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COLORADO FIRE PERIMETERS

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COLORADO FOREST
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COLORADO STATE UNIVERSITY

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Document Development Statement: This database was developed by the Colorado Forest Restoration Institute (CFRI) motivated to support the Colorado Forest Tracker, which helps visualize and assess where forest management activities occur across the state. A consistent, statewide record of wildfire and prescribed fire perimeters was needed to strengthen the Forest Tracker's ability to facilitate evaluating management outcomes and more completely document fire history. Building on this foundation, the database also provides a resource for

land managers and researchers seeking to understand broader patterns of wildfire activity and its relationship to management actions across Colorado.

Stephanie Mueller: Conceptualization, Methodology, Data Curation, Writing - Original Draft, Writing - Review and Editing.
Brett Wolk: Funding acquisition, Writing - Review and Editing, Supervision.

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Background and Overview

The Colorado Fire Perimeter Database was developed by the Colorado Forest Restoration Institute (CFRI) to catalog geospatial wildfire and prescribed fire perimeters occurring across all land ownerships in Colorado to address gaps and redundancies in the current spatial datasets, increase attribute consistency, and facilitate broader use and application of fire occurrence data.

Although several national datasets serve as authoritative sources of fire perimeter data, each have their own unique applications, and none are comprehensive of all current and historical fire information. Fire perimeters are often collected at the local level, and reporting standards, submission timelines, or database criteria for inclusion of fire data, such as minimum fire acreage or fire type, vary across the contributing agencies and databases systems. The existing datasets differ in naming conventions, attribute formats, and geographic completeness, which can limit their use for cross-boundary planning and ecological research.

To address these challenges, we compiled fire perimeter data from multiple sources and implemented a standardized schema to reconcile attribute fields such as fire name, ignition date, and fire type (Table 1). Each source was assigned a priority level for inclusion of data based on spatial accuracy, attribute completeness, and institutional authority. This framework facilitated identifying duplicate or overlapping perimeters to create one standardized dataset of fire occurrence across Colorado.

The database is intended for use by land managers, researchers, and policy makers to support strategic fire response planning, fuel treatment effectiveness monitoring, and statewide fire history trends. In particular, data on wildfire interactions with land management activities, watersheds, and the wildland-urban interface (WUI), among others, are critical for improving our understanding of wildfire outcomes across diverse landscapes to help our communities better live with fire.

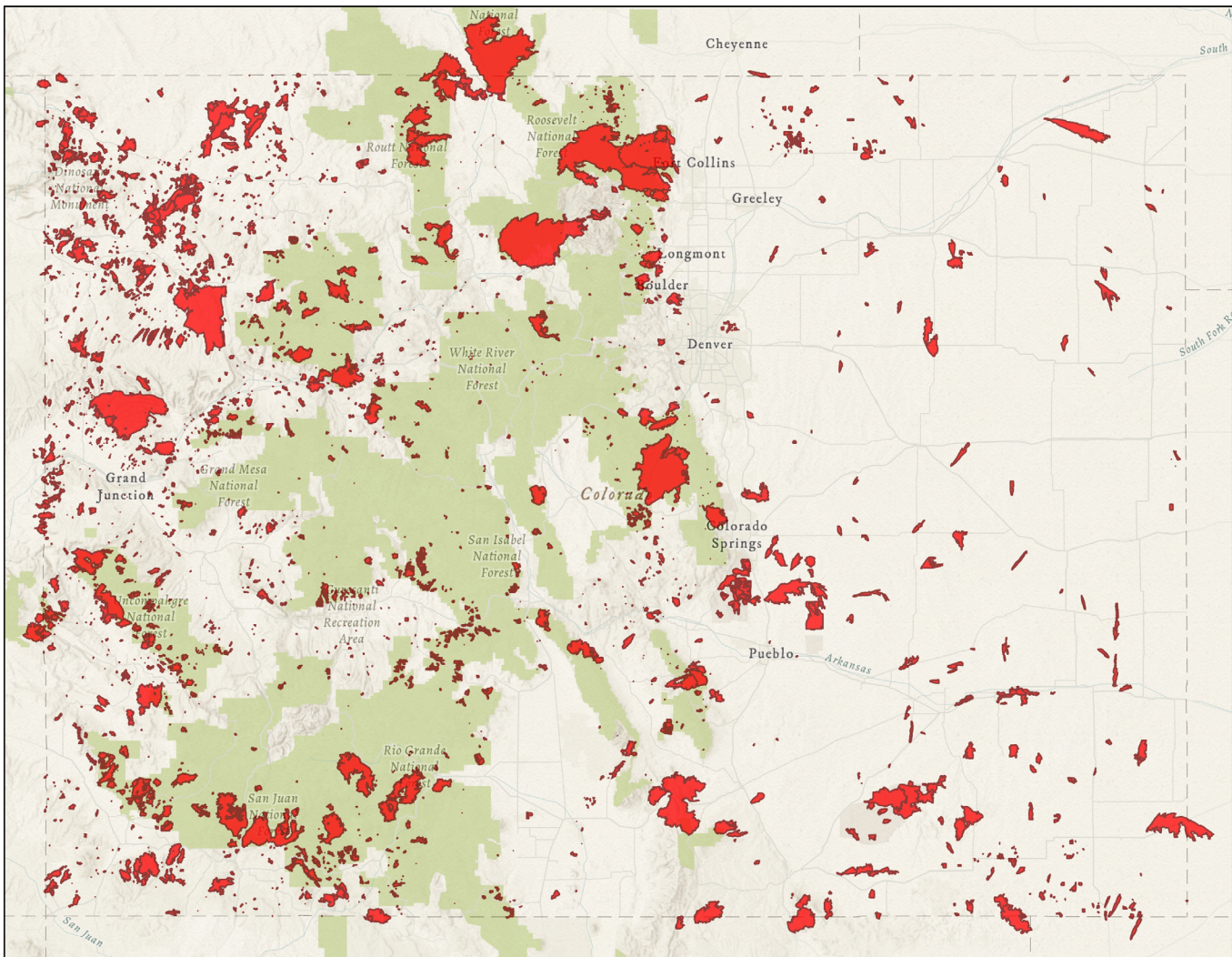


Figure 1: Overview map of fire perimeters in Colorado from 1984 to 2024.

Methods

Data Collection

To construct a comprehensive and consistent spatial database of fire perimeters in Colorado, we compiled fire perimeter data from six sources reported by multiple agencies with varied naming conventions, attribute formats, and spatial accuracy. To ensure consistency, a

standardized schema was developed along with a set of source-specific rules to extract key information, such as fire name, discovery date, and fire type, into a single database schema (Table 1).

Duplication of perimeters across datasets and even within datasets was common. This includes exact geometry duplicates and ‘fuzzy’ duplicates, where perimeter boundaries differ slightly for the same fire

Table 1. List and description of Colorado Fire Perimeters 1984-2024 database attributes.

Name	Alias	Description
Fire_ID	Fire Identifier	Fire_ID is based on the methods for the Event-ID field in MTBS. If the fire perimeter has an MTBS Event-ID, Fire_ID was extracted from MTBS Event-ID. Otherwise, the Fire_ID is generated by combining several attributes taken from the fire ignition location and start date. It is constructed from the two-letter state abbreviation, the decimal degree latitude and longitude (6 and 5 digits, respectively, without periods), and the start date formatted as YYYYMMDD (e.g., CO2672909780020110102).
Fire_Name	Fire Name	Name of the fire. NULL if not identifiable from source fire datasets.
Fire_Label	Fire Label	Fire name edited for mapping purposes.
Year	Year	The calendar year the fire occurred.
StartMonth	Start Month	The month the fire started.
StartDay	Start Day	The day the fire started.
Fire_Type	Fire Type	Documented type of fire: wildfire, prescribed fire, or undetermined.
GIS_Acres	GIS Acres	Total area of fire polygon in acres as calculated in Arc-GIS.
Agency	Agency	The agency having land and resource management responsibility for an incident as provided by federal, state or local law.
Source	Source	The originating source of the perimeter.
Source_ID	Source Identifier	Unique identifier assigned by the highest priority source database. Not all sources assign a unique ID to each perimeter.

perimeter. To resolve the duplication issue, each dataset was assigned a priority tier based on completeness, spatial accuracy, and agency source: MTBS perimeters were prioritized first because they are derived from satellite imagery and independently validated for accuracy; NIFC's databases were prioritized second and third as the primary federal authority for interagency fire coordination and perimeter reporting; historic perimeters from GeoMAC, although no longer updated, were retained as a valuable static record; and statewide vegetation treatment databases for the Forest Service and Bureau of Land Management were incorporated to capture prescribed fire perimeters that are often absent from wildfire-only sources. When overlapping perimeters were detected, data from higher-priority sources was prioritized and retained, while missing attribute data were supplemented using the best available information from lower-priority sources.

From the two federal vegetation treatment datasets, only vegetation treatments classified as prescribed fire and broadcast burning or similar spatially extensive burning activities were included. Prescribed fire or broadcast burning refers to the intentional application of fire across a defined area to meet management objectives, whereas wildfire refers to unplanned ignitions that spread across the landscape and are mapped as fire perimeters. Pile burning treatments were excluded because they consist of localized piles of concentrated fuels rather than continuous fire across an area and are therefore mapped as only treatment polygon boundaries rather than fire perimeters.

Data Sources

The following wildfire and prescribed fire perimeter sources were included, each with custom attribute mapping (Table 2). Sources are displayed in priority order:

1. MTBS - Monitoring Trends in Burn Severity National Dataset of Large Fire Perimeters

MTBS provides a comprehensive national dataset of burned area boundaries, mapping the extent of fire-affected landscapes across the United States using Landsat and Sentinel-2 satellite imagery (Eidenshink et al. 2007). By applying consistent satellite-based methods, MTBS ensures continuity and validation in the mapping and characterization of large fires through time. The dataset includes perimeters for all MTBS-mapped fires from 1984 to the present but is limited to

large wildfires (≥ 404 hectares in the western U.S.). MTBS data are updated quarterly; however, because severity mapping requires imagery from the calendar year following a fire, the dataset is typically one year behind in availability.

Access dataset: [MTBS Direct Download](#) (MTBS, 2024).

2. NIFC WFIGS – WFIGS Current Interagency Fire Perimeters

This dataset provides the most up-to-date fire perimeter data from 2021 to the present. It is actively being updated with new fire perimeters as they become available. WFIGS compiles fire perimeter data from multiple federal agencies, ensuring consistency and accuracy in fire mapping.

Access dataset: [NIFC WFIGS Current Interagency Fire Perimeters](#) (NIFC, 2024b).

3. NIFC Historical - Interagency Wildland Fire Perimeter History

This national dataset aggregates historical fire perimeter data from various federal agencies, including the USDA Forest Service, Bureau of Land Management, Bureau of Indian Affairs, Fish and Wildlife Service, and National Park Service. The dataset includes perimeters from all major federal land management agencies. In addition, many agencies are now using WFIGS as their authoritative source, beginning in mid-2020.

Access dataset: [NIFC Interagency Wildland Fire Perimeter History](#) (NIFC, 2024c).

4. GeoMAC - Historic Perimeters Combined 2000-2018 GeoMAC (Geospatial Multi-Agency Coordination Group)

GeoMAC was an internet-based mapping tool originally designed for fire managers to access online maps of current fire locations and perimeters in the US and were submitted to GeoMAC by field offices. This file contains fire perimeters that were processed by the GeoMAC team between 2000 and 2018.

Access dataset: [GeoMAC](#) (NIFC, 2024a).

5. BLM – BLM CO Completed Vegetation Treatments Polygons

This dataset represents the spatial extent of completed vegetation treatment areas and associated attribute information for the Bureau of Land Management in Colorado. Vegetation treatments in the dataset are classified by the general method applied to the treated area. For this project, we included only treatments classified as prescribed fire and applied as broadcast burns. Other treatment types, such as pile burns or non-fire activities, were excluded to ensure that the dataset reflects only relevant fire perimeters.

Access dataset: [BLM CO Completed Vegetation Treatments](#) (BLM, 2024).

6. USFS - Activity FACTS Common Attributes

The U.S. Forest Service's Forest Activity Tracking System (FACTS) is used to manage data on USFS-funded treatment activities across the agency. This dataset includes the locations of planned, ongoing, and completed treatments. Treatment records were filtered to include only relevant prescribed fire activities, such as broadcast burns, underburns, and other forms of broad-scale intentional burning. Other treatment types, such as pile burns or non-fire activities, were excluded to ensure that the dataset reflects only relevant fire perimeters.

Access dataset: [FACTS Common Attributes](#) (USFS, 2024).

Consolidation and Standardization of Fire Perimeter Data [1984–2024]

After mapping and translating attributes from multiple sources and merging fire perimeter datasets, we implemented a deduplication process to identify overlapping or redundant fire perimeters. To identify and resolve true duplicate fire perimeter features, we developed a geospatial process using Python. The process consisted of spatial proximity analysis, attribute standardization, and final consolidation into a single dataset.

First, perimeters that occurred in the same year were grouped based on spatial proximity, defined as overlapping or within 500 meters of each other. Within the grouped perimeters, if either the fire name or start date (month/day) matched, the perimeters were flagged as potential duplicates. Then, for each group of perimeters tagged as duplicates, we selected the best attribute values available based on a predefined priority system. The process sorted each group by dataset priority and fills in fields such as fire name, start date, and agency using the first available, non-null value from each source in priority order. For example, MTBS data does not include jurisdictional or responding agency as one of its attributes; however, WFIGS Interagency tracks this information for most of its perimeters. When a duplicate perimeter in MTBS was also found in WFIGS, the relevant attribute information was supplemented from this other data source in the final perimeter. Perimeters assigned as true duplicates were dissolved into a single final perimeter with each attribute populated using the most complete and accurate information available, prioritizing higher-ranked sources when multiple values were available.

Assigning Additional Attributes and Provenance Tracking

To ensure each fire perimeter could be uniquely identified and its original source(s) clearly documented, additional attributes were created. MTBS maintains a unique Event_ID for all of their mapped fires, which was retained when available. For fire records lacking an MTBS Event_ID, a Fire_ID was assigned following the same methodology, constructed from the fire's centroid coordinates and date (formatted as CO<latitude><longitude><YYYYMMDD>). This approach ensures that every fire in the database has a consistent and unique reference ID.

A Provenance_ID was also created to track which original records contributed to each single or merged perimeter. A provenance table was then generated, linking each Provenance_ID to its source dataset. This allows future users of the dataset to trace which source or sources contributed to each final perimeter.

Table 2. Field mapping of attributes from each source dataset to the standardized schema adopted in the Colorado Fire Perimeter Database. This mapping ensures consistent representation of key information such as fire name, year, and agency across datasets with differing formats and field definitions. The Priority field reflects the relative reliability or authority of each source and guided data selection during deduplication. MTBS = Monitoring Trends in Burn Severity; WFIGS Interagency = Wildland Fire Interagency Geospatial Services Interagency database; WFIGS Historical = Wildland Fire Interagency Geospatial Services Historical Fire database; GeoMAC = Geospatial Multi-Agency Coordination Group; BLM CO = Bureau of Land Management Colorado State office; USFS FACTS = United States Forest Service Activity Tracking System.

Attribute Name	MTBS	WFIGS Interagency	WFIGS Historical	GeoMAC	BLM CO	USFS FACTS
Priority	1	2	3	4	5	6
Fire_ID	Event_ID	N/A	N/A	N/A	N/A	N/A
Fire_Name	Incid_Name	poly_IncidentName	INCIDENT	incidentname	TRTMNT_NM	NAME
Fire_Label	Incid_Name	poly_IncidentName	INCIDENT	incidentname	TRTMNT_NM	NAME
Year	Ig_Date (year)	attr_FireDiscoveryDateTime (year)	FIRE_YEAR	fireyear	TRTMNT_START_DT (year)	DATE_COMPLETED (year)
StartMonth	Ig_Date (month)	attr_FireDiscoveryDateTime (month)	N/A	perimeterdatetime (month)	TRTMNT_START_DT (month)	DATE_COMPLETED (month)
StartDay	Ig_Date (day)	attr_FireDiscoveryDateTime (day)	N/A	perimeterdatetime (day)	TRTMNT_START_DT (day)	DATE_COMPLETED (day)
Fire_Type	Incid_Type	attr_IncidentTypeCategory	FEATURE_CA	'Wildfire'	"Prescribed Fire"	"Prescribed Fire"
Agency	N/A	attr_POOProtectingAgency	AGENCY	agency	"BLM"	"USFS"
SourceID	Event_ID	attr_UniqueFireIdentifier	UNIQUE_FIRE_ID	uniquefireidentifier	UNIQUE_ID	EVENT_CN

The script additionally attempts to refine fire name attributes by removing trailing text such as "Unit2" or "Unita, b" to consolidate and consistently label prescribed fire units that were spatially adjacent or overlapping. While this improves name standardization, some limitations remain where naming inconsistencies persist. For example, a prescribed fire led by the BLM in 2000 was recorded as 'Red Creek,' while the USFS, acting as an assisting agency, reported the same fire as 'PSFRXASST1' with a slightly different perimeter and start date. Such differences can prevent complete standardization of fire names across sources and therefore, correct merging of duplicate perimeters.

Finally, GIS-derived acreage values were calculated for all dissolved perimeters using geometry-based area calculations and added as an attribute in the database. These values reflect the final perimeter geometries, which may differ slightly from the original source perimeters due to the merging of overlapping or 'fuzzy' boundaries.

Results Summary

From the total number of fires from all databases (5,565), our cleaning and synthesizing resulted in a dataset of 3,319 unique fires (Table 3). The majority of

the fires burned as wildfires, 2,350 fires, with an additional 946 prescribed fire perimeters. Just under half of the perimeters are less than 100 acres, with a median size of 115 acres, but a mean of 1,379 acres due to the influence of a small number of large events. The 2020 Cameron Peak Fire, at 210,164 acres, was the largest wildfire in Colorado's history. Cumulatively, the total area of all fires since 1984 is over 4.6 million acres, encompassing approximately 4.0 million unique footprint acres impacted at least once by fire. About a half a million acres have burned more than once, with a small number of locations (280 acres) experiencing as many as five separate fire events. Together, these patterns illustrate how much fire is a common part of the Colorado landscape and the substantial landscape-scale impact of the largest wildfire years.

Data completeness and data limitations

The fire perimeter database is an ongoing effort to aggregate wildfire and prescribed fire across multi-jurisdictional boundaries in Colorado. However, achieving a fully comprehensive dataset remains challenging due to the variability in data collection methods and reporting standards among agencies. Incomplete and inconsistent spatial and attribute data exists in all current and historical perimeter datasets. Documentation of older wildfires, in particular, is less reliable and attribute data is increasingly sparse. Tracking prescribed fires introduced additional complications, as these events are often

inconsistently documented, reported at smaller spatial scales, or conflated with other management activities, leading to potential underrepresentation or omission of some prescribed fires. We chose to present the data as it is reported, without making modifications or assumptions about its accuracy as a minimum estimate of fire history in Colorado.

Data Maintenance and Availability

As needs persist and data continues to provide value, we intend to update and publish these data annually. The fire perimeter dataset is available to stream into ArcGIS Pro or an ArcGIS Online (AGOL) web map.

ArcGIS Rest Services URL: <https://csfs.maps.arcgis.com/home/item.html?id=59dbadec051d4fc0a4cee-bae703b23f>

A public Git Repository is available at <https://github.com/Colorado-Forest-Restoration-Institute/Fire-Perimeters-Severity>, containing Python scripts as described in the methods.

Table 3. Summary statistics for fire perimeters 1984 - 2024.

Total Fire Perimeters	3,319
Number of Wildfires	2,350
Number of Prescribed Fires	946
Average Fire Size	1,379 acres
Median Fire Size	115 acres
Largest Fire	Cameron Peak Fire - 210,164 acres
Total Area of all Fire Occurrences	4,577,261 acres
Total Footprint of Acres Impacted by Fire	4,017,294 acres

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