Timber Harvests and Wildfires

Team Fire: bho15, jbartol2, whacket1

Abstract

Hypothesis

The impact of wildfires on the average American has increased significantly over the past 40 years. In just the past few years, Canada's wildfires have led to widespread air quality issues on the east coast, a location not accustomed to such climate events. The news has cited many factors for their increasing presence: climate change, residential encroaching on areas that are very prone to wildfires, gender reveal parties gone wrong, etc. The lumber industry, however, has been reasonably protected from criticism in the public eye. Thus, we sought to look at how the practice timber harvests linked these fires. We wanted to test if these practices impacted the severity distributions and increased burn acreage of wildfires.

Data

We chose to get data for the following states: Colorado, Washington, Wyoming, Idaho, and California. From three different USDA sources we got spacial wildfire data, timber harvest data, and Ecological Subsections. We used spatial joins on the data then aggregated timber harvest based on a 20 year look back period for each fire. We created the following variables to indicate types of timber harvests: comp_cut (complete cut), part_cut (partial cut), old_cut (old trees cut), young_cut (young trees cut), mix_cut (less than partial), and misc_cut (other types of cuts). Our data had 477 fires with timber harvests and 2397 fires without harvests.

Findings

(Good projects will likely have at least two claims, an initial thing and a follow up thing prompted by the initial one. Negative claims are fine. More claims don't necessarily make a project better. Some projects will have multiple figures/supports for a single claim, that is fine too.)

Claim #1: Burn acreage of wildfires with timber harvests in the prior twenty years will be different from those of wildfires without any harvests in that window.

We used the Wilcoxon rank-sum statistic for the two samples, which tests whether or not the samples came from the same distribution. The test gave us a p-value of around 1.14e-40, which suggests that the two samples are taken from different distributions. However, this may be caused by the nature of the land where timber harvests occur, rather than the timber harvests themselves.

Claim #2: The number of acres of different types of timber harvests has a positive correlation with the number of acres burned.

	Acres Clear Cut		Acres Partial Cut		Acres of Old Cut		Acres of Young Cut		Acres of Mix Cut		Acres of Misc Cut	
	P val	SCC	P val	SCC	P val	SCC	P val	SCC	P val	SCC	P val	SCC
BA	3.3e-41	.247	7.7e-44	.254	1.6e-39	.242	3.5e-38	.238	1.5e-45	.260	1.5e-8	.105

* P val = P value
* SCC = Spearman Correlation Coefficient
* BA = Burn Acres

The above table showed a positive correlation for the burn acres and the acres of each type of cut using the spearman rank order correlation. Furthermore, the p value for each one showed that these correlations were statistically significant. This shows that the acres of timber harvesting does seem to correlate with burn acres of fires; however, that could be due to the characterization of areas with greater timber harvest having more acres to burn. There are a bunch of confounding variables that need to be accounted for before saying that timber harvests result in greater burn acres, but it does garner a reason to look into this.

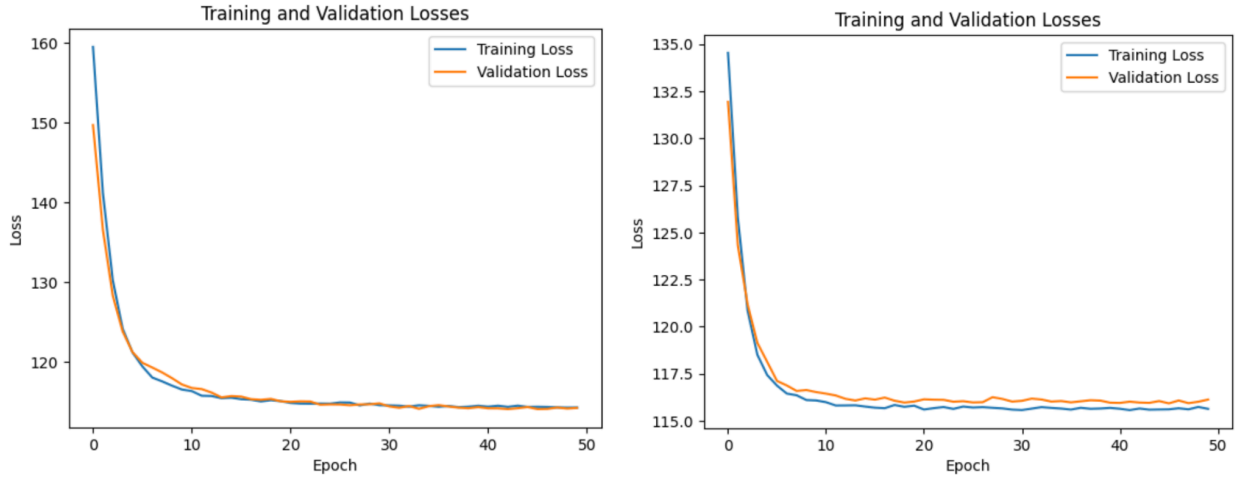
Claim #3: The type of timber harvest acres per acre burned showed correlation with different fire severity distributions where the data seems to skew towards a more severe distribution.

	Acres Clear Cut / Burn Acres		Acres Partial Cut / Burn Acres		Acres of Old Cut / Burn Acres		Acres of Young Cut / Burn Acres		Acres of Mix Cut / Burn Acres		Acres of Misc Cut / Burn Acres	
	P val	SCC	P val	SCC	P val	SCC	P val	SCC	P val	SCC	P val	SCC
Low	5.4e-23	-.183	3.2e-21	-.175	9.3e-13	-.133	6.1e-15	-.145	8.1e-24	-.186	1.2e-6	-.09
Med	6.4e-10	.115	1.6e-7	.098	4.8e-6	.085	1.7e-6	.089	2.1e-9	.111	4.4e-3	.053
High	5.0e-66	.312	1.4e-58	.294	9.2e-37	.233	4.2e-38	.237	9.3e-66	.312	3.6e-12	.129

* P val = P value
* SCC = Spearman Correlation Coefficient

Looking at all these correlations, we can see that all the relationships have significant p values. Furthermore, we see positive correlations between the number of acres of timber harvested per burn acres and the medium and high severity and a negative correlation with the low severity. This seems to imply that as the number of acres of timber harvested per burn acres increases, the distribution seems to start to skew towards a distribution with larger medium and high area of severity and lower lower severity area. What this can imply is that the health cuts being performed are unlikely to help with reduction of severity.

Claim #4: Our data and/or feature set were not adequate to predict the intensity distribution of fires using an out of the box neural network.



The above graphs show validation and training loss on models trained to predict fire intensity based on all data (left), and only the feature describing ecoregion classification (right). We can see that the model exhibits almost the exact same performance when training on just ecosystem classification as when it is trained on all data. This goes to show that the model is still mainly making inferences off of the fire location (along with information about the general distribution) when making a prediction about fire intensity, and ignoring actual data about past timber harvests. We think this may be due to 1) our relatively small dataset or 2) the way we list information about timber harvests.

Socio-historical Context and Impact Report

Socio-historical Context

While our project seeks to interrogate links between timber harvesting and forest fires, it is important to note that deforestation in this context may have other effects on the environment that are not as visible as wildfires. Pfeifer and Lefebvre et al. (2017) bring up how newly created forest edges can affect the ecosystem. In their meta-analysis of studies on edge effects find a mix of positive and negative effects on species (in terms of total count). However, the science behind these interactions are more complex than just the loss or gain of a certain species. For instance, the authors note that organism size can correlate with how animals respond to forest edges, where larger animals have a greater mobility and can move into core forest areas. When looking at how timber harvests affect forest fires, we cannot disregard the effect of its ensuing deforestation on other aspects of the ecosystem, including on different species.

Furthermore, if we widen our lens, we need to be wary of the impacts of our study in terms of our response to wildfires. If a response to further research into these links leads us to rethink fire management practices, we need to take into account Indigenous fire stewardship practices. The United States, as formerly Indigenous land, has an ethical obligation to adopt practices used by

tribes for thousands of years, especially cultural burning (Hoffman and Christianson et al., 2022). As of present, power imbalances have prevented Indigenous fire practitioners from being able to organize and teach in every level of government.

As far as implications towards our project, it would mean that our project would have to be very careful in our framing of the issue. First and foremost, we have to be specific about our language when describing any findings. We aren't making value judgements of whether or not we should harvest timber in certain regions or in certain ways. We are only stating correlations between two possibly related phenomena. As far as interpreting our data, especially due to the complexity of the ecological effects of timber harvesting, we also need to be clear that the causal impacts require further research.

This leads to a discussion surrounding stakeholders in this project. We can say that those living in areas possibly affected by wildfires are the biggest consideration. According to Burke et al. (2021), 50 million homes exist on the wildland-urban interface in the U.S. (essentially denoting areas under wildfire risk) and that one million more homes are added to this figure every three years. The other big players would be the timber industry, whose interests are purely within the realm of profitability, as well as the government, which must balance the interests of the timber industry and its citizens. Our current findings show a relationship between timber harvests and several characteristics of wildfires, however we aren't certain of the specifics in the trend. The government's response to findings that might suggest a correlation between harvests and more intense fires may lead to a decrease in profitability for timber companies and better conservation practices and fire management. However, if the relationship is not negative in this way, it may make timber companies more brazen in their actions, affecting overall ecosystem health in unforeseen ways.

Ethical Considerations

On the surface, our dataset consisting of ecoregion divisions, timber harvests, and wildfire data aren't entirely problematic. One might say that they are strictly scientific data and a strictly scientific problem. However, this would be ignoring the ethical problems in the very way we define the problem—in our epistemologies. O'Brien (1993), in her comment paper titled "Being a Scientist Means Taking Sides," draws a distinction between risk assessments and alternatives assessments. In the former, she provides the example of a study trying to decipher the amount of toxin that one could safely ingest. As an example of the latter is perhaps a study looking into alternatives to the chemical in whatever process it is used in. Our study, while preliminary, falls squarely in the first camp as a risk assessment. We ask—what is the effect of timber harvests on wildfires? If the results turn out to be negative, will our next move be to figure out an ideal amount of timber harvests to limit wildfire risk, or would we be looking into entirely different ways of organizing the industry? That will be a choice that we will have to make.

As far as data integrity is concerned with regards to biases, one would hope that data collected by the U.S. government agencies would be sound, especially when concerned with something as seemingly clear cut. However, it is possible that our data coming from this one source may be missing smaller-scale operations on private land (where the government would have no jurisdiction). It would be beneficial to look for other data sources if this project were to expand,

as having data only on timber harvests on federal land implicitly dictates a limit on our actions. We want to encourage harvesters on all land to make decisions with forest fires in mind. This leads to other issues in interpretation, such as the one above where readers of our work will only keep in mind fires when thinking about timber harvesting. As we've discussed, this is only one of multiple possible and confirmed effects of deforestation.

Finally, we have to address the question of how we use the data we have. By its very nature, our data affects everyone that lives in these places increasingly at risk of fire-related harms. We need to be thoughtful about how people want to manage land. Do they think that economic gains from timber harvesting are boosting local economies? Do they want to incorporate Indigenous fire management practices into their local government agencies? I think there is a delicate balance here between education and democracy—where we would want to listen to the constituency as much as we want them to listen to us.

Works Cited

Burke, Marshall, et al. "The changing risk and burden of wildfire in the United States." *Proceedings of the National Academy of Sciences* 118.2 (2021): e2011048118.

Hoffman, Kira M., et al. "The right to burn: barriers and opportunities for Indigenous-led fire stewardship in Canada." *Facets* 7.1 (2022): 464-481.

O'Brien, Mary H. "Being a scientist means taking sides." *BioScience* 43.10 (1993): 706-708.

Pfeifer, M., et al. "Creation of forest edges has a global impact on forest vertebrates." *Nature* 551.7679 (2017): 187-191.