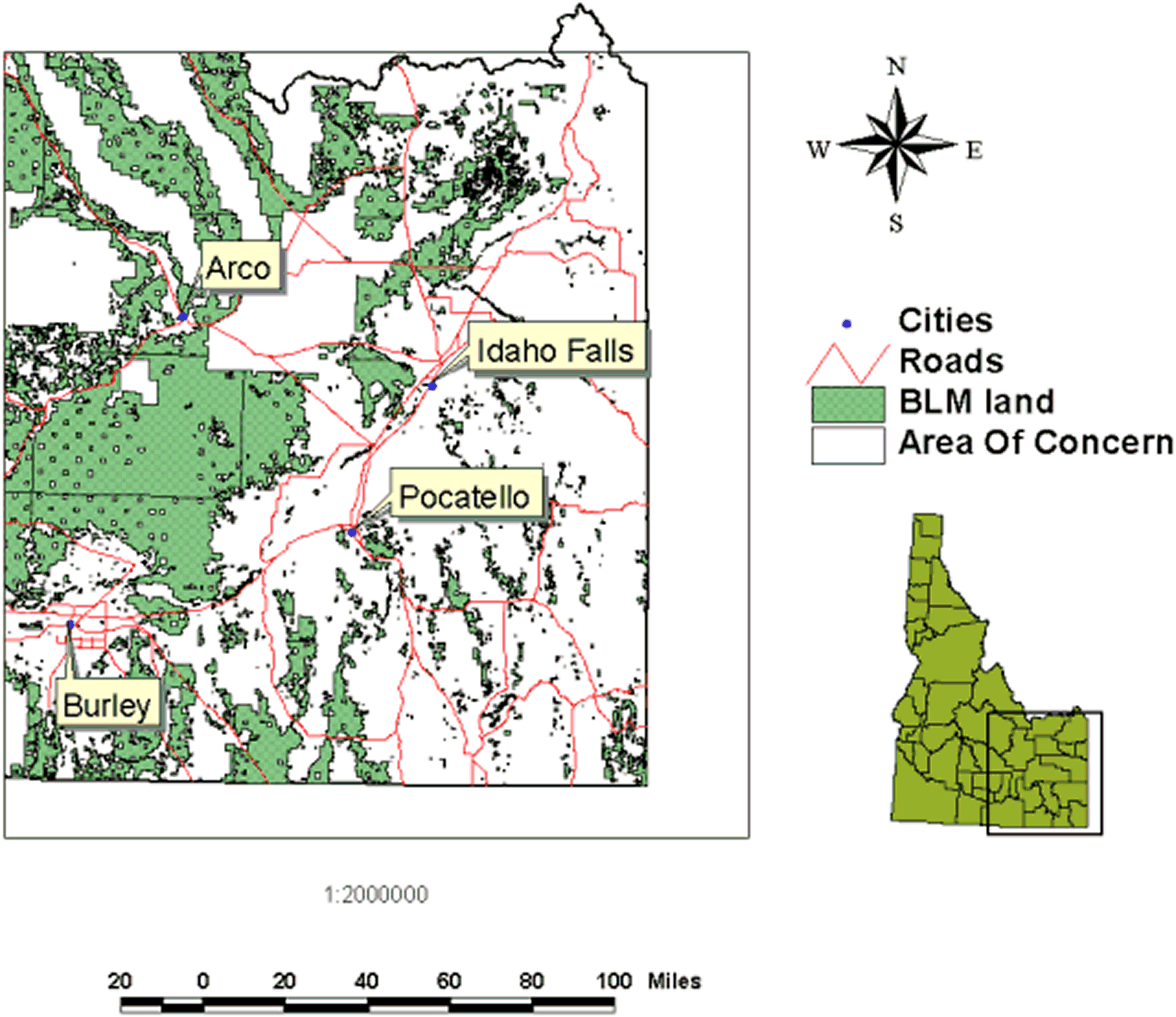

Figure 1. This map illustrates our Area Of Concern.

Methods:

All file names are described in Appendix A.

1. To digitize the fire areas we used ArcView. All reports contained hand drawn maps. In more recent years (1970-1997) these are drawn on a topographic map background. By using Digital Raster Graphics (DRG) of the area we could find the fire area specified on the DRG and then easier digitize these areas. Earlier reports only contain the Township/ Range/ Section identifiers. We created a new shape file for each year. We added the following fields to the attribute table: fire_year (containing the fire year in two digits), fire_number (an alphanumeric fire number assigned by the BLM and provided on fire documentation forms). We also calculated the area, perimeter and acreage of each fire polygon (Table 1).

In some years, fires occurred ≥1X in the same area. To address this problem we created two shape files for that year (e.g., one was called *fire_64.shp* and the next was called *fire_641.shp*). To deliver this information to the BLM we converted the shape files into ArcInfo coverages using an aml called *shape2arc.aml*. After this, the coverages were exported as interchange files.

2. We MERGED all themes together in ArcView and created a theme called *mergeny.shp*. We then CLIPPED this theme with *aocblm.shp* (which contains BLM land within our area of concern) and a shape file showing the dispatch area to produce a coverage containing only fires on BLM land within the dispatch area. We exported the database tables to Excel to determine the proportion of land burned on BLM land within the dispatch area.

3. Next we selected fires from each decade and calculated acreage using methods described in 2 (above).

4. The most difficult task was determining fire frequency. For this we used two approaches. The first approach was to use raster grids. All fire coverages were rasterized using a new field called z for the pixel's digital number (Table 1). This Boolean field indicates where there has been a fire. Areas where a fire had occurred were given a value of 1. This also required that we RECLASS all grids so NoData pixels were assigned a 0. All grids were added together with the MAP CALCULATOR. This resulted in a grid called *gridallf* with grid cells indicating the number of times each pixel had burned. From this grid we could query the areas that had burned >1X etc. To determine the acreage that had burned >1X we exported the database files to excel and calculated area.

The second approach was a vector-based solution using UNION in ArcInfo for years 1939-1997. The coverage created was *allunion*. To create this coverage we first created an aml called *fixuniv[1, 2, 3].aml*. This aml assigns the number 1 to every fire polygon and the number 0 to the universal external polygon of each coverage (where acre = 0)(Fig. 2).

After this we UNIONED all coverages with the aml called *union.aml*. We also dropped all *software generated fields*, (e.g., temp39#, temp39-id, fire_39# and fire_39-id etc). The remaining fields of interest were f_39, f_40 etc. These fields were used to determine the total number of fires occurring in all UNIONED polygons. We calculated this sum with the aml called *sum.aml* (Fig. 3).

From the *allunion* coverage we selected fires that had burned once, twice and so on. Acreage was calculated in Excel.

Attributes of Fire_94.shp

Shape	Id	Fire_year	Fire_numbe	Area	Perimeter	Acres	Z
Polygon	1	94	F770	683548.573	3265.477	168.908	1
Polygon	2	94	F771	1015594.635	6398.529	250.958	1
Polygon	3	94	F775	498605.340	4110.898	123.208	1
Polygon	4	94	F778	6750910.899	16936.049	1668.180	1
Polygon	5	94	F779	2076273.144	7600.565	513.056	1
Polygon	6	94	F787	492723.082	3364.688	121.754	1
Polygon	7	94	F790	2929174.500	9605.449	723.812	1
Polygon	8	94	F792	11098529.192	23547.438	2742.495	1
Polygon	9	94	F793	573307.901	3396.822	141.667	1
Polygon	10	94	F798	887699.140	8466.826	219.354	1
Polygon	11	94	F804	830639.152	5523.601	205.255	1
Polygon	12	94	F807	92083304.287	91086.400	22754.189	1

Table 1. This shows the attribute table for one of the fire years.

```
sel fire_64.pat
calc f_64 = 1
reselect acres = 0
calc f_64 = 0
/*
sel fire_641.pat
calc f_641 = 1
reselect acres = 0
calc f_641 = 0
/*
```

Figure 2. This shows the aml that gives the number 1 to every fire and 0 to the universal external polygon.

```
addit allunion.pat temp1 1 1 n 0
sel allunion.pat
calc temp1 = f_39 + f_40 + f_41 + f_43 + f_44 + f_45
/*
----- all other years
/*
calc f_sum = temp12 + f_811 + f_411 + f_431 + f_601 + f_631
dropit allunion.pat temp12
```

Figure 3. Here you can see how the attribute f_sum was built up by all the other years to get a sum of fires in every polygon.

5. To address the question of proportion of vegetation types existing on BLM land we needed a vegetation coverage of our study area. To produce this we created a boundary polygon (a rectangle) of our area of concern (AOC) called *aocbdy.shp*. This rectangle was used to CLIP a coverage of BLM land, giving us the BLM land within our AOC (*aocblm.shp*). This shape file was converted to a grid and each pixel was assigned the value 1 for BLM land. This grid was multiplied with a vegetation grid resulting in a vegetation grid of BLM land within our AOC. The resulting grid contained approximately 130 different vegetation types. To simplify the grid we used RECLASS so all sagebrush types were in one class, and so on (this grid was titled *Reclveg)*(Table 2). This simplified grid contained 41 vegetation types. The percentage of vegetation types on BLM land were calculated in Excel.

6. To determine the vegetation types burned >1X we used *gridallf* (cf. methods: 4). Each pixel was given a value of 1 resulting in the grid *allf1*. This grid was multiplied with the grid *reclveg* (reclassified vegetation described above) to determine the vegetation burned by the fires. This produced the grid called *alf1vny*. We repeated this procedure with areas that had burned ≥2X and this grid was called *alf2vny*.

7. To determine if vegetation types burned in proportion to their availability we converted the database file from *alf1vny* (which shows the proportion of vegetation types burned ≥1X) and examine the data in Excel. These data were compared to data describing the proportion of vegetation types on BLM land.

8. To determine mean and median fire intervals we used two approaches. The first approach was to open and activate all fire shape files in ArcView and the *gallf2* grid (which contains areas that had burned ≥2X). Using the IDENTIFY tool we selected a point on the grid and received information regarding the fires that had occurred there. The results were then added to an Excel spreadsheet and descriptive statistics were calculated.

The second approach was to use the attribute table from *allunion*. This contained the fields F_39-F_97 (containing 1 for fire and 0 for non-fire years). We copied the 1's and 0's to a new Excel sheet and at the end of every field we entered the fire year (39-97). We then created a formula that changed the 1's to the actual year. We then copied the fire years to a CSV (Comma Separated Values) file (e.g., *allfires.csv*). This file was put into a VB program that gave fire intervals for every record (polygon). We then copied these intervals to the *intervals.xls* file and calculated descriptive statistics on the values.

A second solution was an entirely Excel solution. We started in the same way and created an Excel file, the 1's and 0's were copied to a new sheet where we then calculated fire years. In the next sheet (years) we deleted the 0's and calculated the fire intervals (Table 3).

An additional task

To determine if fire intervals had changed during the time period of this study (1939-1997) we analyzed the years 39-68 and 69-97. We created two new coverages (as described earlier) and titled them *uni39-68* and *uni69-97*. The fire years were calculated in the same way with the VB program and Excel.

During our analyses we began to speculate if the acreage of individual fire areas was increasing or decreasing. To make this determination we analyzed the acreage by examining the mean, median, and the quartiles of the polygons. To analyze the mean we used ArcInfo and Tables using STATISTICS. This makes it possible to find the MEAN with an aml and a watch file that

Type	Value	Value range	Newvalue	
0 (1) Alpine Fir 1*	0	0--3	1	Alpine Fir
2 Alpine Fir 2	2			
3 Alpine Fir 3	3			
5 Alpine Fir/Doug Fir 2	5	5--6	2	Alpine Fir/Doug Fir
6 Alpine Fir/Doug Fir 3	6			
8 Alpine Fir/Lodgepole 2	8	8--9	3	Alpine Fir/Lodgepole
9 Alpine Fir/Lodgepole 3	9			
11 Alpine Fir/Spruce 2	11	11--12	4	Alpine Fir/Spruce
12 Alpine Fir/Spruce 3	12			
14 Alpine Fir/Whitebark 2	14	14	5	Alpine Fir/Whitebark
16 Doug Fir 1	16	16--18	6	Doug Fir
17 Doug Fir 2	17			
18 Doug Fir 3	18			
23 Doug Fir/Lodgepole Pine 2	23	23--24	7	Doug Fir/Lodgepole Pine
24 Doug Fir/Lodgepole Pine 3	24			
31 Juniper,Utah 1	31	31--32	8	Juniper, Utah
32 Juniper,Utah 2	32			

Table 2. This table illustrates how we combined similar types of vegetation into general vegetation types, (e.g., the 3 different types of Alpine Fir with value 0, 2, 3 were added together into one Alpine Fir class with the new value 1,etc).

1st fire.	2nd fire.	3rd fire.	4th fire.	5th fire.	6th fire.	2nd - 1st fire.	3rd - 2nd fire.	4th -3rd fire.	5th - 4th fire.	6th - 5th fire.
66	71					5				
41	63	71				22	8			
91										
41	43	44	63	71	81	2	1	19	8	10
41	44	63	71	81		3	19	8	10	
66	66					0				
66	66					0				
66	66					0				

Table 3. This table shows how we calculated the fire intervals.

wrote all output to a text file. This text file was opened in Excel and a chart was created illustrating the mean acres burned each decade.
To analyze the median we again used an aml that writes the acreage of each fire to a watch file. To calculate the median we used Excel. To determine quartiles we used a program called boxplot. This program takes a dbf file with acres and calculates median, 1st, and 3rd quartiles. The input dbf files were created from the second watch file, described above.

Results:
The results of digitizing and the location of each coverage is given in Appendix A.

The percent of BLM land burned within the dispatch area per decade is shown in table 4 and figure 4. Note: burned acreage follows a decreasing trend.

Figure 5 illustrates the results of determining areas that burned >1X and >2X. These data can be reviewed by using the grid *gridallf*.

Gridallf has values 0-4 in the attribute table describing the number of times an area has burned. The areas 0-4 are scaled in color so its possible to see those areas burned most. Areas burned >1X, are given in Appendix B.

The result of the vector-based approach was the coverage *allunion*. This coverage includes the attributes F_39 -> F_97 where the value 1 indicates a fire had occurred in that polygon. This coverage also contains an attribute (F_sum) showing how many times each area has burned. The total area burned >1X was 702 km^2, or 3.56% of BLM land. There were areas that had burned 6X.

Appendix B gives the proportion of vegetation found on BLM land and in burned areas. This table shows the number of pixels of each vegetation type that has burned once or more, and twice or more. It also shows the proportion of vegetation types burned.

Fire intervals calculated for all years are given in table 5.

The results of fire interval trend analysis are given in tables 6 and 7.

The results of fire acreage analyses are given in fig's 6-9.

Discussion: As seen in figure 4 there is a decrease in area burned from the 1940's to the 1990's. If you examine tables 6 and 7 you will see the median fire intervals change from 8 years to 10 years. This indicates that areas that have burned every 8th year now only burn every 10th year. This may not be too important since it is comparison between only two fire periods. However, when we look at the areas burned for every decade (Fig. 8) we can see that fires are probably controlled faster now than in the 1940's. The reasons are many. Today's equipment is better and roads are more numerous and often in better condition. The effect of such suppression is difficult to assess. If we continue to control fires quickly we will load fuels on possible fire areas. A dry year with inevitable thunderstorms could be catastrophic. Also of interest is the fact that 72% of the BLM land within the dispatch area has not burned during the study period (1939-1997). Fire managers may want to find areas most at risk to wildfire and consider using prescribed burns to reduce fuel loads.

Fire decade	Acres	Percent of blm land burned within dispatch area.
40	276,167	10%
50	13,646	1%
60	181,606	7%
70	138,490	5%
80	90,530	3%
90	48,981	2%
Total	749,419	28%

Table 4. Fire areas and percent of BLM dispatch area burned. Note: the 90's are years 1990-1997 only.

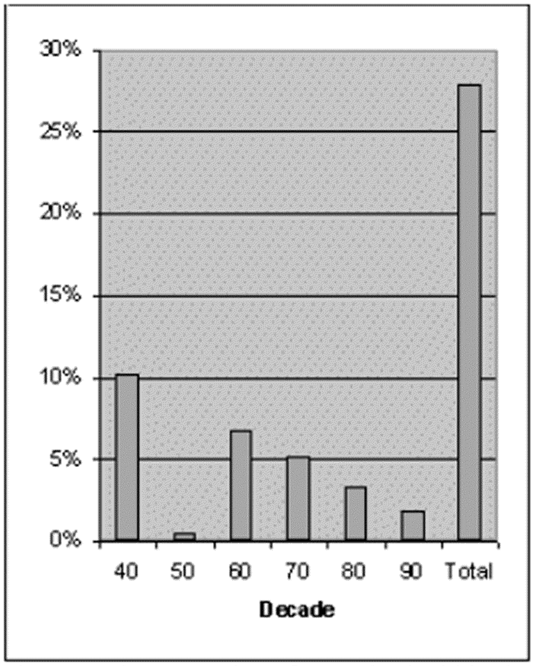

Figure 4. The proportion of BLM land within the dispatch area that has burned each decade and the total. Note: the 90's are years 1990-1997 only.

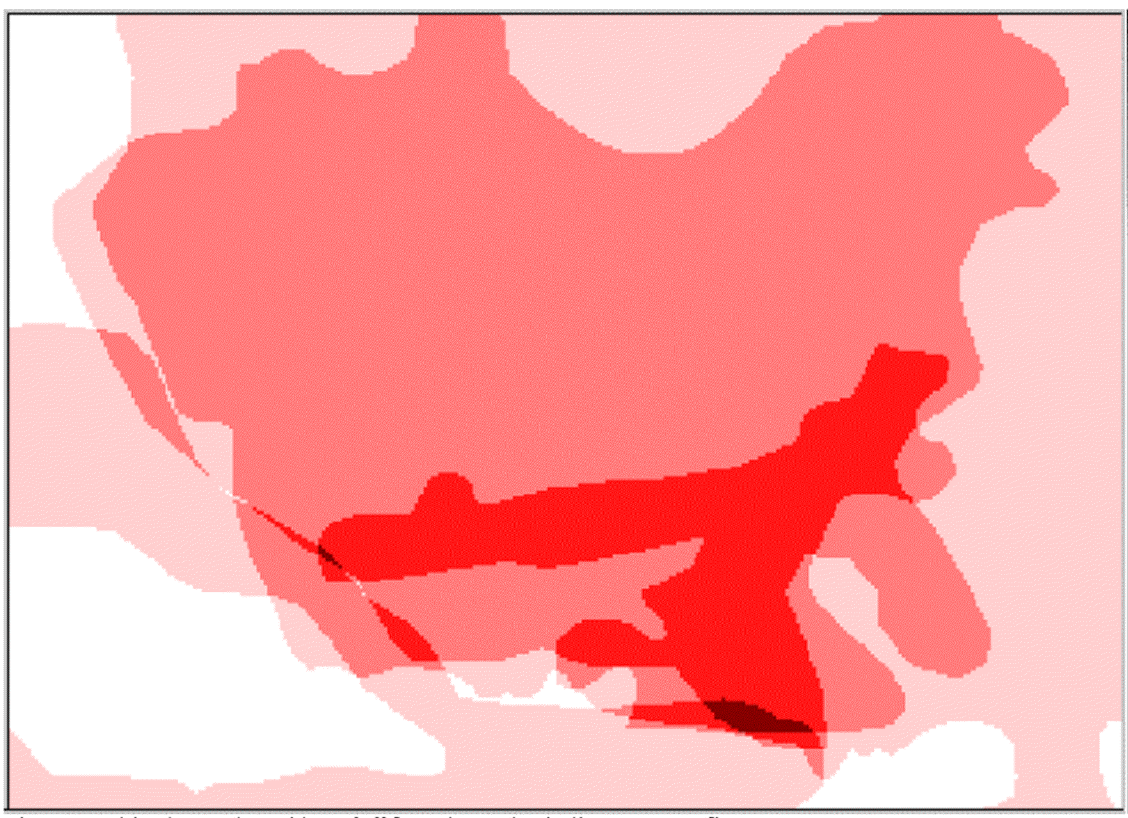

Figure 5. This shows the grid *gridallf.* Darker color indicates more fires.

Including fire areas that burned >1X in the same year.

Mean	14.70327724
Standard Error	0.366299192
Median	10
Mode	0
Standard Deviation	12.3078709
Sample Variance	151.4836861
Kurtosis	-0.29905667
Skewness	0.680869227
Range	55
Minimum	0
Maximum	55
Sum	16600
Count	1129

Excluding fire areas that burned >1X in the same year.

Mean	15.97690087
Standard Error	0.372606184
Median	14
Mode	1
Standard Deviation	12.01040997
Sample Variance	144.2499476
Kurtosis	-0.295328284
Skewness	0.635821663
Range	54
Minimum	1
Maximum	55
Sum	16600
Count	1039

Table 5. Descriptive statistics for fire years intervals in 1939-1997.

Including fire areas that burned >1X in the same year.

Mean	8.164102564
Standard Error	0.64197086
Median	3
Mode	0
Standard Deviation	8.964635191
Sample Variance	80.36468411
Kurtosis	-0.892448426
Skewness	0.816468986
Range	26
Minimum	0
Maximum	26
Sum	1592
Count	195

Excluding fire areas that burned >1X in the same year.

Mean	10.14012739
Standard Error	0.712826572
Median	8
Mode	1
Standard Deviation	8.931691343
Sample Variance	79.77511024
Kurtosis	-1.288471909
Skewness	0.534325841
Range	25
Minimum	1
Maximum	26
Sum	1592
Count	157

Table 6. Descriptive statistics for fire years intervals in 1939-1968.

Including fire areas that burned >1X in the same year.

Mean	9.849246231
Standard Error	0.471874759
Median	9
Mode	10
Standard Deviation	6.656612641
Sample Variance	44.31049185
Kurtosis	-0.463020524
Skewness	0.501716545
Range	27
Minimum	0
Maximum	27
Sum	1960
Count	199

Excluding fire areas that burned >1X in the same year.

Mean	10.48128342
Standard Error	0.465430951
Median	10
Mode	10
Standard Deviation	6.36467253
Sample Variance	40.50905641
Kurtosis	-0.419587966
Skewness	0.550940078
Range	26
Minimum	1
Maximum	27
Sum	1960
Count	187

Table 7. Descriptive statistics for fire years intervals in 1969-1997.

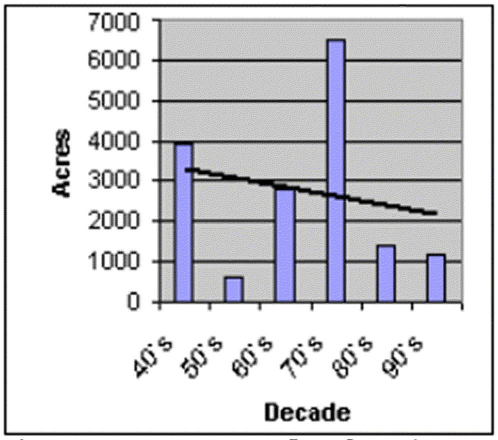

Figure 6. Mean acreage fires from the 1940-1997. (Note: the 90's decade are years 1990-1997)

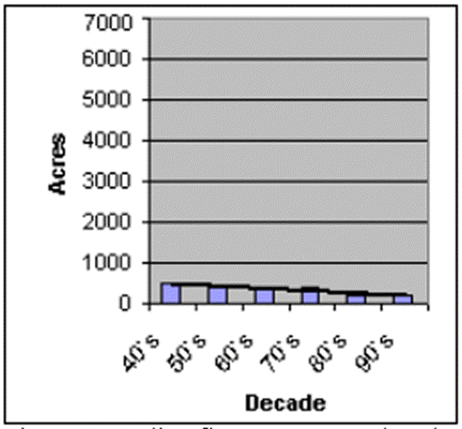

Figure 7. Median fire acreage per decade. (Note: the 90's decade are years 1990-1997). The y-axis has been adjusted to allow easy comparison with figure 6.

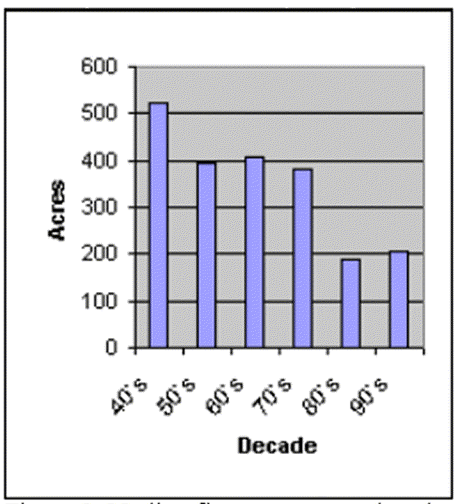

Figure 8. Median fire acreage per decade. (Note: the 90's decade are years 1990-1997). This is the same chart as figure 7 but with a different y-axis to better illustrate these data.

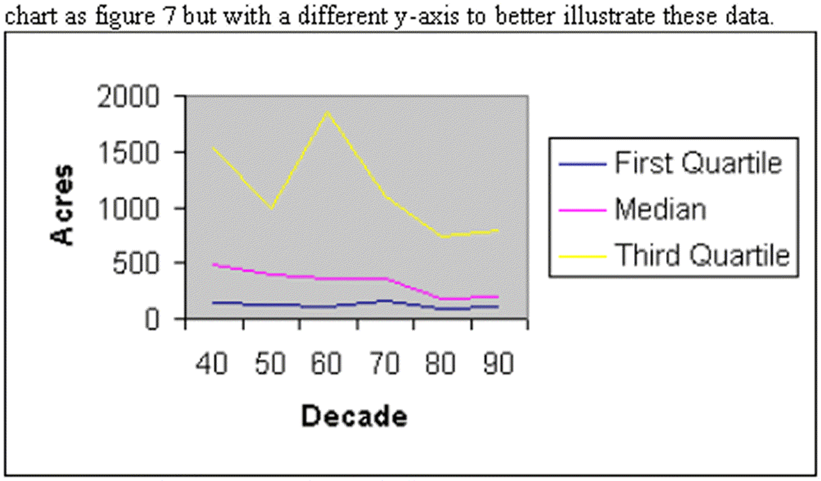

Figure 9. Results from boxplot analysis where we examined fire size.

Assessment of Errors and Bias: The reports used to digitize may not be consistent because different people who approximate area and reported acreage differently made them (Appendix C). The accuracy of the report varies a great deal from the beginning to the end. One thing to consider is that the person who drew the map probably was not thinking about the possibility that the maps would be further analyzed. Even though there are some parts with poor accuracy we don not think that it affects our discussion of whether fire acreage has decreased. Further, these maps are still the best information available.

Appendix A

Files in d:\data\blm_fire.
Example:
Name of the file: *(explanation how the name is shortened)* A description of the file. *Where to find the file.*

%fblm.xls: *(percent of fires on blm land)* Excel sheet with the percent of BLM land burned during each decade (1960`s to 1990`s). *analysnew\newexcel*
alf1vny: *(all fires once vegetatoin new ("ny" is the Swedish word for new))* vegetation where there is burned once or more. *analysnew*
alf2vny: *(all fires twice vegetatoin new ("ny" is the Swedish word for new))* vegetation on all areas that has burned twice or more. *analysnew*
allf1: *(all fires once)* all areas that has burned once or more. *analysnew*
allf2: *(all fires twice)* all fires that has burned twice or more. *analysnew*
allfblm.shp: *(all fires on blm land)* mergeny.shp is clipped with aocblm.shp. This gives all fires within blm land with the attributes from mergeny.shp which includes fire years. *analysnew*
allfires.csv: *(all fires)* A comma seperated value file with all the years when there has been a fire on a polygon.
allfveg.xls: *(all fires vegetation)* Excel sheet from allfveg. *analysnew\newexcel*
allny.xls: *(all new ("ny" is the Swedish word for new))* describes the percent burned on blmdsp.shp every decade and total. *allexcel*
allungr: *(allunion grid)* all fire polygons from 1939-1997 converted to a grid. *allfires*
allunion: *(all UNION)* All fires from 1939-1997 UNIONED to a coverage.
aocbdy.shp: *(area of concern boundaries)* a rectangle drawn around all our digitized fires. *analysnew*
aocblm.shp: *(area of concern on blm land)* blmbutm.shp cut with aocbdy.shp. This gives blm land within our area of concern to give better statistics. *analysnew*
blmbutm.shp: *(blm boundaries in UTM projection)* all blm land in Idaho in UTM projection. *someshp*
blmdsp.shp: *(blm dispatch)* shows the dispatch area on BLM land. *classified (may only be used with a permission from BLM)*
blmf60s.shp: *(blm fires 60`s)* fires on blm land during the 60`s. *analysnew\blmfdec*
burnprop.xls: *(burn proportions)* a sheet showing the proportion of vegetation types burned ≥1X and ≥2X from the years 1939-1997. *allexcel.*
fire_97: *(fires 1997)* a grid with the number 1 for a fire and 0 for none fire. This is fires even outside of BLM land. *analysnew\oddgrid, analysnew\evengrid, earlygrid.*
fire_97.shp: *(fires 1997)*. the shp files that we created for each year. *saved_data, daniel_fire, earlyfires.*
fire_97.xls: *(fires the year 1997)*. an Excel spreadsheet that show the comparison between the digitized acres and the reported acres for each year. *excel, earlyxls, g:\data\blm_fire\excel.*
fixuniv[1,2,3].aml: *(fix universal external polygon)* assigns the value 1 for fire areas and the value 0 to the universal external polygon and other non fire polygons in every fire coverage. *saved_data, daniel_fire, earlyfires.*

Appendix A

gallf2: *(grid all fires twice)* a grid showing areas from years 1964-1997 that has burned twice or more.
gridallf: *(grid all fires)* all fires from 1964-1997 in a grid sorted after how many times they has burned. *analysnew*
intervals.xls: *(intervals)* the output from a VB program. This is numbers that are year intervals between fires on the same polygon. *allfires*
ivdanne.xls: *(interval Daniel)* the descriptive data from when Daniel did the interval task. *allfires*
mergeny.shp: *(MERGE new)* All fires MERGED together. This gives all areas that has burned independent of how many times they has burned. *someshp*
reclveg: *(reclassified vegetation)* the reclassified vegetation grid. All grids that use the vegetationgrid is only on BLM land. *allfires*
reclveg.xls: *(reclassified vegetation*) the excel sheet from vegrecl. *allexcel*
shape2arc.aml: *(shape to arc)* converts a shape file to an ArcInfo coverage.
sum.aml: *(sum)* creates a new field F_sum in the coverage allunionthat shows how many times a polygon has burned. *saved_data.*
uni39-68: *(UNION 1939-1968)* all fire coverages from 1939-1968 UNIONED to a coverage. *saved_data*
uni69-97: *(UNION 1969-1997)* all fire coverages from 1969-1997 UNIONED to a coverage. *saved_data*
union.aml: *(UNION)* UNION all the fire coverages to one big coverage called allunion. *saved_data.*
vegny.xls: *(vegetation new ("ny" is the Swedish word for new))* shows how we reclassified the vegetation types. *analysnew\newexcel*
vegrecl.avc: *(vegetation reclassification)* the reclassification file to veg. *allfires*
vpropny.xls: *(vegetation proportions new("ny" is the Swedish word for new))* a sheet showing the proportion of vegetation types burned ≥1 and ≥2 from the years 1964-1997. *analysnew\newexcel*

Appendix B
All fires 1939-1997

Pixel count of areas burned >=1X	Pixel count of areas burned >=2X	Pixel count of Vegetation	Vegetation Code	Vegetation Type	Proportion Burned >=1X	Proportion Burned >=2X	Proportion Vegetation on BLM land
			0	Not BLM land			
306		52,253	1	Alpine Fir	0.00%	0.00%	0.24%
		333	2	Alpine Fir/Doug Fir	0.00%	0.00%	0.00%
524		42,252	3	Alpine Fir/Lodgepole	0.00%	0.00%	0.19%
		1,771	4	Alpine Fir/Spruce	0.00%	0.00%	0.01%
		207	5	Alpine Fir/Whitebark	0.00%	0.00%	0.00%
5,487	276	351,178	6	Doug Fir	0.03%	0.00%	1.60%
575		26,639	7	Doug Fir/Lodgepole Pine	0.00%	0.00%	0.12%
6,656	321	349,286	8	Juniper, Utah	0.03%	0.00%	1.60%
3,244	1,312	53,406	9	Lodgepole	0.01%	0.01%	0.24%
		304	10	Lodgepole Sapling	0.00%	0.00%	0.00%
		33	11	Spruce	0.00%	0.00%	0.00%
56		87,575	12	Whitebark/Limber Pine	0.00%	0.00%	0.40%
		49,791	13	Pinyon/Juniper	0.00%	0.00%	0.23%
1,407	350	194,565	14	Aspen	0.01%	0.00%	0.89%
5		46,499	15	Aspen/Conifer	0.00%	0.00%	0.21%
159		7,050	16	Maple	0.00%	0.00%	0.03%
298		55,648	17	Mountain Mahogany	0.00%	0.00%	0.25%
1,946,558	673,356	14,434,550	18	Sagebrush	8.89%	3.08%	65.95%
81,765	1,573	291,899	19	Bitterbrush	0.37%	0.01%	1.33%
7,550	201	282,762	20	Shrub	0.03%	0.00%	1.29%
1,423	6	68,790	21	Rabbitbrush	0.01%	0.00%	0.31%
69		79,739	22	Salt Desert Scrub	0.00%	0.00%	0.36%
		338	23	Silver Sage	0.00%	0.00%	0.00%
		8,782	24	Herbaceous	0.00%	0.00%	0.04%
		40,415	25	Annual Grass/Forb	0.00%	0.00%	0.18%
4,179	906	41,749	26	Dry Meadow	0.02%	0.00%	0.19%
154,335	41,713	2,604,942	27	Perennial Grass	0.71%	0.19%	11.90%
87		1,723	28	Tall Forb Montane	0.00%	0.00%	0.01%
217	2	10,995	29	Wet Meadow	0.00%	0.00%	0.05%
292		9,223	30	Barren	0.00%	0.00%	0.04%

Appendix B

All fires 1939-1997

	Pixel count		Vegetation		Proportion		
of areas burned >=1X	of areas burned >=2X	of Vegetation	Code	Type	Burned >=1X	Burned >=2X	Vegetation on BLM land
226,293	58,294	2,143,086	31	Lava	1.03%	0.27%	9.79%
43		8,721	32	Rock	0.00%	0.00%	0.04%
2,706	8	97,943	33	Sand Dune	0.01%	0.00%	0.45%
19		11,524	34	Water	0.00%	0.00%	0.05%
1,874	209	115,445	35	Riparian	0.01%	0.00%	0.53%
40		9,658	36	Marsh	0.00%	0.00%	0.04%
		4	37	Aquatic Bed	0.00%	0.00%	0.00%
		337	38	Mud Flat	0.00%	0.00%	0.00%
10,180	1,105	292,283	39	Agricultural	0.05%	0.01%	1.34%
48		10,526	40	Disturbed	0.00%	0.00%	0.05%
3		3,267	41	Urban	0.00%	0.00%	0.01%
2,456,398	**779,632**	**21,887,491**		**TOTAL**	**11.22%**	**3.56%**	**100.00%**

Appendix C

Example of fire polygon area agreement (1941)

			ACRES				
ID	FIRE_YEAR	FIRE_NUMBER	DIGITIZED	REPORTED	AGREEMENT	<75%AND>130%	EXTREMES
1	41	4	6,709	2,500			268%
2	41	5	80	40			200%
3	41	8	30,920	35,000	88%		
4	41	9	2,865	3,000	95%		
5	41	10	662	700	95%		
6	41	11	252	500			50%
7	41	12	238	300	79%		
8	41	17	144,713	138,000	105%		
9	41	20	244	50			489%
10	41	21	2,042	2,000	102%		
11	41	22	89	50		177%	
				MEAN	**94%**		

Note:

Polygons indicated under the columns "<75%AND>130%" and EXTREMES have been checked and verified with source maps.

Problems:

Fire number 16, Township reported as 23 without N or S. It was not digitized

Fire number 17, then source map does not look like the digitized polygon. It was digitized and made into its own shape file.

Fire number 22, we are not sure about the reported acres.