



Agency records of wildfires caused by firearms use in the United States

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ABSTRACT

While previously disputed as a plausible ignition source, civilian firearms use has emerged as a wildfire cause of concern in the United States (US). The National Wildfire Coordinating Group (NWCG) included it as a newly recognized fire cause in the wildfire-reporting data standard approved in 2020. Here we report on shooting-caused wildfire ignitions using data mapped over to the new NWCG cause standard from historical wildfire records spanning 1992–2018. This is the first time that data on shooting-related fires have been assembled and summarized for the US, with the intention of raising awareness concerning this relatively small but impactful cause of preventable wildfires.

Wildfires have many human causes that are broadly categorized to inform fire prevention programs in the United States (US) and elsewhere [1]. The categories used in individual fire reports and agency summaries reflect the major concerns of the time. Historical causes of concern, entered in US Forest Service (USFS) fire reports beginning in 1905, included debris burning, camping, arson/incendiarism, and railroads. Smoking and equipment use were added as wildfire causes in 1920 and 1960, respectively. Children and powerlines were added as general causes in 1970 [1]. A ‘miscellaneous’ category has historically been used for human-ignited fires that do not neatly fit the definitions of other general (i.e., statistical) causes.

While not historically tracked for statistical purposes, wildfires started by firearms use are increasingly reported by media and fire authorities in the US. Ordnance and small arms are well known causes of fires on military lands and often involve tracer or incendiary ammunition [2,3]. The possibility that civilian firearms use and commercial ammunition could be a significant source of wildfire ignitions had been debated until research revealed some physical mechanisms for ignition by black powder or muzzle loading rifles [4], conventional rifle bullets [5], and exploding targets [6]. In these cases, dry vegetation may ignite from the cotton ‘patch’ used with round-ball ammunition in muzzle loaders, steel or solid copper bullets from modern rifles after fragmenting against a hard target such as steel or rock, and the high temperature explosion and burning metal from pressure-sensitive mixtures of ammonium nitrate and aluminum powder. Recognizing its emergence as a cause of concern, the US National Wildfire Coordinating Group (NWCG) updated the fire-cause data standard in 2020 to include ‘firearms and explosives use’ as a general cause under the broader

human-source classification [7, Table 1].

Data that distinguish wildfires caused by firearms use are valuable for organizing and monitoring the effectiveness of fire prevention programs. Knowledge of the seasonal and geographic patterns of occurrence, for example, can be used to develop and disseminate information regarding safe firearms use and recommended target-shooting materials. It can also reveal conditions of weather and drought or other seasonal variables under which such fires are most likely. Recently, fire-prevention information regarding safe firearms use was highly publicized in the US state of Utah [8], leading to a two-thirds reduction in human-caused wildfires, including those from target shooting [9]. Here we report on shooting-caused wildfire ignitions using data mapped over to the new NWCG cause standard from historical wildfire records spanning 1992–2018. In anticipation of future implementation of the updated NWCG standard in fire-reporting applications, this report may serve as a baseline to frame subsequent characterization and monitoring of firearms-related wildfire trends in the US.

We summarized firearms-related wildfire data from the records contained in the fifth-edition Fire Program Analysis Fire-Occurrence Database (FPA FOD), which spans 1992–2018 [10,11]. The FPA FOD includes 2.2M geo-referenced wildfire reports from US federal, state, and local systems of record and accounts for ~67M hectares (ha) burned during the 27-year period. Because wildfires caused by firearms and explosives use have not been reported in any explicit, standardized manner historically, they appear as such under *General Cause* in the FPA FOD only if there was sufficient specific-cause detail or narrative information in the historical reports on which to base the attribution. The new NWCG data standard includes categories of *Specific Cause* and

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Table 1

Comparison of new (2020) NWCG standard to previously reported general causes under the human-cause classification [7]. General causes previously tracked for statistical purposes by may vary to some degree by agency prior to adoption of the 2020 NWCG standard. Current convention used by the National Association of State Foresters (NASF) is presented as a typical example.

NASF General Cause	NWCG Standard General Cause
Arson (incendiarism)	Arson (incendiarism)
Campfire	Recreation and ceremony
Children	Misuse of fire by a minor
Debris burning	Debris and open burning
Equipment use	Equipment and vehicle use
Fireworks	Fireworks
Miscellaneous	Other causes
Powerline	Power generation/transmission/distribution
Railroad	Railroad operations and maintenance
Smoking	Smoking
Structure	Other causes ^a
	Firearms and explosives use ^b

^a Structure is now a Specific Cause under Other causes.

^b Firearms and explosives use is a new category of General Cause in the 2020 NWCG standard.

Table 2

NWCG standard for reporting wildfires caused by firearms and explosives use [7].

Cause Classification	General Cause	Specific Cause	Specific Cause Detail
Human	Firearms and explosives use	Black powder/muzzle loading	All-lead projectile
		Blasting	Copper-jacketed projectile
		Exploding target shooting	Solid copper projectile
		Flares/fusees	Steel component projectile
		Inert target shooting	Tracer/incendiary projectile
		Military ordnance	Other (remarks required)
		Non-military tracer	Unknown (remarks required)
		Other explosives	
		Other (remarks required)	
		Unknown (remarks required)	
		Unspecified shooting (for historical mapping only)	

Specific Cause Detail nested under each *General Cause* (Table 2), but those levels are not included in the published FPA FOD due to the haphazard level of detail in the historical data (e.g., see Table 3). However, we did the data mapping to *Specific Cause* where possible for this exercise. Due to historical reporting idiosyncrasies, we cannot provide a full accounting of wildfires caused by firearms and explosives use over the analysis period. Instead, we provide a necessarily conservative accounting that still allows for the first exploration of patterns and trends in shooting-related fire events across the US.

Ninety-two percent of the fires in the fifth-edition FPA FOD [11]

Table 3

Examples of specific-cause detail or narrative information in the historical fire reports on which the Specific Cause attribution was based for this analysis. All were mapped to the new General Cause of firearms and explosives use.

Original report General Cause	Original report detail	Specific Cause assigned
Incendiary	Muzzle loaded rifle emission	Black powder/muzzle loading
Incendiary	Blasting	Blasting
Incendiary	Shooting binary target	Exploding target shooting
Miscellaneous	Firearms use against an explosive device	Exploding target shooting
Recreation	Explosive material was shot at in a duffy stump	Exploding target shooting
Incendiary	Flares used in survival training for kids at camp	Flares/fusees
Miscellaneous	Suspect shot two flare/parachutes into the air	Flares/fusees
Equipment Use	People were target shooting with rifles	Inert target shooting
Incendiary	Shrapnel from target practicing	Inert target shooting
Miscellaneous	Steel core ammo on rocks (target shooting)	Inert target shooting
Recreation	Recreational shooting w/1/2 case steel rounds	Inert target shooting
Debris Burning	Military artillery	Military ordnance
Equipment Use	Laser precision bomb	Military ordnance
Incendiary	60 mm mortar	Military ordnance
Miscellaneous	155 mm high explosive field artillery round	Military ordnance
Incendiary	Farmer firing tracer rounds to scare off birds	Non-military tracer
Miscellaneous	Men shooting tracer bullets	Non-military tracer
Recreation	Tracer round fired into timber	Non-military tracer
Incendiary	Smoke bombs	Other explosives
Miscellaneous	Explosive device, not fireworks or pipebomb	Other explosives

have a human or natural cause attributed, with 84% reported as human-caused (highest tier *Cause Classification*; see Table 2). Of the human-caused fires that could be assigned a *General Cause* from the source information, only 0.2% (2226) were placed in the new firearms and explosives use category (Fig. 1).

Of the 2226 fires assigned a *General Cause* of firearms and explosives use, half were given a *Specific Cause* of military ordnance, while 40% were attributed to target shooting (787 or 35% from shooting at inert targets; 102 or 5% from exploding targets; Fig. 2).

Without the option of firearms and explosives use as a *General Cause*, fires started by target shooting, for example, traditionally had causes most often labeled as arson/incendiarism, equipment use, or miscellaneous/other (e.g., see Table 3). Because the specific cause detail required to identify shooting-related fires in the historical reports is rare, any assessments – including ours – necessarily underestimate actual occurrence.

However conservative, our estimates indicate that most wildfires caused by target shooting occurred in the western US. The number of fires caused by shooting at inert targets has apparently increased since the 1990s, with an apparent peak in 2012 (Fig. 3). States with the most fires reported as caused by shooting inert targets were – in descending order – California, Utah, Idaho, and Nevada (Fig. 4). The largest fire reported as from inert target shooting was the 2017 Detwiler fire in California (Table 4), which burned 33,114 ha and 131 structures,

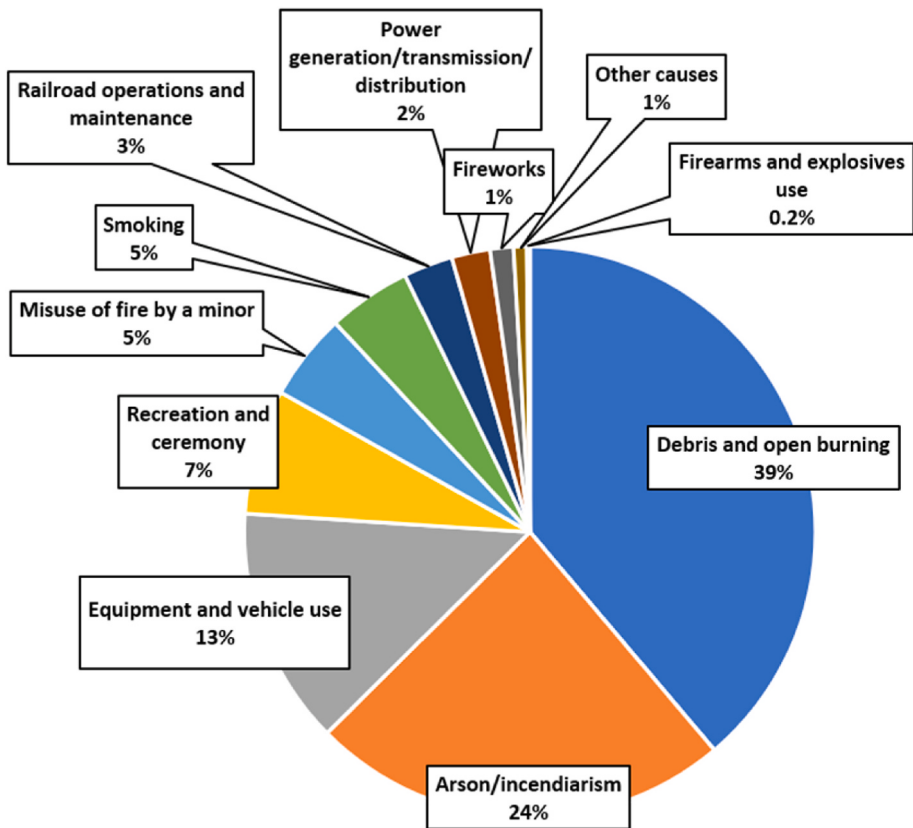


Fig. 1. Of the human-caused wildfires that could be assigned a *General Cause* from the source information, only 0.2% (2226) were placed in the firearms and explosives use category in the fifth-edition FPA FOD [11].

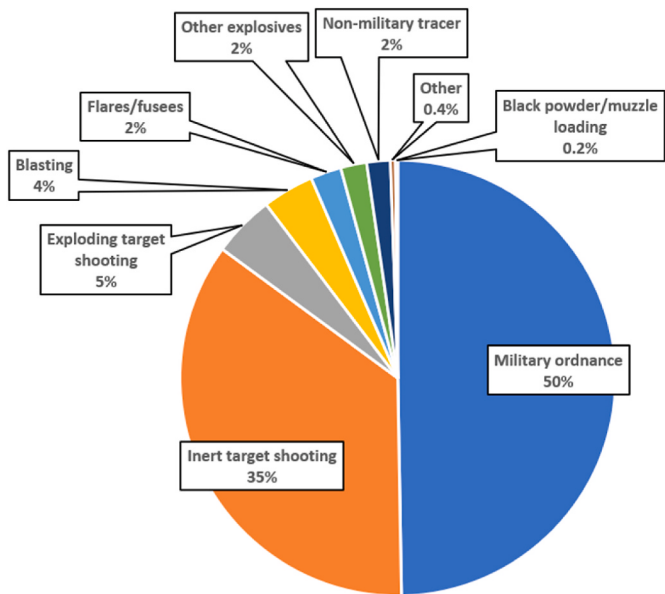


Fig. 2. Of the 2226 wildfires assigned a *General Cause* of firearms and explosives use, half were given a *Specific Cause* of military ordnance, while 40% were attributed to target shooting.

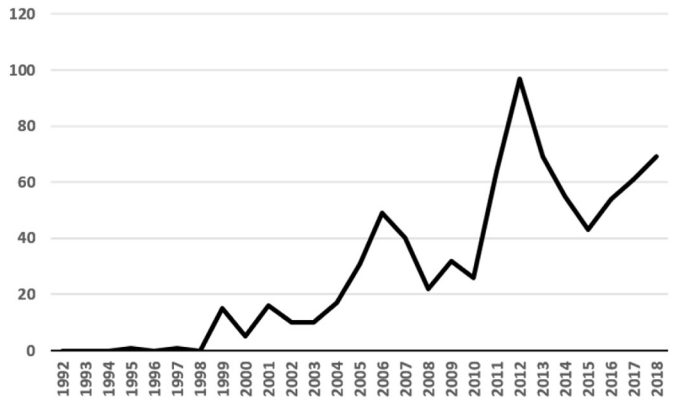


Fig. 3. Number of wildfires caused by shooting at inert targets from the final fire reporting data by year, 1992–2018.

including 63 homes and one business. Very few fires caused by exploding targets were discernable in the final fire reporting data prior to 2011 (Fig. 5). The top four states for numbers of fires reported as caused by shooting at exploding targets were – in descending order – Idaho, Utah, California, and Colorado (Fig. 6). The largest fire reported as from exploding target shooting was the 2018 Sharps fire in Idaho (Table 5), which burned 26,207 ha and cost over \$9M (USD) to extinguish.

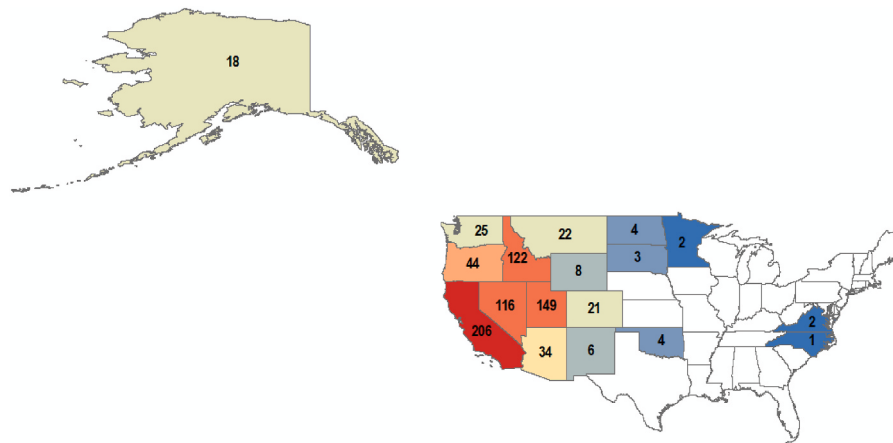


Fig. 4. Count of wildfires reported as caused by shooting at inert targets by state, 1992–2018.

Table 4

Fires ≥ 2023 hectares (5000 acres) reported as caused by shooting at inert targets, 1992–2018.

Year	State	Fire Name	Hectares burned
2017	CA	Detwiler	33114
1997	CA	Logan	20028
2008	CA	Telegraph	13796
2002	CA	Wolf	8759
2016	WA	Black Rock Road	6477
2018	CA	Pawnee	6146
2014	WA	Watermelon Hill	4270
2018	UT	Lakeside	3998
2005	ID	South Black	3378
2000	UT	Tenmile Pass	2374
2014	OR	36 Pit	2229

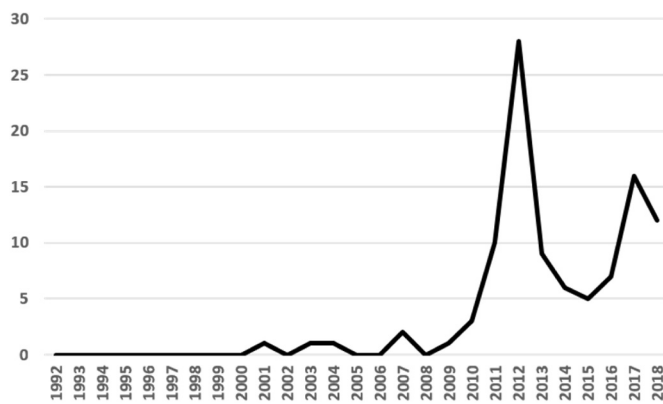


Fig. 5. Number of wildfires caused by shooting at exploding targets discernable in the final fire reporting data by year, 1992–2018.

Compared to all other sources, wildfires caused by firearms use are relatively rare but can inflict significant damage during periods of high fire danger [see 12]. Ninety-one percent of shooting-caused fires ≥ 121 ha in the 11 continuous western states ignited during the relatively warm and dry months of May–October, for example (Fig. 7).

The apparent uptick in firearms-caused fires during recent decades is open to several interpretations. First, the ambiguous fire-cause

categories in the traditional fire reporting systems [1] undoubtedly underrepresent the incidence of firearms-related wildfires and may even exaggerate the recent increase. A positive feedback cycle of greater news reporting on firearms involvement in wildfires since the peak in 2012 (Fig. 3) has led to more research [5,6] and thus greater awareness that this phenomenon was possible. Newly approved NWCG standards for fire reporting [7] will continue to elevate awareness. Second, the popularity of semi-automatic rifles ('modern sporting rifles' e.g., AR-15, AK-47) has increased dramatically during this period [13], along with demand for inexpensive imported ammunition with steel-jacketed or steel-core projectiles (military surplus). Traditional rifle bullets for hunting are made of lead with copper jackets and are much less likely to cause ignitions than those made with steel [5]. Semi-automatic magazine-fed military-pattern rifles can rapidly shoot far more rounds than bolt action or lever action rifles. Third, exploding targets are relatively recent commercial products, appearing in the early-2000s and are thus newly available ignition sources.

The relative abundance of shooting-caused fires in western versus eastern US landscapes may be related to fuel ignitability, but land ownership differences and fire-reporting idiosyncrasies are also important factors to consider. There is far more public land in the West, where target shooting is generally allowed (e.g., under jurisdiction of the USFS, Bureau of Land Management (BLM), Fish and Wildlife Service), and where fire causes are investigated and reported consistently. Specific fire-cause details associated with such activities have been included in free-text fields in final fire reports of the federal agencies, making it more likely to find fires attributed accordingly from public lands. Firing tracer bullets or incendiary ammunition has always been prohibited on public lands, and exploding targets are banned on most USFS lands and subject to seasonal restrictions on other ownerships. For example, exploding targets are banned on BLM and State land in Idaho from 10 May through 10 October due to fire risk. Most public lands are subject to seasonal closure to all target shooting when conditions become very dry. Under Stage 2 fire restrictions it is prohibited to discharge a firearm, air rifle, exploding targets or gas gun except while engaged in a lawful hunt pursuant to state, federal or tribal laws and regulations.

In summary, wildfires caused by firearms use in the US are ostensibly rare but could be rarer with future prevention programs informed by data that should become more complete and reliable as the new NWCG fire-reporting cause standard sees widespread use.

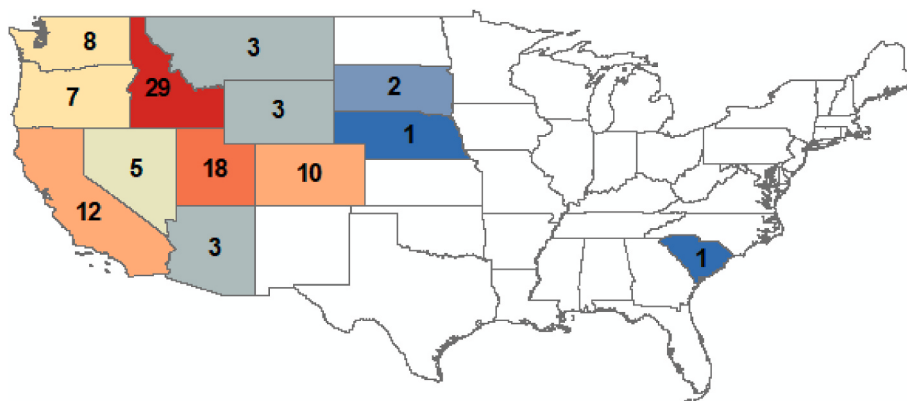


Fig. 6. Count of wildfires reported as caused by shooting at exploding targets by state, 1992–2018.

Table 5

Fires ≥ 2023 hectares reported as caused by shooting at exploding targets, 1992–2018.

Year	State	Fire Name	Hectares burned
2018	ID	Sharps	26207
2017	AZ	Sawmill	19017
2011	UT	Lakeside	6583
2012	WA	Goat	2986
2017	OR	Ana 238	2377
2012	UT	Dump	2229

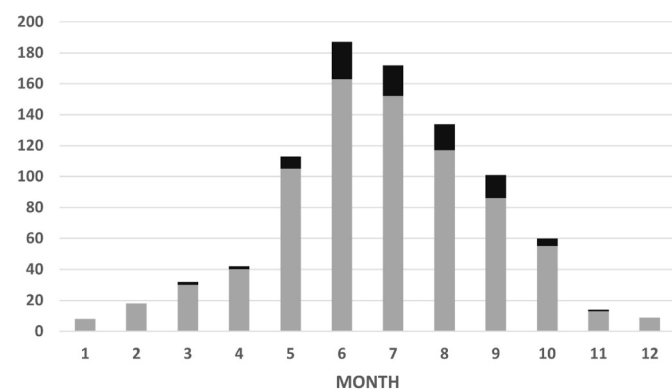


Fig. 7. Number of target-shooting wildfires by ignition month. Black segments represent the subset of fires in the 11 conterminous western states ≥ 121 ha. Ninety-one percent of the latter ignited May–October.

Author statement

KCS and MAF: Conceptualization; Methodology; Writing – original draft, review, and editing; KCS: Data curation, Analysis, and Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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