fire-color: preview Data

identifying post-fire color changes in lakes of the western U.S.

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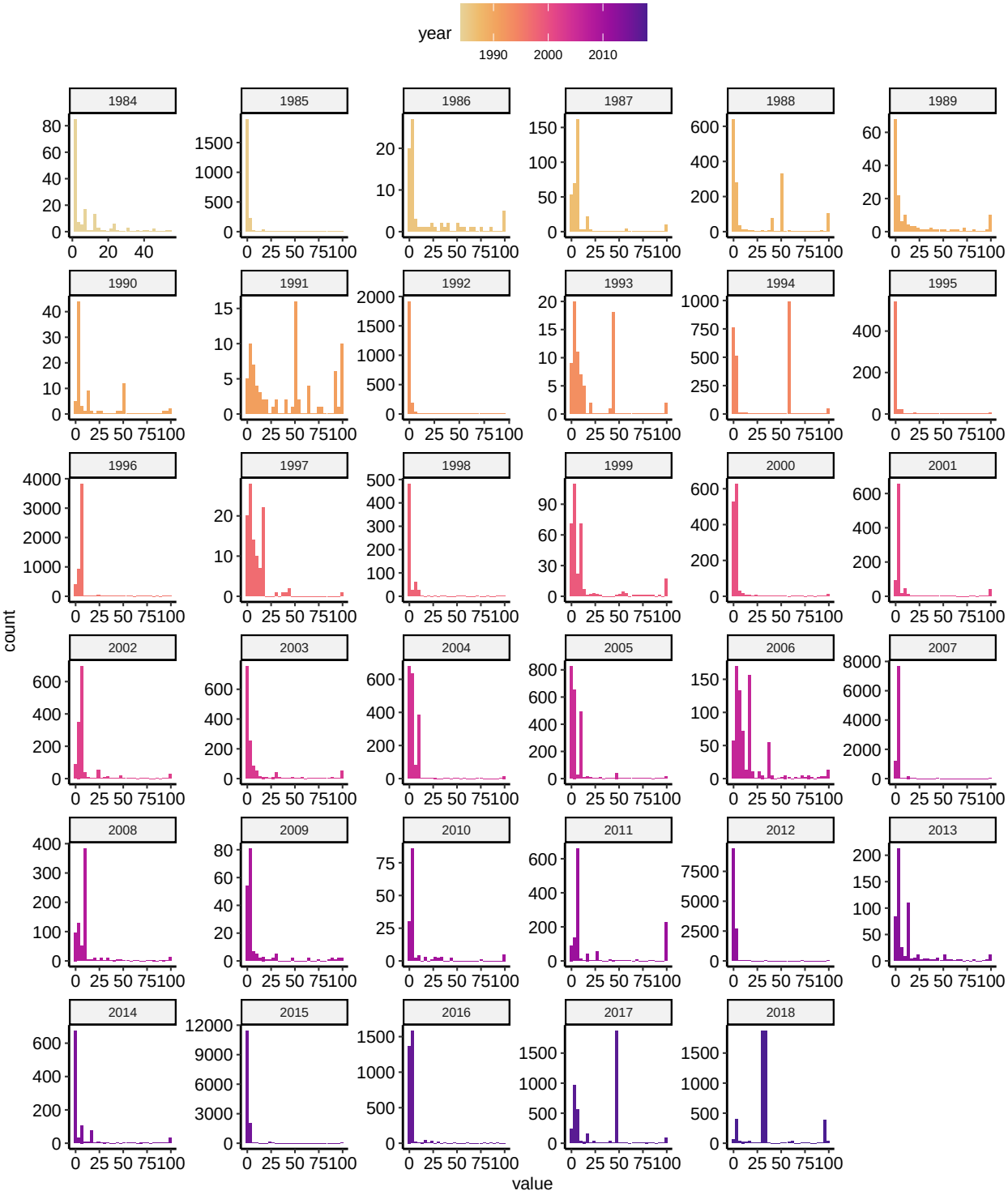
Contents

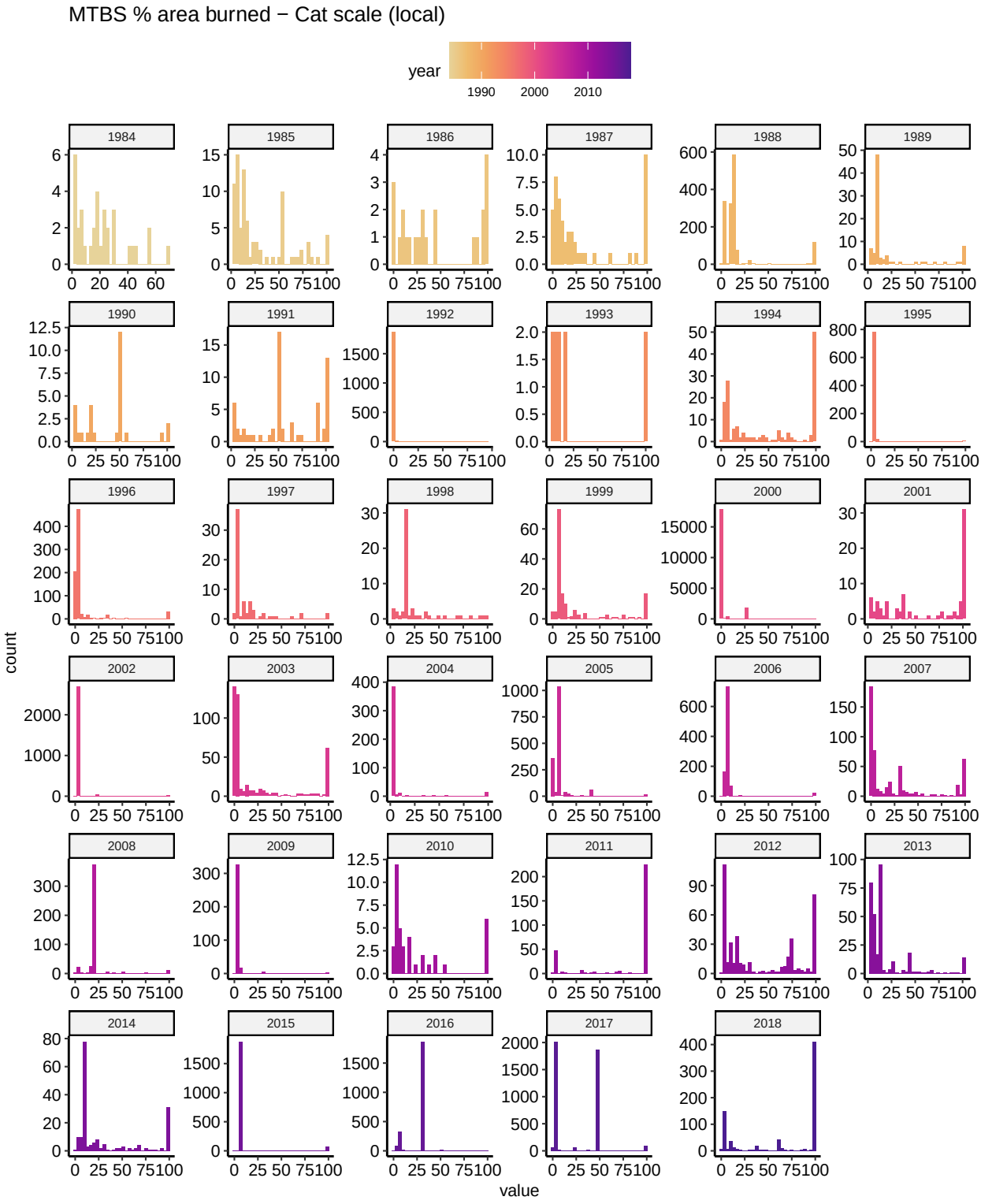
1 MTBS data visualization

The data below are summaries of the Monitoring Trends in Burn Severity (MTBS) data, extracted from EPA's LakeCat dataset. Before diving into this project, we want to get a sense for just how many lakes in the western U.S. are affected by fires every year. This particular dataset spans the years 1984-2018.

1.1 Histograms of % area burned by Ws and Cat scales

MTBS % area burned − Ws scale





In every year there are always a number of lakes that burn severly (>90% of the total area of every local catchment. If you look at the full watershed (Ws) scale there are a lot more lakes on the low end (<20%).

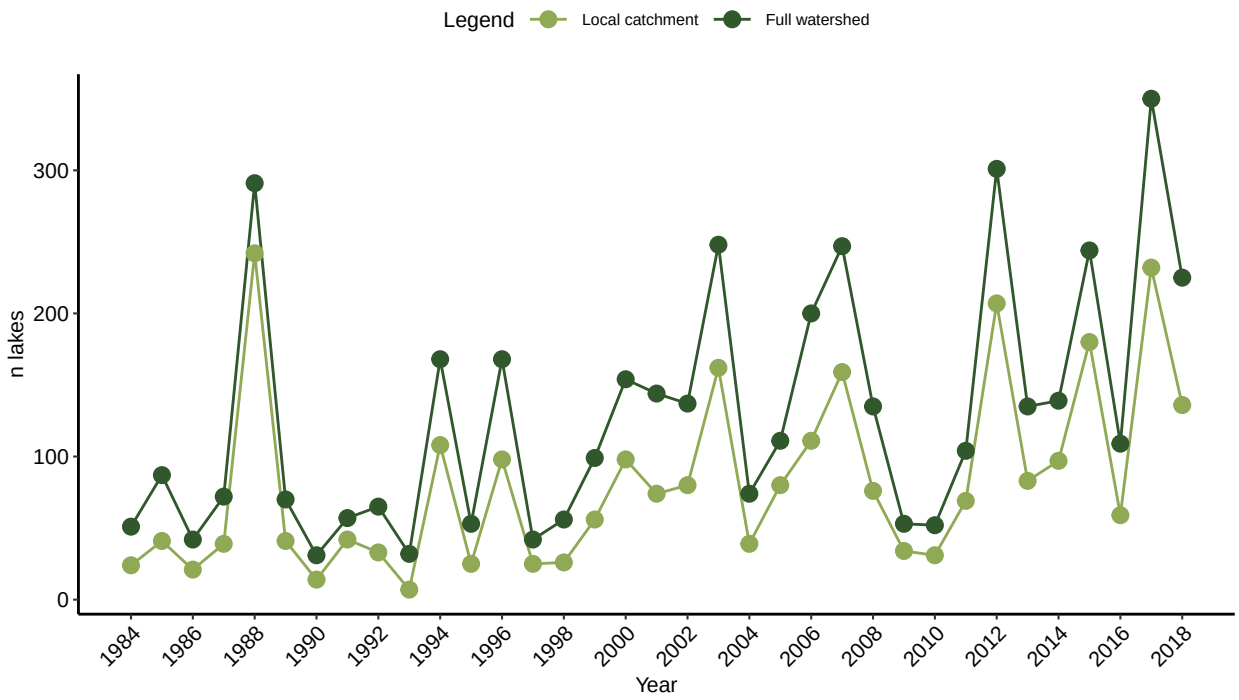
Table 1: Table summarizing the number of lakes with any percentage burn (>1%) at the local catchment (Cat) and full watershed (Ws) scale, by year

year	n_lakes_Cat	n_lakes_Ws
1984	24	51
1985	41	87
1986	21	42
1987	39	72
1988	242	291
1989	41	70
1990	14	31
1991	42	57
1992	33	65
1993	7	32
1994	108	168
1995	25	53
1996	98	168
1997	25	42
1998	26	56
1999	56	99
2000	98	154
2001	74	144
2002	80	137
2003	162	248
2004	39	74
2005	80	111
2006	111	200
2007	159	247
2008	76	135
2009	34	53
2010	31	52
2011	69	104
2012	207	301
2013	83	135
2014	97	139
2015	180	244
2016	59	109
2017	232	350
2018	136	225

Looks promising, we have hundreds of lakes lakes that were close to forests fires in every year and the numbers fluctuate quite a bit year-to-year.

1.2 Total annual number of lakes in burned watersheds/local catchments

Number of lakes in burned watersheds/local catchments



Looks like there is a step-change increase in the number of lakes in burned watersheds in the early 2000s, though no breakpoint detected using segmented regerssion.

```
##
## Call:
## lm(formula = n_lakes_Cat ~ year, data = MTBS_summary2)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -75.14 -38.53 -11.91  17.60 196.33
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -5418.2672  1918.2474  -2.825  0.00797 **
## year            2.7485     0.9586   2.867  0.00716 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 57.28 on 33 degrees of freedom
## Multiple R-squared:  0.1994, Adjusted R-squared:  0.1752
## F-statistic:  8.22 on 1 and 33 DF,  p-value: 0.007164
```

1.3 Total number of burned lakes by burn severity class

I was also curious to see if there is an increasing trend in the number of lakes burned within each size class at the local catchment and full watershed scales. Below I plotted the trends and printed the results from simple linear models (though another method like sen slopes would probably be more appropriate here).

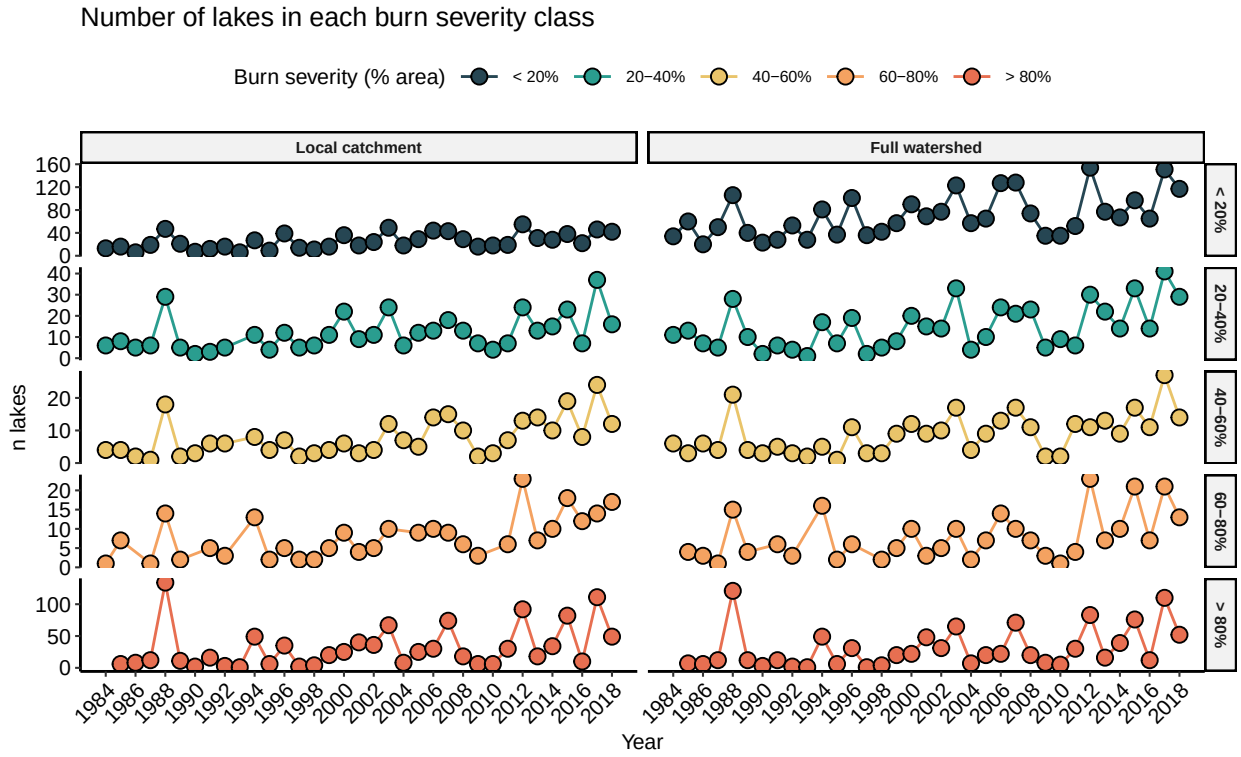


Table 2: Table summarizing the linear model results

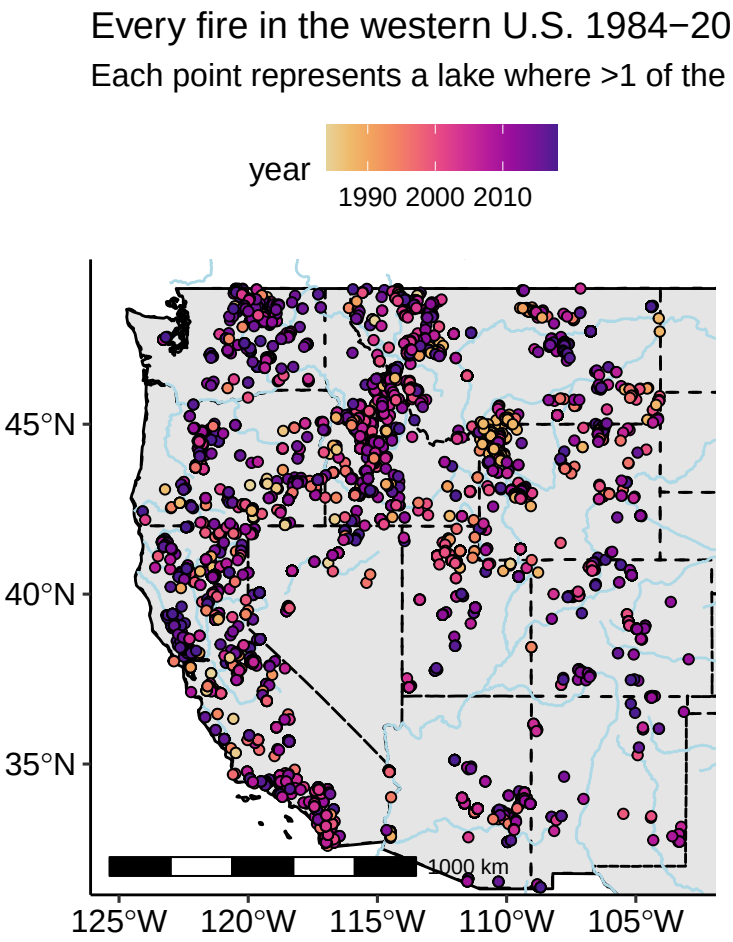
scale	burnSeverityClass	term	estimate	std.error	statistic	p.value
Cat	< 20%	(Intercept)	1991.4864433	3.2050032	621.368012	0.0000000
Cat	< 20%	n_lakes	0.3766680	0.1117912	3.369388	0.0019310
Ws	< 20%	(Intercept)	1990.9664088	3.2753978	607.854834	0.0000000
Ws	< 20%	n_lakes	0.1429868	0.0414420	3.450284	0.0015518
Cat	20-40%	(Intercept)	1994.9541456	2.8533211	699.169167	0.0000000
Cat	20-40%	n_lakes	0.5352357	0.2000177	2.675942	0.0116491
Ws	20-40%	(Intercept)	1993.8122910	2.6444915	753.949221	0.0000000
Ws	20-40%	n_lakes	0.4913473	0.1478448	3.323400	0.0021848
Cat	40-60%	(Intercept)	1993.6657763	2.5776096	773.455296	0.0000000
Cat	40-60%	n_lakes	0.9823038	0.2709963	3.624786	0.0009919
Ws	40-60%	(Intercept)	1993.5648791	2.7005622	738.203644	0.0000000
Ws	40-60%	n_lakes	0.8421658	0.2527725	3.331714	0.0021366
Cat	60-80%	(Intercept)	1993.4267028	2.7306789	730.011401	0.0000000
Cat	60-80%	n_lakes	1.0649526	0.2872013	3.708035	0.0009140
Ws	60-80%	(Intercept)	1996.8333333	2.7344295	730.255924	0.0000000
Ws	60-80%	n_lakes	0.6904762	0.2746416	2.514099	0.0177372
Cat	> 80%	(Intercept)	1998.6449728	2.2851727	874.614409	0.0000000
Cat	> 80%	n_lakes	0.0907205	0.0501717	1.808199	0.0799825
Ws	> 80%	(Intercept)	1998.3328102	2.2764005	877.847622	0.0000000
Ws	> 80%	n_lakes	0.1051606	0.0525861	1.999781	0.0540731

The number of fires in every size class has been increasing through time with the exception of $> 80\%$ burn at the local catchment and full watershed scales. The strongest trend is at the local catchment scale with burned severity of 60-80% and 40-60%, though the total number of lakes affected is still relatively low.

1.4 Burn severity maps

I'd like to use these maps to understand a few spatiotemporal patterns

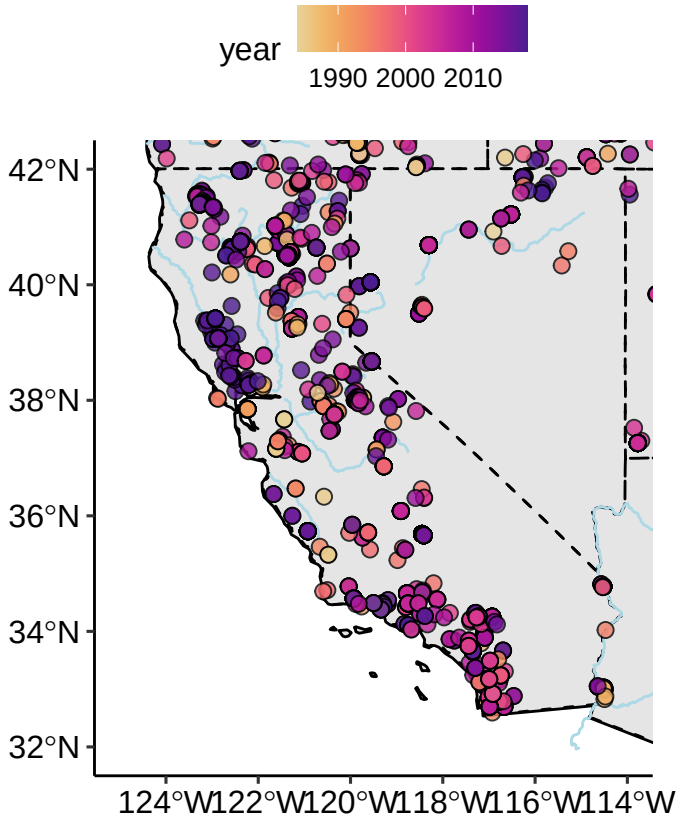
- Can we see how the location of fires has changed over time?
- Where have the most severe burns taken places?
- Which areas have the most small fires? large fires? medium fires?

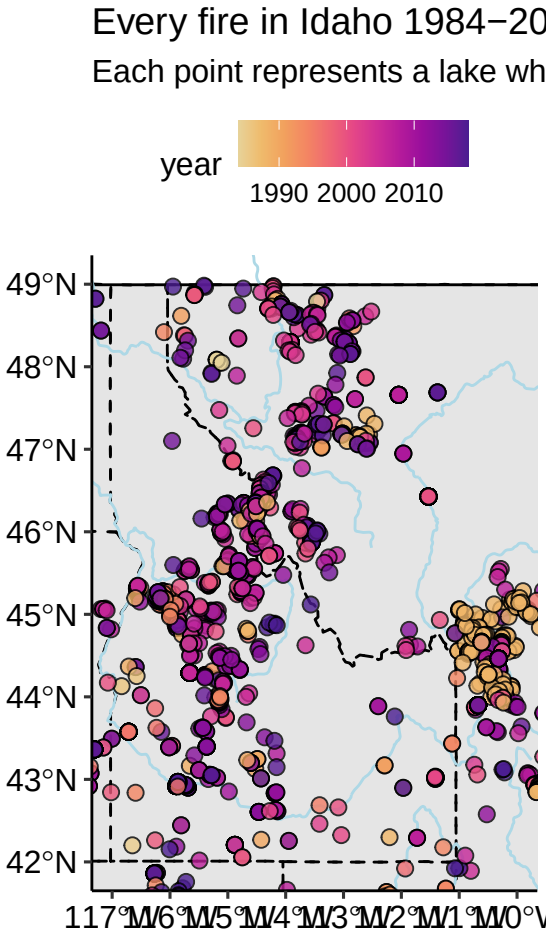


Right away you can see some clustering. For example, the 1988 Yellowstone fire complex shows up pretty vividly in the northwestern corner of Wyoming. There appears to be a lot more redish/purple hues in California where we know wildfires have been increasing.

Every fire in California 1984−2018

Each point represents a lake where >1 of the local catchment bu





If you zoom in on just cal-ifornia you can see that there is a large group of lakes in northern California that bruned in the late 2010s. There is another group of lakes in southern California that burned about 10 years earlier. Will be interesting to see the burn severity on those sites, and look at their recovery trajectory. Looking at Idaho, it appears that there are more fires in recent years though you do see a handfull of sites from the 90s scattered about.

2 Water color proof of concept

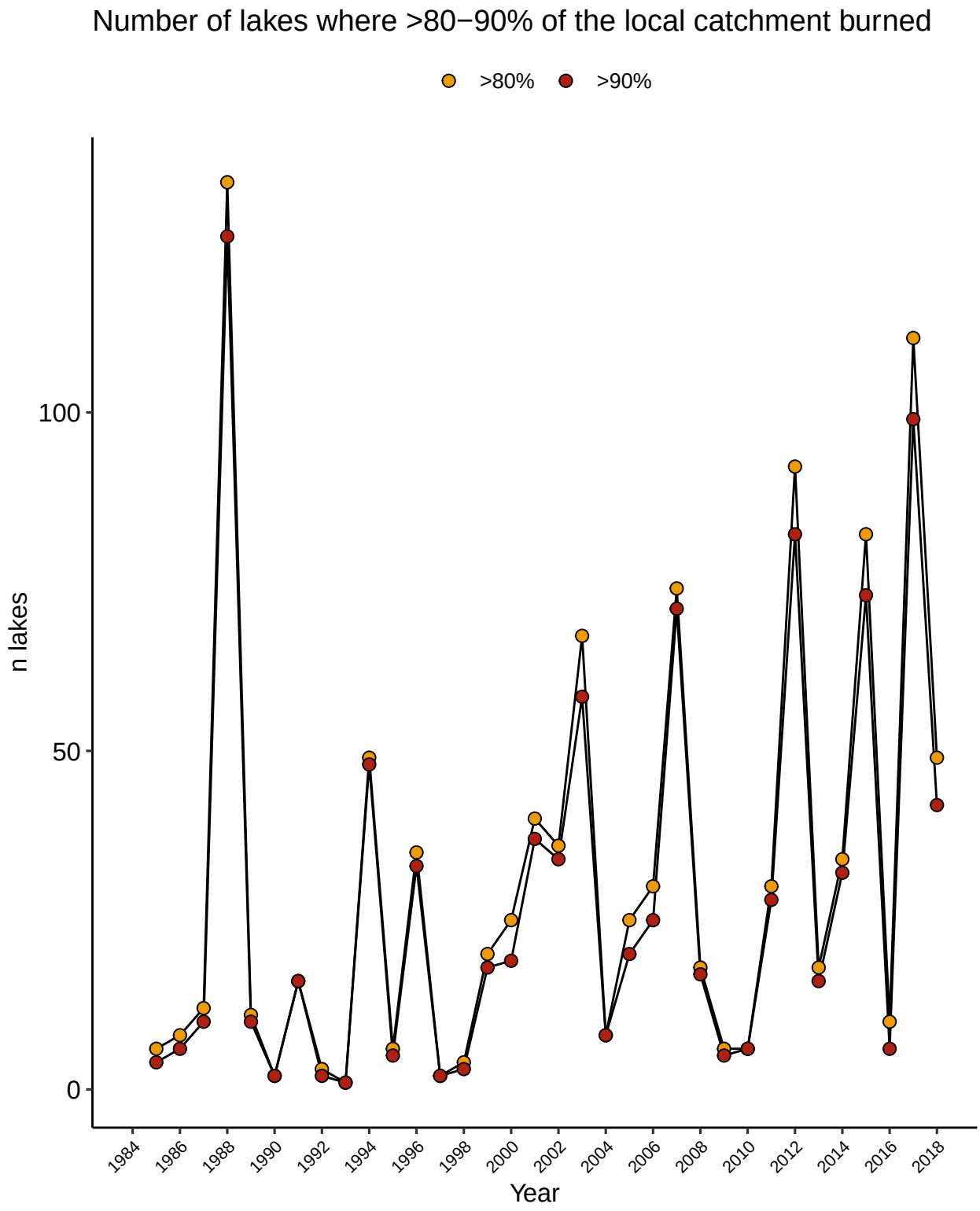
How many lakes do we have where the local catchment burned >90%? We think that is where we are most likely to see a color response if there is one.

Table 3: Table summarizing the number of lakes with severe burns at the local catchment (Cat) scale, by year

year	n lakes > 80% burned	n lakes > 90% burned
1985	6	4
1986	8	6
1987	12	10
1988	134	126
1989	11	10
1990	2	2
1991	16	16
1992	3	2
1993	1	1
1994	49	48

year	n lakes > 80% burned	n lakes > 90% burned
1995	6	5
1996	35	33
1997	2	2
1998	4	3
1999	20	18
2000	25	19
2001	40	37
2002	36	34
2003	67	58
2004	8	8
2005	25	20
2006	30	25
2007	74	71
2008	18	17
2009	6	5
2010	6	6
2011	30	28
2012	92	82
2013	18	16
2014	34	32
2015	82	73
2016	10	6
2017	111	99
2018	49	42

We have a total of 1070 lakes to check out if we used the >80% burn threshold cut off. We have 964 if we use the >90% cut-off.



2.1 Write .csv file with comids for all lakes with fires