



WILDFIRE PREDICTION

M . A . Z . A

6132

fires

16.5M

Hectares of
Burned Land

1 hectare = 100m x 100m

(Approx. 2 Canadian football fields)



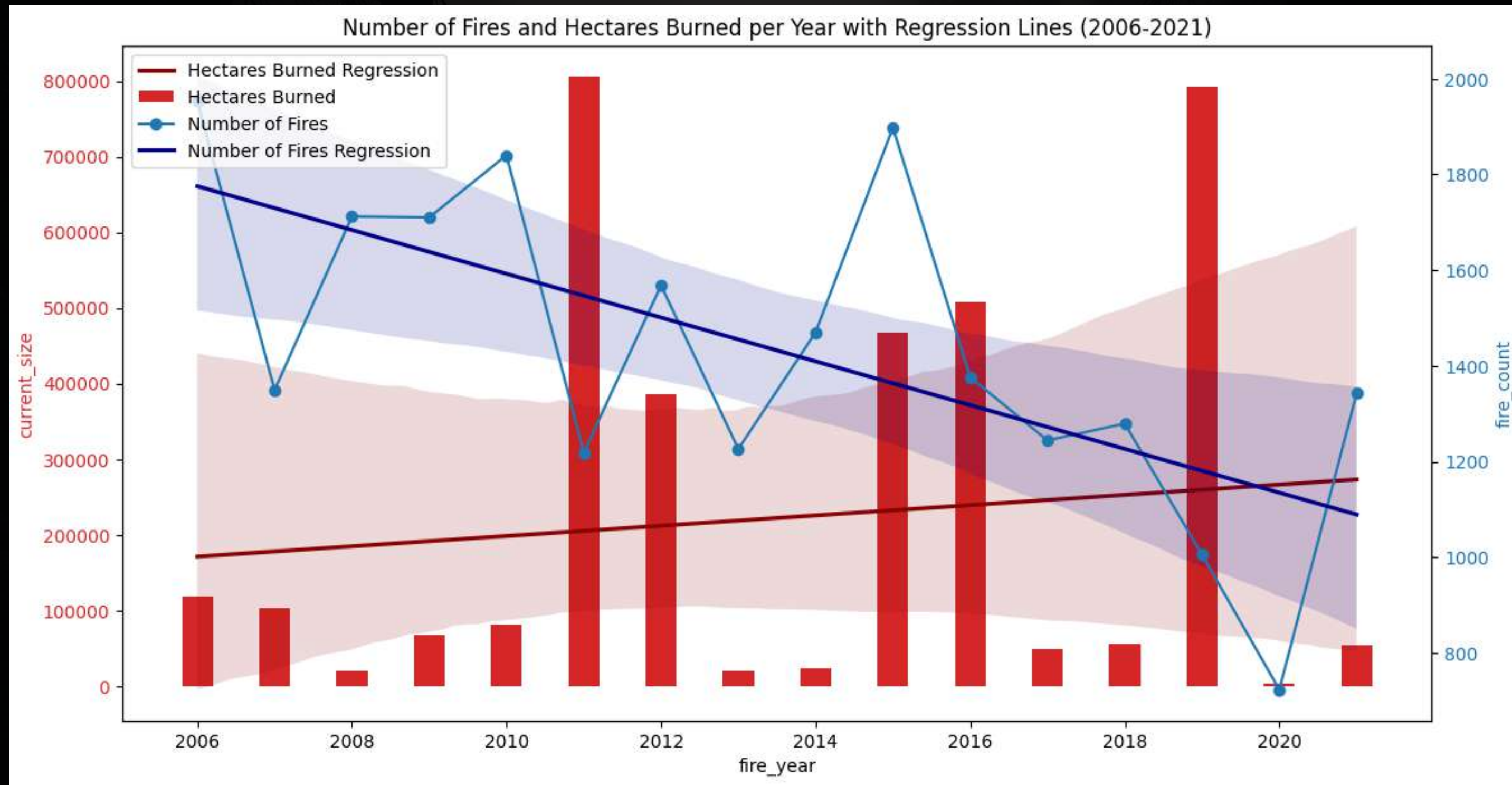


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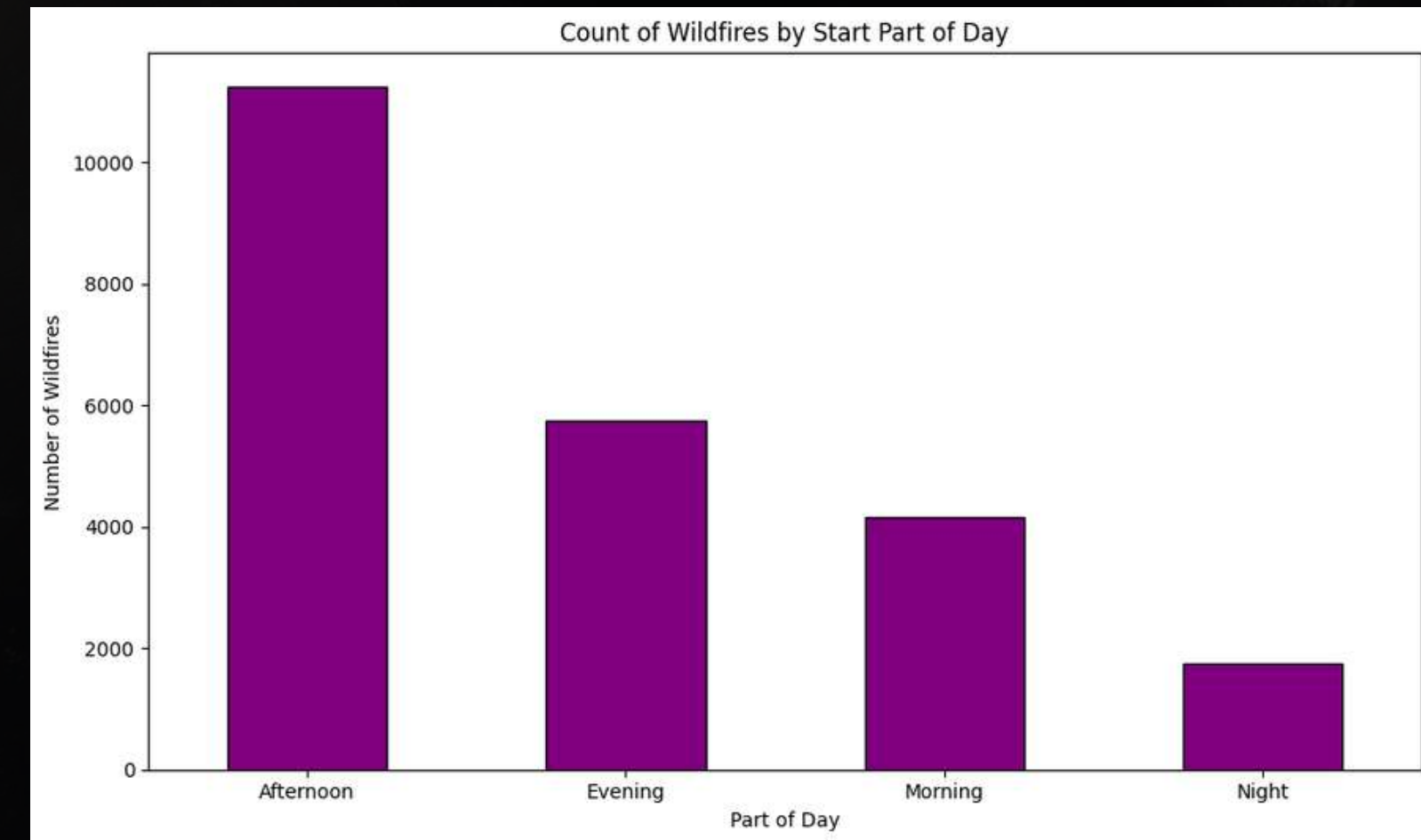
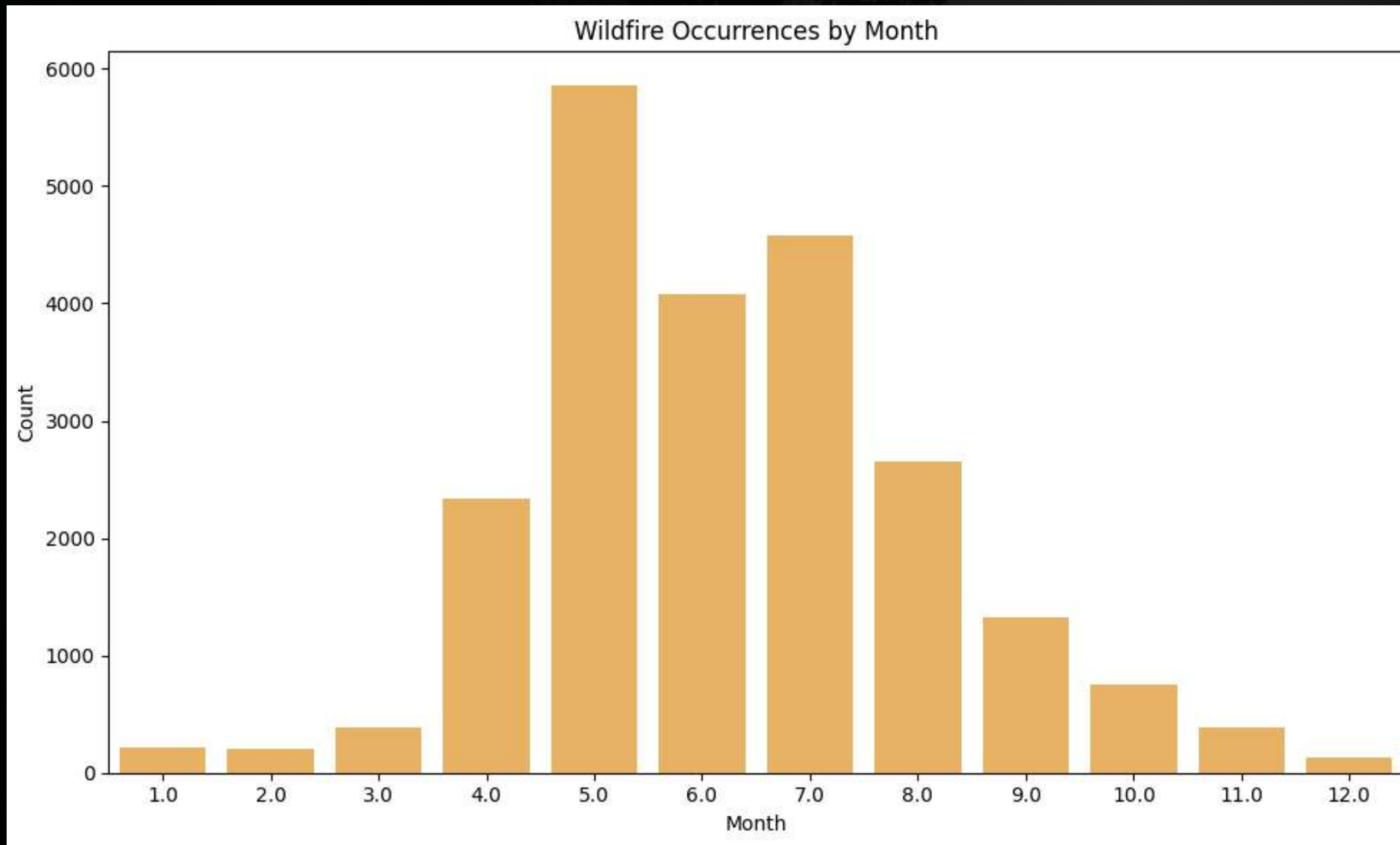
EXPLORATION

Wildfire count has been steadily decreasing, but total area burned has been increasing with great variance



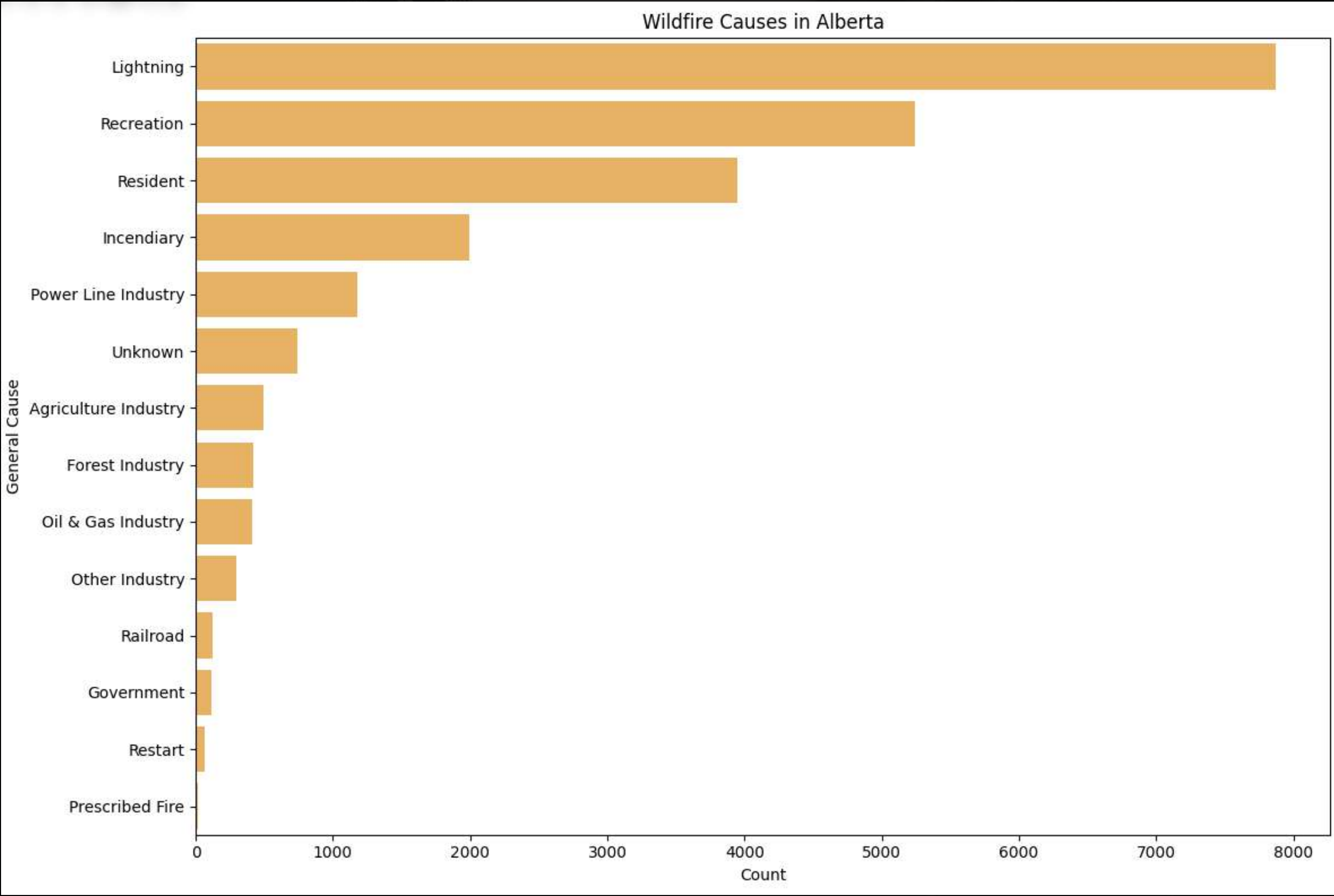
EXPLORATION

Wildfire season is March to September and most start with sunlight



EXPLORATION

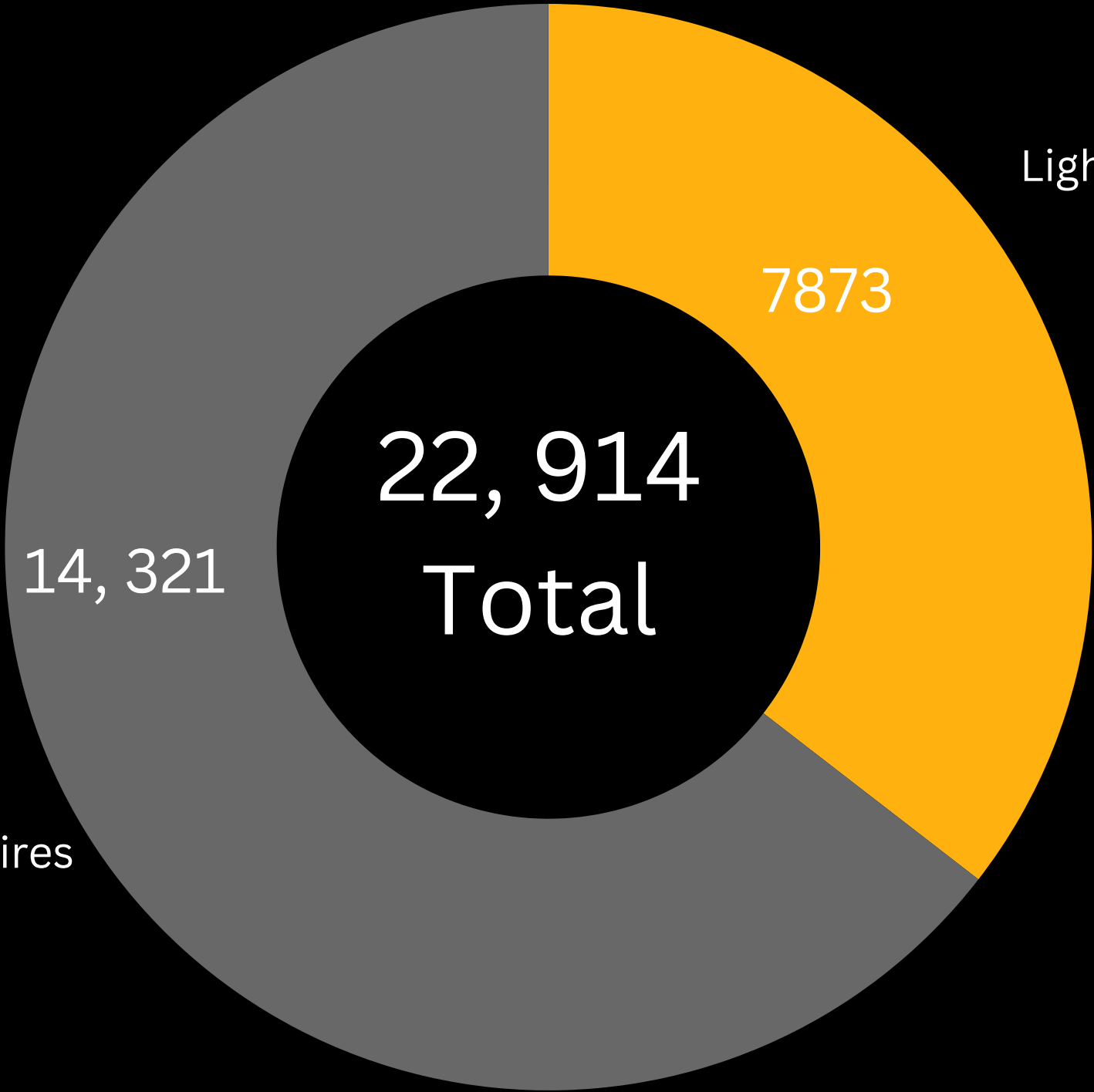
While some causes are natural, many others are by humans



HUMAN CAUSED WILDFIRES

Lightning Caused Fires

Human Caused Fires



Top 4 general causes of human-caused Wildfires



34% Recreation



26% Resident

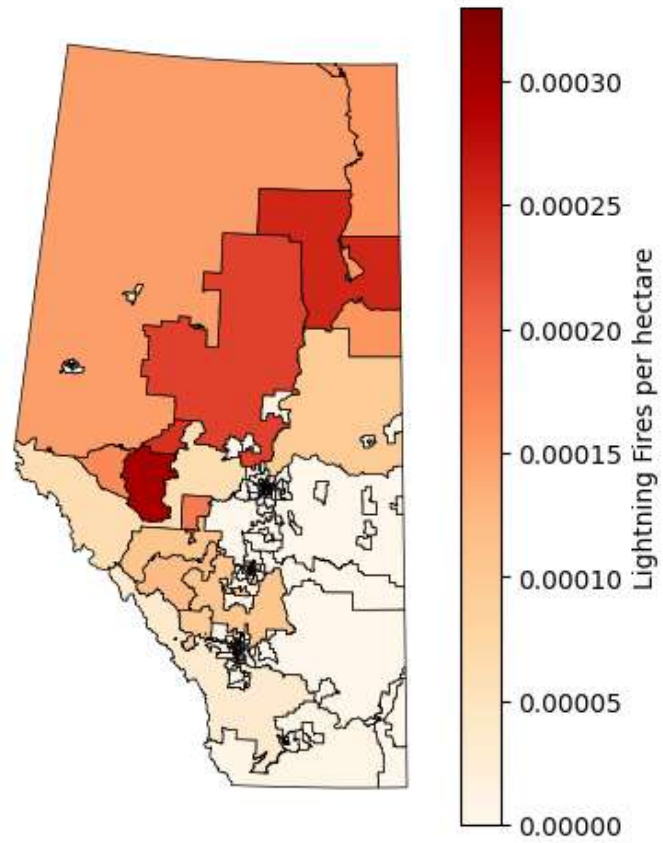


13% Incendiary

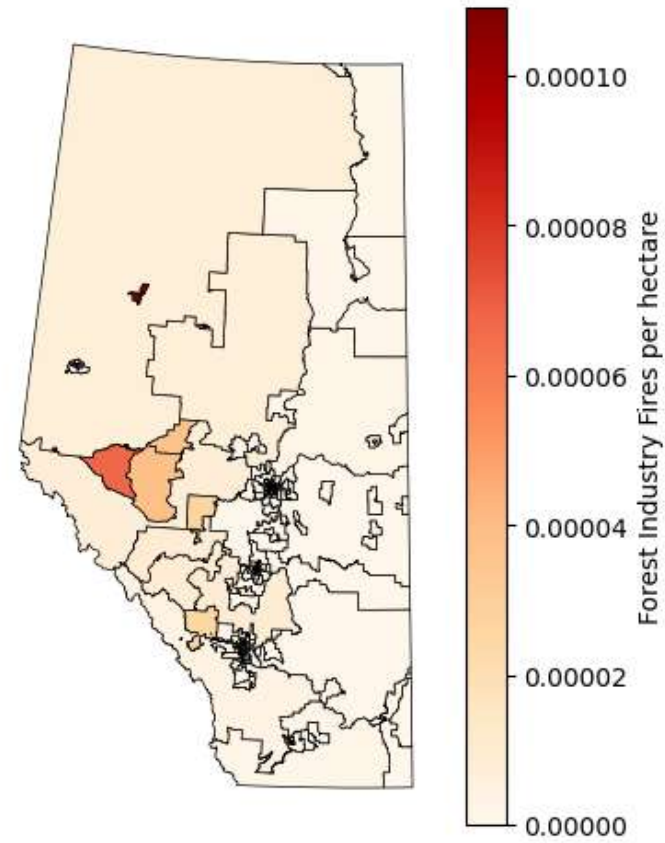


8% Power Line Industry

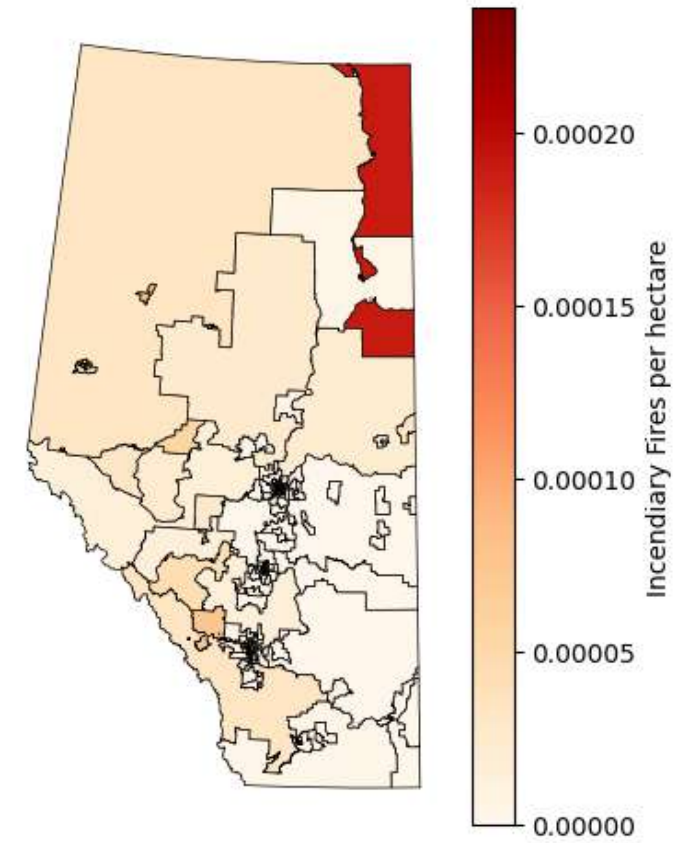
Lightning Fire Density by FSA in Alberta



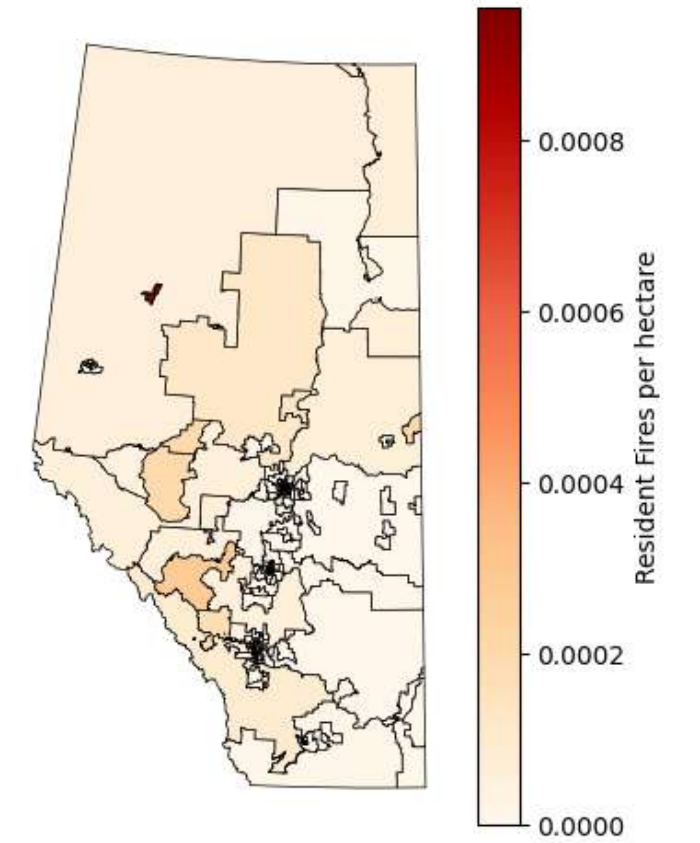
Forest Industry Fire Density by FSA in Alberta



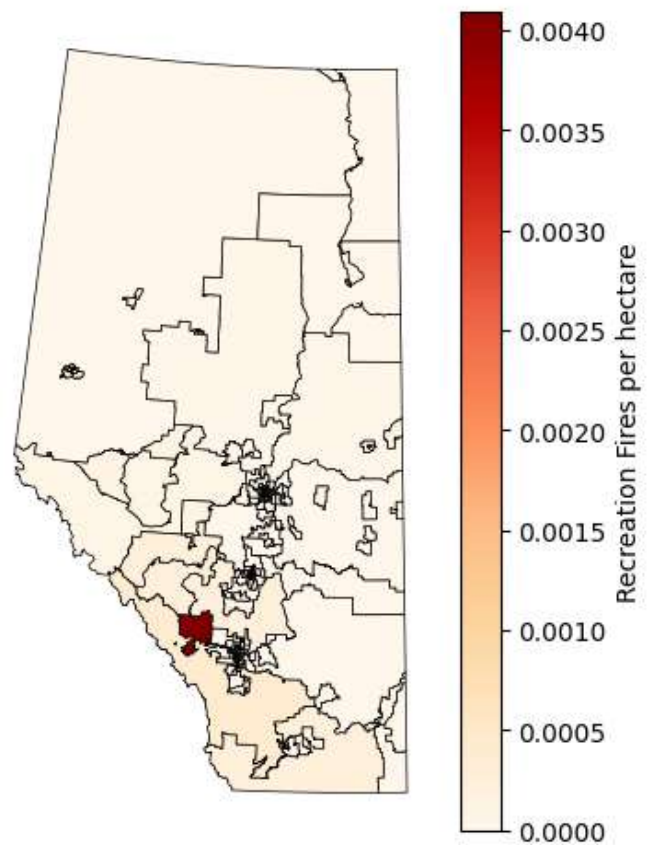
Incendiary Fire Density by FSA in Alberta



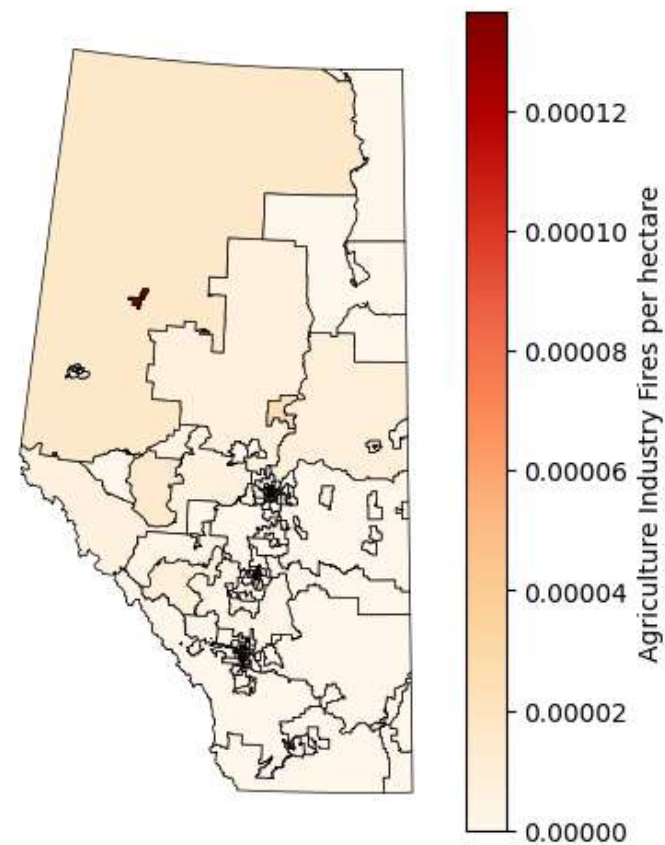
Resident Fire Density by FSA in Alberta



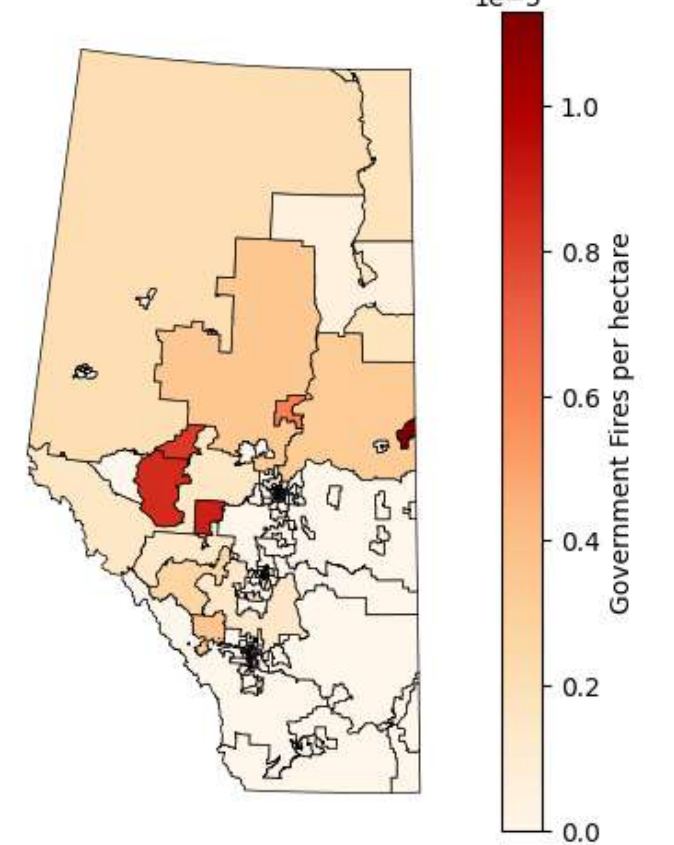
Recreation Fire Density by FSA in Alberta



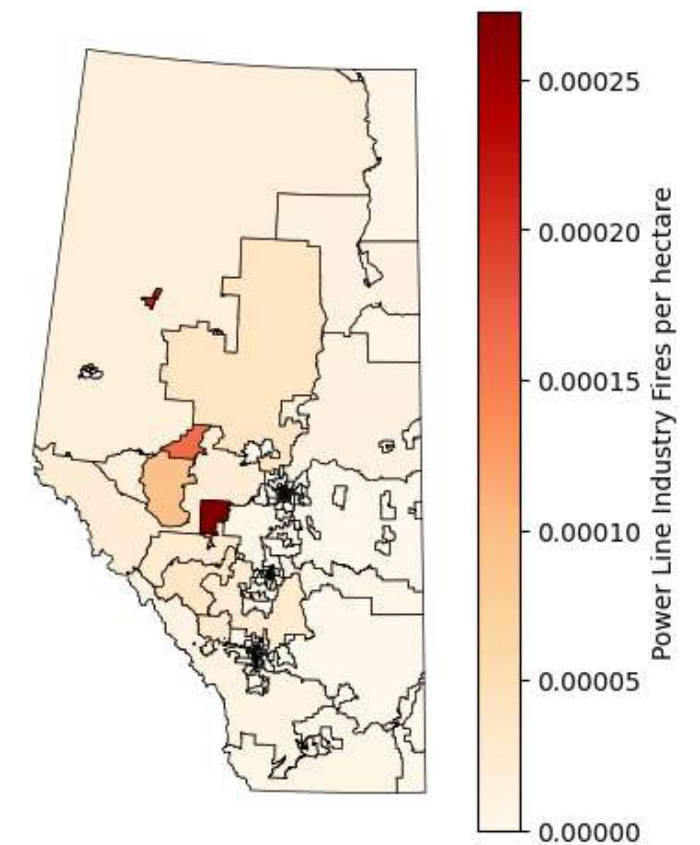
Agriculture Industry Fire Density by FSA in Alberta



Government Fire Density by FSA in Alberta



Power Line Industry Fire Density by FSA in Alberta



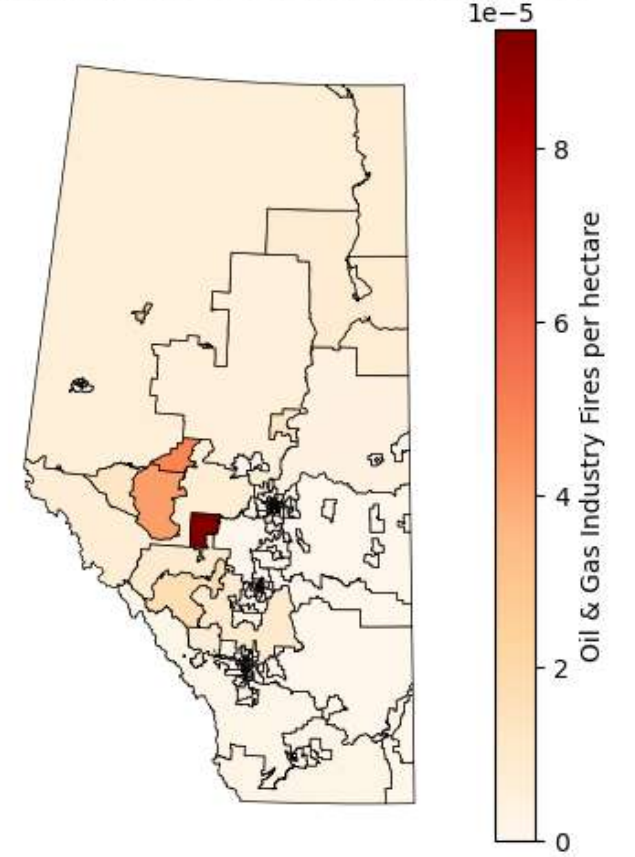
Oil & Gas Industry Fire Density by FSA in Alberta

Unknown Fire Density by FSA in Alberta

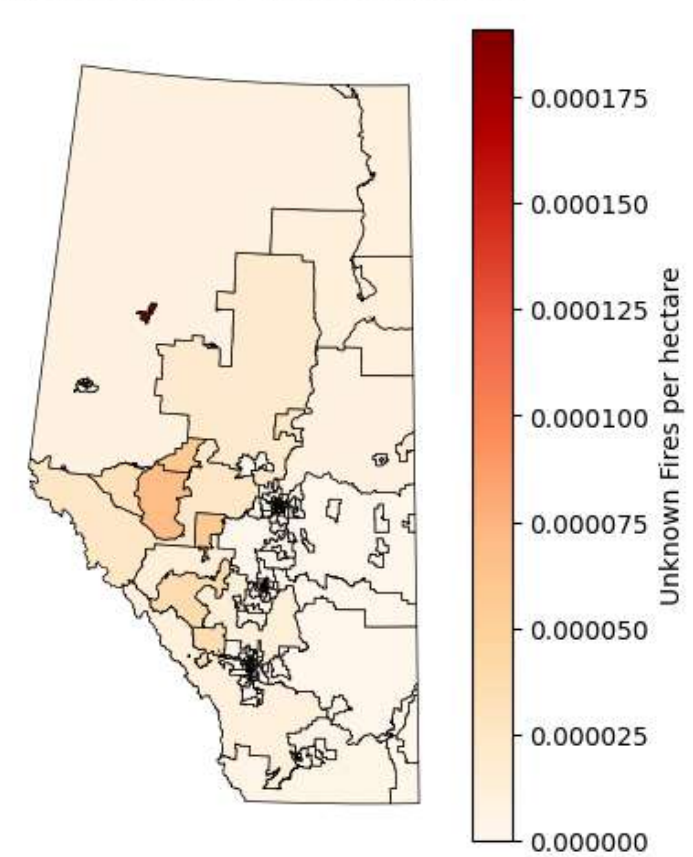
Railroad Fire Density by FSA in Alberta

Other Industry Fire Density by FSA in Alberta

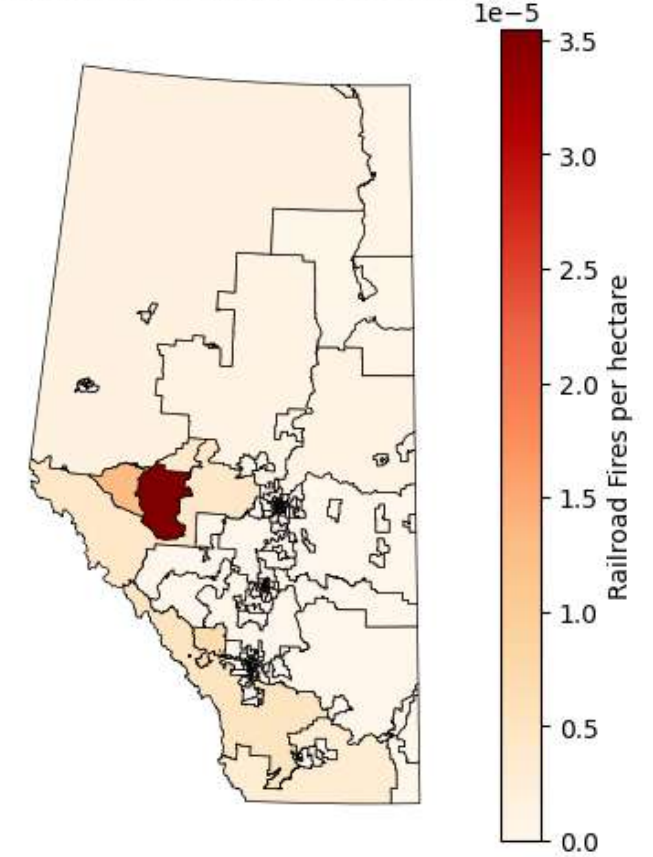
Oil & Gas Industry Fire Density by FSA in Alberta



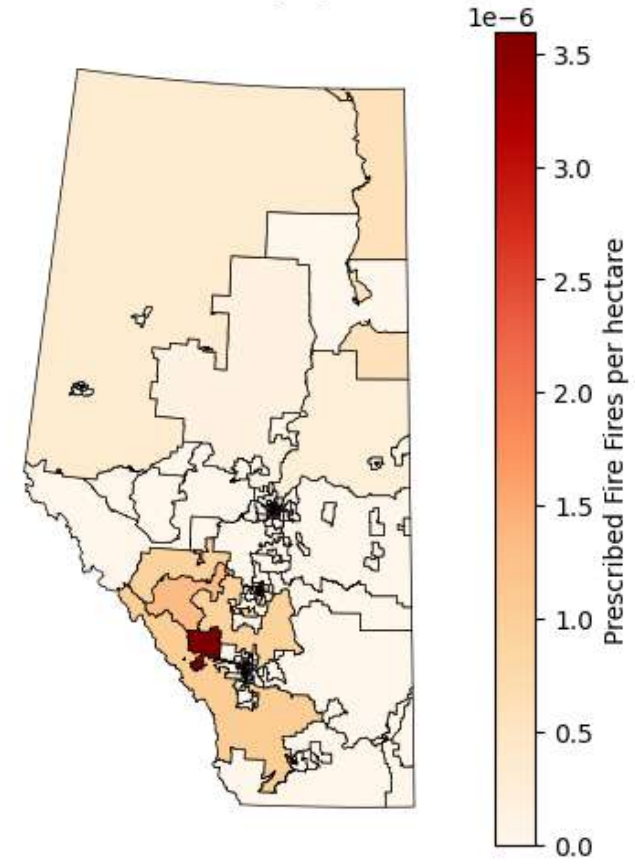
Unknown Fire Density by FSA in Alberta



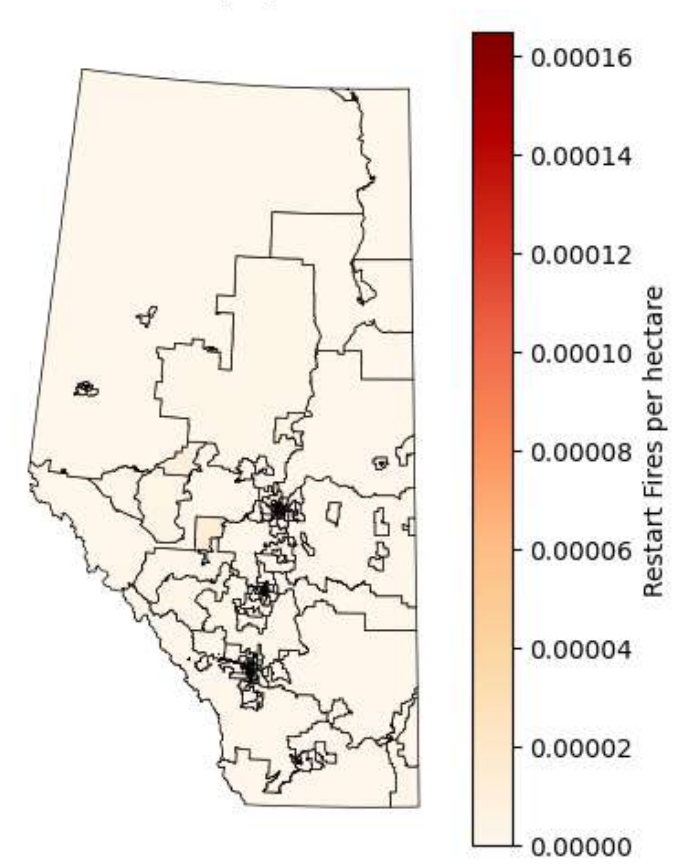
Railroad Fire Density by FSA in Alberta



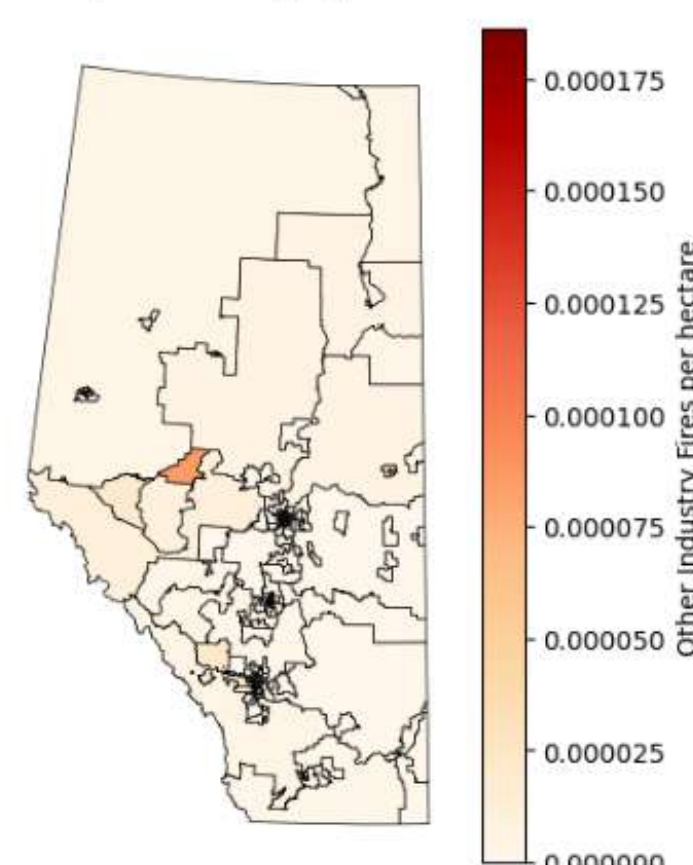
Prescribed Fire Fire Density by FSA in Alberta



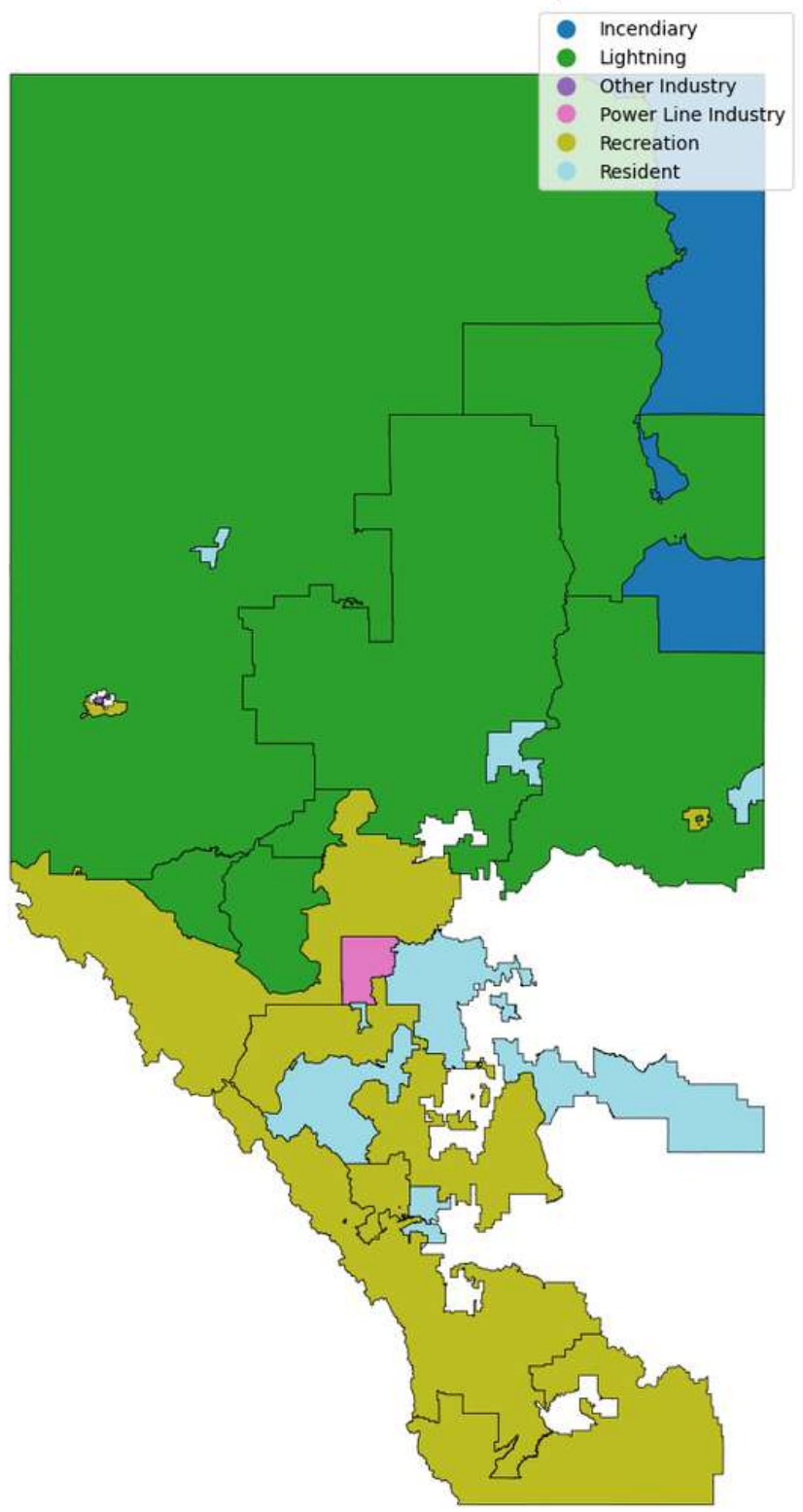
Restart Fire Density by FSA in Alberta

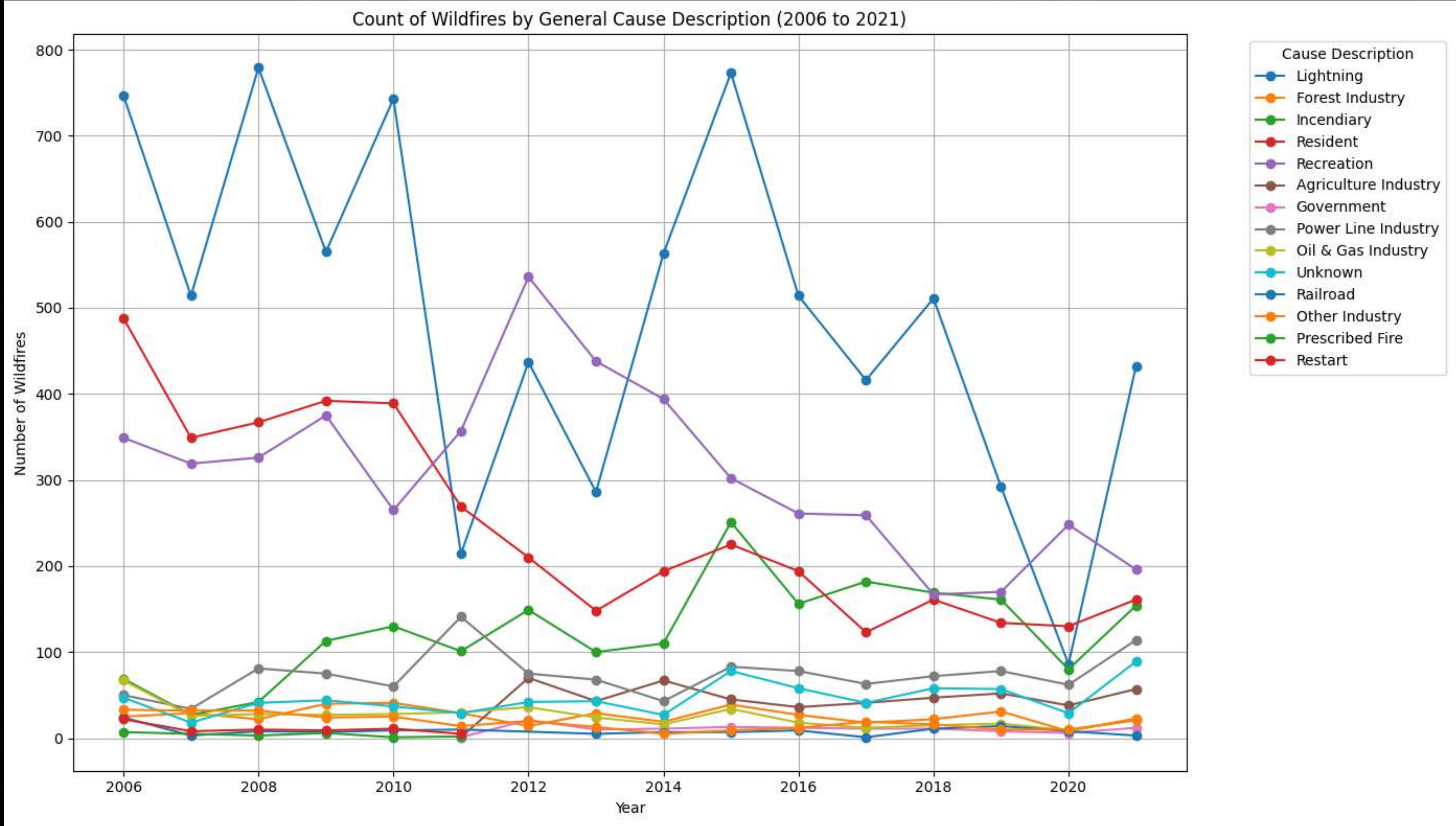


Other Industry Fire Density by FSA in Alberta



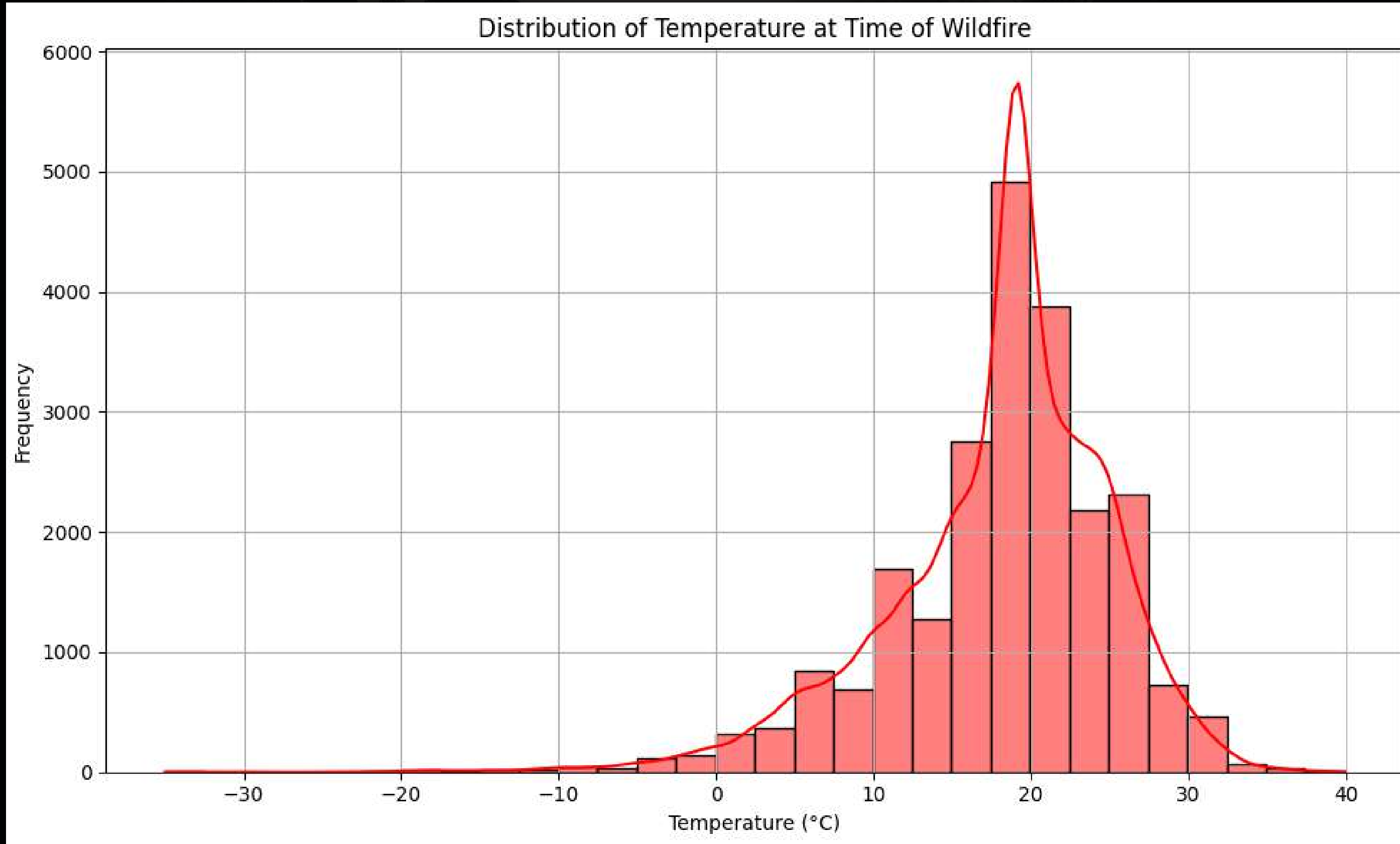
Most Common Cause of Wildfires by FSA





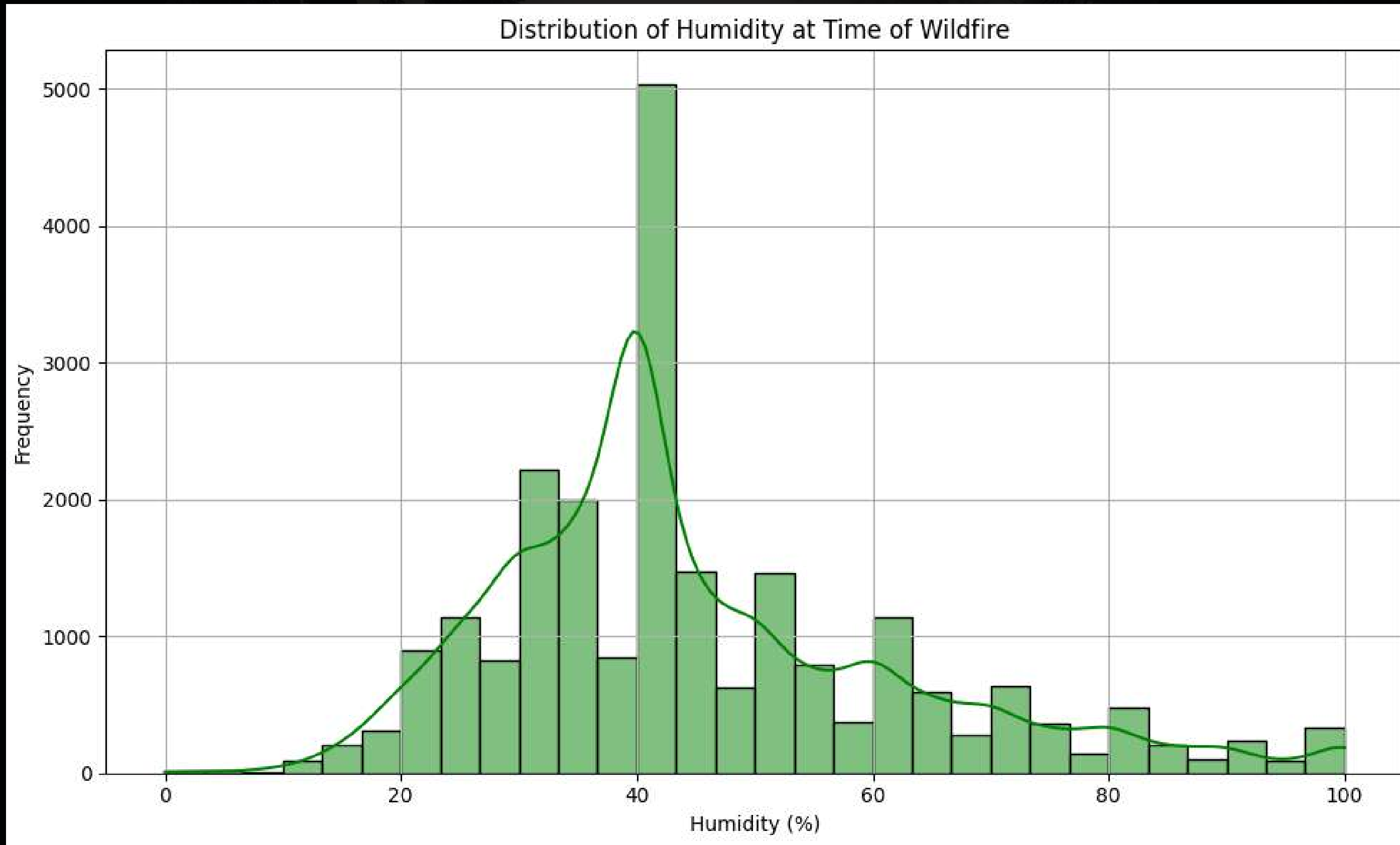
EXPLORATION

Temperature has a sweet spot between 10-to-25 °C



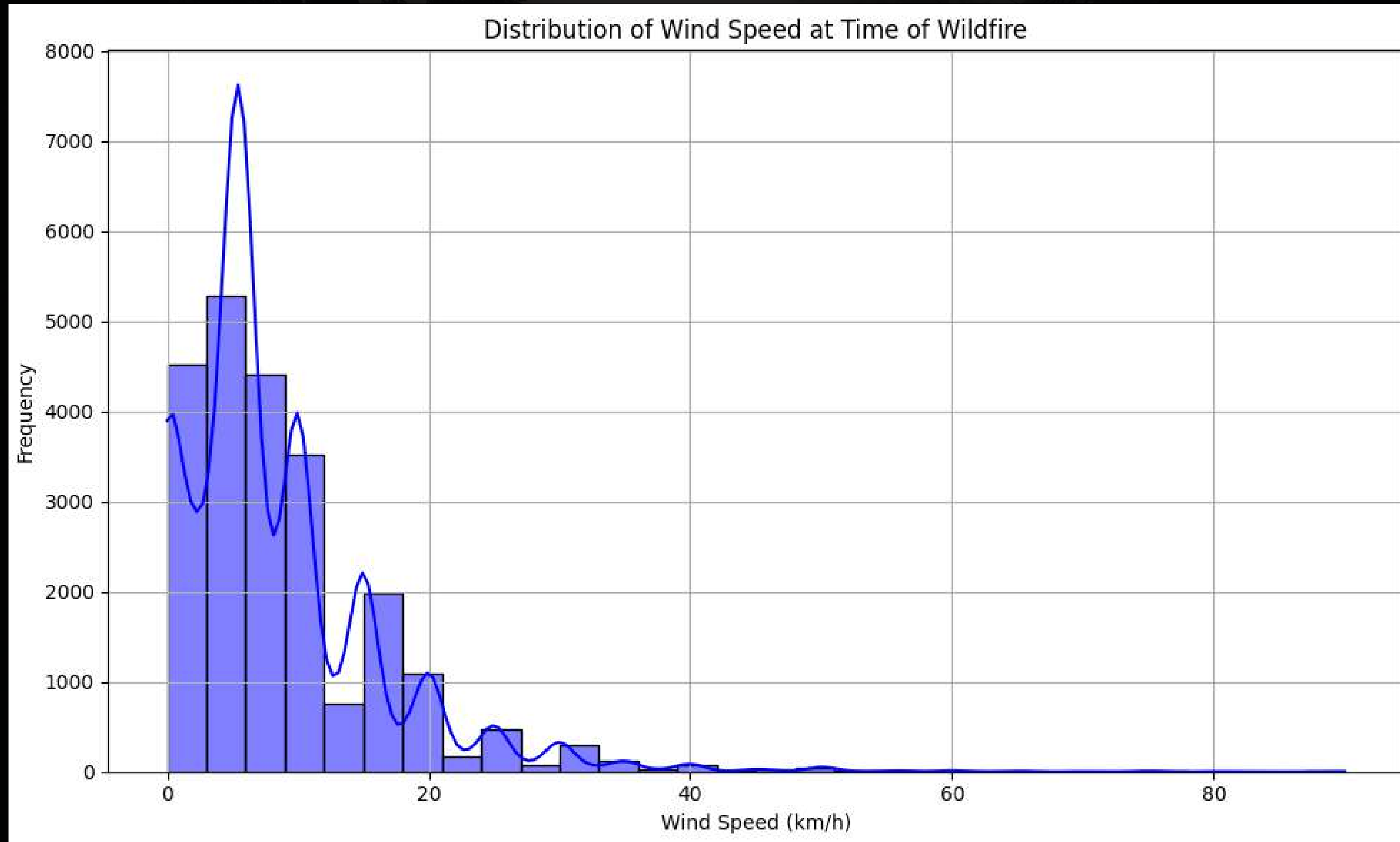
EXPLORATION

Humidity of 40% has a sharp peak, perhaps due to ecological reasons?



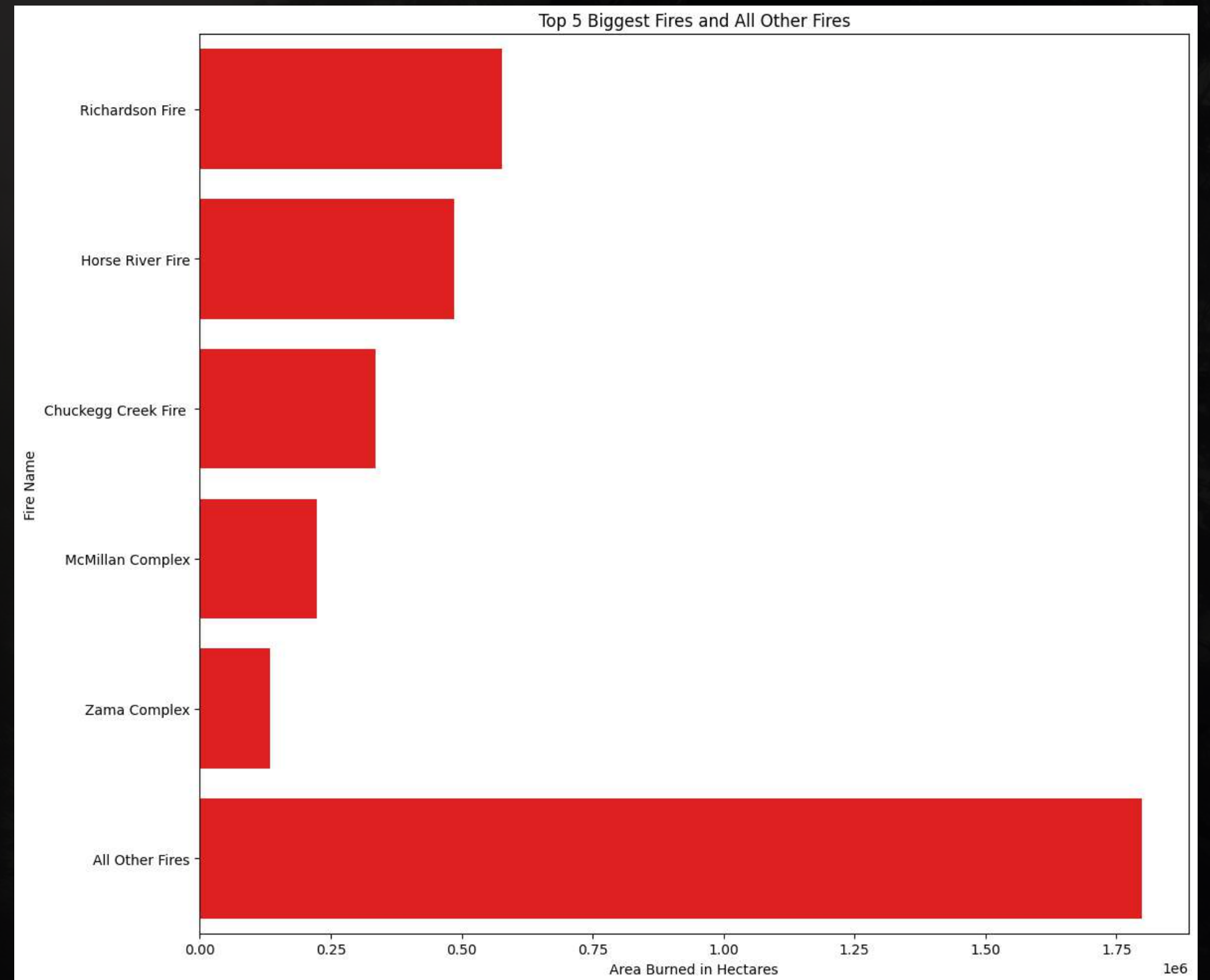
EXPLORATION

Too high wind speeds diminish fires from starting, they prefer up to ~12 km/h

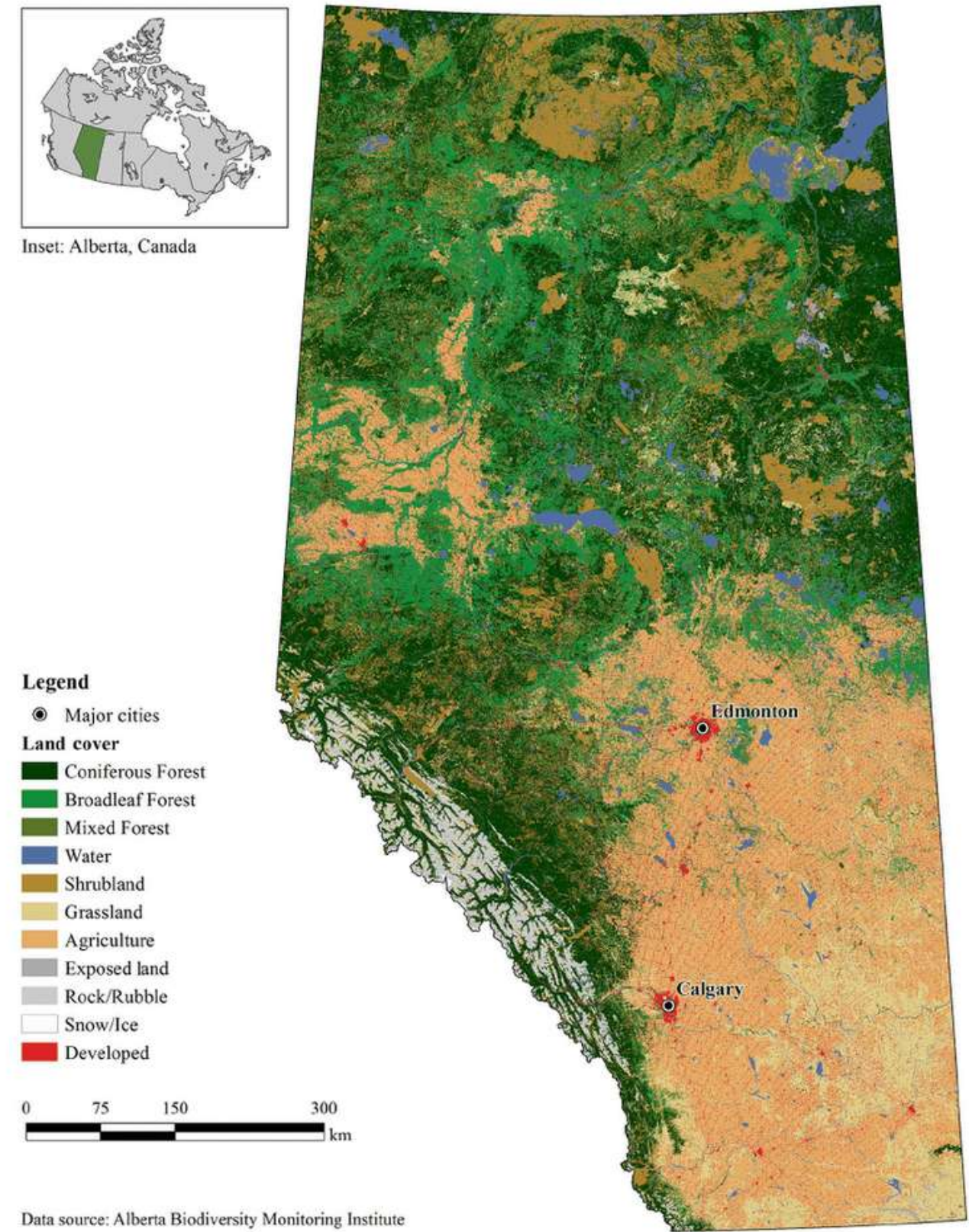
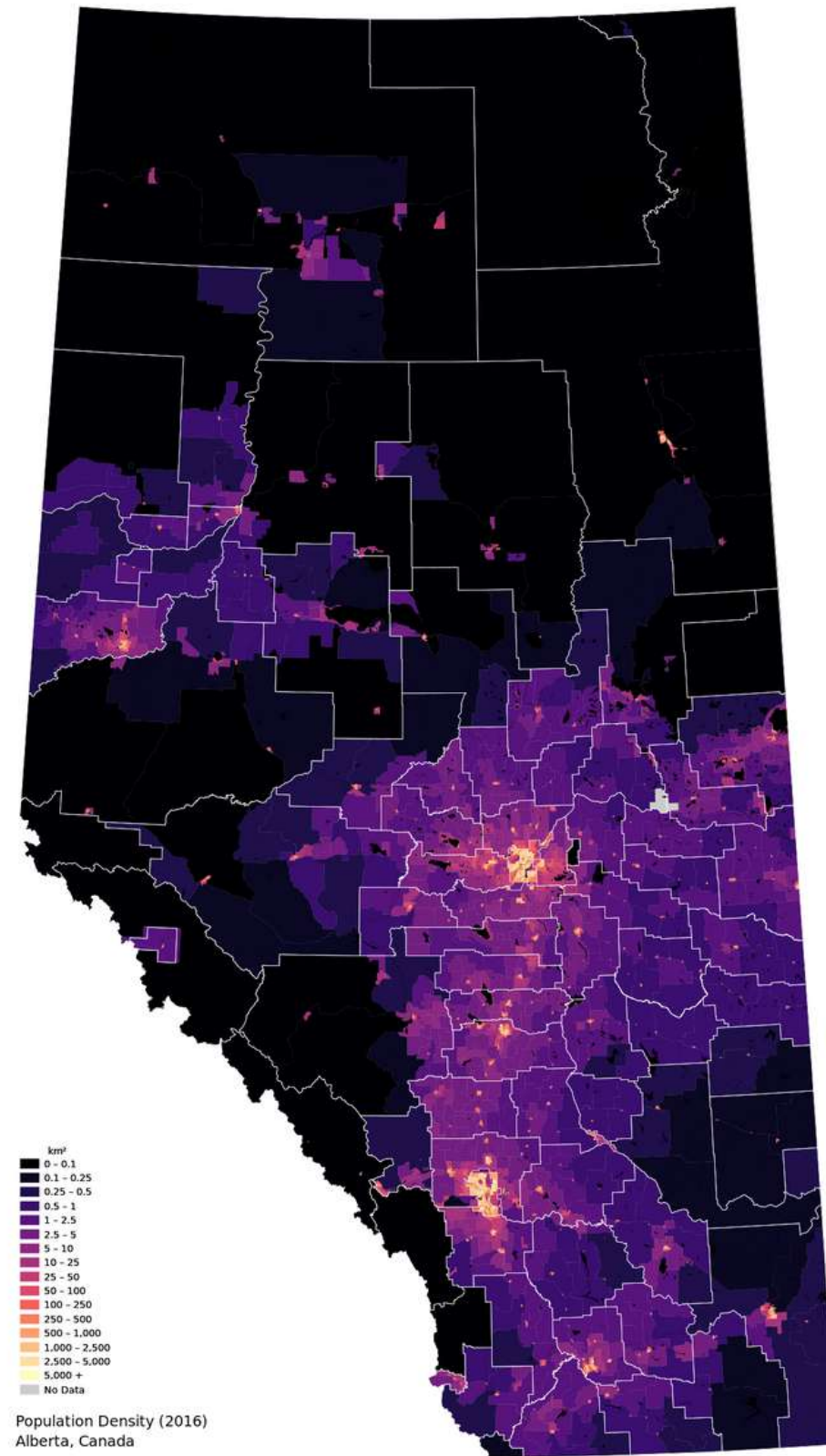
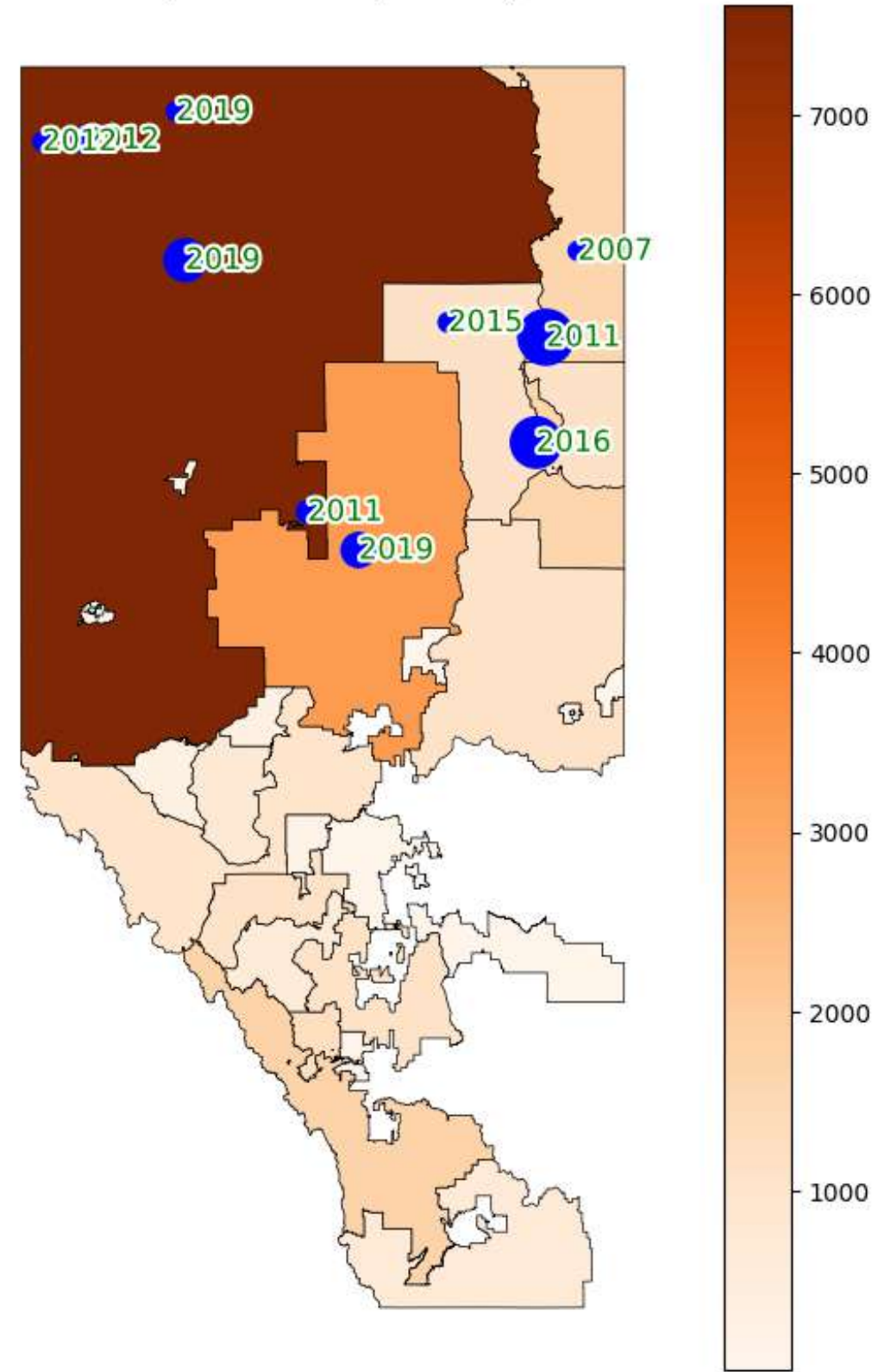


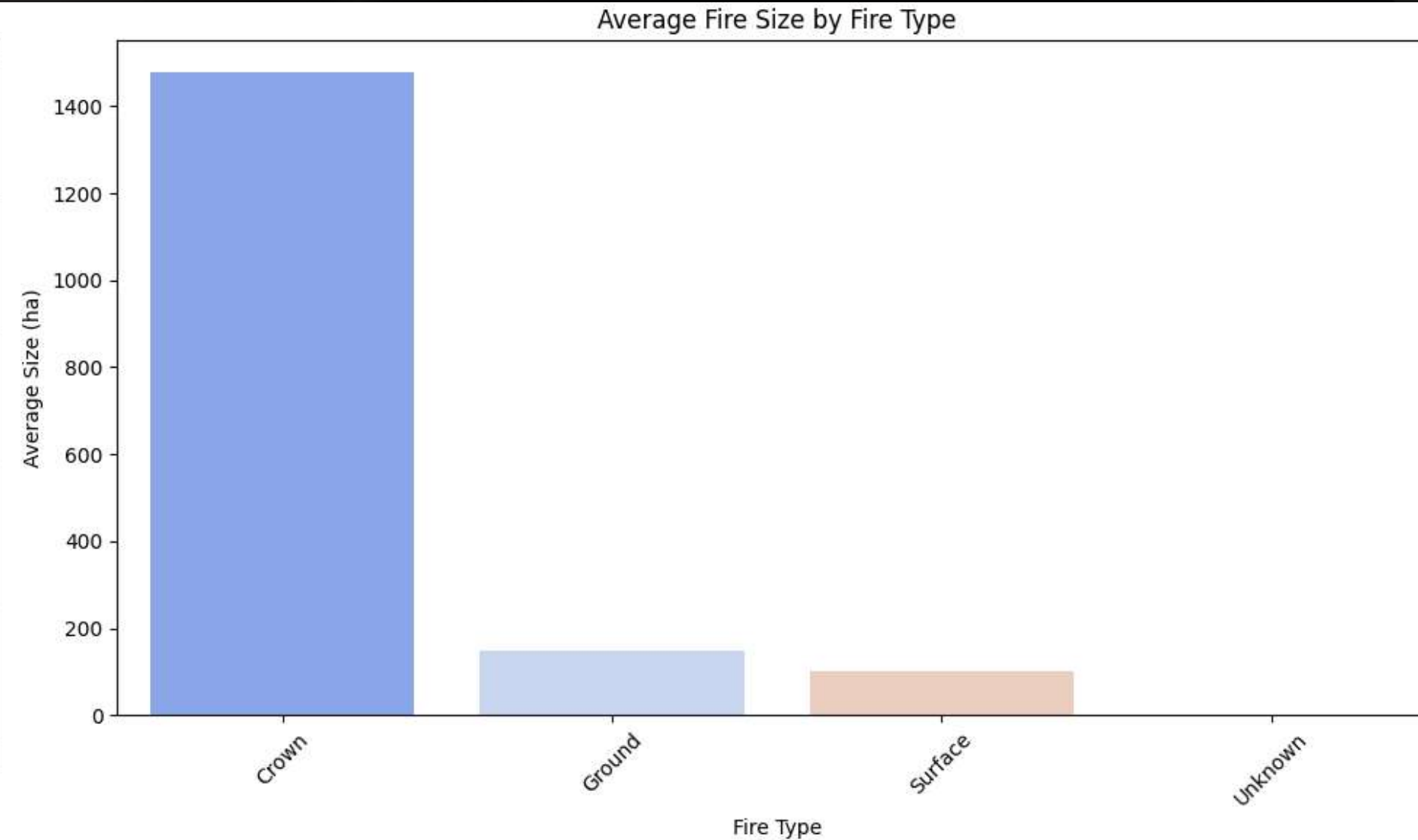
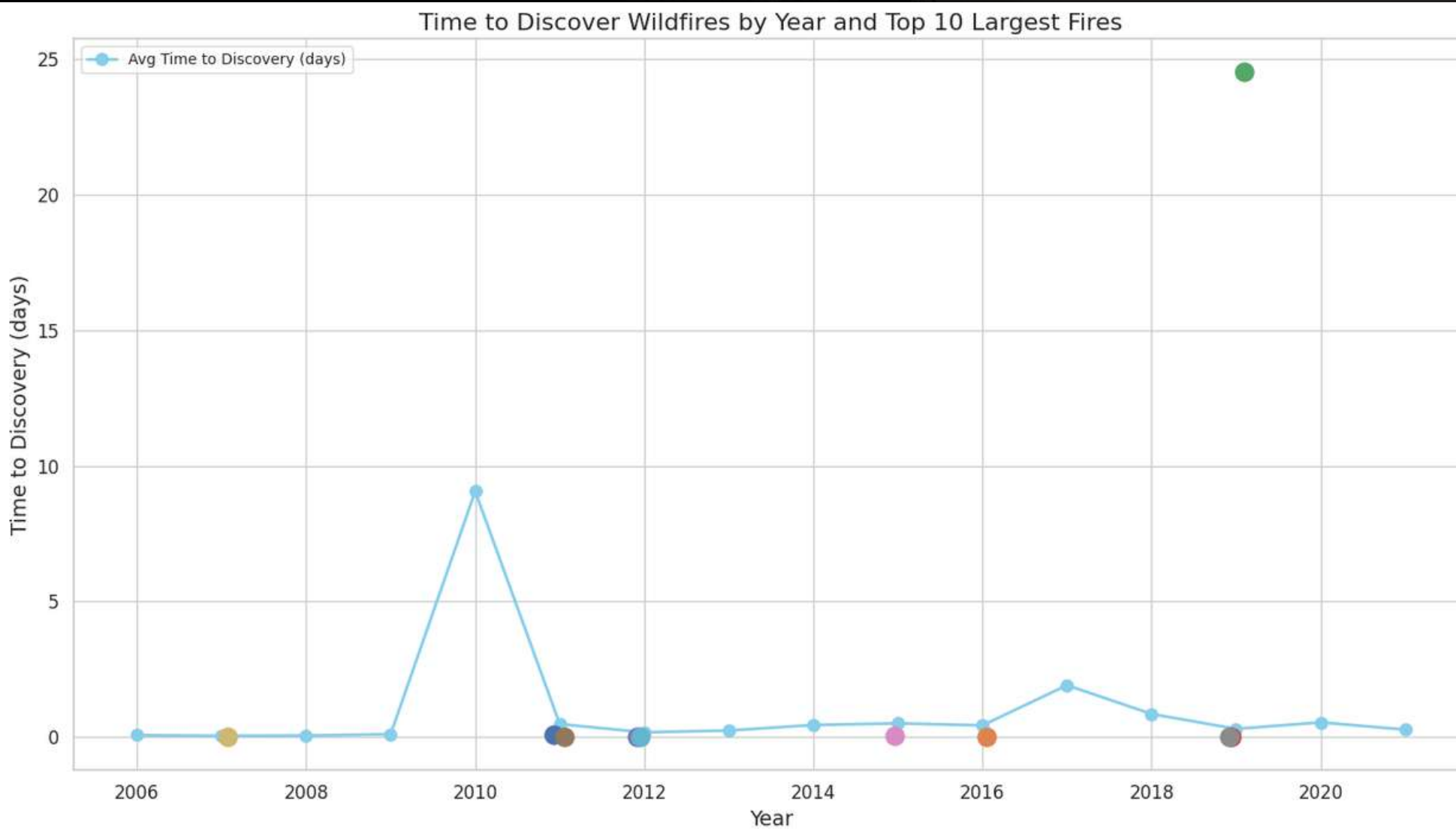
EXPLORATION

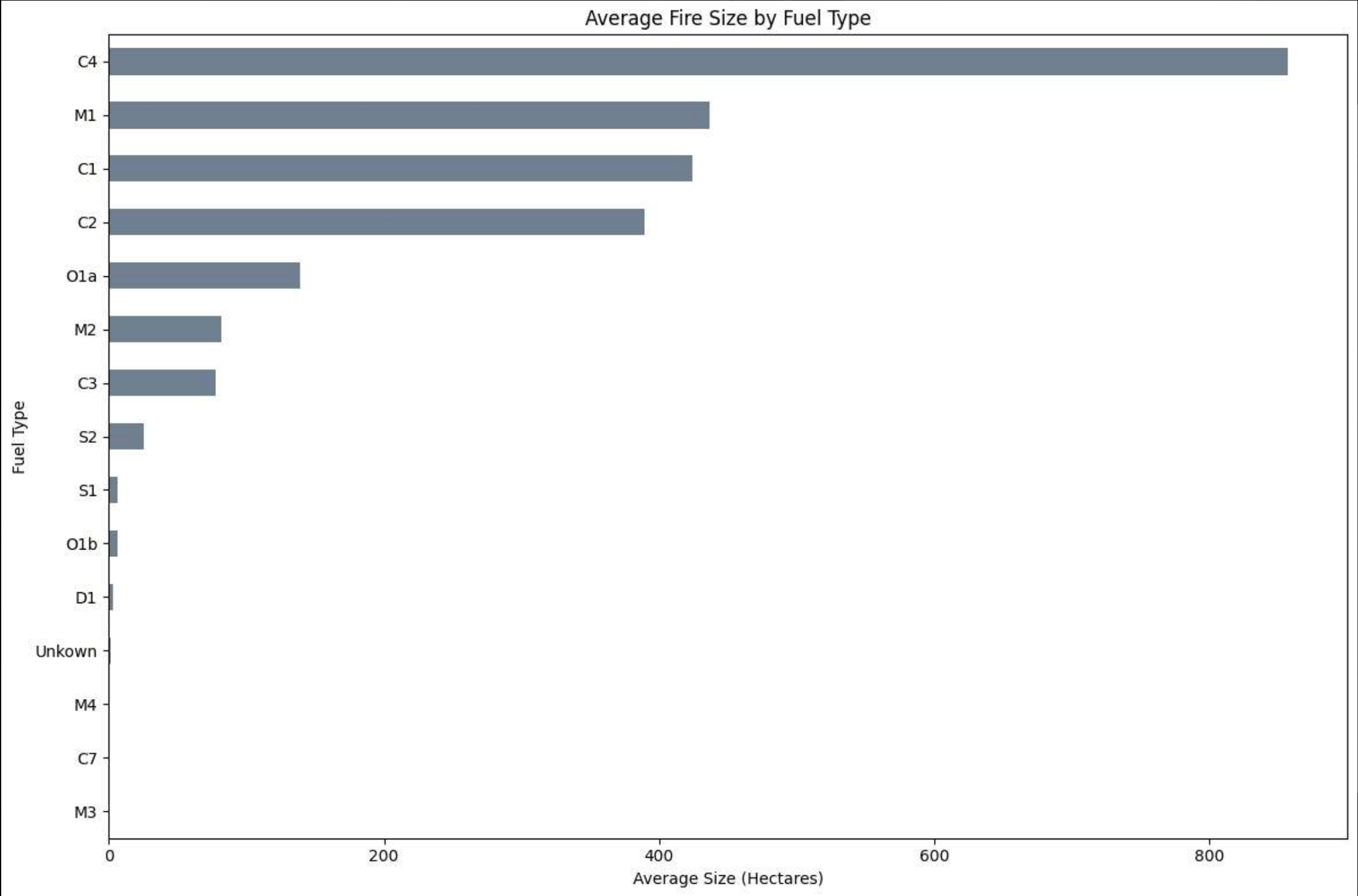
- Supermassive fires, like 2011's Richardson, contribute disproportionately more to total area burned.



Wildfire Count per FSA and Top 10 Largest Wildfires





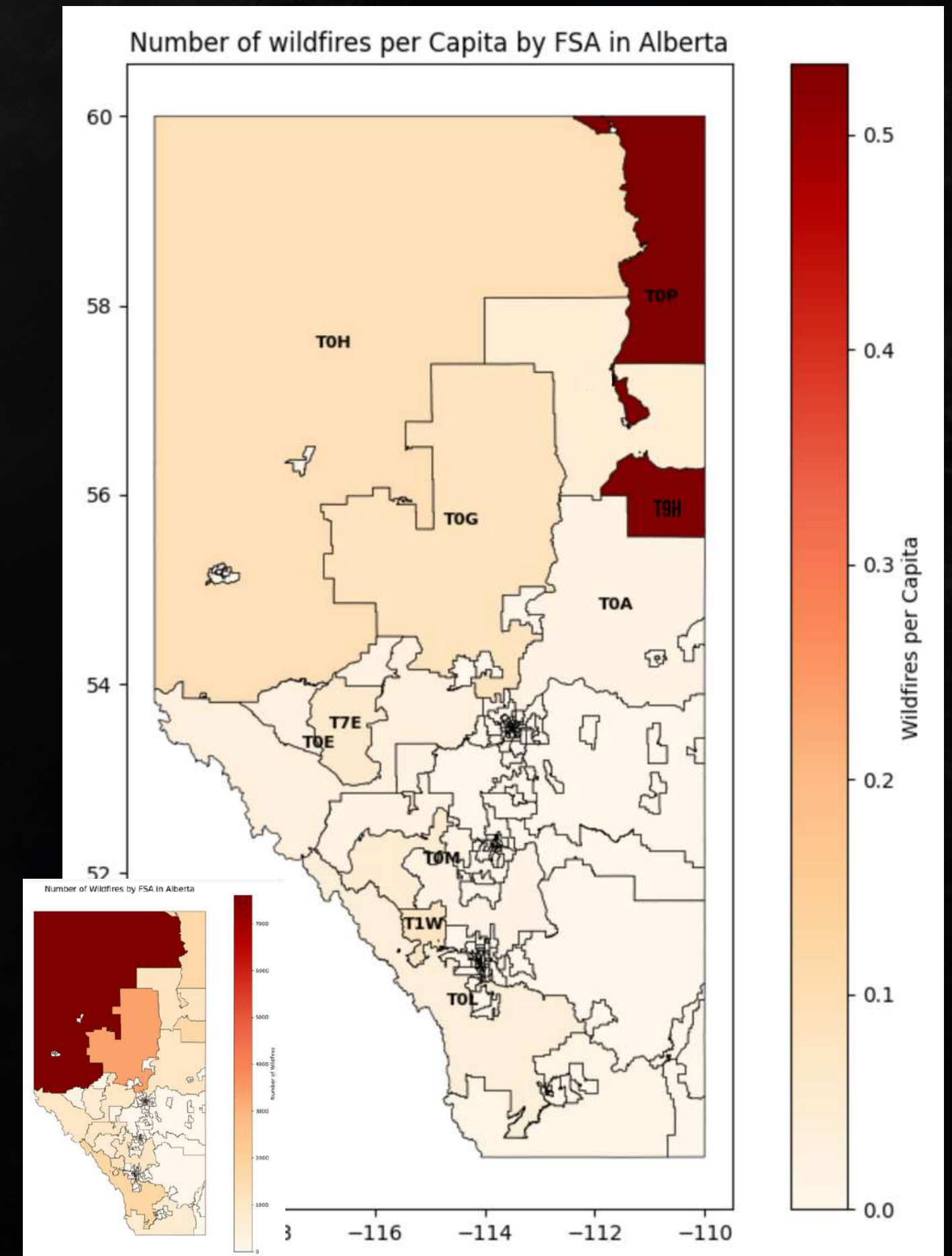
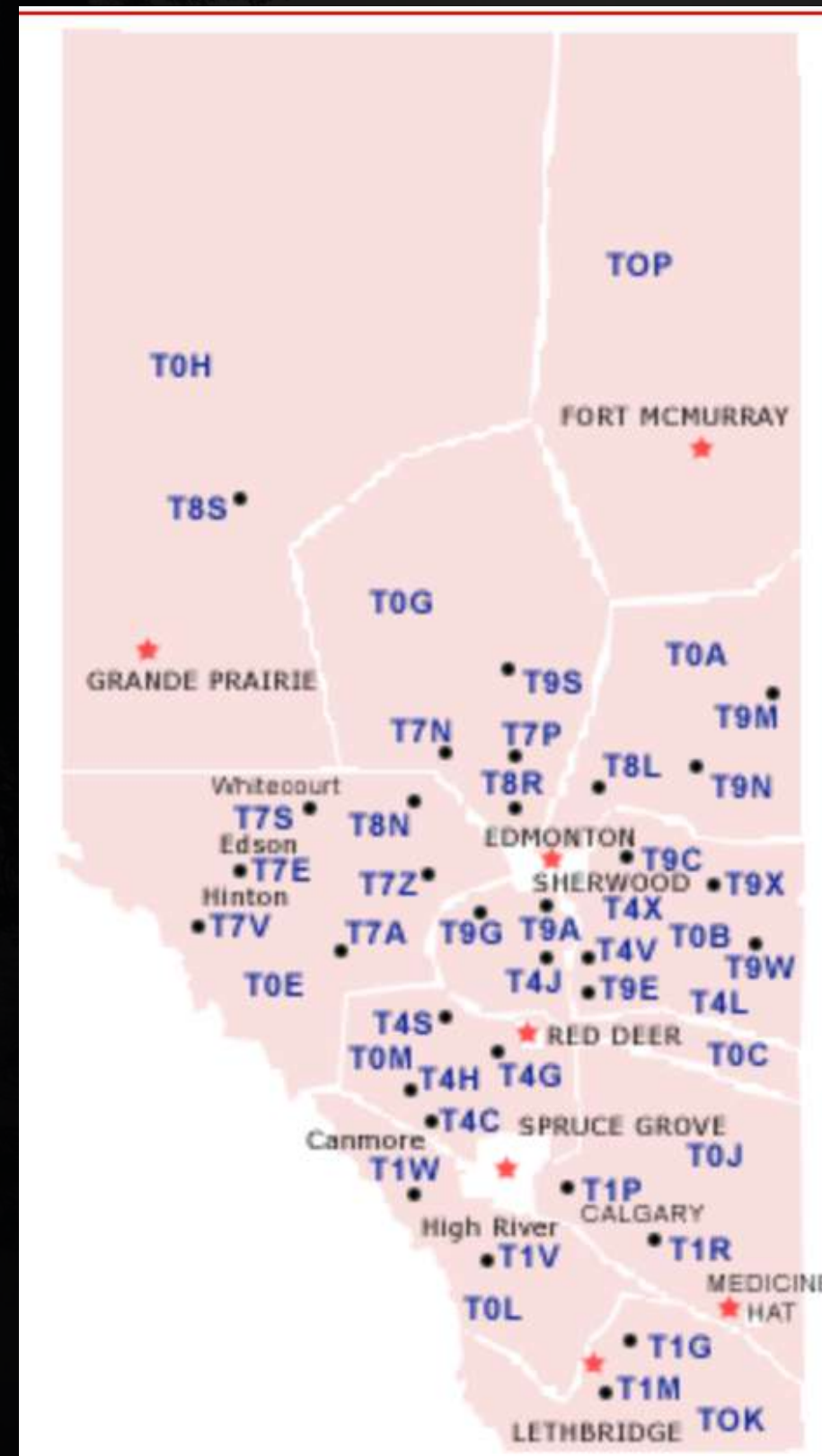


	fire_name	fire_year	general_cause_desc
13380	Richardson Fire	2011	Unknown
5893	Horse River Fire	2016	Unknown
3065	Chuckegg Creek Fire	2019	Lightning
2451	McMillan Complex	2019	Incendiary
12218	Zama Complex	2012	Lightning
13471	Utikuma Complex	2011	Power Line Industry
7924	Unnamed	2015	Lightning
2567	Jackpot Creek Fire	2019	Lightning
20518	Old Fort Fire	2007	Lightning
12214	Zama Complex	2012	Lightning

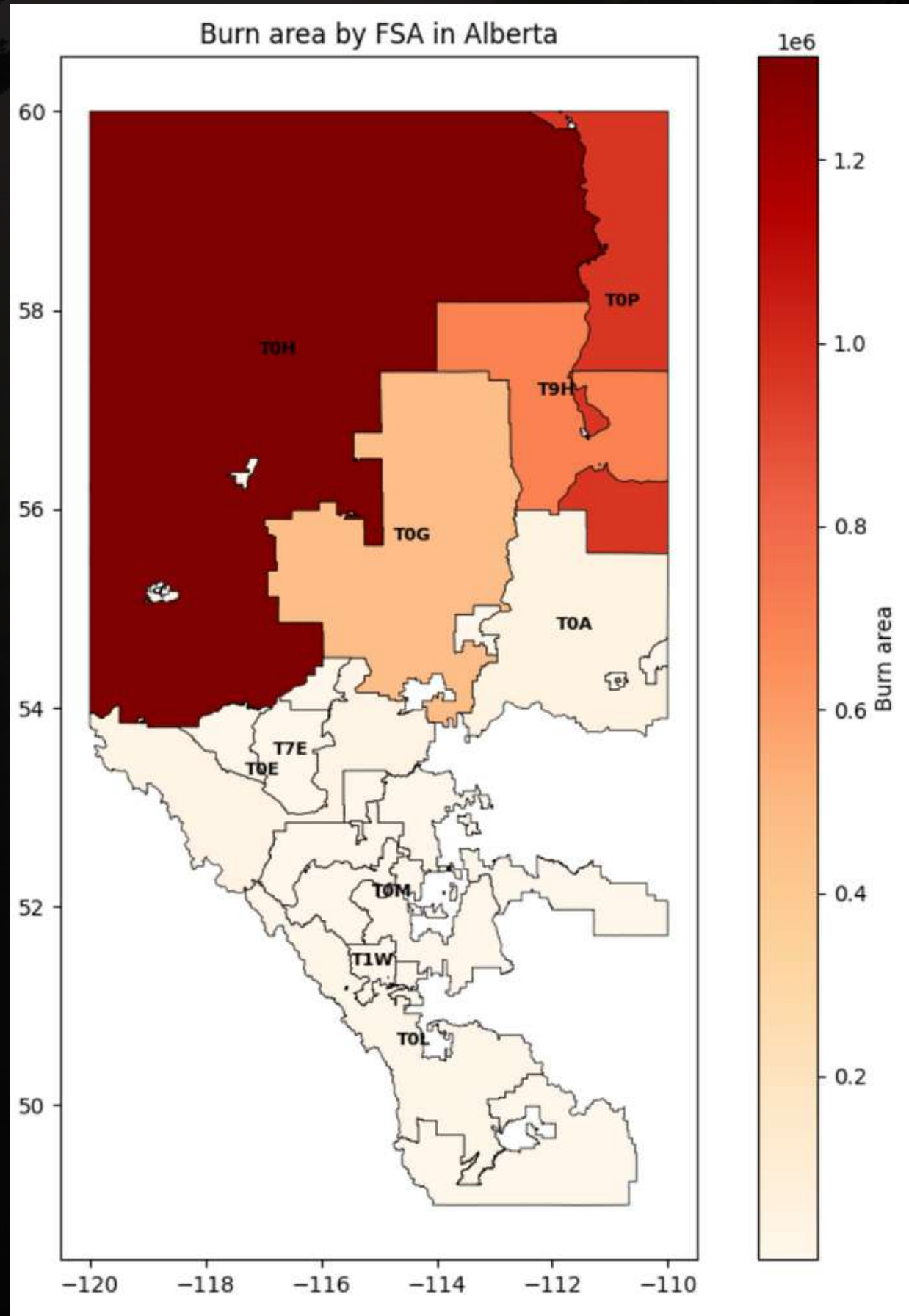
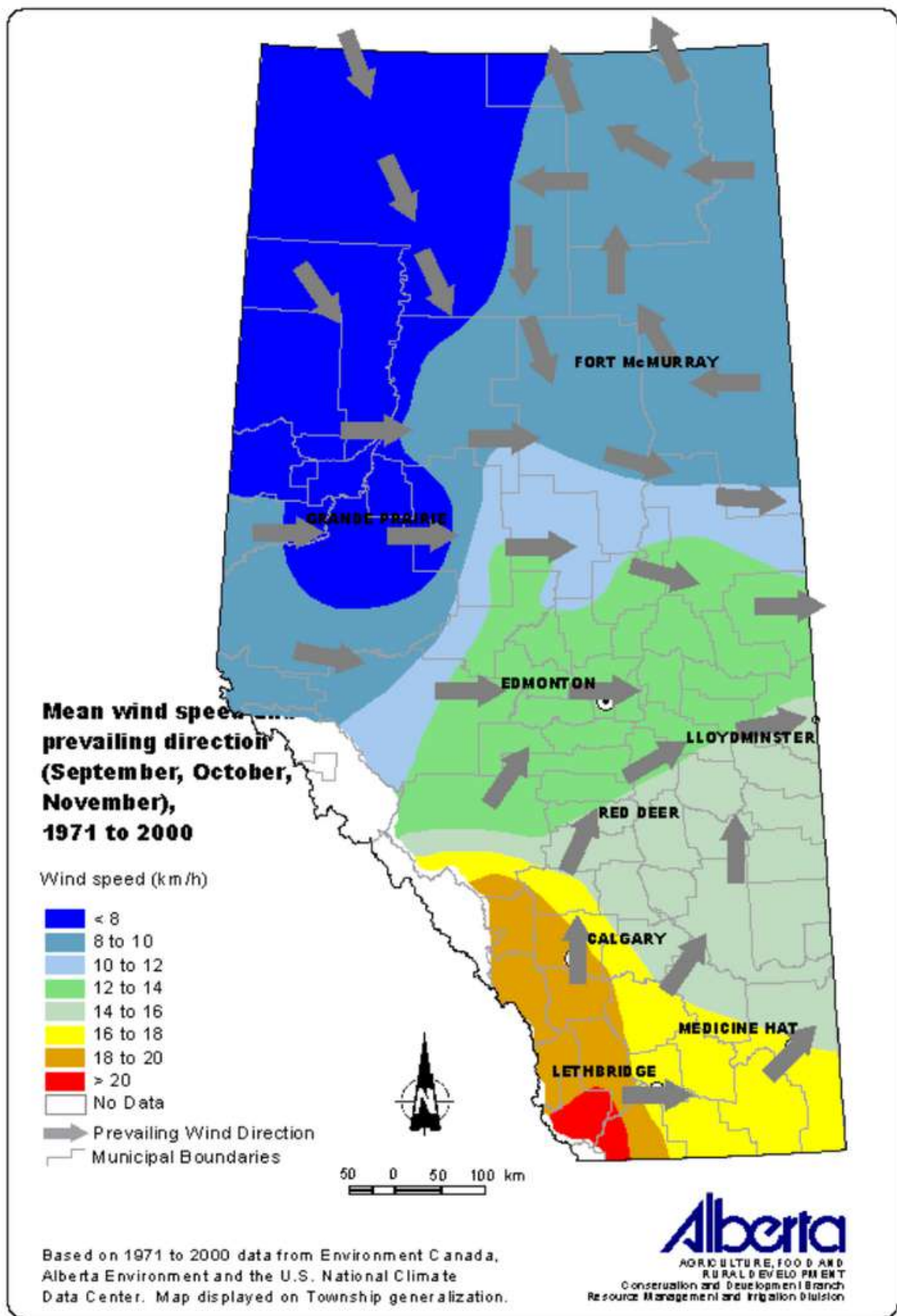
POPULATION



POPULATION **VS** WILDFIRE COUNT



WIND FLOWS



- Wind flows directs smog to non-epicenter zones



WILDFIRES & INDIGENOUS PEOPLE

News / Local News

By the numbers: Responding to Fort Chipewyan wildfire a massive logistics effort

Vincent McDermott

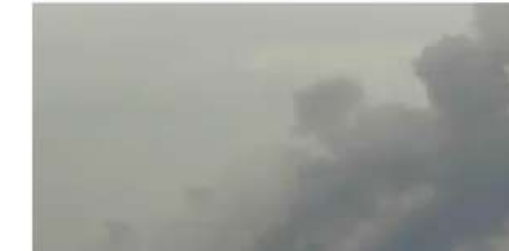
EDMONTON | New

'I'm sorry to bring the bad news': Mikisew Cree First Nation chief confirms cabins destroyed by wildfire

Devil's Gate Reserve

Cabins destroyed in northern Alberta wildfire: 'I'm terribly sorry'

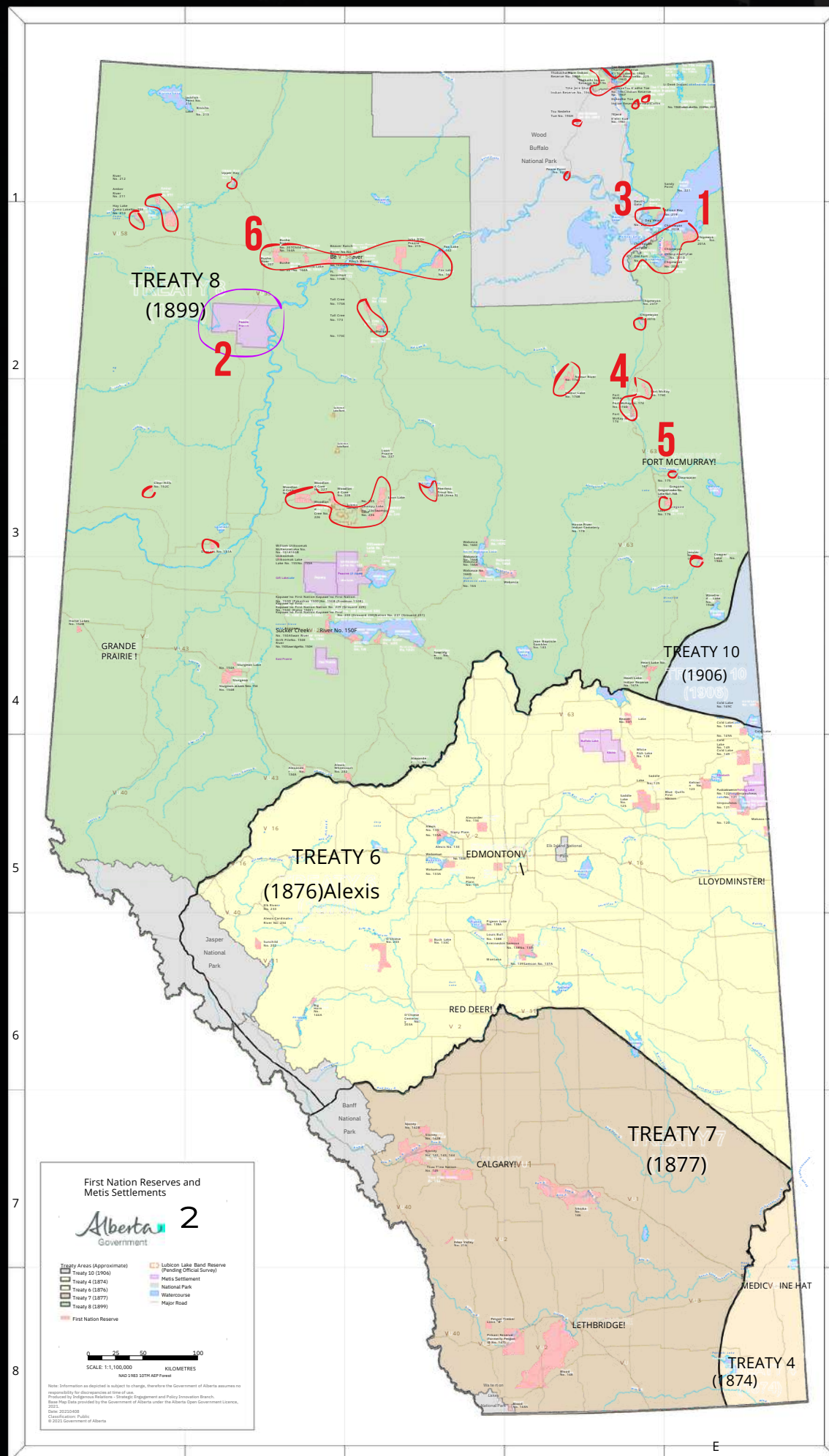
The chief of Mikisew Cree First Nation said some homes have been destroyed by a wildfire that's burning near Fort Chipewyan in northern Alberta.



Within four or five hours, an evacuation point was set up in Fort McKay with more supplies for the incoming boaters and speedily erected barriers for

On May 1, 2016, a [wildfire](#) began southwest of [Fort McMurray, Alberta](#), Canada. On May 3, it swept through the community, forcing the largest wildfire evacuation in [Alberta's history](#), with upwards of 88,000 people forced from their homes.^{[14][7]} Firefighters were assisted by personnel from both the [Canadian](#)

Chief and council issued an evacuation order Monday night for members of Bushe River, where the fire spanning nearly 80,000 hectares burned about four kilometres away.

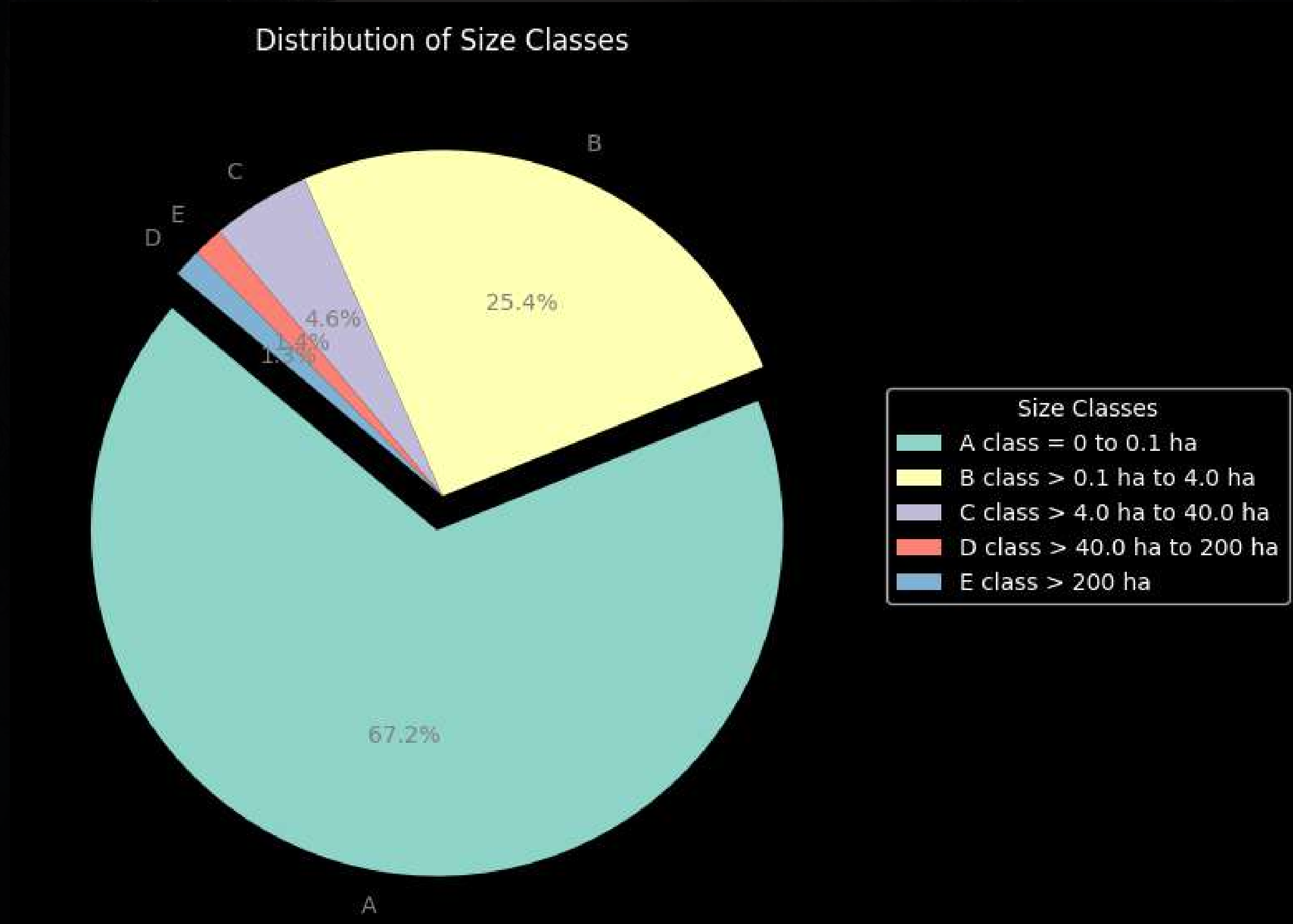




IMBALANCED MULTICLASS CLASSIFICATION PROBLEM

Goal: **predict fire size class** based on available data at the point
when the fire was assessed

TARGET VARIABLE IMBALANCE



SOLVING AN IMBALANCE PROBLEM

- Oversampling Minority Class
- Undersampling Majority Class
- Weighting classes inversely proportional to their frequency:

$$Weight_i = \sqrt{\frac{TotalNumberofSamples}{NumberofSamplesinClass_i}}$$

DATASET PREPROCESSING

Data Imputation
Feature engineering
Feature encoding
Feature normalization

DATA IMPUTATION

- Mean/Median/Mode Imputation:
 - e.g. median response time for a given size area
- K-Nearest Neighbors (KNN) Imputation:
 - e.g. imputing missing fire origin based on the nearest fire

FEATURE ENGINEERING AND ENCODING

- Fire Region extraction from the first letter of the fire number.
- Ordinal encoding of the size class.
- One-Hot encoding of the other categorical features.
- Creating time interval features as days between (ex. days to extinguish, days to report)
- Grouping activity class and true cause categories to more general ones to group smaller categories.

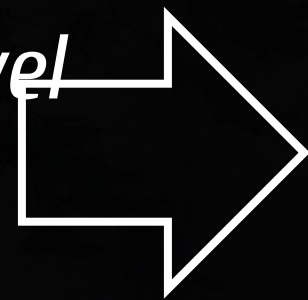
Flaring Gas

Heavy Equipment

Mechanized Travel

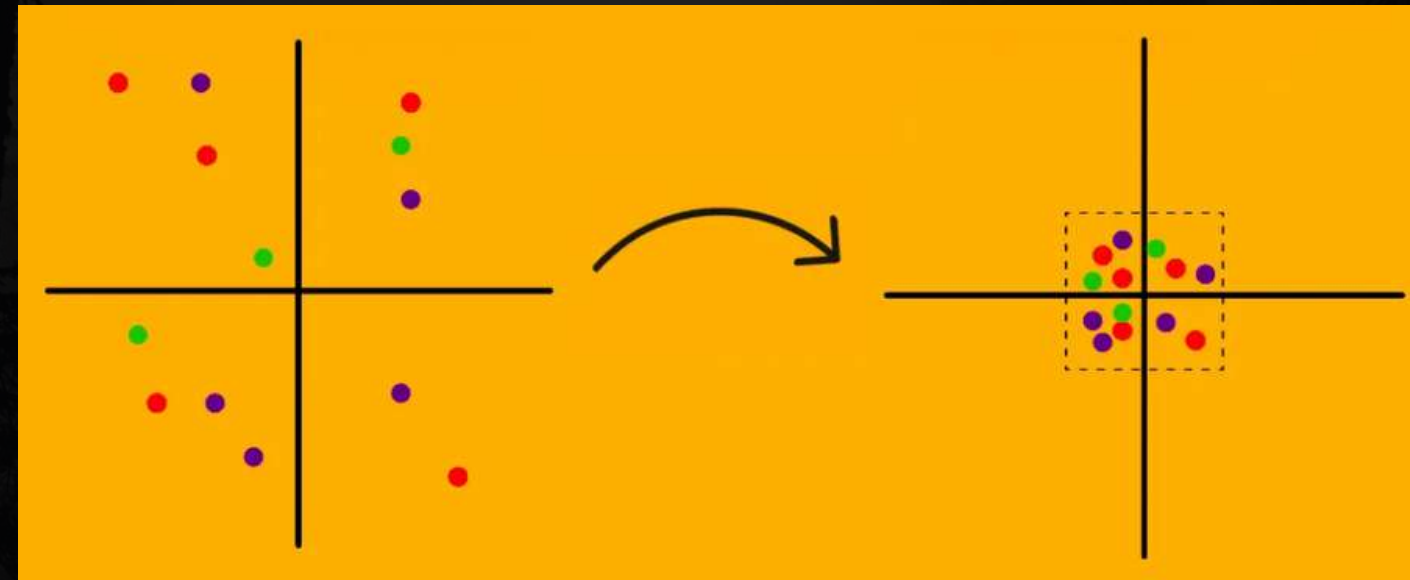
Operations

Welders



Industrial Activities

FEATURE NORMALIZATION



Min-Max Normalization

$$x' = \frac{x - \min(x)}{\max(x) - \min(x)}$$

Sigmoid

$$x' = \frac{1}{1 + e^{-x}}$$

CLASSIFICATION ALGORITHMS

XGBoost

Random Forest

Gradient Boosting

Support Vector Classifier (SVC)

Logistic Regression

METRICS

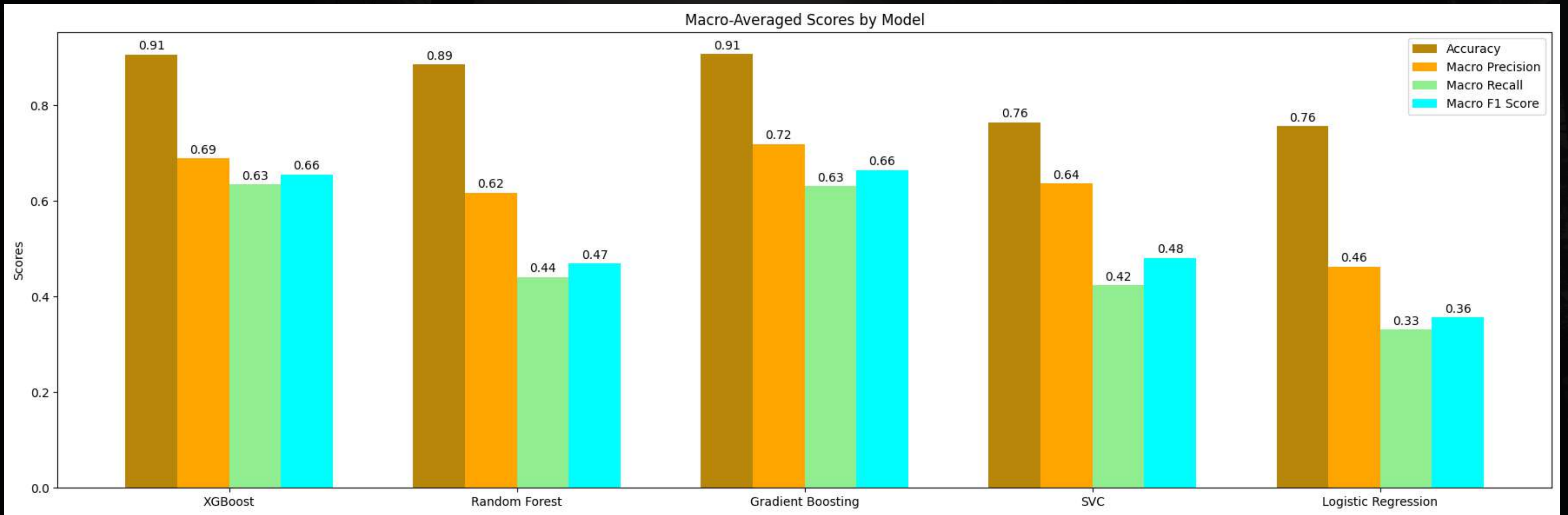
Accuracy

Precision

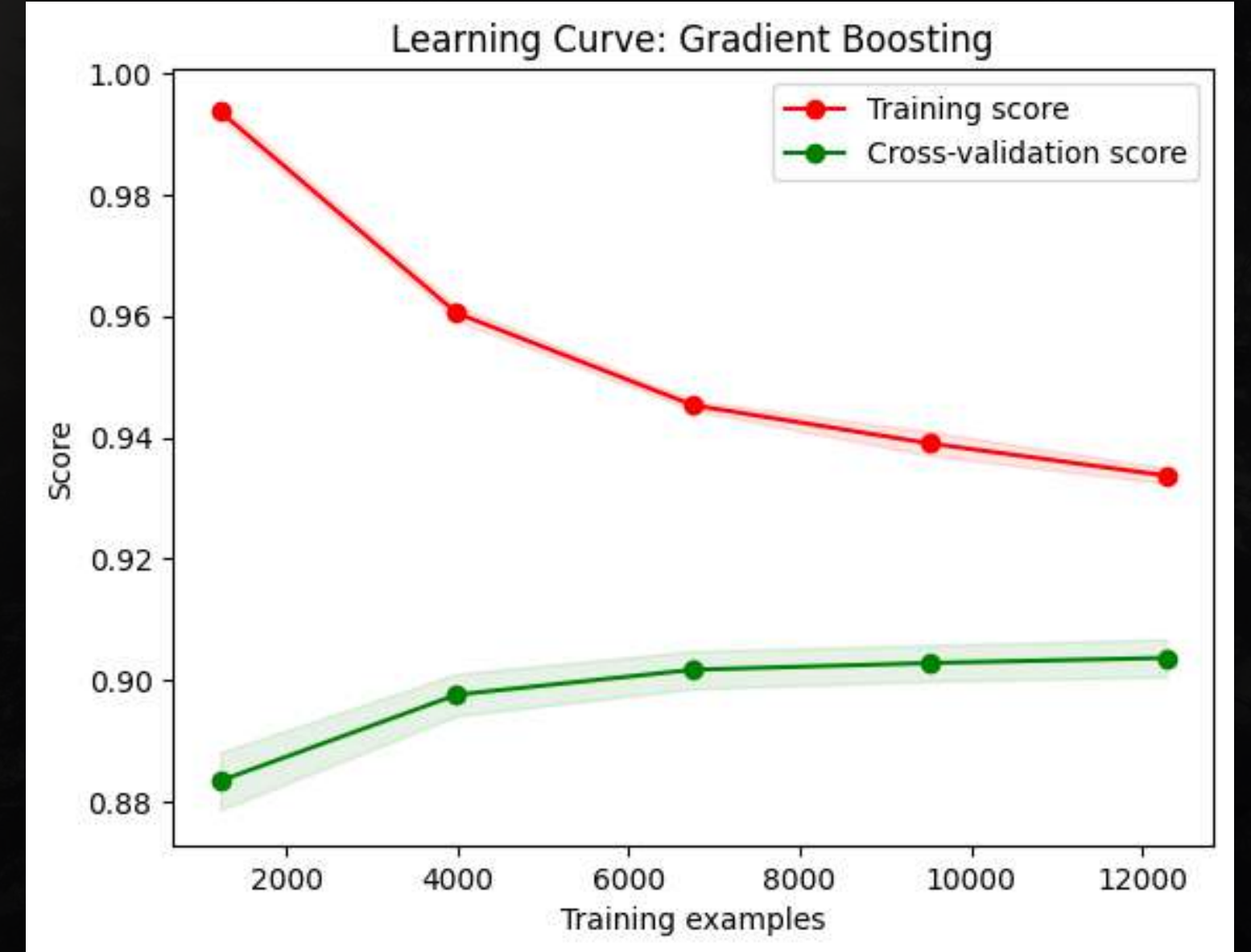
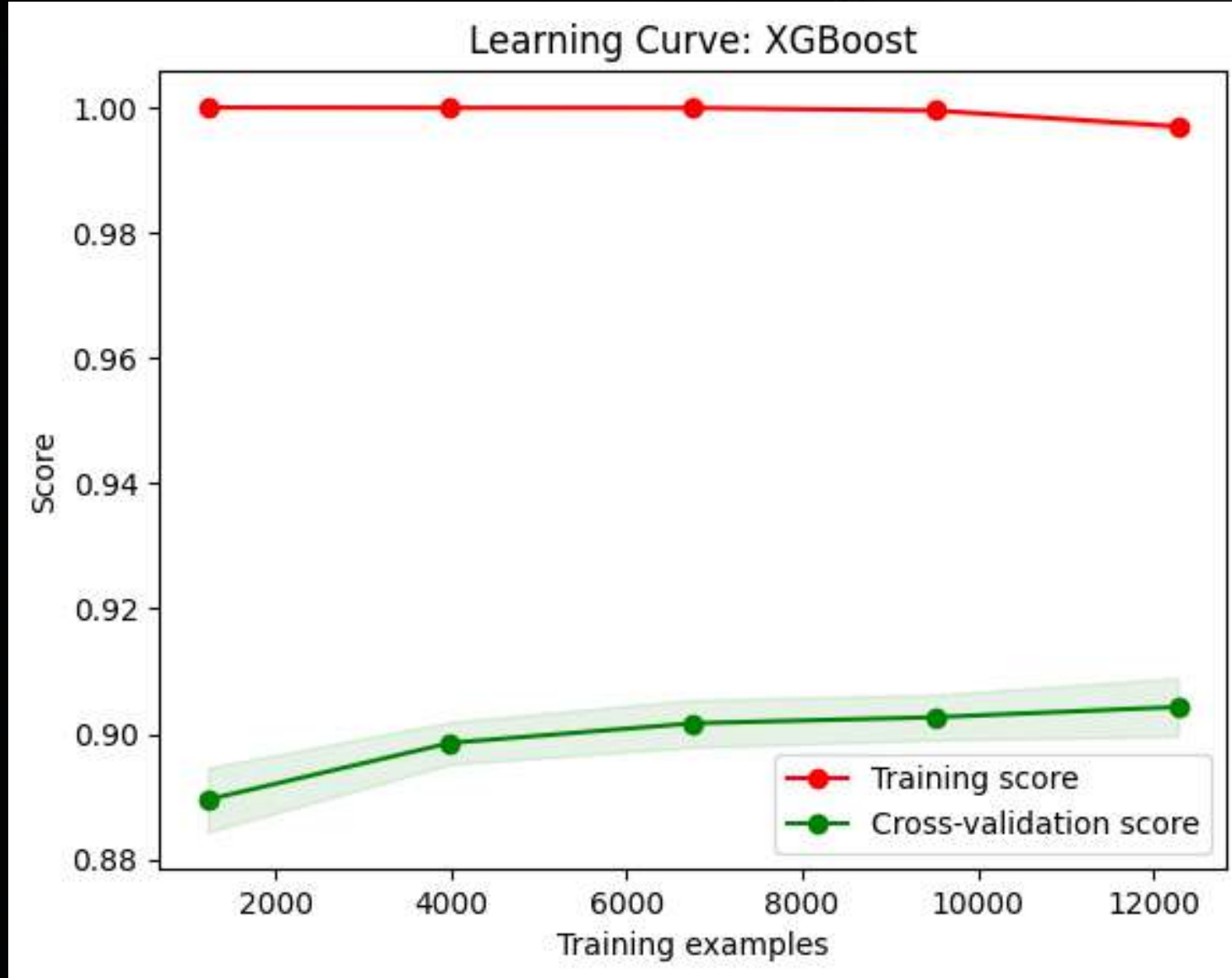
Recall

Macro f1 score

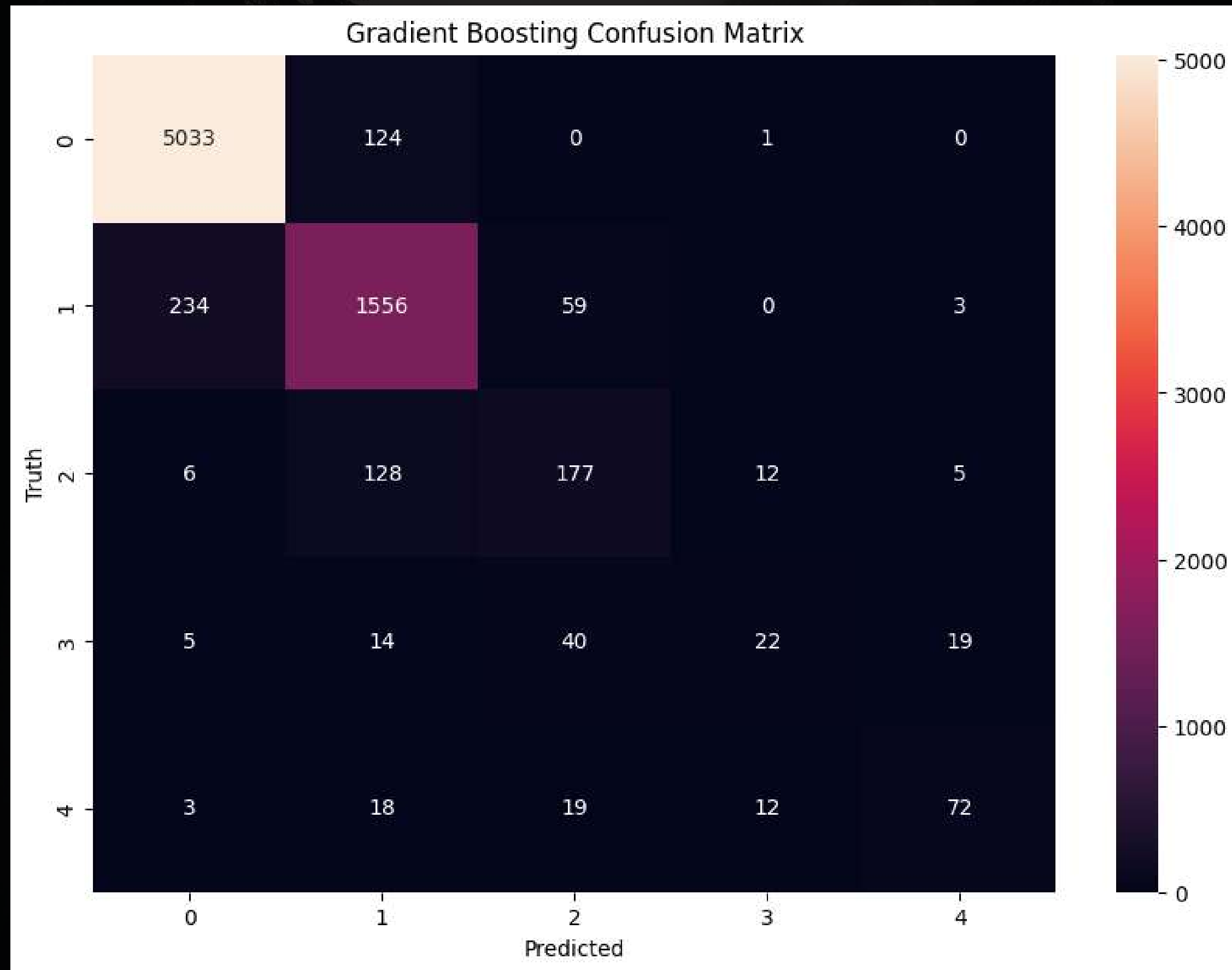
MODEL COMPARISON



MODEL COMPARISON



MODEL COMPARISON



FEATURE IMPORTANCE



- Assessment hectares
- Fire spread rate
- Distance from water
- Latitude and longitude
- Humidity
- Wind conditions
- Temperature
- Fire cause

MODEL IMPROVEMENT

- Can employ ensemble techniques like Voting, Stacking, Blending
- Use more datasets to find larger patterns
 - Ex. more granular wind data from weather networks
- Experiment with deep learning (may fare better or worse)

TAKE AWAYS

- Fire count is decreasing, fire size is increasing; Alberta needs to stop fires from growing!
- Fires are concentrated at the Northern Half which disproportionately affects FSAs and Indigenous communities there.
- The importance of employing data science;
 - feature importance, predicting sizes to inform resource allocation, etc.



Q & A