Wildfire Report Series

An Analysis of NFIRS Data for Selected Wildfires Including Impacts in Wildland Urban Interface Areas

Executive summary

This analysis compares the publicly reported loss metrics (e.g., deaths, injuries, dollar losses and acres burned) from media and government sources for 6 named wildfires between 2016 and 2018 with the data reported by local fire departments to the National Fire Incident Reporting System (NFIRS). The 6 wildfires were selected by the U.S. Fire Administration (USFA) to reflect a diversity of wildland urban interface (WUI) conditions, land management responsibilities, locations, terrains and climates:

- Chimney Tops 2, Tennessee, 2016.
- Northwest Oklahoma Complex, Oklahoma/Kansas, 2017.
- West Mims, Georgia/Florida, 2017.
- Spring Creek, Colorado, 2018.
- Woolsey, California (Southern), 2018.
- Camp, California (Northern), 2018.

Overall, the data in the NFIRS for these wildfires significantly understates the publicly reported losses except for acres burned, which was often overreported in the NFIRS (Table 1).

Table 1: Loss metrics

	Metric	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp[1]
Public sources	Deaths	14[a]	2[b]	0	0	3[c]	85[d]
	Injuries	191[e]	0	0	0	3[f]	13[g]
	Dollar loss ($M)	922.0[h]	64.6[i,j]	38.2[k]	8.2[l]	2,930.0[m]	8,470.0[n]
	Acres burned	17,140[o]	782,333[p]	152,515[q]	108,045[r]	96,949[s]	153,336[t]
ICS-209[u,2]	Deaths	14	2	0	0	3	85
	Civilian injuries	134	5	0	0	0	0
	Responder injuries	5	2	8	10	3	3
	Acres burned	17,140	779,292	152,515	108,045	96,949	153,336
NFIRS	Deaths	12	0	0	0	0	0
	Injuries	3	0	0	0	0	9
	Dollar loss ($M)	303.4	1.6	0.3	0.0	7.0	0.8
	Acres burned	5,935	1,134,623	1,976,030	0	377,308	608,694

Sources: USFA analysis of NFIRS and National Interagency Fire Center (NIFC) data.

[a]Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News.* www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/
[b]Associated Press. (2017, March 7). Officials: Harper County woman died while fighting fire on her farm. *Fox 25*. okcfox.com/news/local/officials-harper-county-woman-died-while-fighting-fire-on-her-farm
[c]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents

[1]Losses from NFIRS-reported incidents immediately preceding and following the ignition and containment dates/times for the Camp wildfire are summarized in Appendix A: Incidents in Expanded Time Range.
[2]Form ICS-209 is the Incident Status Summary report filed daily by the Incident Management Team (IMT) assigned to the wildfire. The IMT may consist of federal, state and local fire departments depending on the severity of the incident. ICS-209 forms are filed with the Geographic Area Coordination Center (GACC) that has jurisdiction over the fire.

FEMA | U.S. Fire Administration
Working for a fire-safe America

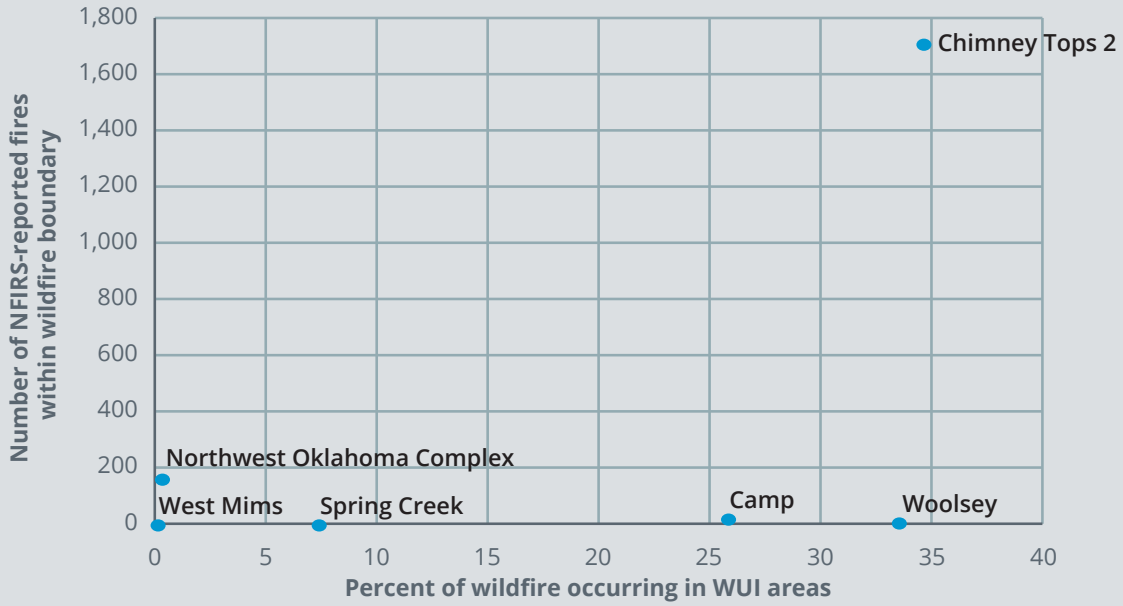
National Fire Data Center
16825 S. Seton Ave.
Emmitsburg, MD 21727
usfa.fema.gov

[d]CAL FIRE. (2019, November 15). *2018 Incident Archive — Camp Fire.* www.fire.ca.gov/incidents/2018/11/8/camp-fire/
[e]Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News.* www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/
[f]Holland, E. (2018, November 28). $6 billion in real estate destroyed in Woolsey fire: Report. *Patch.* patch.com/california/malibu/6-billion-real-estate-destroyed-woolsey-fire-report
[g]Sernoffsky, E. (2018, November 15). Five firefighters among dozen-plus patients burned in Camp fire. *San Francisco Chronicle.* www.sfchronicle.com/california-wildfires/article/Five-firefighters-among-dozen-plus-patients-13396604.php
[h]Ahillen, S. (2017, August 9). Tennessee mountain community getting back on its feet after devastating wildfire. *Insurance Journal.* www.insurancejournal.com/news/southeast/2017/08/09/460619.htm
[i]Legislative Division of Post Audit. (2018). *Performance audit report: Kansas wildfire management: Evaluating the adequacy of Kansas' wildfire suppression system.* State of Kansas. www.kansasforests.org/fire_management/fire_docs/Final_Report.pdf
[j]Oklahoma Farm Report. (2017, March 25). Oklahoma State extension says over sixteen million dollars in losses to agriculture as a result of Northwest Oklahoma Fire Complex. *Radio Oklahoma Network.* www.oklahomafarmreport.com/wire/news/2017/03/01349_OSUExtensionCostEstimate03252017_112959.php#.YFOQpC2cbOQ
[k]Bates, C. (n.d.). *Wildfire damage assessment for the West Mims fire.* Georgia Forestry Commission. gatrees.org/wp-content/uploads/2020/02/Wildfire-Damage-Assessment-for-the-West-Mims-Fire.pdf
[l]Craddock, M. (2018, July 26). Property losses in Huerfano County top $8.2 million from Spring fire. *World Journal.* worldjournalnewspaper.com/property-losses-in-huerfano-county-top-8-2-million-from-spring-fire/
[m]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal*. www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[n]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[o]Badger, S. G. (2017, November, December). Large-loss fires in the United States in 2016. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-Media/NFPA-Journal/2017/November-December-2017/Features/Large-Loss-Fires-2016
[p]Oklahoma Forestry Services. (2017, March 21). *Fire situation report — March 21, 2017.* Oklahoma Department of Agriculture, Food and Forestry. www.forestry.ok.gov/fire-situation-report-–-march-21-2017
[q]U.S. Fish and Wildlife Service. (n.d.). Southeast Region Fire Division report FY2017. www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf
[r]KOAA News5. (2018, September 10). Spring fire now officially 100 percent contained. www.koaa.com/news/covering-colorado/2018/09/10/spring-fire-now-officially-100-percent-contained/
[s]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[t]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[u]National Fire and Aviation Management Web Applications. *SIT/209 Historical* [Data set]. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

For 3 of the wildfires — Chimney Tops 2, Woolsey and Camp — over one-quarter of the area affected by the fire was WUI. For purposes of this report, WUI areas are defined as census tracts where housing density is greater than 1 housing unit per 40 acres and either half the census tract is vegetation or it is within 1.5 miles of a large area (over 1,235 acres) that is at least 75% vegetated.[3] Notably, the number of fire incidents reported to the NFIRS had no relationship to the share of the affected area that was WUI. In other words, wildfires with high WUI shares may be expected to have a larger number of NFIRS reports, but this was not the case (Figure 1).

[3]Stewart, S. I., Radeloff, V. C., Hammer, R. B., & Hawbaker, T. J. (2007, June). Defining the wildland–urban interface. *Journal of Forestry, 201-207.* silvis.forest.wisc.edu/wp-content/uploads/2018/10/Stewart-et-al-JOF-2007.pdf

Figure 1: Relationship between WUI and number of NFIRS-reported fires



Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

Within the wildfire boundaries of the Chimney Tops 2, Woolsey and Camp fires, most of the NFIRS-reported incidents were from within WUI areas (Table 2). This reinforces the principle that extra attention should be placed on planning for wildfires in WUI areas. However, in the Woolsey and Camp fires, far more incidents were reported to NFIRS from outside the wildfire boundary. Some of these incidents may have actually occurred within the wildfire boundary but lacked precise address information for accurate geocoding. Others — particularly emergency medical services (EMS) and other incidents — may have been service calls related to the wildfire.

Table 2: NFIRS incidents in WUI areas and overall for selected wildfires

Incident type	Chimney Tops 2[a]			Woolsey			Camp		
	In WUI	Within boundary	All incidents	In WUI	Within boundary	All incidents	In WUI	Within boundary	All incidents
Fire	1,700	1,708	2,076	12	14	128	17	18	67
EMS	3	3	183	75	87	989	11	13	478
Other	26	35	213	97	112	784	21	21	271

Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

[a]For the Chimney Tops 2 wildfire, 1,607 incidents were geocoded within WUI areas based on their ZIP codes. More accurate location information may have placed these incidents in other locations.

This analysis compares how each of the wildfires was reported by local fire departments in the NFIRS. Each wildfire is reported quite differently:

- Chimney Tops 2: 98% of the NFIRS incidents from within the fire boundary were fires, and nearly all of these were exposure fires from a natural vegetation fire. There were nearly 2,500 NFIRS reports for this wildfire from over 50 different fire departments. Most of the exposure fire reports were identical except for the amount of property loss.
- Northwest Oklahoma Complex: Similar to Chimney Tops 2, 96% of the NFIRS incidents from within the fire boundary were fire incidents, and this wildfire also included a significant number of exposure reports. While there were fewer reports than Chimney Tops 2 overall (330 total) from a similar number of fire departments, they did not complete the optional fields in the Fire module to the same degree. Also, "property loss" was frequently left blank.

- West Mims: Most of the fire boundary was within the Okefenokee National Wildlife Refuge, under the jurisdiction of the U.S. Fish and Wildlife (FWS) Service. As such, there were only 2 NFIRS reports for this fire from within the fire boundary. Outside the fire boundary, the Fire module was used by local fire departments to report additional information about a number of fires despite the fact that a majority of those fires were natural vegetation fires where the Wildland Fire module could have been used.
- Spring Creek: The Spring Creek fire had the fewest NFIRS reports among the 6 wildfires. Portions of this fire occurred in areas managed by the Bureau of Land Management (BLM), which does not contribute data to the NFIRS. It also appears that a portion of this fire fell within the jurisdiction of a nonreporting local fire department, where most of the damaged and destroyed structures were located. In addition, all the fires that were reported to the NFIRS for the Spring Creek wildfire used the Wildland Fire module.
- Woolsey: The primary responsibility for combating fires in California is divided between federal, state and local authorities based on geographic area. A significant portion of the area affected by this wildfire (including WUI areas) was outside local direct protection areas. Only 7% of the NFIRS incidents recorded for the Woolsey fire were fires, including 1 natural vegetation fire where 616 buildings were involved. Only 44 structure or mobile property used as fixed structure fires were reported in NFIRS. The majority of incidents for the Woolsey fire in NFIRS were EMS, Good Intent and Service Calls, including 248 incidents that were canceled en route.
- Camp: Like the Woolsey fire, much of the affected area was outside the local direct protection area, including large WUI areas. One-third of the NFIRS incidents from within the wildfire boundary were fires, with a significant number of EMS and Service Call incidents. Public reports state that 85 lives were lost in the Camp fire, and that nearly 19,000 structures were damaged or destroyed. There are only 8 NFIRS reports for fires in structures or mobile property used as fixed structures associated with the Camp fire, and only 2 of those occurred within the wildfire boundary. No NFIRS reports list any fatalities.

Based on this analysis, it is recommended that the USFA provide clear guidance to local fire departments regarding how to report incidents that are related to wildfires. With the current NFIRS form, it appears that there are 2 options listed below. Neither option, however, adequately addresses the challenges of multijurisdictional response and data from NFIRS nonreporters.

- Using the Wildland Fire module, a department can report the wildfire as a natural vegetation fire and indicate how many buildings were involved in the fire. It can report property and contents losses as well as deaths and injuries in the Basic Incident module. It can specify location information using the U.S. National Grid. This approach, however, cannot capture vehicle, nonbuilding structure or mobile property used as fixed structure fires, and it does not capture any granular detail about those fires.
- Using the Fire and Structure Fire modules, a department may report a natural vegetation fire and exposure fires for each structure or vehicle that is damaged by the wildfire. This approach allows local departments to capture detailed information by completing an NFIRS report for each instance of damage. However, this is a considerable amount of data to collect and enter. It also strains the understanding of NFIRS as a system used to record information about incidents to which a fire department responded. If a department was able to respond to the natural vegetation fire but was unable to make any effort to combat exposure fires, it is unclear whether the department "responded" to the exposure fires or not.

USFA should consider the data it wants to collect regarding wildfires and determine which of the approaches above comes closest to its goals.

Recommendations include:

- Define a new NFIRS form that captures the most salient details for each property affected by a wildfire (e.g., incident type, property use, property and contents loss, location, wildfire perimeter, casualties, and selected data elements from the Fire module) as an appendix to the Wildland Fire module (augmenting the Buildings Involved field).
- Consider using the Special Study field as a way to denote which NFIRS incidents are related to named wildfires and should encourage the use of the U.S. National Grid as a way of identifying location, regardless of whether street address information is available.

This analysis revealed that none of these 6 wildfires were thoroughly reported to the NFIRS. Discrepancies between the loss metrics reported by the media and those in NFIRS are significant. While some of this discrepancy can be explained by the role of NFIRS nonreporters, there are also issues with the comprehensiveness of the NFIRS reports that were submitted. Local fire departments appear to follow different protocols for using NFIRS (e.g., reporting exposure fires, choosing between the Fire and Wildland Fire modules, and completing optional data elements). USFA guidance on the best practices for collecting wildfire-related data (accompanied, if necessary, by changes to the NFIRS itself) could improve how data is captured for future wildfires.

Wildfire comparison

Introduction

This analysis examines 6 notable wildfires from 2016 to 2018 and compares publicly reported loss metrics for each one to data reported by responding fire departments in the NFIRS. The goals of the analysis are to assess the completeness of NFIRS reporting and to examine variations in how each of the wildfires was reported in the NFIRS.

Table 3: Wildfires selected for analysis

Wildfire	State(s)	Dates
Chimney Tops 2	Tennessee	Nov. 23 to Dec. 21, 2016[a]
Northwest Oklahoma Complex	Oklahoma, Kansas	March 6 to 21, 2017[b]
West Mims	Georgia, Florida	April 6 to June 11, 2017[c]
Spring Creek	Colorado	June 27 to Sept. 10, 2018[d]
Woolsey	California (Southern)	Nov. 8 to 21, 2018[e]
Camp	California (Northern)	Nov. 8 to 25, 2018[f]

[a]National Fire and Aviation Management Web Applications. (2017). SIT/209 Historical, CY 2016 [Data set]. Incident Number TN-GSP-016062. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]National Fire and Aviation Management Web Applications. (2018). SIT/209 Historical, CY 2017 [Data set]. Incident Number OK-OKS-000529. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[c]National Fire and Aviation Management Web Applications. (2018). SIT/209 Historical, CY 2017 [Data set]. Incident Number OK-OKS-000529. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[d]National Fire and Aviation Management Web Applications. (2019). SIT/209 Historical, CY 2018 [Data set]. Incident Number CO-CTX-001266. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[e]National Fire and Aviation Management Web Applications. (2019). SIT/209 Historical, CY 2018 [Data set]. Incident Number CO-CTX-001266. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[f]National Fire and Aviation Management Web Applications. (2019). SIT/209 Historical, CY 2018 [Data set]. Incident Number CO-CTX-001266. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

The wildfires selected by the National Fire Data Center (NFDC) for this analysis were chosen to reflect a variety of locations, terrains and climates. They were not selected randomly; the findings from this analysis may not be representative of wildfires overall.

The objectives of this analysis were to:

- Develop a method for identifying incidents in the NFIRS that are associated with wildfires.
- Evaluate the completeness of the NFIRS reports for each wildfire.
- Compare the NFIRS reporting for each wildfire to both publicly reported sources and to each other.
- Develop recommendations to improve data collection for wildfires in the NFIRS.

The wildfires selected for this analysis were generally large wildfires (4 of the 6 consumed more than 100,000 acres, 1 burned over 95,000 acres, and the remaining wildfire burned approximately 17,000 acres) but were also selected for their diversity of WUI composition, land management responsibility, terrain and geographic location.

- A large proportion of the area affected by 3 wildfires (Chimney Tops 2, Woolsey and Camp) was WUI; the WUI proportion of the other 3 fires (Northwest Oklahoma Complex, West Mims and Spring Creek) was much smaller.
- 2 of the fires (Chimney Tops 2 and West Mims) occurred predominantly in lands maintained by the federal government. For 3 others (Spring Creek, Woolsey and Camp), approximately one-fifth of the fire occurred on federal land, and no part of the Northwest Oklahoma Complex wildfire occurred on federal land. One-third of the Woolsey fire occurred on state or local (city/county) land (Table 4).
- 4 of the wildfires occurred in mountainous areas (Chimney Tops 2, Spring Creek, Woolsey and Camp), while the Northwest Oklahoma Complex fire occurred in grasslands and the West Mims fire occurred in the Okefenokee Swamp.
- 3 of the fires (Chimney Tops 2, Northwest Oklahoma Complex[4] and West Mims) occurred in the Southern Area Coordination Center region, while each of the others was the only fire examined within its region (Spring Creek: Rocky Mountain Area Coordination Center; Woolsey: Southern California Geographic Coordination Center; Camp: Northern California Geographic Coordination Center).

Table 4: Land management for selected wildfires

Wildfire	Federal	State	Local (city/county)	Private	Total
Chimney Tops 2	63%			37%	100%
Northwest Oklahoma Complex		4%		96%	100%
West Mims	78%	1%		21%	100%
Spring Creek	20%	4%		76%	100%
Woolsey	21%	17%	16%	46%	100%
Camp	23%	2%		74%	100%

Sources: USFA analysis of NIFC data; Wildland Fire Decision Support System. (2020). ***Boundaries/responsible agency (protection)*** [Data set]. wfdss.usgs.gov/wfdss/WFDSS_Data_Downloads.shtml

The NFIRS-reported losses are much lower than publicly reported losses for all 6 of the wildfires in this analysis, with some limited exceptions (Table 5). The number of NFIRS-reported deaths in the Chimney Tops 2 fire was 12, compared to 14 in public and ICS-209[5] reporting; 2 of those 14 deaths occurred during the evacuation of Gatlinburg, Tennessee, and may not have been related to a specific NFIRS incident. Also, acres burned is often overestimated in NFIRS, likely due to multiple reports of the entire wildfire.

The Form ICS-209 reports for these wildfires are most likely the primary source for the media-reported loss metrics, and the 2 data sets are very similar. This information, collected by the IMT, is generally released to the media daily during a wildfire incident. Form ICS-209 does not record any information about dollar losses.

[4]A portion of the Northwest Oklahoma Complex wildfire affected Kansas, which is in the Rocky Mountain Area Coordination Center region.
[5]Form ICS-209 is the Incident Status Summary report filed daily by the IMT assigned to the wildfire. The IMT may consist of federal, state and local fire departments depending on the severity of the incident. ICS-209 forms are filed with the GACC that has jurisdiction over the fire.

Taken as a group, the NFIRS-reported figures represent 11.5% of the publicly reported deaths, 5.8% of the publicly reported injuries and 2.5% of the publicly reported dollar losses for these 6 wildfires. Conversely, the NFIRS-reported figure for acres burned is 313% of the official total for these 6 wildfires.

Of the 6 wildfires, the fire departments that fought the Chimney Tops 2 wildfire submitted the most reports to the NFIRS with a total of 2,472 reports. There are 1,901 reports associated with the Woolsey fire in the NFIRS, though less than 7% of them are for fires. Slightly over 8% of the 816 NFIRS reports for the Camp fire were for fires. The NFIRS contains a smaller number of reports for the Northwest Oklahoma Complex, West Mims and Spring Creek fires.

Table 5: Loss metrics for selected wildfires

	Metric	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp[6]
Public sources	Deaths	14[a]	2[b]	0	0	3[c]	85[d]
	Injuries	191[e]	0	0	0	3[f]	13[g]
	Dollar loss ($M)	922.0[h]	64.6[i,j]	38.2[k]	8.2[l]	2,930.0[m]	8,470.0[n]
	Destroyed/damaged structures	2,460[o]	140[p]	4[q]	140[r]	2,007[s]	18,793[t]
	Acres burned	17,140[u]	782,333[v]	152,515[w]	108,045[x]	96,949[y]	153,336[z]
ICS-209[aa]	Civilian deaths	14	2	0	0	3	85
	Civilian injuries	134	5	0	0	0	0
	Responder injuries	5	2	8	10	3	3
	Structures damaged	249	23	0	119	364	727
	Structures destroyed	2,066	151	4	225	1,643	18,804
	Acres burned	17,140	779,292	152,515	108,045	96,949	153,336
	Estimated suppression cost ($M)	8.3	3.2	45.5	32.0	56.9	102.8
NFIRS	Civilian deaths	12	0	0	0	0	0
	Civilian injuries	3	0	0	0	0	0
	Responder injuries	0	0	0	0	0	9
	Dollar loss ($M)	303.4	1.6	0.3	0.0	7.0	0.8
	Imputed dollar loss ($M)[7]	317.5	6.2	0.5	0.0	6.5	0.9
	Fires	2,076	239	58	11	128	67
	Other incidents	396	91	89	15	1,773	749
	Buildings involved	0	147	0	0	616	0
	Buildings threatened	0	0	0	0	0	3
	Acres burned	5,935	1,134,623	1,976,030	0	377,308	608,694

Sources: USFA analysis of NFIRS and NIFC data.

[a]Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News*. www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/

[b]Associated Press. (2017, March 7). Officials: Harper County woman died while fighting fire on her farm. *Fox 25*. okcfox.com/news/local/officials-harper-county-woman-died-while-fighting-fire-on-her-farm

[6]Losses from NFIRS-reported incidents immediately preceding and following the ignition and containment dates/times for the Camp wildfire are summarized in Appendix A.

[7]Imputed dollar loss is calculated by aggregating fire incidents into 282 distinct groups by incident type, structure type, fire spread, how mobile property was involved, type of aid and the median home value of the ZIP Code Tabulation Area in which the fire occurred. Median loss (property and contents) is calculated for each group. If the reported dollar loss for an incident is blank (or in some cases, zero) the median is substituted for the reported value. The reported value is also substituted with the median if aid is given for an incident. (Imputed dollar loss is lower than reported dollar loss for the Woolsey fire because an aid-given incident reported total losses of $700,000 for an incident, but this value was substituted with the median of $1,000.) This calculation is dependent on the number and types of incidents that are reported in the NFIRS.

[c]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal*. www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[d]CAL FIRE. (2019, November 15). *2018 Incident Archive — Camp Fire*. www.fire.ca.gov/incidents/2018/11/8/camp-fire/
[e]Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News*. www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/
[f]Holland, E. (2018, November 28). $6 billion in real estate destroyed in Woolsey fire: Report. *Patch*. patch.com/california/malibu/6-billion-real-estate-destroyed-woolsey-fire-report
[g]Sernoffsky, E. (2018, November 15). Five firefighters among dozen-plus patients burned in Camp fire. *San Francisco Chronicle*. www.sfchronicle.com/california-wildfires/article/Five-firefighters-among-dozen-plus-patients-13396604.php
[h]Ahillen, S. (2017, August 9). Tennessee mountain community getting back on its feet after devastating wildfire. *Insurance Journal*. www.insurancejournal.com/news/southeast/2017/08/09/460619.htm
[i]Legislative Division of Post Audit. (2018). *Performance audit report: Kansas wildfire management: Evaluating the adequacy of Kansas' wildfire suppression system.* State of Kansas. www.kansasforests.org/fire_management/fire_docs/Final_Report.pdf
[j]Oklahoma Farm Report. (2017, March 25). Oklahoma State extension says over sixteen million dollars in losses to agriculture as a result of Northwest Oklahoma Fire Complex. *Radio Oklahoma Network.* www.oklahomafarmreport.com/wire/news/2017/03/01349_OSUExtensionCostEstimate03252017_112959.php#.YFOQpC2cbOQ
[k]Bates, C. (n.d.). *Wildfire damage assessment for the West Mims fire.* Georgia Forestry Commission. gatrees.org/wp-content/uploads/2020/02/Wildfire-Damage-Assessment-for-the-West-Mims-Fire.pdf
[l]Craddock, M. (2018, July 26). Property losses in Huerfano County top $8.2 million from Spring fire. *World Journal*. worldjournalnewspaper.com/property-losses-in-huerfano-county-top-8-2-million-from-spring-fire/
[m]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal*. www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[n]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal*. www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[o]Knoxville News Sentinel. (2016, December 28). By the numbers: Gatlinburg fire. *Knox News*. www.knoxnews.com/story/news/local/tennessee/2016/12/28/numbers-gatlinburg-fire/95847766/
[p]Morrison, O. (2017, June 16). Damage from historic wildfires more than $80 million. *The Wichita Eagle*. www.kansas.com/news/state/article156506309.html
[q]U.S. Fish and Wildlife Service. (n.d.). Southeast Region Fire Division Report FY2017. www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf
[r]KOAA News5. (2018, September 10). Spring fire now officially 100 percent contained.www.koaa.com/news/covering-colorado/2018/09/10/spring-fire-now-officially-100-percent-contained/
[s]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf (page 14).
[t]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[u]Badger, S. G. (2017, November, December). Large-loss fires in the United States in 2016. *NFPA Journal*. www.nfpa.org/News-and-Research/Publications-and-Media/NFPA-Journal/2017/November-December-2017/Features/Large-Loss-Fires-2016
[v]Oklahoma Forestry Services. (2017, March 21). *Fire situation report — March 21, 2017. Oklahoma Department of Agriculture, Food and Forestry.* www.forestry.ok.gov/fire-situation-report-––march-21-2017
[w]U.S. Fish and Wildlife Service. (n.d.). Southeast Region Fire Division report FY2017. www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf
[x]KOAA News5. (2018, September 10). Spring fire now officially 100 percent contained. www.koaa.com/news/covering-colorado/2018/09/10/spring-fire-now-officially-100-percent-contained/
[y]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[z]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal*. www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[aa]National Fire and Aviation Management Web Applications. (2017). *SIT/209 Historical* [Data set]. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Findings

A comparison of the loss metrics from public sources, Form ICS-209 and the NFIRS reveals that the NFIRS data for each of these wildfires is incomplete, but that some wildfires are more complete than others. Table 6 shows the average error between the NFIRS data for each wildfire and public sources and Form ICS-209, respectively.

Table 6: Comparison of public source and ICS-209 data to NFIRS

	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Versus public sources						
Deaths	14%	100%	0%	0%	100%	100%
Injuries (civilian and responder)	98%	0%	0%	0%	100%	31%
Dollar loss (imputed)	66%	90%	99%	100%	100%	100%
Acres burned	65%	45%	1196%	100%	289%	297%
Overall error	61%	59%	324%	50%	147%	132%
Versus ICS-209						
Deaths	14%	100%	0%	0%	100%	100%
Injuries (civilian and responder)	98%	100%	100%	100%	100%	200%
Acres burned	65%	46%	1196%	100%	289%	297%
Overall error	59%	82%	432%	67%	163%	199%

Sources: USFA analysis of NFIRS and NIFC data.

Error is calculated as the absolute value of the difference between the NFIRS data for deaths, injuries (civilian and responder), dollar loss (imputed dollar loss for NFIRS; omitted for ICS-209) and acres burned as a percentage of the value from public sources or Form ICS-209, respectively. The individual errors are weighted equally to compute an average error score for each wildfire and source. A lower score indicates that there is a smaller difference between the NFIRS data and the source to which it is compared.

- Chimney Tops 2 was the best-reported wildfire with respect to deaths excluding fires in which no deaths occurred (West Mims and Spring Creek).
- Differences between the public sources and Form ICS-209 for these fires complicates interpretation of the error rates for injuries; the ICS-209 forms track injuries to responders closely, but it is not clear that these figures are included in public media reports. 3 fires had a 0% error rate compared to public sources because no injuries were reported in either NFIRS or by the media, but the ICS-209 forms for these fires recorded responder injuries that were not recorded by the NFIRS.
- Dollar loss is not tracked in Form ICS-209. Imputed losses for the Chimney Tops 2 fire were closest to the amounts reported by the media but were still inaccurate.
- The error for acres burned is large for 2 different reasons: first, for all fires except Chimney Tops 2 and Spring Creek, there were multiple NFIRS reports that included the entire acreage, resulting in higher totals than the actual value. Second, NFIRS reports for Chimney Tops 2 underreported acres burned, and no NFIRS reports for Spring Creek reported any acres burned.

Overall, the Chimney Tops 2, Northwest Oklahoma Complex and Spring Creek fires had values in the NFIRS that were "closest" to the values in public sources and Form ICS-209. These fires do not seem to share characteristics that might explain why their NFIRS reporting was more accurate than that for other fires. The Chimney Tops 2 fire's affected area included a large share of WUI, but so did the Woolsey and Camp fires. Chimney Tops 2 and Northwest Oklahoma Complex both occurred in the Southern Area Coordination Center region, which may have influenced

reporting behavior, but so did the West Mims fire. In addition, there were fewer NFIRS reports for the Spring Creek fire than for any other fire, so the relatively "good" error score for this incident is due more to the fact that there were no civilian deaths or injuries associated with this fire, and the error methodology weights those factors equally.

The Chimney Tops 2 and Northwest Oklahoma Complex fires stand out particularly due to the number of NFIRS reports submitted by the local departments that participated in suppression activities. The lower error for these fires may be more attributable to local norms and expectations of fire data collection than to other factors. At the same time, many reports submitted for these fires did not complete optional fields, and the values reported for many fields were the same for nearly all reported incidents.

Factors in NFIRS reporting

Many factors could be responsible for the differences in how these wildfires were reported in the NFIRS, as listed below. Additional research including interviews with local fire departments would be required to determine the role each factor played in how each wildfire was reported.

- Federal and state agencies that fight wildfires do not report to the NFIRS, which may account for some missing data. Most of the wildfires in this analysis involved federal land, and federal agencies played a role in coordinating response for all of them. Loss metrics reported using Form ICS-209 are noted separately in Table 5.
- Because NFIRS is a voluntary system, some local fire departments do not report their data. For the Spring Creek wildfire, at least 1 local fire department that may have been impacted has not reported to the NFIRS since 2015.
- The NFIRS is used to report incidents to which fire departments respond. If a department is unable to respond to an incident (which may be common in wildfires), it may not be reported. A department may submit reports for exposure fires from a fire to which it responded even if it was unable to respond directly to the exposure fires. This may have been the case for the Chimney Tops 2 and Northwest Oklahoma Complex wildfires, which were the only wildfires in this analysis with exposure fires. Further USFA guidance on proper reporting in these cases may be necessary. (Correspondence regarding some fire departments' reporting practices is summarized in Appendix B: Correspondence with Responding Fire Departments.)
- Dispatch systems may be strained by the volume of calls during a wildfire or affected by telecommunication and electrical problems caused by a wildfire. This may cause local fire departments to temporarily lose the ability to capture records from a wildfire incident. For example, there are relatively few NFIRS reports from within the wildfire boundary for the Woolsey and Camp fires, but many more from the 10-kilometer zone surrounding it. This could be due to disruptions to automated record-keeping systems as well as other factors. (Correspondence regarding some fire departments' reporting practices is summarized in Appendix B.)

This report begins with a discussion of the analysis methodology and data sources used. It then compares the 6 wildfires, first by presenting the differences in land use in the affected areas and then by examining differences in the types of incident reported for each wildfire and the quality of data reported to the NFIRS. The report discusses limitations and caveats about the analysis, recommendations for collecting data about wildfires, and areas for further study. The report concludes with a detailed examination of the available NFIRS data for incidents associated with each wildfire.

Methodology and data sources

The wildfire boundaries were obtained from the NIFC, which compiled final fire perimeters from multiple federal and state sources into a single dataset. The data are formatted as shapefiles, which store geographic location information as well as attributes about each wildfire such as the name and year of the incident.

The NFIRS is a collection of data about incidents to which fire departments respond. Submission of data to the NFIRS is voluntary, and participating fire departments use a common set of definitions to capture and record information about incidents. In each year from 2016 to 2018, over 1,000,000 fires and over 25,000,000 other incident types were submitted to the NFIRS. Over 20,000 fire departments submit data to the NFIRS.

The NFDC prepares an annual Public Data Release (PDR) containing records that have been cleared for release by state NFIRS program managers. The PDR consists of multiple files, generally corresponding to the NFIRS modules used to record incident data. The Basic Incident file contains data such as the time and date of the incident, the incident type, casualty information, and actions taken by the fire department. Other files contain specialized information depending on the type of incident. The Fire and Wildland Fire files contain information related to structure, vehicle, natural vegetation and other fires, for example. Data used in this analysis comes from the PDR files for 2016-2018.

Incident data from the NFIRS was geocoded by the NFDC using the PROC GEOCODE procedure in SAS. This geocoding uses the address or location information reported by the fire department to identify the geographic coordinates of the incident. Due to limitations in the quality of address and location information in the NFIRS, not all incidents can be geocoded precisely. For instance, some incidents are geocoded to the midpoint of a named road, or to the center of a ZIP code.

To identify those NFIRS incidents that were located within or near a wildfire boundary, the analysis tool R and the R package sf were used. The sf package contains functions for geospatial analysis, including the ability to find intersections between shapefiles. Additional R packages, including dplyr and data.table, were used to analyze incidents. The ggplot2 package was used to generate maps of the wildfires.

This analysis identifies 3 groups of NFIRS incidents based on their location in relation to the wildfire boundary.

- "Within Boundary" describes NFIRS incidents that were reported within the wildfire perimeter during the period of the wildfire.
- "Within Buffer" describes NFIRS incidents located zero to 10 kilometers outside the wildfire boundary. The purpose of the buffer is to identify NFIRS incidents that may have been related to the wildfire but are not located within the wildfire boundary due to imprecision in either the wildfire shapefile or in the NFIRS geocoding.
- "Beyond Buffer" describes NFIRS incidents located 10 to 20 kilometers outside the wildfire boundary that (a) lacked address or location information to be precisely geocoded to an address, and (b) were reported by a fire department that reported incidents within the wildfire boundary or 10-kilometer buffer.

A wildfire event impacts the operations of all fire departments in the surrounding area, whether they respond directly to the wildfire or not. This analysis does not examine the impact of wildfires on nonresponding fire departments, but the techniques used to identify wildfire-related incidents in the NFIRS could be extended to explore this topic.

The analysis examines NFIRS incidents where the reported alarm time is later than the beginning of the wildfire and the reported last unit cleared or incident controlled time is earlier than the date the wildfire was extinguished or completely contained. Some incidents that are included based on the time and location criteria may not have been related to wildfires, especially in situations where the wildfire grew slowly or did not reach population centers for several days.

For each wildfire, the associated NFIRS incidents include:

- Fire incidents — all primary incidents (where the NFIRS report does not indicate that the department was giving aid), except those that occurred within 5 minutes and 50 meters of another primary incident, which are presumed to be duplicate incidents. Exposure fires (fires caused by another fire) are included regardless of whether the NFIRS report indicates that aid was given or not.
- Fire incidents — all aid-given incidents where no corresponding primary incident was reported within time and distance parameters that differ based on incident type and type of aid. Aid-given incidents from fire departments that are from outside the state(s) where the wildfire occurred are only included if the fire department's home state is within 100 kilometers of the wildfire.[8]
- Nonfire incidents — all incidents are included.

[8]This rule may exclude "strike teams" that are called in from out of state to provide aid during a wildfire. To date, no standard or formal data entry guidance has been provided to NFIRS users on how to report incidents when resources from a department are deployed out of state to serve in a response effort. The 100-kilometer rule is intended to prevent aid-given incidents that have imprecise or incorrect geocodes from being evaluated when examining NFIRS incident reports to identify unduplicated aid-given incidents. For example, if an aid-given incident from a fire department located in Maryland reports a ZIP code as 2115 instead of 21150, the geographic coordinates for the incident will be in Boston, Massachusetts, instead of Columbia, Maryland, because the ZIP code is read as '02115,' not '21150.'

For purposes of this analysis, phrases such as "incidents associated with the wildfire" indicate NFIRS incidents that occurred within the geospatial and temporal boundaries for each wildfire as described above, as the NFIRS does not provide a way to indicate that an incident report is related to a wildfire.

Public reports of deaths, injuries and other losses were obtained from multiple sources, primarily from media websites and state and federal government websites. Sources are noted in footnotes and in the bibliography.

Wildland urban interface

An aspect of the analysis was to examine the impact of WUI areas on wildfires and how they are reported in the NFIRS. The affected area for 3 of the wildfires examined in this analysis, Chimney Tops 2, Woolsey and Camp, included a large amount of WUI (Table 7). These wildfires also had the highest number of deaths and the highest value of property losses in both public media reports and NFIRS, and the most reports in NFIRS. A smaller but still notable portion of the Spring Creek fire also affected WUI areas, though this was not reflected in the number of NFIRS reports or in the loss estimates.

Table 7: Wildfires by land use

Area type		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
WUI	**Interface**	4.79%	0.06%	0%	0.02%	7.69%	1.90%
	Intermix	29.87%	0.08%	0%	7.41%	25.70%	23.91%
Non-WUI vegetated	**No housing**	51.07%	53.04%	95.41%	32.07%	53.33%	45.30%
	Very low housing density	13.03%	38.81%	3.28%	60.39%	11.52%	27.95%
Nonvegetated or agriculture	**Low and very low housing density**	1.24%	7.58%	0.01%	0.10%	1.30%	0.34%
	Medium and high housing density	0%	0%	0%	0%	0.10%	0%
	Water	0%	0.43%	1.30%	0%	0.35%	0.61%
Total		100%	100%	100%	100%	100%	100%

Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

The data used to determine whether an area is WUI or not was obtained from the University of Wisconsin-Madison[9] and is based on the 2010 Census (particularly census tract boundaries and housing density) and the 2011 National Land Cover Database (vegetation type). Changes in housing density and vegetation may have occurred in the intervening years, so the portion of each wildfire that occurred in WUI areas may be different than what is shown in the table. For instance, areas of low housing density where development occurred between 2010 and 2016 to 2018 may have actually been WUI at the time of the wildfire. Some areas may have experienced sufficient development to reduce the amount of vegetation so that they would be considered nonvegetated medium or high housing density areas.

Within the wildfire boundaries of the Chimney Tops 2, Woolsey and Camp fires, most of the NFIRS-reported incidents were from within WUI areas (Table 8). This reinforces the principle that extra attention should be placed on planning for wildfires in WUI areas. Note that for the Chimney Tops 2 fire, 1,607 fire incidents within the WUI were geocoded to a ZIP code; more accurate location information for these incidents may have resulted in different coordinates that may not have been within the WUI. Also note that for the Woolsey and Camp fires, a significant portion of NFIRS incidents were located outside the wildfire boundary. This may also have been the result of imprecise location information,

[9]University of Wisconsin-Madison. (n.d.). *Wildland-urban interface (WUI) change 1990-2010: 2010 data, all classes.* Silvis Lab: Spatial Analysis For Conservation and Sustainability. silvis.forest.wisc.edu/data/wui-change/

though preparation for wildfires should also anticipate a spike in service calls of all types, particularly near the area directly impacted by the fire.

Table 8: NFIRS incidents in WUI areas and overall for selected wildfires

Incident type	Chimney Tops 2			Woolsey			Camp		
	In WUI	Within boundary	All incidents	In WUI	Within boundary	All incidents	In WUI	Within boundary	All incidents
Fire	1,700 (82%)	1,708 (82%)	2,076 (100%)	12 (9%)	14 (11%)	128 (100%)	17 (25%)	18 (27%)	67 (100%)
EMS	3 (2%)	3 (2%)	183 (100%)	75 (8%)	87 (9%)	989 (100%)	11 (2%)	13 (3%)	478 (100%)
Other	26 (12%)	35 (16%)	213 (100%)	97 (12%)	112 (14%)	784 (100%)	21 (8%)	21 (8%)	271 (100%)
Total	1,729 (70%)	1,746 (70%)	2,472 (100%)	184 (10%)	213 11%)	1,901 (100%)	49 (6%)	52 (6%)	816 (100%)

Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

Incident type

In the NFIRS, incident type describes the situation encountered by the fire department when they arrived on scene. Examining only those incidents that occurred within the wildfire boundary, some distinctions emerge (Table 9).

Nearly all of the incidents reported for the Chimney Tops 2 and Northwest Oklahoma Complex wildfires were fires. Furthermore, nearly all of these were reported as building fires. These were the only 2 wildfires where any exposure fires were reported. For both wildfires, the originating incident was a natural vegetation fire (Incident Type 140 series), and most of the structure fires were reported as exposures.

In the Spring Creek fire, there were only 6 NFIRS reports from within the wildfire boundary, and 4 of these were natural vegetation fires. Even outside the wildfire boundary, no structure or vehicle fires were reported. Additionally, no values were reported from the Spring Creek fire for the number of buildings involved (Fire and Wildland Fire modules) or the number of buildings threatened (Wildland Fire module). However, data from the Costilla County Assessor indicates that over 140 homes were damaged or destroyed by the wildfire. It is unclear whether these should have been reported as exposure fires by 1 of the departments that submitted NFIRS reports.

In the West Mims fire, only 2 NFIRS reports came from within the wildfire boundary, and neither was for a fire. Most of the area affected by the West Mims fire was in the Okefenokee National Wildlife Refuge, though the fire did burn commercial timberlands adjacent to the refuge. Beyond the wildfire boundary, 61 fires were reported for West Mims, including 5 structures, 8 vehicles, 1 rubbish and 47 natural vegetation fires.

Only a small share of the NFIRS incidents from within the Woolsey and Camp wildfire boundaries were for fires. A large share of reported incidents was for EMS incidents, Service Calls and Good Intent Calls.

Differences in the number of NFIRS incident reports and the distribution of incident types may be due to many factors, including nonreporting fire departments, policies regarding reporting fires to which a department was unable to respond, policies regarding reporting exposure fires, and operability of dispatch and record-keeping systems. Additional investigation is required to determine how these factors affected the NFIRS reporting for each of these wildfires.

Table 9: Distribution of general Incident Types by wildfire

Incident Type	Description	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of incidents within boundary		**1,746**	**170**	**2**	**6**	**213**	**52**
100 series	Fire	98%	96%	0%	67%	7%	35%
200 series	Overpressure Rupture, Explosion, Overheat (No Fire)	0%	0%	0%	0%	0%	0%
300 series	Rescue and Emergency Medical Service (EMS) Incidents	0%	0%	50%	0%	41%	25%
400 series	Hazardous Condition (No Fire)	0%	0%	0%	0%	2%	6%
500 series	Service Call	1%	2%	0%	0%	19%	13%
600 series	Good Intent Call	1%	1%	50%	33%	22%	4%
700 series	False Alarm and False Call	0%	0%	0%	0%	8%	4%
800 series	Severe Weather and Natural Disaster	0%	1%	0%	0%	0%	4%
900 series	Special Incident Type	0%	1%	0%	0%	1%	10%
Total		100%	100%	100%	100%	100%	100%

Sources: USFA analysis of NFIRS and NIFC data.

Table 10 lists the number of incidents, by Incident Type, for each wildfire. This only includes incidents that were reported within the wildfire boundary.

Table 10: Number of incidents, by specific Incident Type, per wildfire

Incident Type	Description	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
100	Fire, other	4	1	0	0	3	1
111	Building fire	1,685	136	0	0	3	2
112	Fires in structure other than in a building	0	6	0	0	0	0
113	Cooking fire, confined to container	0	0	0	0	1	0
140	Natural vegetation fire, other	0	1	0	0	0	1
141	Forest, woods or wildland fire	18	1	0	2	4	12
142	Brush or brush-and-grass mixture fire	0	8	0	1	2	1
143	Grass fire	0	11	0	1	0	0
150	Outside rubbish fire, other	0	0	0	0	1	0
160	Special outside fire, other	1	0	0	0	0	1
200	Overpressure rupture, explosion, overheat, other	0	0	0	0	1	0
300	Rescue, EMS incident, other	0	0	0	0	52	1
311	Medical assist, assist EMS crew	2	0	0	0	0	2

Table 10: Number of incidents, by specific Incident Type, per wildfire (continued)

Incident Type	Description	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
321	EMS call, excluding vehicle accident with injury	1	0	0	0	25	8
322	Motor vehicle accident with injuries	0	0	1	0	8	1
324	Motor vehicle accident with no injuries	0	0	0	0	1	1
365	Watercraft rescue	0	0	0	0	1	0
400	Hazardous condition, other	0	0	0	0	0	3
412	Gas leak (natural gas or liquefied petroleum gas (LPG))	1	0	0	0	1	0
444	Power line down	0	0	0	0	3	0
445	Arcing, shorted electrical equipment	0	0	0	0	1	0
500	Service call, other	0	1	0	0	5	0
510	Person in distress, other	1	0	0	0	0	1
520	Water problem, other	0	0	0	0	1	0
531	Smoke or odor removal	0	0	0	0	4	0
541	Animal problem	0	0	0	0	1	0
550	Public service assistance, other	0	0	0	0	9	2
551	Assist police or other governmental agency	3	2	0	0	8	1
553	Public service	1	0	0	0	11	0
554	Assist invalid	0	0	0	0	1	1
571	Cover assignment, standby, moveup	6	0	0	0	1	2
600	Good intent call, other	0	0	0	0	14	1
611	Dispatched and canceled en route	1	1	0	0	21	1
622	No incident found on arrival at dispatch address	0	0	0	0	1	0
632	Prescribed fire	0	0	1	0	0	0
641	Vicinity alarm (incident in other location)	0	0	0	0	4	0
651	Smoke scare, odor of smoke	15	0	0	1	4	0
652	Steam, vapor, fog or dust thought to be smoke	0	0	0	1	0	0
671	Hazmat release investigation with no hazmat	0	0	0	0	2	0
700	False alarm or false call, other	0	0	0	0	10	2
711	Municipal alarm system, malicious false alarm	0	0	0	0	1	0
712	Direct tie to fire department, malicious false alarm	0	0	0	0	1	0
730	System malfunction, other	0	0	0	0	1	0
733	Smoke detector activation due to malfunction	0	0	0	0	1	0

Table 10: Number of incidents, by specific Incident Type, per wildfire (continued)

Incident Type	Description	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
735	Alarm system sounded due to malfunction	0	0	0	0	1	0
740	Unintentional transmission of alarm, other	0	0	0	0	1	0
744	Detector activation, no fire - unintentional	0	0	0	0	1	0
745	Alarm system activation, no fire - unintentional	1	0	0	0	0	0
800	Severe weather or natural disaster, other	2	1	0	0	0	2
815	Severe weather or natural disaster standby	1	0	0	0	0	0
900	Special type of incident, other	3	1	0	0	1	5
911	Citizen complaint	0	0	0	0	1	0
Total		1,746	170	2	6	213	52

Sources: USFA analysis of NFIRS and NIFC data.

Completeness of NFIRS reporting

There are observable differences in how each of these 6 wildfires was reported in the NFIRS. There are differences in the numbers and comprehensiveness of NFIRS reports, and in the types of incidents reported. There are differences between the sum of loss metrics from NFIRS and estimates from public sources. The following factors may explain some of these differences:

- These wildfires occurred at least partly on federal land and/or the response was coordinated through one of the GACCs composed of federal and state authorities. These federal and state authorities typically do not report in the NFIRS, which may account for missing information.
- Reporting to the NFIRS is voluntary. Some local fire departments involved in wildfire response may not participate in the NFIRS, which would create omissions in the data.
- Wildfires, especially in WUI areas, are large-scale events that make real-time information collection very difficult. Damage to electrical and telecommunications infrastructure may impact the ability to receive service calls so local fire departments may not have a reliable source to examine when recording incidents after the fact.[10,11] The high volume of calls and the need to focus on evacuation and life safety rather than extinguishment may also hamper record-keeping.
- Differences in fire departments' policies may also be reflected in the NFIRS reporting. Some departments may record fires to which they were unable to respond as exposure fires from an incident to which they responded. This may be the case for Chimney Tops 2 and the Northwest Oklahoma Complex. Fire departments that responded to other wildfires may have different policies. (See Appendix B.)
- A final factor in the completeness of NFIRS reporting may be differences in how the dispatch system is integrated with the record-keeping system. In the Woolsey fire, there were 248 incidents that were canceled en route (Incident Type 611) — 13% of all NFIRS-reported incidents for that fire. Calls may have been canceled en route for many reasons, but it is notable that so many of these incidents were reported to the NFIRS. It suggests that data about these calls was captured in real time and did not have to be reconstructed afterward. If a department's dispatch and record-keeping systems are not integrated (or are disrupted by infrastructure failure), it would be unusual for calls that are canceled en route to be manually entered after the fact.

[10]Lakin, M. (2017, November 22). 'Like Armageddon': How the Gatlinburg fire became unstoppable and swarmed a city. *Knox News.* www.knoxnews.com/story/news/2017/11/22/gatlinburg-wildfire-one-year-later-911-calls-evacuation-orders-communications-failures/856270001/
[11]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf (Page 13).

Regardless of the reasons for the differences, one way to assess the completeness of NFIRS reporting for these wildfires is to calculate the percentage of data elements that were populated with valid, known values. This metric includes required fields, fields that are conditionally required based on values in other fields, and fields that are always optional. It also includes fields where the reported value was "None" if that value is a valid response, and fields where the reported value was "zero" if that value is a valid response. Note that the Basic module contains a larger share of required data elements than the Fire or Wildland Fire modules, which is reflected in the scores. Table 11 contains the average score for each wildfire and NFIRS module; detailed scores by module are presented in Table 12 (Basic module), Table 14 (Fire module) and Table 15 (Wildland Fire module).

Table 11: Overall completeness of NFIRS reporting

Module	Metric	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Basic module	No. of reports	2,472	330	147	26	1,901	816
	% valid and known	59	57	67	58	64	66
Fire module	No. of reports	2,032	169	43	0	82	22
	% valid and known	27	24	16	n/a	17	25
Wildland Fire module	No. of reports	5	18	0	8	6	4
	% valid and known	27	12	n/a	13	8	30

Sources: USFA analysis of NFIRS and NIFC data.

The West Mims wildfire had the most complete Basic modules associated with it, but the least complete Fire modules and no Wildland Fire modules. The Chimney Tops 2 wildfire had less complete Basic modules than 3 other wildfires but had the most complete Fire modules and the second-most complete Wildland Fire modules. Overall, the Camp wildfire had the most complete NFIRS reporting by this metric.

However, completeness should also be judged in terms of how well the NFIRS-reported data compares to the publicly reported loss metrics for each wildfire. By that measure, none of the 6 wildfires were complete in NFIRS, due to NFIRS nonreporters and missing data from NFIRS reporters. Completeness should probably also ignore fields that are always required, such as Incident Type. It should also reflect that some NFIRS data elements are required based on the value of other fields or the presence or absence of other modules. It is further complicated by the fact that some local fire departments use software that prepopulates default values for some fields (e.g., "zero" or "None") which can impact the completeness of their NFIRS reports.

Finally, for examining an incident as complex as a wildfire, focusing on whether the NFIRS submissions are complete may obscure the central purpose of collecting this data — is the data useful? Can the data be used to determine why certain structures burned and others did not? Can the data be used to determine how the fire departments' response affected the outcome? Is there information that can be used to improve response for the next wildfire? For example, in the wildfires where many NFIRS fire incident reports were submitted (Chimney Tops 2 and Northwest Oklahoma Complex), many of the values for data elements such as Item First Ignited, Area of Origin and Actions Taken are identical for each fire. The homogeneity of the data in NFIRS makes it very challenging to draw conclusions about fire behavior and response.

Data quality

In the NFIRS, some fields are required, others are required only under certain conditions, and the remaining are optional. For example, Arrival Time is required unless the Incident Type is 611 (canceled en route), and Incident Controlled Time is only required if the Wildland Fire module is submitted for the incident. Of particular interest is how often optional fields are populated with useful data. The following tables examine the Basic, Fire and Wildland

Fire modules submitted for the incidents associated with each wildfire. The tables show the percent of reports where the data element was completed with a valid response other than Unknown/Undetermined.[12,13]

In the Basic module, a large portion of NFIRS reports included values for Actions Taken #2 and #3, which are optional fields (Table 12). This was particularly pronounced in the West Mims, Chimney Tops 2 and Spring Creek wildfires. A large portion of NFIRS reports also included values for Property and Contents Loss. However, the most common value for these fields was 0. Only the Chimney Tops 2 wildfire had more than 20 nonzero values for Property Loss.

Table 12: Basic module; valid and known responses as share of all responses

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		**2,472**	**330**	**147**	**26**	**1,901**	**816**
VERSION	NFIRS Data Version	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DEPT_STA	Fire Department Station	27.2%	34.8%	76.2%	11.5%	34.7%	98.7%
INC_TYPE	Incident Type	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ADD_WILD	Address on Wildland Flag	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
AID	Aid Given or Received	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ALARM	Alarm Date and Time	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ARRIVAL	Arrival Date and Time	98.3%	97.3%	91.2%	96.2%	91.6%	99.6%
INC_CONT	Incident Controlled Date and Time	22.9%	13.6%	32.0%	34.6%	2.5%	3.7%
LU_CLEAR	Last Unit Cleared Date and Time	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
SHIFT	Shift	13.7%	27.6%	61.2%	0.0%	37.2%	4.8%
ALARMS	Alarms	13.8%	30.9%	27.9%	0.0%	21.7%	3.6%
DISTRICT	District	12.5%	29.1%	25.2%	0.0%	15.8%	32.2%
ACT_TAK1	Actions Taken #1	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ACT_TAK2	Actions Taken #2	19.3%	3.9%	49.7%	19.2%	5.4%	7.1%
ACT_TAK3	Actions Taken #3	18.4%	1.5%	14.3%	0.0%	2.0%	2.0%
APP_MOD	Apparatus/Personnel Module Used	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
SUP_APP	Suppression Apparatus	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
EMS_APP	EMS Apparatus	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
OTH_APP	Other Apparatus	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
SUP_PER	Suppression Personnel	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
EMS_PER	EMS Personnel	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
OTH_PER	Other Personnel	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

[12]Note: Valid responses other than Unknown/Undetermined may include "None." Refer to the discussion of each individual wildfire for tables showing the most common values for selected data elements.

[13]This "usability index" can be used as an indicator to help determine if a data element should be used in analyses. For example, the U.S. Census Bureau's Service Annual Survey suppresses estimates from publication if the Total Quality Response Rate is less than 50%. USFA recommends considering the usability index when conducting further analyses of these data elements, also considering that the denominator for this ratio is all incidents for which the module was submitted (noted as "Number of reports" in Table 12, Table 14 and Table 15) rather than those where the data element is required, conditionally required or optional. U.S. Census Bureau. (n.d.). Service annual survey methodology: Two types of response rates. www.census.gov/programs-surveys/sas/technical-documentation/methodology.html#par_textimage_20

Table 12: Basic module; valid and known responses as share of all responses (continued)

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		**2,472**	**330**	**147**	**26**	**1,901**	**816**
RESOU_AID	Resources Include Aid Received	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
PROP_LOSS	Property Loss	87.9%	14.8%	55.8%	50.0%	67.2%	68.9%
CONT_LOSS	Contents Loss	6.6%	14.5%	55.8%	50.0%	66.8%	68.9%
PROP_VAL	Property Value	6.2%	11.5%	24.5%	30.8%	66.3%	68.3%
CONT_VAL	Contents Value	6.2%	11.5%	23.8%	30.8%	66.1%	68.3%
FF_DEATH	Fire Service Deaths	99.2%	92.4%	100.0%	84.6%	100.0%	100.0%
OTH_DEATH	Other Fire Deaths	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
FF_INJ	Fire Service Injuries	99.2%	92.4%	100.0%	84.6%	100.0%	100.0%
OTH_INJ	Other Fire Injuries	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%
DET_ALERT	Detector Alerted Occupants	0.0%	0.0%	22.4%	0.0%	0.4%	0.1%
HAZ_REL	Hazardous Material Released	2.0%	5.2%	8.2%	3.8%	13.6%	67.8%
MIXED_USE	Mixed Use	2.0%	0.3%	9.5%	0.0%	0.3%	2.1%
PROP_USE	Property Use	97.2%	82.4%	91.2%	84.6%	87.4%	94.9%
CENSUS	Census Tract	0.1%	0.0%	35.4%	0.0%	31.9%	0.6%

Sources: USFA analysis of NFIRS and NIFC data.

The NFIRS Fire and Structure Fire modules are required for fires in buildings and mobile property used as structures, as well as for "other" fires (Incident Types 111, 120-123 and 100). For fires in structures other than buildings (Incident Type 112), the Fire module and the Structure Type field from Structure Fire are required. The Fire module is required for mobile property and special outdoor fires (Incident Types 130-138 and 161-164). Either the Fire module or the Wildland Fire module is required for natural vegetation fires, crop fires and "other" special outdoor fires (Incident Types 140-143, 160 and 170-173). The Fire module is optional for fires confined to their objects of origin and outdoor rubbish fires (Incident Types 113-118 and 150-155) and for fire incidents where aid is given. The Structure Fire module is also optional for incident types where fires are confined to their objects of origin.

Where either the Fire/Structure Fire or Wildland Fire modules could be used, fire departments tended to select the Fire module (Table 13). The Northwest Oklahoma Complex and Spring Creek wildfires are the exceptions.

Table 13: Use of Fire and Wildland Fire modules

Required	Submitted	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Fire only	Fire	1	2	5	0	13	4
Fire and STRUC_TYPE	Fire	0	6	0	0	1	0
Fire and Structure Fire	Fire	2,016	148	3	0	27	7
Fire or Wildland	Fire	13	11	35	0	26	5
Fire or Wildland	Wildland	5	16	0	8	4	3
Neither	Fire	2	2	0	0	15	6
Neither	Wildland	0	2	0	0	2	1

Sources: USFA analysis of NFIRS and NIFC data.

Optional data elements in the Fire/Structure Fire modules were unlikely to be populated (Table 14). Since "None" is a valid response for some of these fields, the percent of responses containing valid, known values can appear to be higher than it actually is. In the West Mims wildfire, 15 incidents reported On Site Materials #1 as "trees, plants, flowers" (code 131), and 3 other incidents reported other "non-None" values. However, for the Camp wildfire, 21 of 22 reports indicated that the On Site Materials #1 was "None." For the Woolsey wildfire, 41 reports used "None" for On Site Materials #1.

Required fields such as Area of Origin, Heat Source, Item First Ignited, Cause of Ignition and Factors Contributing to Ignition #1 contained a large number of Unknown/Undetermined values for some wildfires. For the Chimney Tops 2 and Northwest Oklahoma Complex fires, where these values were more likely to contain values other than Unknown, virtually all of the NFIRS reports contain identical information.

The wildfires where fire departments submitted a higher percentage of NFIRS reports for structure fire incident types (Chimney Tops 2 and Northwest Oklahoma Complex) also provided more valid, known values for variables that can help in understanding the breadth of the damage caused, namely Structure Type, Stories Above/Below Grade, Total Square Footage and Fire Origin.

Table 14: Fire module; valid and known responses as share of all responses

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		**2,032**	**169**	**43**	**0**	**82**	**22**
VERSION	NFIRS Data Version	100.0%	100.0%	100.0%	n/a	100.0%	100.0%
NUM_UNIT	Number of Residential Units	99.6%	95.3%	60.5%	n/a	72.0%	100.0%
NOT_RES	Not Residential Flag	100.0%	100.0%	100.0%	n/a	100.0%	100.0%
BLDG_INVOL	Number of Buildings Involved	0.6%	5.9%	60.5%	n/a	92.7%	90.9%
ACRES_BURN	Acres Burned	0.3%	5.3%	46.5%	n/a	35.4%	27.3%
LESS_1ACRE	Less than one Acre	100.0%	100.0%	100.0%	n/a	100.0%	100.0%
ON_SITE_M1	On Site Materials #1	0.8%	7.7%	60.5%	n/a	52.4%	100.0%
MAT_STOR1	Material Storage Use #1	0.4%	1.2%	41.9%	n/a	0.0%	100.0%
ON_SITE_M2	On Site Materials #2	0.0%	0.0%	2.3%	n/a	0.0%	0.0%
MAT_STOR2	Material Storage Use #2	0.0%	0.0%	2.3%	n/a	0.0%	0.0%
ON_SITE_M3	On Site Materials #3	0.0%	0.0%	2.3%	n/a	0.0%	0.0%
MAT_STOR3	Material Storage Use #3	0.0%	0.0%	2.3%	n/a	0.0%	0.0%
AREA_ORIG	Area of Origin	100.0%	95.9%	67.4%	n/a	62.2%	68.2%
HEAT_SOURC	Heat Source	99.9%	97.6%	37.2%	n/a	52.4%	54.5%
FIRST_IGN	Item First Ignited	99.3%	8.9%	46.5%	n/a	47.6%	63.6%
CONF_ORIG	Confined To Origin	0.0%	0.0%	7.0%	n/a	3.7%	31.8%
TYPE_MAT	Type of Material	0.2%	1.8%	7.0%	n/a	34.1%	18.2%
CAUSE_IGN	Cause of Ignition	100.0%	99.4%	51.2%	n/a	70.7%	77.3%
FACT_IGN_1	Factors Contributing To Ignition #1	100.0%	97.6%	44.2%	n/a	61.0%	63.6%
FACT_IGN_2	Factors Contributing To Ignition #2	0.0%	0.0%	0.0%	n/a	14.6%	4.5%
HUM_FAC_1	Human Factors #1	0.5%	8.3%	100.0%	n/a	98.8%	100.0%
HUM_FAC_2	Human Factors #2	0.0%	0.0%	0.0%	n/a	0.0%	0.0%

Table 14: Fire module; valid and known responses as share of all responses (continued)

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		2,032	169	43	0	82	22
HUM_FAC_3	Human Factors #3	0.0%	0.0%	0.0%	n/a	1.2%	0.0%
HUM_FAC_4	Human Factors #4	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
HUM_FAC_5	Human Factors #5	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
HUM_FAC_6	Human Factors #6	0.2%	0.0%	0.0%	n/a	0.0%	0.0%
HUM_FAC_7	Human Factors #7	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
HUM_FAC_8	Human Factors #8	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
AGE	Age of Person	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
SEX	Sex of Person	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
EQUIP_INV	Equipment Involved	0.1%	3.6%	14.0%	n/a	2.4%	40.9%
SUP_FAC_1	Suppression Factors #1	99.9%	0.6%	9.3%	n/a	3.7%	27.3%
SUP_FAC_2	Suppression Factors #2	99.6%	0.0%	0.0%	n/a	1.2%	0.0%
SUP_FAC_3	Suppression Factors #3	99.6%	0.0%	0.0%	n/a	1.2%	0.0%
MOB_INVOL	Mobile Property Involved	0.4%	3.6%	20.9%	n/a	18.3%	100.0%
MOB_TYPE	Mobile Property Type	0.1%	0.6%	11.6%	n/a	14.6%	22.7%
MOB_MAKE	Mobile Property Make	0.1%	0.6%	11.6%	n/a	14.6%	22.7%
MOB_MODEL	Mobile Property Model	0.1%	0.6%	7.0%	n/a	13.4%	13.6%
MOB_YEAR	Mobile Property Year	0.1%	0.6%	7.0%	n/a	13.4%	4.5%
MOB_LIC_PL	Mobile Property License Plate	0.1%	0.6%	4.7%	n/a	9.8%	9.1%
MOB_STATE	Mobile Property State	0.1%	0.0%	81.4%	n/a	9.8%	9.1%
MOB_VIN_NO	Mobile Property VIN Number	0.0%	0.0%	7.0%	n/a	8.5%	0.0%
EQ_BRAND	Equipment Brand	0.0%	0.0%	0.0%	n/a	0.0%	4.5%
EQ_MODEL	Equipment Model	0.0%	0.0%	0.0%	n/a	0.0%	4.5%
EQ_SER_NO	Equipment Serial Number	0.0%	0.0%	0.0%	n/a	0.0%	4.5%
EQ_YEAR	Equipment Year	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
EQ_POWER	Equipment Power	0.0%	0.0%	0.0%	n/a	14.6%	18.2%
EQ_PORT	Equipment Portability	0.0%	0.0%	0.0%	n/a	14.6%	18.2%
FIRE_SPRD	Fire Spread	99.2%	87.0%	7.0%	n/a	12.2%	27.3%
STRUC_TYPE	Structure Type	99.2%	90.5%	7.0%	n/a	12.2%	27.3%
STRUC_STAT	Structure Status	99.2%	87.0%	7.0%	n/a	12.2%	27.3%
BLDG_ABOVE	Building Height: Stories Above Grade	99.2%	87.0%	7.0%	n/a	12.2%	27.3%
BLDG_BELOW	Building Height: Stories Below Grade	99.2%	87.0%	7.0%	n/a	12.2%	27.3%
BLDG_LGTH	Building Length	0.0%	34.3%	4.7%	n/a	0.0%	9.1%
BLDG_WIDTH	Building Width	0.0%	34.3%	4.7%	n/a	0.0%	9.1%
TOT_SQ_FT	Total Square Feet	99.2%	52.7%	2.3%	n/a	12.2%	18.2%
FIRE_ORIG	Fire Origin	99.2%	87.0%	7.0%	n/a	12.2%	27.3%

Table 14: Fire module; valid and known responses as share of all responses (continued)

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		**2,032**	**169**	**43**	**0**	**82**	**22**
ST_DAM_MIN	Number of Stories with Damage: Minor	0.2%	25.4%	7.0%	n/a	8.5%	27.3%
ST_DAM_SIG	Number of Stories with Damage: Significant	0.2%	25.4%	7.0%	n/a	8.5%	27.3%
ST_DAM_HVY	Number of Stories with Damage: Heavy	0.2%	25.4%	7.0%	n/a	8.5%	27.3%
ST_DAM_XTR	Number of Stories with Damage: Extreme	0.2%	25.4%	7.0%	n/a	8.5%	27.3%
FLAME_SPRD	No Flame Spread/Same As First/Unknown	99.2%	90.5%	7.0%	n/a	12.2%	27.3%
ITEM_SPRD	Item Contributing Most To Spread	0.1%	0.0%	0.0%	n/a	1.2%	9.1%
MAT_SPRD	Type Material Contributing Most To Spread	0.1%	0.0%	0.0%	n/a	1.2%	9.1%
DETECTOR	Detector Presence	0.1%	58.0%	4.7%	n/a	6.1%	9.1%
DET_TYPE	Detector Type	0.0%	0.0%	0.0%	n/a	4.9%	4.5%
DET_POWER	Detector Power	0.0%	0.0%	0.0%	n/a	4.9%	4.5%
DET_OPERAT	Detector Operation	0.0%	0.0%	0.0%	n/a	2.4%	4.5%
DET_EFFECT	Detector Effectiveness	0.0%	0.0%	0.0%	n/a	1.2%	4.5%
DET_FAIL	Detector Failure Reason	0.0%	0.0%	0.0%	n/a	0.0%	0.0%
AES_PRES	AES Presence	0.2%	60.9%	7.0%	n/a	11.0%	18.2%
AES_TYPE	AES Type	0.0%	0.0%	0.0%	n/a	1.2%	0.0%
AES_OPER	AES Operation	0.0%	0.0%	0.0%	n/a	1.2%	0.0%
NO_SPR_OP	Number of Sprinklers Operating	0.0%	0.0%	0.0%	n/a	1.2%	0.0%
AES_FAIL	AES Failure Reason	0.0%	0.0%	0.0%	n/a	0.0%	0.0%

Sources: USFA analysis of NFIRS and NIFC data.

There are very few examples of fires reported using the Wildland Fire module (Table 15). Optional fields regarding weather conditions were well-populated for Chimney Tops 2, and fields regarding terrain and fire behavior were well-populated for the Camp wildfire. Departments that reported for the Northwest Oklahoma Complex and Woolsey fires included information about the number of buildings involved. (Number of Buildings Involved was also populated for the reports from the Camp fire, but the value in those records is zero.) None of the NFIRS reports provided details about property ownership/management. That is a particular challenge given the coordination that takes place between local, state and federal authorities when combating a wildfire.

Table 15: Wildland Fire module; valid and known responses as share of all responses

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		5	18	0	8	6	4
VERSION	NFIRS Data Version	100.0%	100.0%	n/a	100.0%	100.0%	100.0%
LATITUDE	Latitude	0.0%	27.8%	n/a	12.5%	16.7%	25.0%
LONGITUDE	Longitude	0.0%	27.8%	n/a	12.5%	16.7%	25.0%
TOWNSHIP	Township	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
NORTH_SOU	North/South	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
RANGE	Range	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
EAST_WEST	East/West	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
SECTION	Section	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
SUBSECTION	Subsection	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
MERIDIAN	Meridian	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
AREA_TYPE	Area Type	100.0%	100.0%	n/a	100.0%	100.0%	100.0%
FIRE_CAUSE	Wildland Fire Cause	100.0%	27.8%	n/a	50.0%	0.0%	25.0%
HUM_FACT1	Human Factors Contributing #1	100.0%	94.4%	n/a	100.0%	100.0%	100.0%
HUM_FACT2	Human Factors Contributing #2	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HUM_FACT3	Human Factors Contributing #3	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HUM_FACT4	Human Factors Contributing #4	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HUM_FACT5	Human Factors Contributing #5	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HUM_FACT6	Human Factors Contributing #6	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HUM_FACT7	Human Factors Contributing #7	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HUM_FACT8	Human Factors Contributing #8	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
FACT_IGN1	Factors Contributing to Ignition #1	100.0%	77.8%	n/a	50.0%	33.3%	50.0%
FACT_IGN2	Factors Contributing to Ignition #2	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
SUPP_FACT1	Fire Suppression Factors #1	100.0%	0.0%	n/a	12.5%	16.7%	100.0%
SUPP_FACT2	Fire Suppression Factors #2	100.0%	0.0%	n/a	0.0%	0.0%	0.0%
SUPP_FACT3	Fire Suppression Factors #3	100.0%	0.0%	n/a	0.0%	0.0%	0.0%
HEAT_SOURC	Heat Source	100.0%	61.1%	n/a	50.0%	16.7%	25.0%
MOB_PROP	Mobile Property Type	0.0%	0.0%	n/a	0.0%	0.0%	50.0%
EQ_INV_IGN	Equipment Involved In Ignition	0.0%	0.0%	n/a	0.0%	0.0%	25.0%
NFDRS_ID	NFDRS Weather Station ID	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
WEATH_TYPE	Weather Type	100.0%	0.0%	n/a	25.0%	0.0%	25.0%
WIND_DIR	Wind Direction	100.0%	0.0%	n/a	37.5%	0.0%	25.0%
WIND_SPEED	Wind Speed	100.0%	0.0%	n/a	37.5%	0.0%	50.0%
AIR_TEMP	Air Temperature	100.0%	0.0%	n/a	37.5%	16.7%	50.0%
REL_HUMID	Relative Humidity	100.0%	0.0%	n/a	12.5%	0.0%	50.0%
FUEL_MOIST	Fuel Moisture	0.0%	0.0%	n/a	12.5%	0.0%	25.0%

Table 15: Wildland Fire module; valid and known responses as share of all responses (continued)

NFIRS data element		Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Number of reports		5	18	0	8	6	4
DANGR_RATE	Fire Danger Rating	100.0%	0.0%	n/a	12.5%	0.0%	25.0%
BLDG_INV	Number of Buildings Involved	0.0%	27.8%	n/a	0.0%	16.7%	100.0%
BLDG_THR	Number of Buildings Threatened	0.0%	11.1%	n/a	0.0%	0.0%	100.0%
ACRES_BURN	Total Acres Burned	100.0%	100.0%	n/a	100.0%	100.0%	100.0%
CROP_BURN1	Primary Crop Burned 1	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
CROP_BURN2	Primary Crop Burned 2	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
CROP_BURN3	Primary Crop Burned 3	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
UNDET_BURN	Undetermined Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	50.0%
TAX_BURN	Tax Paying Acres Burned %	0.0%	11.1%	n/a	25.0%	0.0%	50.0%
NOTAX_BURN	Non-Tax Paying Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
LOCAL_BURN	City, town, village, local Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
COUTY_BURN	County or parish Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
ST_BURN	State or province Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	50.0%
FED_BURN	Federal Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
FOREI_BURN	Foreign Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
MILIT_BURN	Military Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
OTHER_BURN	Other Acres Burned %	0.0%	11.1%	n/a	0.0%	0.0%	25.0%
PROP_MANAG	Property Management Ownership	100.0%	0.0%	n/a	25.0%	0.0%	25.0%
FED_CODE	Federal Agency Code	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
NFDRS_FM	NFDRS Fuel Model at Origin	0.0%	0.0%	n/a	12.5%	0.0%	50.0%
PERSON_FIR	Person Responsible for Fire	100.0%	0.0%	n/a	0.0%	16.7%	25.0%
GENDER	Gender	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
AGE	Age	0.0%	0.0%	n/a	0.0%	0.0%	25.0%
ACTIVITY_W	Activity of Person	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
HORIZ_DIS	Horizontal Distance from ROW	0.0%	0.0%	n/a	0.0%	0.0%	25.0%
TYPE_ROW	Type of ROW	0.0%	0.0%	n/a	0.0%	0.0%	0.0%
ELEVATION	Elevation	0.0%	11.1%	n/a	0.0%	0.0%	75.0%
POS_SLOPE	Relative Position on Slope	0.0%	0.0%	n/a	0.0%	0.0%	50.0%
ASPECT	Aspect	0.0%	0.0%	n/a	0.0%	0.0%	50.0%
FLAME_LGTH	Flame Length	0.0%	11.1%	n/a	0.0%	0.0%	75.0%
SPREAD_RAT	Rate of Spread	0.0%	11.1%	n/a	0.0%	0.0%	75.0%

Sources: USFA analysis of NFIRS and NIFC data.

Limitations

This analysis compares incidents reported during 6 wildfires to one another and to publicly reported information about the fires. These wildfires were selected because they represent a variety of locations, terrains and climates. Since the 6 wildfires were not selected randomly, these conclusions may not be applicable to all wildfires.

In addition, the identification of NFIRS incidents for each wildfire is subject to a degree of error. The wildfire boundaries used are the final perimeter for each fire, rather than a sequence of perimeters taken over the life of the event. The Northwest Oklahoma Complex, Spring Creek, Woolsey and Camp fires grew rapidly and caused the most damage on their first day. The Chimney Tops 2 fire grew most rapidly and reached the town of Gatlinburg, Tennessee, on its fourth day, and the West Mims fire grew most rapidly beginning 2 weeks after ignition. Some of the NFIRS incidents associated with each fire may have occurred before or after the wildfire was active in that area.

This analysis uses geocoded location information provided by the NFDC. The geocoding process returns latitude and longitude coordinates and a value indicating the precision of the geocodes (Table 16). Some NFIRS incidents cannot be geocoded to an address, so the coordinates that are returned may be the center point of a street or a ZIP code. To capture incidents that may have been within the wildfire boundary if not for the imprecision of the location information, a 10-kilometer buffer around each wildfire was used. Some incidents that appear to be associated with an event may not be.

Table 16: Precision of geocoding by wildfire

Geocode precision	Chimney Tops 2	Northwest Oklahoma Complex	West Mims	Spring Creek	Woolsey	Camp
Address	12%	51%	28%	23%	71%	84%
City	0%	0%	0%	0%	0%	0%
City mean	0%	0%	0%	0%	3%	0%
Street	8%	6%	42%	8%	14%	2%
ZIP	80%	44%	30%	69%	13%	14%
Total incidents	2,472	330	147	26	1,901	816

Sources: USFA analysis of NFIRS and NIFC data.

Recommendations[14]

Federal and state agencies that participate in wildfire response may capture data for their own use that is not recorded in the NFIRS. **Efforts should be made to coordinate with those agencies to obtain that data so that it can be analyzed by the NFDC.** For large wildfires, it may be advisable to augment reported data from federal, state and local sources with information obtained from public sources. **USFA may want to work more closely with the NIFC to receive daily ICS-209 reports (including inventories of damaged or destroyed property) and wildfire shapefiles for active incidents.**

Clear guidance from NFDC to fire departments about reporting data from a wildfire-related incident in NFIRS would be helpful, since there appears to be variation in the incidents that are reported and the completeness of those reports. This guidance could take the form of an NFIRSGram or may involve more direct outreach to fire departments (including NFIRS nonreporters) that protect large areas of WUI. The guidance should address topics such as:

- Identifying that an incident is related to a wildfire: **NFDC may want to consider using a Special Study field so that responding departments can indicate the wildfire that is associated with the incident.** This would allow NFDC to identify incidents from a specific wildfire without needing to use geospatial/temporal matching. Ideally, this data could also be shared in the NFIRS PDR.

[14]Additional recommendations are provided in Appendix A.

- Choosing between the Fire and Wildland Fire modules, when applicable: **Reiterate the guidance that the Wildland Fire module should be used for natural vegetation fires that affect a large area.** Stress that optional variables (weather, terrain, buildings involved or threatened, property management) are important for understanding wildfires.
  - **USFA may want to consider requiring the Wildland Fire module for natural vegetation fires** rather than allowing fire departments to choose between the Fire and Wildland Fire modules.
- Reporting incidents where the fire department was unable to respond: In wildfires, a fire department may not be able to respond to each structure fire (or other incident type) and may not even receive a call for an incident.
  - For the Chimney Tops 2 and Northwest Oklahoma Complex wildfires, it appears that many structure fire incidents were reported as exposures from natural vegetation fires, and this data may have been collected after the fact. Capturing the data for structures that were damaged is important, but this practice may contravene the expectation that the NFIRS is used to capture "every incident (or emergency call) to which the department **responds**" (emphasis added).[15]
  - Another option may be to advise fire departments to use the Wildland Fire module to record the natural vegetation fire, complete the Buildings Involved and Buildings Threatened fields in that module (among others) and record total losses in the Basic Incident module. However, this approach would omit other fire incident types such as vehicle fires and would also omit important details about differences in how the fire affected different structures, vehicles and outdoor areas.
  - **Future enhancements to the NFIRS might include developing an option to allow local fire departments to report wildfires using the Wildland Fire module with supplemental schedules that capture key data about each structure, vehicle and outdoor area that is affected.**
- Reporting for departments giving aid: Large wildfires often involve support from fire departments from outside the local area. These outside fire departments may be the only ones at a scene, prompting the question of whether they are actually giving aid. NFDC should clarify how it would like these departments to record their activities in NFIRS — either as giving aid or as no aid (under the aid-receiving department's fire department identification (FDID) number, accompanied by a cover assignment report).
- Improving incident location information: Better information for determining the location of an incident would improve the quality of analysis. The U.S. National Grid is ideal for locations where an address cannot be determined and should be emphasized.
- Reporting losses: Public sources generally reported higher values for casualties and property losses than the NFIRS reports for these wildfires. **USFA may request that fire departments monitor media sources for consolidated reports and update their NFIRS reporting accordingly.**
- Encouraging completion of optional data elements: There are many optional fields in the Basic, Fire, Structure Fire and Wildland Fire modules that could be used for capturing useful information in wildfires. For instance, the Number of Stories with Minor/Significant/Heavy/Extreme Damage fields could be useful in estimating property losses, and the fields related to On Site Materials could be useful in estimating contents losses.

Additional guidance and training on reporting wildfires in NFIRS would be helpful but may not address all of the data needs presented by a wildfire. Deploying a data collection team from USFA after a wildfire could be very helpful. In addition to ensuring that incidents are reported accurately in NFIRS, a data collection team could also examine other factors that are important for community risk reduction in WUI areas by collecting data and working with local governments. Many of these data are not currently captured in NFIRS.

[15]U.S. Fire Administration, National Fire Data Center. (2015). *National Fire Incident Reporting System: Complete reference guide.* FEMA. https://www.usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf (Page 2-2).

- Comprehensive information about structures: Documenting the types of materials used in construction, types of structure features (e.g., soffits, eaves, decks), landscape elements (e.g., tree/plant selections, defensible perimeters) and other features would be useful for understanding how design/construction/maintenance choices impact a structure's resilience to fire.
- Data about what **did not** burn: Data about structures that were not damaged or destroyed in a wildfire is useful as well. Information about materials, features and landscaping could be used to improve building codes, guide reconstruction and carry out future research.

Further study

With geospatial data that show the progression of a wildfire over time, it would be possible to remove false positive NFIRS incidents from the data used in this analysis. These geospatial data could be constructed from satellite-based fire detection data or assembled from shapefiles. However, the impact of this effort might be limited for 2 reasons.

- First, for 4 of the selected wildfires, most of the destruction occurred within the first 24 hours of ignition, and for a fifth, most of the destruction occurred in an identifiable 4-hour period on the fourth day of the wildfire. Where possible, the analysis that follows distinguishes between incidents reported on a key date and incidents reported during the remainder of the wildfire event.
- Second, given the imprecision of incident location information in NFIRS, it would still be necessary to use a buffer around the wildfire boundary to identify incidents that may have been caused by the wildfire.

Analysis of selected wildfires

Chimney Tops 2, Tennessee, 2016

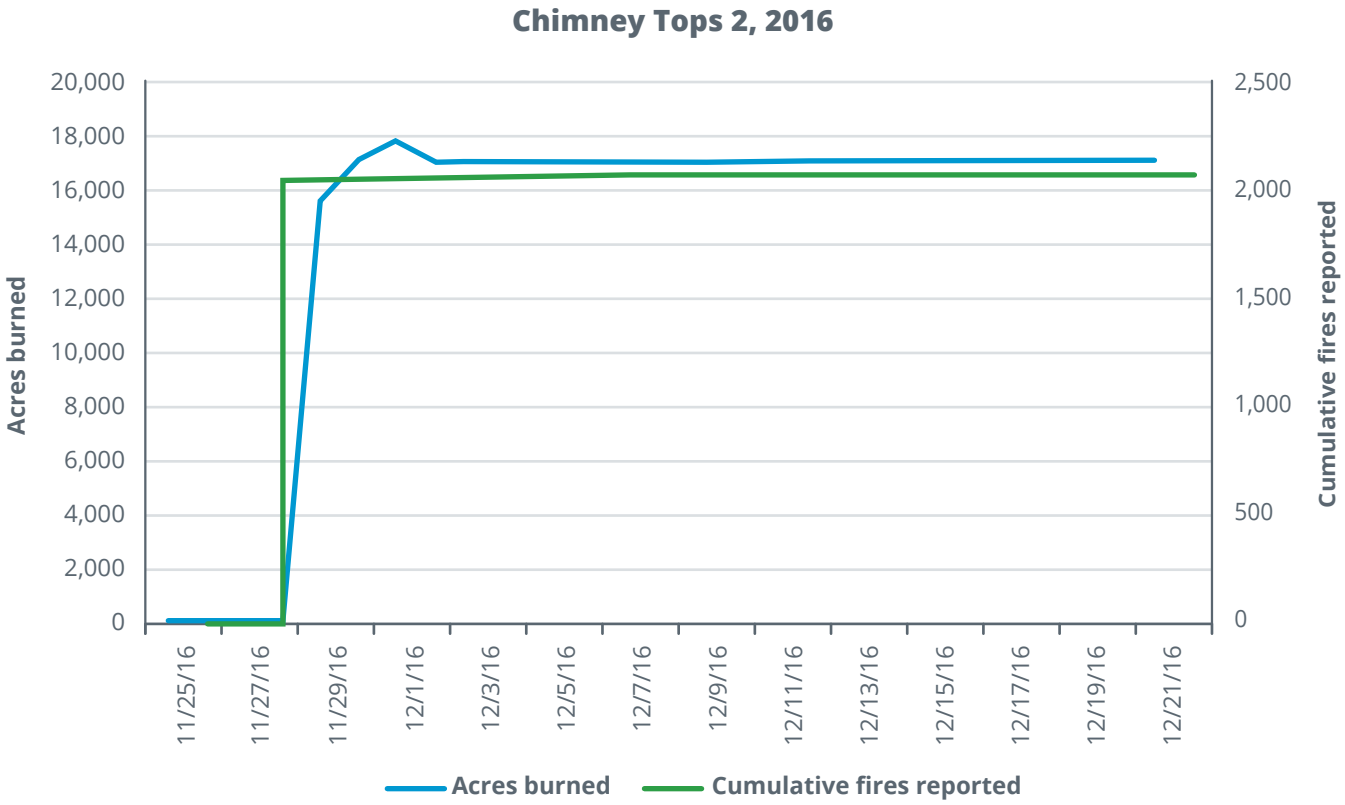
The Chimney Tops 2 fire was a human-caused fire[16,17] that began on Nov. 23, 2016, in Great Smoky Mountains National Park. It grew slowly over the Thanksgiving weekend, then rapidly the following Monday, Nov. 28, propelled by strong winds. It reached the town of Gatlinburg, Tennessee, in the late afternoon where it caused extensive damage. The wildfire was controlled on Dec. 22, 2016.

Of the 2,472 NFIRS incidents associated with the Chimney Tops 2 wildfire, 80% provided location information that allowed the incident to be geocoded to the center point of a ZIP code; only 12% of incidents could be geocoded to an address, and the remaining incidents were geocoded to the center of a named street. While the geocodes are used as the basis for determining where the incident occurred relative to the wildfire boundary, the imprecision of those geocodes should be considered when examining the wildfire.

Figure 2 shows the number of acres burned by the Chimney Tops 2 wildfire and the cumulative number of NFIRS fire reports submitted over time.[18]

[16]National Park Service. (2016, December 22). Great Smoky Mountains: Chimney Tops 2 fire. www.nps.gov/grsm/learn/chimney-tops-2-fire.htm
[17]Satterfield, J. (2017, July 5). Attorney: Arson charges against teens in fatal Gatlinburg wildfire dropped. *Knox News*. www.knoxnews.com/story/news/local/tennessee/gatlinburg/2017/06/30/attorney-arson-charges-against-teens-fatal-gatlinburg-wildfire-dropped/442706001
[18]Form ICS-209 reports are generally completed once per day; acres burned is recorded as of the time the report is submitted and is not intended to depict the real-time progression of the wildfire.

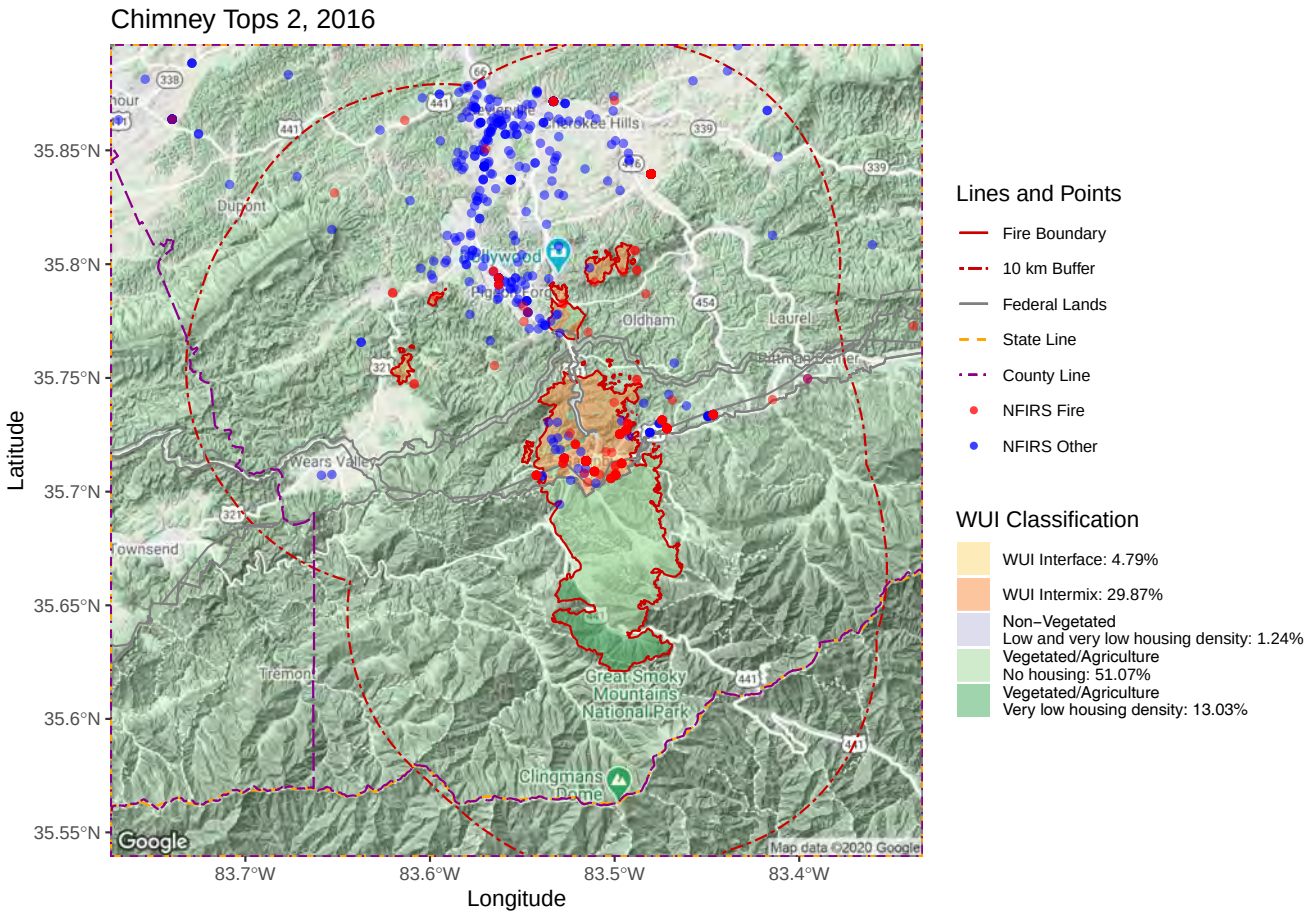
Figure 2: Chimney Tops 2 cumulative acres burned and fires reported by date



Sources: USFA analysis of NFIRS and NIFC data; National Fire and Aviation Management Web Applications. (2017). ***SIT/209 Historical, CY 2016*** [Data set]. Incident Number TN-GSP-016062. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Figure 3 is a map of the wildfire showing the fires and other incident types reported in NFIRS. The yellow and orange shading reflects WUI areas, representing nearly one-third of the wildfire area. The northern portion of the largest wildfire polygon contains Gatlinburg, Tennessee, and the smaller fire polygons show smaller fires that mainly affected WUI areas. Red and blue points that appear more opaque in the map indicate that multiple incidents were geocoded to that location.

Figure 3: Chimney Tops 2 wildfire



Sources: USFA analysis of NFIRS, NIFC, University of Wisconsin-Madison, U.S. Census and BLM data.

Losses

Table 17 summarizes the losses from the Chimney Tops 2 fire from public sources, incident status summary reports (Form ICS-209) filed with the Southern Area Coordination Center, and from the NFIRS incidents that were determined to be associated with this event.

Table 17: Chimney Tops 2 loss metrics

Metric	Public sources	ICS-209[a]	NFIRS Within Boundary	NFIRS Within Buffer	NFIRS Beyond Buffer
Deaths	14[b]	14	12	0	0
Injuries	191[c]	139	3	0	0
Dollar losses	$922 M[d]	n/a	$270 M	$33 M	$ 0
Imputed dollar losses	n/a	n/a	$278 M	$39 M	$ 0
Acres burned	17,140[e]	17,140	2,543	3,392	0
Structures damaged or destroyed	2,460[f]	2,315	n/a	n/a	n/a
Fire incidents	n/a	n/a	1,708	366	2
Nonfire incidents	n/a	n/a	38	331	27

Sources: USFA analysis of NFIRS and NIFC data.

[a]National Fire and Aviation Management Web Applications. (2017). *SIT/209 Historical, CY 2016* [Data set]. Incident Number TN-GSP-016062. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News.* www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/
[c]Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News.* www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/
[d]Ahillen, S. (2017, August 9). Tennessee mountain community getting back on its feet after devastating wildfire. *Insurance Journal.* www.insurancejournal.com/news/southeast/2017/08/09/460619.htm
[e]Badger, S. G. (2017, November, December). Large-Loss Fires in the United States in 2016. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-Media/NFPA-Journal/2017/November-December-2017/Features/Large-Loss-Fires-2016
[f]Badger, S. G. (2017, November, December). Large-Loss Fires in the United States in 2016. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-Media/NFPA-Journal/2017/November-December-2017/Features/Large-Loss-Fires-2016

The 14 deaths reported by public sources include 1 death in a vehicle accident and 1 death from a heart attack during evacuation. The 12 deaths reported in the NFIRS (in both the Basic Incident and Civilian Casualty modules) occurred in incidents where the incident type was a fire. Although the fire service may have been involved in the response to the remaining 2 deaths, there are no EMS module reports associated with the Chimney Tops 2 fire, so it is not possible to determine whether these deaths were associated with an EMS incident type, a different incident type or were not reported by the fire service.

Dollar losses reported by public sources include property and contents lost due to the wildfire and exclude the costs of fighting the fire, which were estimated at $8.8 million within Great Smoky Mountains National Park19 and were not available for the overall incident. Other sources contained dollar loss estimates from the Chimney Tops 2 fire that ranged from $500 million20 to $2 billion[21]. Related incidents in the NFIRS contained a total of $303 million[22] in property and contents losses; 90% of that was within the wildfire boundary.

Public sources reported the number of structures destroyed or damaged by the fire was between 1,600[23] and 2,500.[24] The 2,076 fire incidents reported in the NFIRS for this fire is within that range. Virtually all of the fire incidents in NFIRS were for structure fires where the fire spread beyond the building of origin.

[19]Knoxville News Sentinel. (2016, December 28). By the numbers: Gatlinburg fire. *Knox News.* www.knoxnews.com/story/news/local/tennessee/2016/12/28/numbers-gatlinburg-fire/95847766/
[20]Knoxville News Sentinel. (2016, December 28). By the numbers: Gatlinburg fire. *Knox News.* www.knoxnews.com/story/news/local/tennessee/2016/12/28/numbers-gatlinburg-fire/95847766/
[21]Satterfield, J. (2020, April 6). Gatlinburg's former fire chief lambasts National Park Service in deadly wildfires lawsuit. *Knox News.* www.knoxnews.com/story/news/crime/2020/04/06/gatlinburg-fire-chief-blames-national-park-service-deadly-wildfires/5116729002/
[22]This figure includes 16 separate incidents where property loss was reported as $1,879,600.
[23]Zenteno, R., Hanna, J., & Park, M. (2016, December 5). 14 confirmed dead in Tennessee wildfires. *CNN.* www.cnn.com/2016/12/05/us/tennessee-gatlinburg-wildfires/index.html
[24]National Park Service. (2017, August 31). *Chimney Tops 2 fire review: Individual fire review report.* U.S. Department of the Interior, Division of Fire and Aviation. https://www.wildfirelessons.net/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=2291b1f9-d65a-4915-2257-d76919c16132&forceDialog=0 (Page 6).

Public sources reported over 190 injuries in the Chimney Tops 2 wildfire, compared to only 3 in the NFIRS incidents. The 3 injuries reported in NFIRS were part of the same incident as one in which 2 fatalities were recorded. No firefighter injuries related to the Chimney Tops 2 wildfire were reported in NFIRS, and no supplemental EMS modules were submitted.

NFIRS data for the wildfire

There were 2,472 incidents associated with the Chimney Tops 2 wildfire in NFIRS (Table 18). Of those, 1,746 incidents were located within the wildfire boundary. In total, 2,076 fires were reported, and 1,708 of those were within the wildfire boundary. The 2,049 fires reported on Nov. 28, 2016, the day the wildfire reached Gatlinburg, comprise 83% of all incidents reported. Nearly 1,600 fires were reported with an alarm time of 5:48 p.m. on Nov. 28.

Table 18: Chimney Tops 2 reported incidents by type, date and location

Location	Date	Fire	EMS	Hazmat	Service	Good Intent	False Alarm	Weather	Special	Total
All associated incidents	11/23/16-11/27/16	2	16	0	6	7	2	0	0	33
	11/28/16	2,049	9	2	8	4	2	4	2	2,080
	11/29/16-12/22/16	25	158	6	56	76	25	9	4	359
Within Boundary	11/23/16-11/27/16	0	1	0	0	1	0	0	0	2
	11/28/16	1,702	0	0	3	0	1	1	1	1,708
	11/29/16-12/22/16	6	2	1	8	15	0	2	2	36
Within Buffer	11/23/16-11/27/16	2	11	0	6	5	2	0	0	26
	11/28/16	346	9	2	5	4	1	3	1	371
	11/29/16-12/22/16	18	144	4	46	57	24	6	1	300
Beyond Buffer	11/23/16-11/27/16	0	4	0	0	1	0	0	0	5
	11/28/16	1	0	0	0	0	0	0	0	1
	11/29/16-12/22/16	1	12	1	2	4	1	1	1	23

Sources: USFA analysis of NFIRS and NIFC data.

A total of 2,049 fires were reported on Nov. 28, 2016. Of these fires, 98.6% were structure fires, and 82.1% of them were located within the wildfire boundary. No mobile structure (120 series), vehicle (130 series), outside rubbish (150 series) or crop (170 series) fires were reported (Table 19).

Table 19: Chimney Tops 2 fire incidents by Incident Type and location (Nov. 28, 2016)

Incident Type	Within Boundary	Within Buffer	Beyond Buffer
100 — Fire, other	2	2	
110 series — Structure fire	1,682	338	1
140 series — Natural vegetation fire	17	6	
160 series — Special outside fire	1		

Sources: USFA analysis of NFIRS and NIFC data.

Of the 2,049 fires reported on Nov. 28, 2016, 98.1% were structure fires involving one- or two-family dwellings (Table 20).

Table 20: Chimney Tops 2 fire incidents by property use (Nov. 28, 2016)

Incident Type	Assembly	One- or two-family dwelling	Other residential	Business	Industrial	Outside/ special	Unknown
100 — Fire, other	1					1	2
110 series — Structure fire	1	2,011	2	1			6
140 series — Natural vegetation fire			3		6	10	4
160 series — Special outside fire							1

Sources: USFA analysis of NFIRS and NIFC data.

Responding fire departments

Fire departments submitted 5 incident reports using the Wildland Fire module and 2,026 incident reports using the Fire module. The remaining fires were Aid Given incidents where neither module is required.

The Gatlinburg and Pigeon Forge fire departments reported the most incidents due to the wildfire. A total of 59 departments reported incidents related to the wildfire, including departments from Indiana, Kentucky and Virginia (Table 21).[25]

Table 21: Chimney Tops 2 responding fire departments

Top 10 departments			Primary				Aid Given			
			Nov. 28		After Nov. 28		Nov. 28		After Nov. 28	
State	FDID	Fire department name	Fires	Other	Fires	Other	Fires	Other	Fires	Other
TN	78113	Gatlinburg Fire Department	1,613	1,598	2	0	11	0	0	0
TN	78133	Pigeon Forge Fire Department	398	298	5	2	89	1	1	1
TN	78143	Sevierville Fire Department	161	1	6	0	137	0	0	0
TN	78171	Pittman Center Community Volunteer Fire Department	130	130	0	0	0	0	0	0
TN	78101	Wears Valley Volunteer Fire Department	30	3	3	0	19	0	1	0
TN	78151	Seymour Volunteer Fire Department	29	0	0	1	19	1	1	0
TN	78721	Sevier County Fire Department	21	0	1	3	13	0	0	0
TN	82131	Bluff City Fire Department	14	0	0	0	14	0	0	0
TN	82121	Avoca Volunteer Fire Department	5	1	1	1	2	0	0	0
TN	62121	Madisonville Fire Department	4	0	0	0	0	0	0	0
		All Others	0	2	0	9	16	8	17	15

Sources: USFA analysis of NFIRS and NIFC data.

[25]These out-of-state departments are included in the incidents associated with the wildfire because the NFIRS reports they submitted did not indicate that they were giving aid.

Exposures

Among the 2,074 fires reported on Nov. 28 or later, only 58 were recorded as not being caused by exposure to another fire (Table 22). That is, 97.2% of the fires reported in the Chimney Tops 2 wildfire were caused by exposure to another fire. One incident, number 1128165, reported by the Gatlinburg Fire Department, had 800 exposures, and 5 other incidents had over 100 exposures apiece.

Table 22: Chimney Tops 2 exposure fires

Department incident number	TN 78113 1128165	TN 78113 1128162	TN 78113 1128161	TN 78133 1128163	TN 78171 0001128	TN 78113 1128163
Total incidents	801	508	152	146	130	126
Originating Incident Type	141	141	141	141	n/a	141
Structure exposures	798	505	151	145	130	125
Outdoor exposures	2	2				

Sources: USFA analysis of NFIRS and NIFC data.

Completeness of NFIRS reporting

Completeness is a measure of how many NFIRS reports contained valid, known values for all data elements in the Basic, Fire and Wildland Fire modules. For the Chimney Tops 2 wildfire, the overall completeness of the Basic module improved with distance from the wildfire boundary. The completeness metric for the Fire and Wildland Fire modules was independent of distance (Table 23).

Table 23: Chimney Tops 2 completeness of NFIRS reporting

Module	Metric	Within Boundary	Within Buffer	Beyond Buffer	Overall
Basic module	No. of reports	1,746	697	29	2,472
	% valid and known	56	66	73	59
Fire module	No. of reports	1,686	345	1	2,032
	% valid and known	27	27	27	27
Wildland Fire module	No. of reports	3	2	0	5
	% valid and known	27	27	n/a	27

Sources: USFA analysis of NFIRS and NIFC data.

Selected NFIRS data elements

The Chimney Tops 2 wildfire is notable among the wildfires selected for this analysis because of the number of NFIRS incident reports that are associated with it. However, with the exception of Property Loss and Contents Loss, many of the fire incident reports are identical. Table 24 is an examination of key variables for 2,074 fires reported on or after Nov. 28, 2016.

Table 24: Chimney Tops 2 selected NFIRS data elements

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
ACT_TAK1	Actions Taken #1	1,896	00	Action taken, other	130	15	Confine fire (wildland)	15	11	Extinguishment by fire service personnel
ACT_TAK2	Actions Taken #2	1,620	(blank)		229	73	Provide manpower	131	14	Contain fire (wildland)
ACT_TAK3	Actions Taken #3	1,629	(blank)		223	74	Provide apparatus	131	16	Control fire (wildland)
BLDG_ ABOVE	Building Height: Stories Above Grade	1,106	2		831	1		58	(missing module)	
CAUSE_ IGN (Fire module)	Cause of Ignition	2,017	0	Cause, other	42	(missing module)		7	1	Intentional
FIRE_ CAUSE (Wildland Fire module)	Wildland Fire Cause	2,069	(missing module)		5	1	Natural source			
FIRE_ ORIG	Fire Origin	2,016	1		58	(missing module)				
FIRE_ SPRD	Fire Spread	2,014	5	Beyond building of origin	58	(missing module)		2	4	Confined to building of origin
FIRST_IGN	Item First Ignited	2,012	10	Structural component or finish, other	42	(missing module)		14	UU	Undetermined
HEAT_ SOURC (Fire module)	Heat Source	2,020	80	Heat spread from another fire, other	42	(missing module)		2	81	Heat from direct flame, convection currents
HEAT_ SOURC (Wildland Fire module)	Heat Source	2,069	(missing module)		5	13	Electrical arcing			
INC_TYPE	Incident Type	2,026	111	Building fire	30	141	Forest, woods or wildland fire	10	100	Fire, other
MIXED_ USE	Mixed Use	2,065	(blank)		6	40	Residential use	2	58	Business and residential use

Table 24: Chimney Tops 2 selected NFIRS data elements (continued)

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
PROP_USE	Property Use	2,012	419	One- or two-family dwelling	24	(blank)		7	669	Forest, timberland, woodland
STRUC_ STAT	Structure Status	2,014	2	In normal use	42	(missing module)		16	(blank)	
STRUC_ TYPE	Structure Type	2,016	1	Enclosed building	58	(blank or missing module)				
SUPP_ FACT1 (Wildland Fire module)	Fire Suppression Factors #1	2,069	(missing module)		3	732	Wind, including hurricanes or tornadoes	2	711	Drought or low fuel moisture
SUPP_ FACT2 (Wildland Fire module)	Fire Suppression Factors #2	2,069	(missing module)		3	712	Humidity, low	2	711	Drought or low fuel moisture
SUPP_ FACT3 (Wildland Fire module)	Fire Suppression Factors #3	2,069	(missing module)		2	712	Humidity, low	2	732	Wind, including hurricanes or tornadoes
SUP_ FAC_1 (Fire module)	Suppression Factors #1	2,021	732	Wind, including hurricanes or tornadoes	42	(missing module)		4	NNN	None
SUP_ FAC_2 (Fire module)	Suppression Factors #2	2,020	711	Drought or low fuel moisture	42	(missing module)		8	(blank)	
SUP_ FAC_3 (Fire module)	Suppression Factors #3	2,021	775	Urban-wildland interface area	42	(missing module)		9	(blank)	

Sources: USFA analysis of NFIRS and NIFC data.

For most NFIRS variables of interest, at least 2,000 of the 2,074 incidents reported the same values. Action Taken #1, a required field, was reported as "Action taken, other" in 91.4% of incidents, and Action Taken #2 and #3, optional fields, were left blank in approximately 78% of records. Notably, variables related to the estimation of property loss, such as Building Height: Stories Above Grade, appear to have a greater range of reported values.

Collectively, these values provide an accurate description of the events at Chimney Tops 2 — fire caused by a natural event (Fire Cause), exacerbated by high winds, low humidity and drought conditions (Fire Suppression Factors #1, #2

and #3) spread to a WUI area (Suppression Factor #3) where the fire spread from building to building (Incident Type, Heat Source, Item First Ignited) and destroyed many homes (Fire Spread, Property Use).

NFIRS fields that can capture the extent of damage such as Number of Stories with Minor/Significant/Heavy/Extreme Damage are optional and were not populated for the Chimney Tops 2 wildfire.

Wildland urban interface

Nearly 35% of the area burned by the Chimney Tops 2 fire was WUI. These WUI areas contained 82% of the NFIRS-reported fires. However, nearly 1,600 fires in the WUI had a geocode precision of ZIP code, which means that they may not have actually occurred within the WUI (Table 25).

Table 25: Chimney Tops 2 fires inside/outside of WUI

Location	Fires		Structure fires	
	Number	% of total	Number	% of total
In WUI, Within Boundary	1,700	81.9	1,681	82.9
Outside WUI, Within Boundary	8	0.4	4	0.2
Within Buffer	366	17.6	341	16.8
Beyond Buffer	2	0.1	2	0.1
Total	2,076	100.0	2,028	100.0

Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

Northwest Oklahoma Complex, Oklahoma/Kansas, 2017

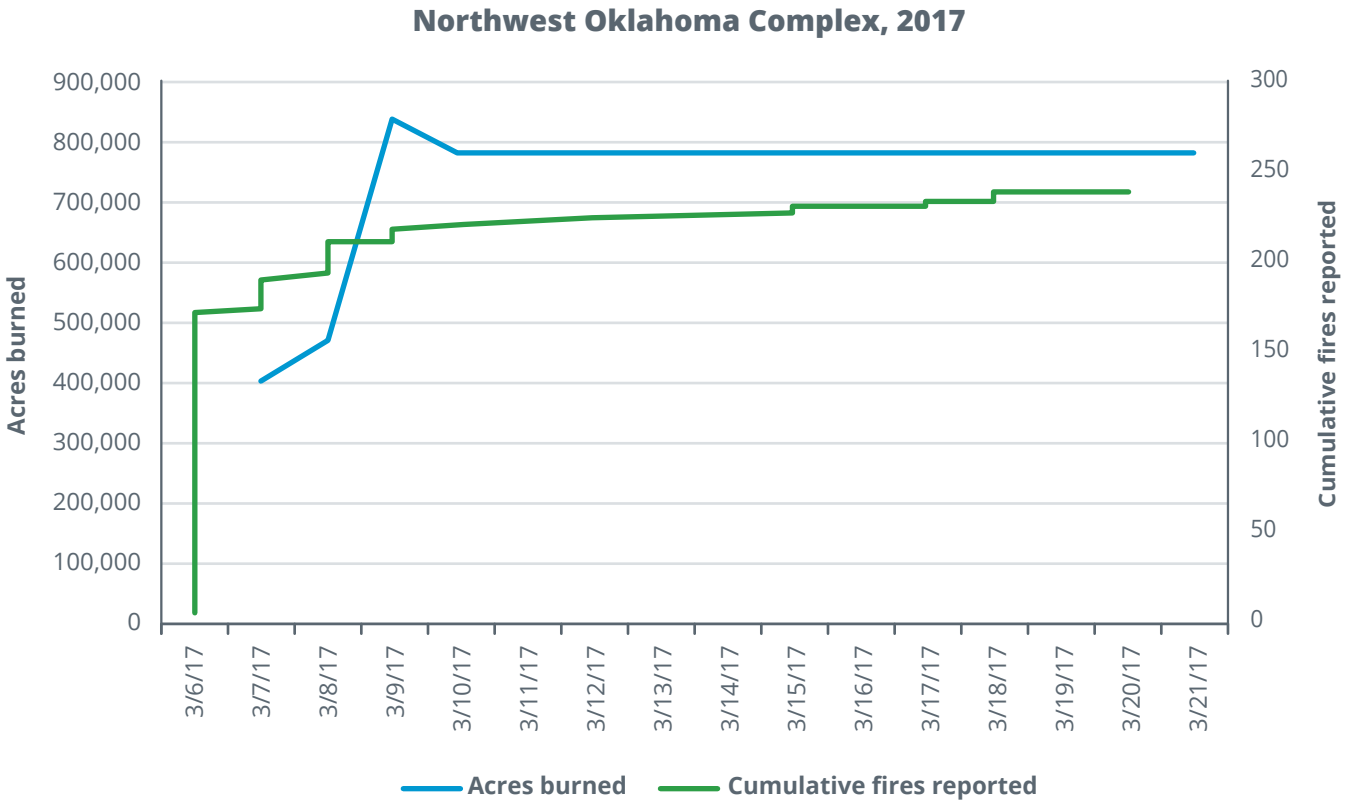
The Northwest Oklahoma Complex consisted of 4 fires — the Starbuck, Selman, 283 and Beaver fires — that burned approximately 780,000 acres across 2 states beginning March 6, 2017. The fire was caused by a downed power line and spread quickly due to dry conditions and high winds.[26] The fire was declared to be contained on March 22, 2017.

Approximately half (51%) of the 330 NFIRS incidents associated with the Northwest Oklahoma Complex wildfire contained enough location information to be geocoded to an address. Another 44% of NFIRS incidents only contained enough location information to be geocoded to a ZIP code, and the remaining NFIRS incidents were geocoded to the center of a named road. The lack of precise location information and geocodes should be considered when examining the wildfire.

Figure 4 shows the cumulative number of fires reported in the NFIRS and acres burned for the Northwest Oklahoma Complex. The apparent decline in acres burned from March 9 to March 10 is due to improved measurement.

[26]Frazier, I. (2018, October 29). The day the Great Plains burned. *The New Yorker.* https://www.newyorker.com/magazine/2018/11/05/the-day-the-great-plains-burned

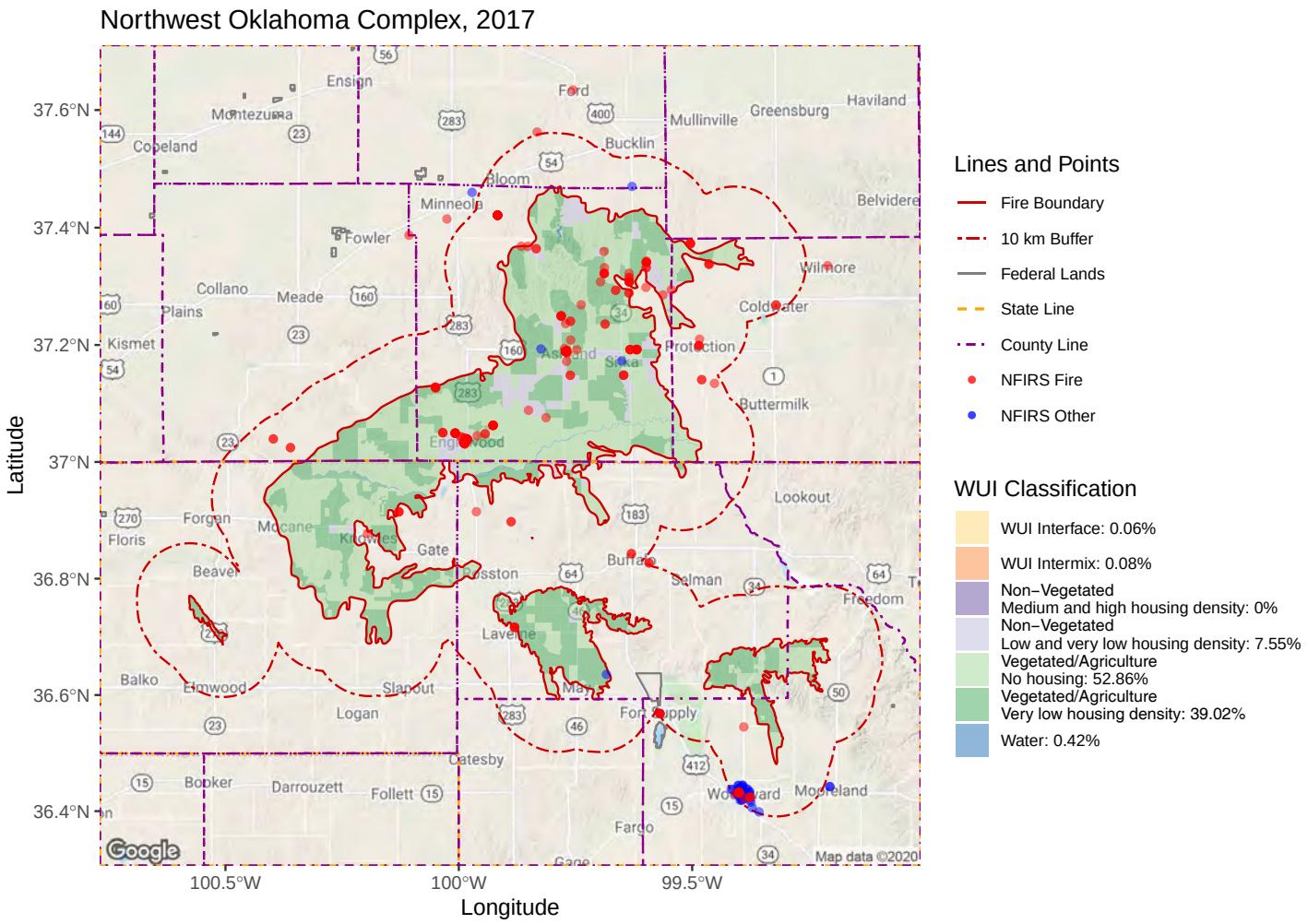
Figure 4: Northwest Oklahoma Complex cumulative acres burned and fires reported by date



Sources: USFA analysis of NFIRS and NIFC data; National Fire and Aviation Management Web Applications. (2018). ***SIT/209 Historical, CY 2017*** [Data set]. Incident Number OK-OKS-000529. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Figure 5 shows the area affected by the fires. Over 90% of the affected area is agricultural, including areas with less than 1 home per 40 acres. The 37 degrees north latitude line is the border between Oklahoma and Kansas. Red and blue points that appear more opaque indicate that multiple NFIRS incidents were geocoded to that location.

Figure 5: Northwest Oklahoma Complex wildfire



Sources: USFA analysis of NFIRS, NIFC, University of Wisconsin-Madison, U.S. Census and BLM data.

Losses

Table 26 summarizes the losses from the Northwest Oklahoma Complex fire from both public sources and from the NFIRS incidents that were determined to be associated with this event.

Table 26: Northwest Oklahoma Complex loss metrics

Metric	Public sources	ICS-209[a]	NFIRS Within Boundary	NFIRS Within Buffer	NFIRS Beyond Buffer
Deaths	2[b]	2	0	0	0
Injuries		7	0	0	0
Dollar losses	$64.6 M[c,d]			$1.5 M	
Imputed dollar losses	n/a		$4.2 M	$1.9 M	$ 0
Acres burned	782,333[e]	779,292	286,721	706,041	141,861
Structures damaged or destroyed	140[f]	174			
Fire incidents			164	68	7
Nonfire incidents			6	82	3

Sources: USFA analysis of NFIRS and NIFC data.

[a]National Fire and Aviation Management Web Applications. (2018). *SIT/209 Historical, CY 2017* [Data set]. Incident Number OK-OKS-000529. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]Associated Press. (2017, March 7). Officials: Harper County woman died while fighting fire on her farm. *Fox 25.* okcfox.com/news/local/officials-harper-county-woman-died-while-fighting-fire-on-her-farm
[c]Legislative Division of Post Audit. (2018). P*erformance audit report: Kansas wildfire management: Evaluating the adequacy of Kansas' wildfire suppression system.* State of Kansas. www.kansasforests.org/fire_management/fire_docs/Final_Report.pdf
[d]Oklahoma Farm Report. (2017, March 25). Oklahoma State extension says over sixteen million dollars in losses to agriculture as a result of Northwest Oklahoma Fire Complex. *Radio Oklahoma Network.* www.oklahomafarmreport.com/wire/news/2017/03/01349_OSUExtensionCostEstimate03252017_112959.php#.YFOQpC2cbOQ
[e]Oklahoma Forestry Services. (2017, March 21). *Fire situation report — March 21, 2017.* Oklahoma Department of Agriculture, Food and Forestry. www.forestry.ok.gov/fire-situation-report-–-march-21-2017
[f]Morrison, O. (2017, June 16). Damage from historic wildfires more than $80 million. *The Wichita Eagle.* www.kansas.com/news/state/article156506309.html

Neither of the deaths attributed to the wildfire were recorded in NFIRS. In one case, a woman who was attempting to fight the fire on her farm in Oklahoma suffered a heart attack; in the other, a truck driver in Kansas was unable to escape the flames.

Quantifying losses from the Northwest Oklahoma Complex fires is more challenging because the Starbuck fire, the largest of the 4 fires in the complex, burned nearly 500,000 acres in Kansas. The remainder of the Starbuck fire and the other 3 fires were within Oklahoma. State insurance, forestry and emergency management resources generally only capture losses that occurred within the state. In Oklahoma, dollar losses were estimated at $14.6 million by the Oklahoma State University Cooperative Extension, including losses of livestock, fencing and feed.[27] In Kansas, dollar losses were estimated at $50 million, including livestock and fencing, but excluding the value of approximately 140 damaged and destroyed structures.[28] The NFIRS contains approximately 240 reports of fire with a total property and contents loss of $1.5 million. There are only 6 NFIRS reports with property losses and none with contents losses.

No EMS, Civilian Casualty or Firefighter Casualty modules were submitted in association with any NFIRS incidents associated with the Northwest Oklahoma Complex wildfire.

NFIRS data for the wildfire

There are 330 incidents in NFIRS that are associated with the Northwest Oklahoma Complex wildfire. Of those, 170 incidents were located within the wildfire boundary. In total, 239 fires were reported, and 164 (69%) of those were within the wildfire boundary. The 174 fires reported on March 6, 2017, the ignition date of the wildfire, comprise 53% of all incidents reported; 138 fires were reported with an alarm time of 3:50 p.m. on March 6 (Table 27).

[27]Oklahoma Farm Report. (2017, March 25). Oklahoma State extension says over sixteen million dollars in losses to agriculture as a result of Northwest Oklahoma Fire Complex. *Radio Oklahoma Network.* www.oklahomafarmreport.com/wire/news/2017/03/01349_OSUExtensionCostEstimate03252017_112959.php#.YFOQpC2cbOQ
[28]Morrison, O. (2017, June 16). Damage from historic wildfires more than $80 million. *The Wichita Eagle.* www.kansas.com/news/state/article156506309.html

Table 27: Northwest Oklahoma Complex reported incidents by type, date and location

Location	Date	Fire	EMS	Hazmat	Service	Good Intent	False Alarm	Weather	Special	Total
All associated incidents	3/6/17	174	3	0	0	2	1	0	0	180
	3/7/17-3/22/17	65	57	2	5	13	4	2	2	150
Within Boundary	3/6/17	146	0	0	0	0	0	0	0	146
	3/7/17-3/22/17	18	0	0	3	1	0	1	1	24
Within Buffer	3/6/17	26	3	0	0	1	1	0	0	31
	3/7/17-3/22/17	42	56	2	2	11	4	1	1	119
Beyond Buffer	3/6/17	2	0	0	0	1	0	0	0	3
	3/7/17-3/22/17	5	1	0	0	1	0	0	0	7

Sources: USFA analysis of NFIRS and NIFC data.

Over the duration of the wildfire, 239 fires were reported in NFIRS. Of these, 153 (64%) were structure fires, and 76 (32%) were natural vegetation fires (Table 28).

Table 28: Northwest Oklahoma Complex fire incidents by Incident Type and location

Incident Type	Within Boundary	Within Buffer	Beyond Buffer
100 — Fire, other	1	1	0
110 series — Structure fire	142	11	0
130 series — Mobile property fire	0	2	0
140 series — Natural vegetation fire	21	50	5
150 series — Outside rubbish fire	0	2	1
160 series — Special outside fire	0	1	0
170 series — Crop fire	0	1	1

Sources: USFA analysis of NFIRS and NIFC data.

Of the 239 fires reported in NFIRS, 132 (55%) involved outside or special property (Table 29).

Table 29: Northwest Oklahoma Complex fire incidents by property use

Incident Type	Assembly	One- or two- family dwelling	Other residential	Business	Industrial	Storage	Outside/ special	Unknown/ other/n/a
100 — Fire, other		1						1
110 series — Structure fire	1	38	1	1		13	99	
130 series — Mobile property fire							2	
140 series — Natural vegetation fire		1			1		28	46
150 series — Outside rubbish fire							3	
160 series — Special outside fire								1
170 series — Crop fire					1			1

Sources: USFA analysis of NFIRS and NIFC data.

A number of outside/special property uses were affected by the wildfire. The property use for 99 of the structure fires was recorded as outbuildings or shelters, and the specific property use for 28 of the natural vegetation fires was recorded as open lands or fields.

Responding fire departments

Fire departments submitted incident reports using the Wildland Fire module for 18 of these fires, including 2 fires where aid was given. The Fire module was used for 169 incident reports of these fires, and all except 1 of the remaining fires were Aid Given incidents where neither module is required.

The Ashland, Kansas, and Woodward, Oklahoma, fire departments reported the most incidents due to the wildfire. A total of 57 other departments reported incidents related to the wildfire, all from Oklahoma and Kansas (Table 30).

Table 30: Northwest Oklahoma Complex responding fire departments

Top 10 departments			Primary				Aid Given			
			March 6		After March 6		March 6		After March 6	
State	FDID	Fire department name	Fires	Other	Fires	Other	Fires	Other	Fires	Other
KS	CA402	Ashland Fire	84	78	0	4	2	0	0	0
OK	77006	Woodward	81	1	5	5	66	0	1	0
KS	CA301	Englewood Rural Volunteer Fire	62	62	0	0	0	0	0	0
KS	CA304	Minneola Fire Department	17	11	0	4	1	0	0	1
KS	CM404	Comanche County Fire	9	1	0	7	0	1	0	0
KS	FO403	Ford County Fire EMS	5	1	0	1	0	0	0	0
KS	ME405	Meade Rural Fire Department	4	4	0	0	0	0	0	0
OK	44005	Ringwood	4	1	0	0	0	0	0	3
OK	77001	Fort Supply	4	0	0	1	1	2	0	0
KS	ME403	Fowler Rural Fire Department	3	0	0	0	0	0	0	3
		All Others	57	2	0	3	5	10	0	33

Sources: USFA analysis of NFIRS and NIFC data.

Exposures

Among the 239 fires associated with the Northwest Oklahoma Complex, 151 were reported as exposures from other fires, 4 fires were reported as the original fire that caused those exposures, and the remaining fires were reported as single events (Table 31).

Table 31: Northwest Oklahoma Complex exposure fires

Department incident number	KS CA402 00Star1	KS CA301 00Star3	KS CA304 00Star2	KS ME405 0017016
Total incidents	78	62	11	4
Originating Incident Type	143	143	143	n/a
Structure exposures	77	61	10	4
Outdoor exposures	1	1	1	0

Sources: USFA analysis of NFIRS and NIFC data.

Completeness of NFIRS reporting

Completeness is a measure of how many NFIRS reports contained valid, known values for all data elements in the Basic, Fire and Wildland Fire modules. For the Northwest Oklahoma Complex wildfire, the overall completeness of the Basic and Wildland Fire modules improved with distance from the wildfire boundary. The completeness metric for the Fire module declined with distance (Table 32).

Table 32: Northwest Oklahoma Complex completeness of NFIRS reporting

Module	Metric	Within Boundary	Within Buffer	Beyond Buffer	Overall
Basic module	Number of reports	170	150	10	330
	% valid and known	54	61	62	57
Fire module	Number of reports	144	23	2	169
	% valid and known	25	20	11	24
Wildland Fire module	Number of reports	6	9	3	18
	% valid and known	8	10	26	12

Sources: USFA analysis of NFIRS and NIFC data.

Selected NFIRS data elements

Many of the incident reports associated with the Northwest Oklahoma Complex wildfire are sparsely populated. Of the 239 fires reported to NFIRS, the Basic modules for those incidents are very similar, with the exception of AID and PROP_USE. The most common value for most variables from the Basic module was either blank (data elements that use codes) or zero (data elements that require a numeric response) (Table 33).

Table 33: Northwest Oklahoma Complex selected NFIRS data elements, Basic module

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
ACT_TAK1	Actions Taken #1	211	11	Extinguish-ment by fire service personnel	7	10	Fire control or extinguishment, other	7	14	Contain fire (wildland)
ACT_TAK2	Actions Taken #2	228	(blank)		3	14	Contain fire (wildland)	2	17	Manage prescribed fire (wildland)
ACT_TAK3	Actions Taken #3	234	(blank)		2	14	Contain fire (wildland)	1	11	Extinguish-ment by fire service personnel
AID	Aid Given or Received	99	1	Mutual aid received	57	2	Automatic aid received	52	3	Mutual aid given
PROP_LOSS	Property Loss	197	(blank)		36	0		1	1	
PROP_USE	Property Use	99	926	Outbuilding, protective shelter	45	(Aid Given, optional)		40	419	One- or two-family dwelling

Sources: USFA analysis of NFIRS and NIFC data.

The Fire module was submitted for 169 fires. Reported values for most of these incidents were the same (Table 34).

Table 34: Northwest Oklahoma Complex selected NFIRS data elements, Fire module

Variable	Description	Most common			Second most common		
		Incidents	Code	Definition	Incidents	Code	Definition
AREA_ORIG	Area of Origin	148	76	Wall surface: exterior	7	94	Open area, outside; included are farmland, field
CAUSE_IGN	Cause of Ignition	152	0	Cause, other	10	2	Unintentional
DETECTOR	Detector Presence	98	N	None present	49	U	Undetermined
FACT_IGN_1	Factors Contributing To Ignition #1	152	71	Exposure fire	4	72	Rekindle
FACT_IGN_2	Factors Contributing To Ignition #2	169	(blank)				
FIRE_ORIG	Fire Origin	147	1				
FIRE_SPRD	Fire Spread	146	5	Beyond building of origin	1	2	Confined to room of origin
FIRST_IGN	Item First Ignited	154	UU	Undetermined	8	72	Light vegetation — not crop, including grass
HEAT_SOURC	Heat Source	149	83	Flying brand, ember, spark	7	43	Hot ember or ash
STRUC_STAT	Structure Status	140	2	In normal use	22		n/a
STRUC_TYPE	Structure Type	86	1	Enclosed building	61	2	Fixed portable or mobile structure
SUP_FAC_1	Suppression Factors #1	168	(blank)		1	NNN	None
SUP_FAC_2	Suppression Factors #2	169	(blank)				
SUP_FAC_3	Suppression Factors #3	169	(blank)				

Sources: USFA analysis of NFIRS and NIFC data.

The Wildland Fire module was used for 18 incidents (Table 35). AREA_TYPE, FIRE_CAUSE, FACT_IGN1 and HEAT_SOURC are required fields, and only FACT_IGN1 contains much variation across the incident reports. (Other values for FACT_IGN1 not shown in Table 35 include 71 (Exposure fire), 72 (Rekindle), 12 (Heat source too close to combustibles), 36 (Arc, spark from operating equipment), 60 (Natural condition, other) and 70 (Fire spread or control, other).)

Table 35: Northwest Oklahoma Complex selected NFIRS data elements, Wildland Fire module

Variable	Description	Most common			Second most common		
		Incidents	Code	Definition	Incidents	Code	Definition
AREA_TYPE	Area Type	15	1	Rural, including farms > 50 acres	3	3	Rural/urban or suburban
BLDG_INV	Number of Buildings Involved	2	0		1	12	
BLDG_THR	Number of Buildings Threatened	2	0				
FACT_IGN1	Factors Contributing to Ignition #1	4	UU	Undetermined	3	61	High wind
FACT_IGN2	Factors Contributing to Ignition #2	18	(blank)				
FIRE_CAUSE	Wildland Fire Cause	13	U	Undetermined	3	4	Open/ outdoor fire
HEAT_SOURC	Heat Source	7	UU	Undetermined	4	43	Hot ember or ash
SUPP_FACT1	Fire Suppression Factors #1	18	(blank)				
SUPP_FACT2	Fire Suppression Factors #2	18	(blank)				
SUPP_FACT3	Fire Suppression Factors #3	18	(blank)				

Sources: USFA analysis of NFIRS and NIFC data.

The NFIRS reports associated with the Northwest Oklahoma Complex wildfire provide a good overview of the event, particularly in enumerating the extent of damage (Fire Spread), how the fire started (Area of Origin, Heat Source) and how the property was used (Property Use). However, there are some inconsistencies and deficiencies in the NFIRS data. For example, the second most common structure type reported in the Fire module is "fixed portable or mobile structure," yet there were no corresponding incident types (120 series — Fire in mobile property used as fixed structure) among the NFIRS reports. Property and content losses were not well reported — only 6 NFIRS reports provided a nonzero value for Property Loss, and virtually all of the losses for the entire wildfire come from a single incident where the reported loss was $1.5 million. (That incident, a tractor-trailer fire reported a week after the wildfire began, may or may not have been related to the wildfire.)

Wildland urban interface

Only a small portion, 0.14%, of the area affected by the Northwest Oklahoma Complex wildfire was WUI.

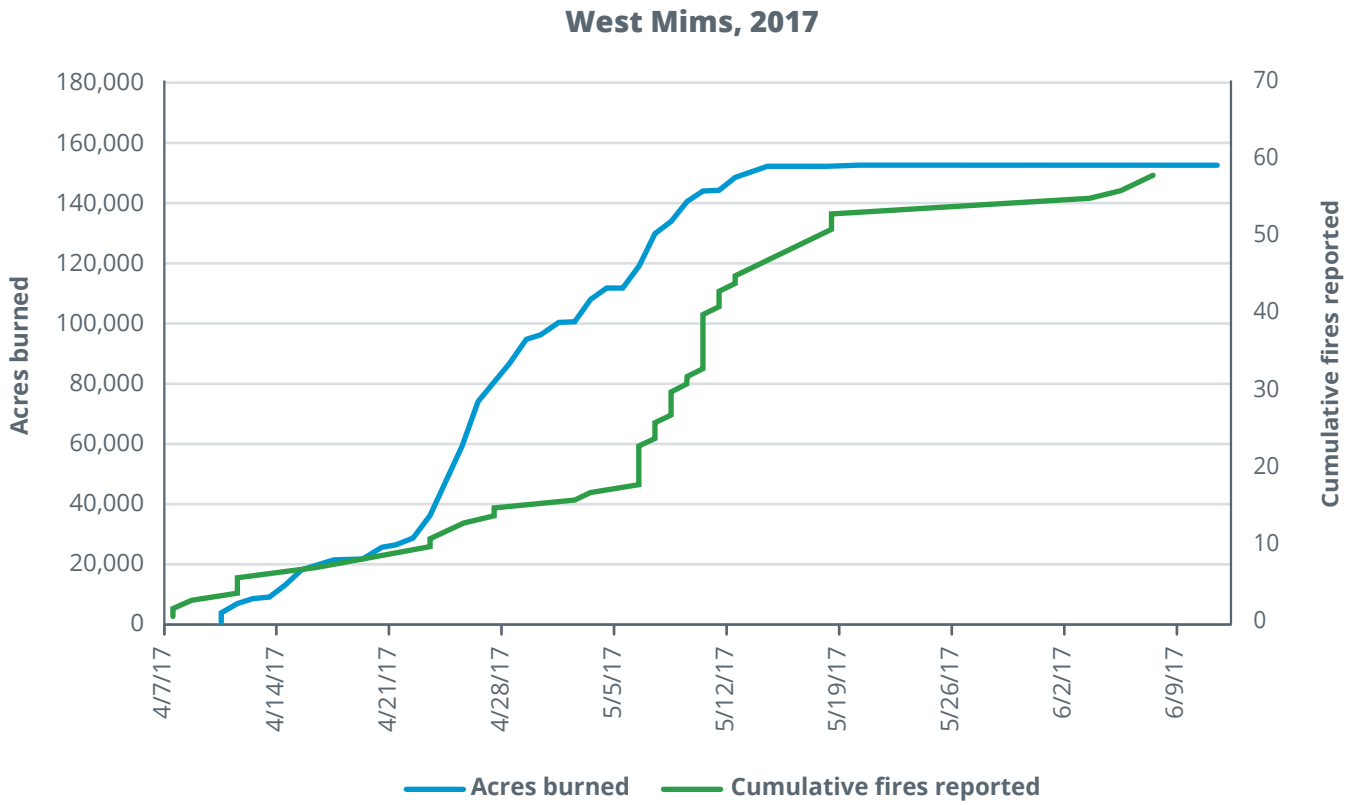
West Mims, Georgia/Florida, 2017

The West Mims wildfire was ignited by lightning in the Okefenokee National Wildlife Refuge on April 6, 2017.[29] It grew to approximately 20,000 acres within a week, and then to 140,000 acres over the next 3 weeks.[30] Because the wildfire was largely contained within the Okefenokee National Wildlife Refuge, it was allowed to burn, but it did ignite commercial timberlands neighboring the refuge. The number of fires reported in NFIRS nearly tripled between May 7 and May 14, which may coincide with the wildfire's spread beyond the Okefenokee National Wildlife Refuge (Figure 6). The wildfire was declared controlled by June 11, 2017.

For the West Mims fire, 28% of NFIRS incidents contained sufficient location information to be geocoded to an address. For 42% of NFIRS incidents, the location information was sufficient to be geocoded to the center of a named street, and 30% of NFIRS incidents were geocoded to the center of a ZIP code. The lack of precise location information and geocodes should be considered when examining the wildfire.

[29]Pohl, J. (2017, May 11). Video: DC-10 makes drop on West Mims fire [Video]. *Fire Aviation.* fireaviation.com/tag/west-mims-fire/
[30]National Weather Service. (n.d.). *West Mims fire 2017.* National Oceanic and Atmospheric Administration. www.weather.gov/jax/WestMimsFire_Apr_thru_Jul_2017

Figure 6: West Mims cumulative acres burned and fires reported by date



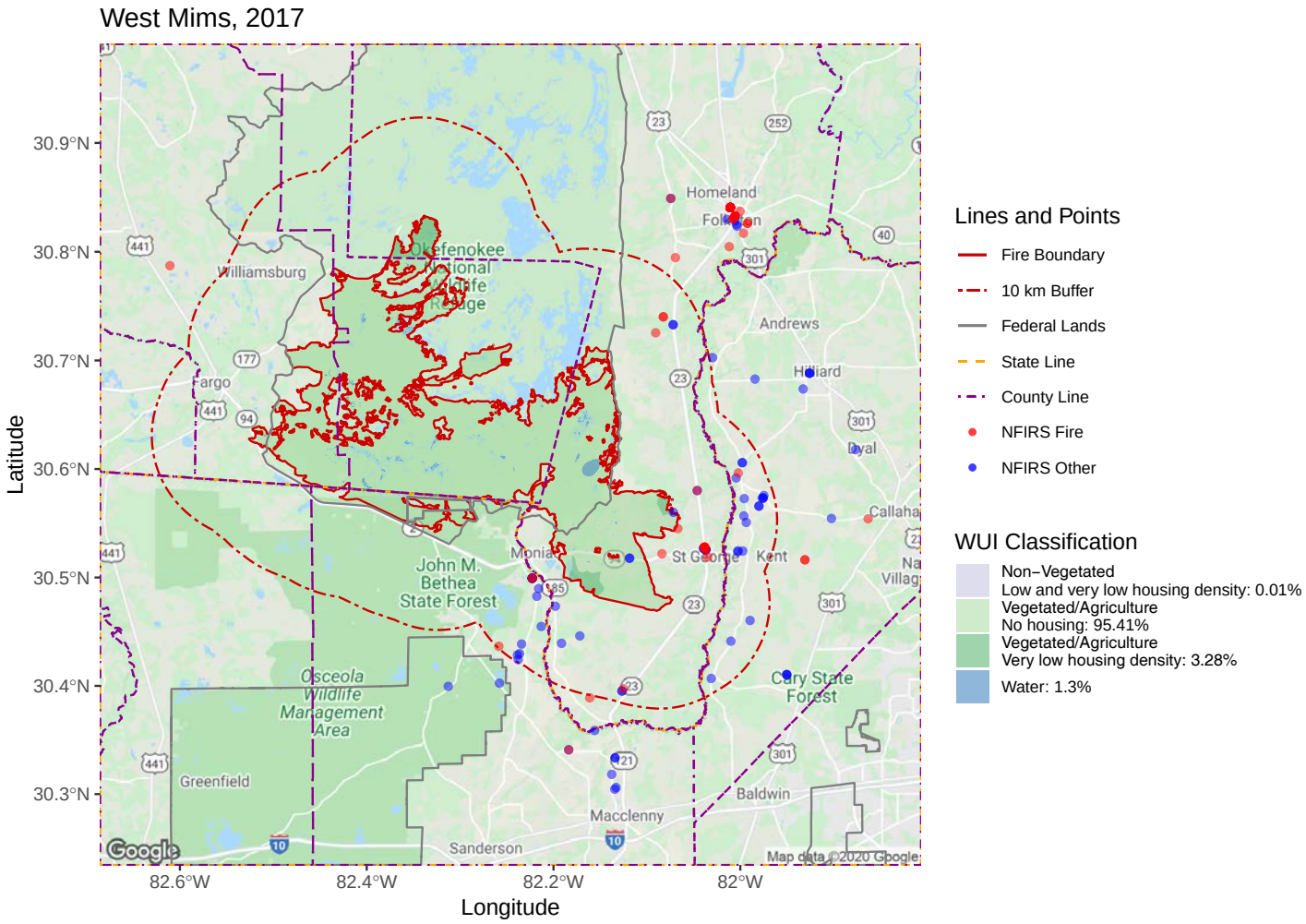
Sources: USFA analysis of NFIRS and NIFC data; National Fire and Aviation Management Web Applications. (2018). ***SIT/209 Historical, CY 2017*** [Data set]. Incident Number GA-OKR-017006. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Figure 7 shows a map of the affected area. Over 95% of the area within the fire boundary (red outline) contains no housing. About 3.25% of the area within the fire boundary consists of low-density housing, which is less than 1 home per 40 acres.

Federally managed lands are outlined in gray. The predominant one is the Okefenokee National Wildlife Refuge, where most of the West Mims wildfire occurred. A portion of the wildfire boundary extends beyond federal lands, particularly on the southeast corner of the refuge. Orange lines in the figure represent the Georgia-Florida border.

The map shows that only 2 NFIRS-reported incidents occurred within the fire boundary. Due to the size of the map, it may appear that some red points (indicating NFIRS-reported fires) are also within the fire boundary, but these are actually polygons that represent "holes" where the wildfire did not burn. Points that appear more opaque indicate that multiple NFIRS incidents were geocoded to that location.

Figure 7: West Mims wildfire



Sources: USFA analysis of NFIRS, NIFC, University of Wisconsin-Madison, U.S. Census and BLM data.

Losses

Table 36 summarizes the losses from the West Mims fire from both public sources and from the NFIRS incidents that were determined to be associated with this event.

Table 36: West Mims loss metrics

Metric	Public sources	ICS-209[a]	NFIRS Within Boundary	NFIRS Within Buffer	NFIRS Beyond Buffer
Deaths	0	0	0	0	0
Injuries	0	8	0	0	0
Dollar losses	$38.2 M[b]	n/a	0	$320 K	0
Imputed dollar losses	n/a	n/a	0	$357 K	$123 K
Acres burned	152,515[c]	152,515	0	19	1,976,011
Structures damaged or destroyed	4[d]	4	n/a	n/a	n/a
Fire incidents	n/a	n/a	0	19	39
Nonfire incidents	n/a	n/a	2	58	29

Sources: USFA analysis of NFIRS and NIFC data.

[a]National Fire and Aviation Management Web Applications. (2018). *SIT209 Historical, CY 2017* [Data set]. Incident Number GA-OKR-017006. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]Bates, C. (n.d.). *Wildfire damage assessment for the West Mims fire.* Georgia Forestry Commission. gatrees.org/wp-content/uploads/2020/02/Wildfire-Damage-Assessment-for-the-West-Mims-Fire.pdf
[c]U.S. Fish and Wildlife Service. (n.d.). Southeast Region Fire Division Report FY2017. www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf
[d]U.S. Fish and Wildlife Service. (n.d.). Southeast Region Fire Division Report FY2017. www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf

No casualties were reported from the West Mims wildfire, either from public sources or from NFIRS. No Civilian Casualty or Firefighter Casualty modules were submitted for this event. 12 EMS modules were submitted: all of them reported "Other" for the provider's initial assessment and indicated that the level of treatment required was EMS Basic. None of the patients required hospital transport. 3 of the EMS modules were submitted for motor vehicle accidents, and the remaining incident types were "EMS call, excluding vehicle accident with injury."

The dollar losses reported by the public sources consist of an estimate from the Georgia Forestry Commission, which estimated the loss of commercial timber at $38.2 million. A report from the FWS estimates the cost of the West Mims wildfire at $51 million, but that figure includes an undetermined subtotal of firefighting costs.[31] The FWS report also reported that 4 outbuildings were destroyed outside the boundary of the Okefenokee National Wildlife Refuge. Losses reported in NFIRS include $50,000 from a structure fire on May 3 and $270,000 from a fire involving an off-road vehicle or heavy equipment on May 18.

The West Mims wildfire burned 152,515 acres according to the FWS and several other public sources. The NFIRS estimate for acres burned includes 13 reports from the same department on sequential days (May 6 through May 18) that reported 152,000 acres burned per incident. This is likely an error in NFIRS reporting.

A challenge for assessing the West Mims wildfire is that the FWS has jurisdiction over much of the affected area and it does not report in the NFIRS.

NFIRS data for the wildfire

There are 147 incidents in NFIRS that are associated with the West Mims wildfire. Just 2 of those incidents were geocoded to be within the wildfire boundary, while 77 were geocoded within 10 kilometers of the perimeter and 68 were geocoded between 10 and 20 kilometers from the perimeter (Table 37).

Table 37 also shows that the most common nonfire incidents were EMS (11 motor vehicle accidents, 17 other EMS calls and 13 calls for medical assistance) and Good Intent (13 canceled en route, 6 smoke scare, 2 prescribed fires and 6 other).

[31]U.S. Fish and Wildlife Service. (n.d.). Southeast Region Fire Division Report FY2017. www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf

Table 37: West Mims reported incidents by type, date and location

Location	Date	Fire	EMS	Hazmat	Service	Good Intent	False Alarm	Weather	Special	Total
All associated incidents	4/6/17-6/11/17	58	41	3	12	27	3	1	2	147
Within Boundary	4/6/17-6/11/17	0	1	0	0	1	0	0	0	2
Within Buffer	4/6/17-6/11/17	19	26	2	10	17	1	0	2	77
Beyond Buffer	4/6/17-6/11/17	39	14	1	2	9	2	1	0	68

Sources: USFA analysis of NFIRS and NIFC data.

Of the 58 fires in NFIRS associated with the West Mims wildfire, the majority (44) were natural vegetation fires, evenly distributed between forest (Incident Type 141) and grassland (Incident Type 142) fires. There were 8 reports of vehicle fires and 5 reports of structure fires. No fires were reported to NFIRS from within the wildfire boundary itself (Table 38).

Table 38: West Mims fire incidents by Incident Type and location

Incident Type	Within Buffer	Beyond Buffer
110 series — Structure fire	4	1
130 series — Mobile property fire	2	6
140 series — Natural vegetation fire	12	32
150 series — Outside rubbish fire	1	

Sources: USFA analysis of NFIRS and NIFC data.

21 incidents were reported on property used for farming timber (PROP_USE 669), including 2 vehicle incident types and 19 natural vegetation incident types. A large share of incidents was reported across a variety of special property uses including open land and roadways (Table 39).

Table 39: West Mims fire incidents by property use

Incident Type	Assembly	One- or two-family dwelling	Other residential	Industrial	Outside/ special	Unknown
110 series — Structure fire	1	3			0	1
130 series — Mobile property fire		0	1	3	3	1
140 series — Natural vegetation fire		2		19	14	9
150 series — Outside rubbish fire		1				

Sources: USFA analysis of NFIRS and NIFC data.

Despite the prevalence of natural vegetation incident types, no NFIRS reports were submitted with the Wildland Fire module. The Fire module was submitted for 43 of the fires but was not required for 14 of the fires because the department was giving aid and was omitted (although required for 1 fire).

Responding fire departments

Charlton County Fire Rescue (Georgia) and Nassau County Fire Rescue (Florida) reported the most incidents related to the West Mims wildfire. In total, 9 fire departments contributed to the response (Table 40).

Table 40: West Mims responding fire departments

All departments			Primary		Aid Given	
State	FDID	Fire department name	Fires	Other	Fires	Other
GA	02401	Charlton County Fire Rescue	66	36	28	2
FL	41022	Nassau County Fire Rescue	33	4	29	0
FL	52021	Baker County Volunteer Fire Department	28	4	23	1
GA	05100	Effingham Fire Department	9	0	0	9
GA	12900	Sumter County Fire Department	4	0	4	0
GA	00204	Atkinson County Volunteer Fire Department	2	0	0	0
GA	02002	Camden County Fire Rescue	2	0	0	1
GA	03401	Coffee County Fire Department	2	0	1	0
GA	08601	Lakeland Lanier Fire Rescue	1	0	0	1

Sources: USFA analysis of NFIRS and NIFC data.

Exposures

None of the fires reported to NFIRS were reported as exposures from other fires.

Completeness of NFIRS reporting

Completeness is a measure of how many NFIRS reports contained valid, known values for all data elements in the Basic, Fire and Wildland Fire modules. As shown in Table 41, for the West Mims wildfire, the overall completeness of the Basic module improved with distance from the wildfire boundary. The completeness metric for the Fire module declined with distance. No NFIRS incidents were submitted using the Wildland Fire module.

Table 41: West Mims completeness of NFIRS reporting

Module	Metric	Within Boundary	Within Buffer	Beyond Buffer	Overall
Basic module	Number of reports	2	77	68	147
	% valid and known	57	66	68	67
Fire module	Number of reports	0	9	34	43
	% valid and known	n/a	23	15	16
Wildland Fire module	Number of reports	0	0	0	0
	% valid and known	n/a	n/a	n/a	n/a

Sources: USFA analysis of NFIRS and NIFC data.

Selected NFIRS data elements

A closer examination of the 58 NFIRS-reported fires provides some additional context for the West Mims wildfire (Table 42). Most of the reported incidents were natural vegetation fires where the property use was timberlands. Trees were the first material ignited, and the material stored on site was timber. Most reports did not include useful information about cause of ignition, fire spread, heat source or suppression factors.

Table 42: West Mims selected NFIRS data elements

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
ACT_TAK1	Actions Taken #1	30	11	Extinguish-ment by fire service personnel	23	73	Provide manpower	2	76	Provide water
ACT_TAK2	Actions Taken #2	21	74	Provide apparatus	17	(blank)		8	73	Provide manpower
ACT_TAK3	Actions Taken #3	40	(blank)		6	76	Provide water	5	73	Provide manpower
DET_ ALERT	Detector Alerted Occupants	52	(blank)		4	2	Detector did not alert occupants	2	U	Unknown
HAZ_REL	Hazardous Material Released	53	(blank)		5	N	No hazmat involved			
INC_TYPE	Incident Type	23	141	Forest, woods or wildland fire	21	142	Brush or brush-and-grass mixture fire	5	111	Building fire
MIXED_ USE	Mixed Use	52	(blank)		4	NN	Not mixed use	2	40	Residential use
PROP_USE	Property Use	21	669	Forest, timberland, woodland	10	(blank)		6	419	One- or two-family dwelling
ACRES_ BURN	Acres Burned	38	(blank)		13	152000		2	0	
AREA_ ORIG	Area of Origin	19	95	Wildland, woods	15	(missing module)		14	UU	Undetermined
CAUSE_ IGN	Cause of Ignition	21	U	Cause undeter-mined after investigation	15	(missing module)		14	4	Act of nature
FACT_ IGN_1	Factors Contributing To Ignition #1	24	UU	Undeter-mined	15	(missing module)		11	60	Natural condition, other
FIRE_SPRD	Fire Spread	55	(blank or missing module)		3	5	Beyond building of origin			

Table 42: West Mims selected NFIRS data elements (continued)

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
FIRST_IGN	Item First Ignited	23	UU	Undetermined	16	73	Heavy vegetation — not crop, including trees	15	(blank)	
HEAT_SOURC	Heat Source	27	UU	Undetermined	15	(missing module)		13	73	Lightning discharge
ON_SITE_M1	On Site Materials #1	15	131	Trees, plants, flowers	15	(missing module)		12	UUU	Undetermined
ON_SITE_M2	On Site Materials #2	42	(blank)		15	(missing module)		1	813	Motor vehicle parts, not including tires
ON_SITE_M3	On Site Materials #3	42	(blank)		15	(missing module)		1	311	Lumber, sawn wood
SUP_FAC_1	Suppression Factors #1	39	(blank)		15	(missing module)		4	NNN	None
SUP_FAC_2	Suppression Factors #2	43	(blank)		15	(missing module)				
SUP_FAC_3	Suppression Factors #3	43	(blank)		15	(missing module)				

Sources: USFA analysis of NFIRS and NIFC data.

There is relatively little data in NFIRS about the West Mims wildfire, likely due to the fact that most of the acreage that was burned was within the Okefenokee National Wildlife Refuge where the FWS coordinated the fire response. Small areas outside the refuge were burned, particularly in the period between May 6 and May 18, mainly consuming standing commercial timber. Smoke from the wildfire affected air quality as far away as Jacksonville, Florida, but the fire boundary only included a very small area where the housing density was greater than 1 home per 40 acres. This helps to explain the lack of structure fires in the NFIRS data as well as the lack of casualties and property losses.

Wildland urban interface

None of the area affected by the West Mims wildfire was WUI.

Spring Creek, Colorado, 2018

The Spring Creek wildfire started on June 27, 2018, from a campfire that was not extinguished.[32] In the first week, it grew to over 94,000 acres[33] as it burned in a mountainous area of southeastern Colorado. Eventually it consumed over 108,000 acres before it was fully contained in early September.[34]

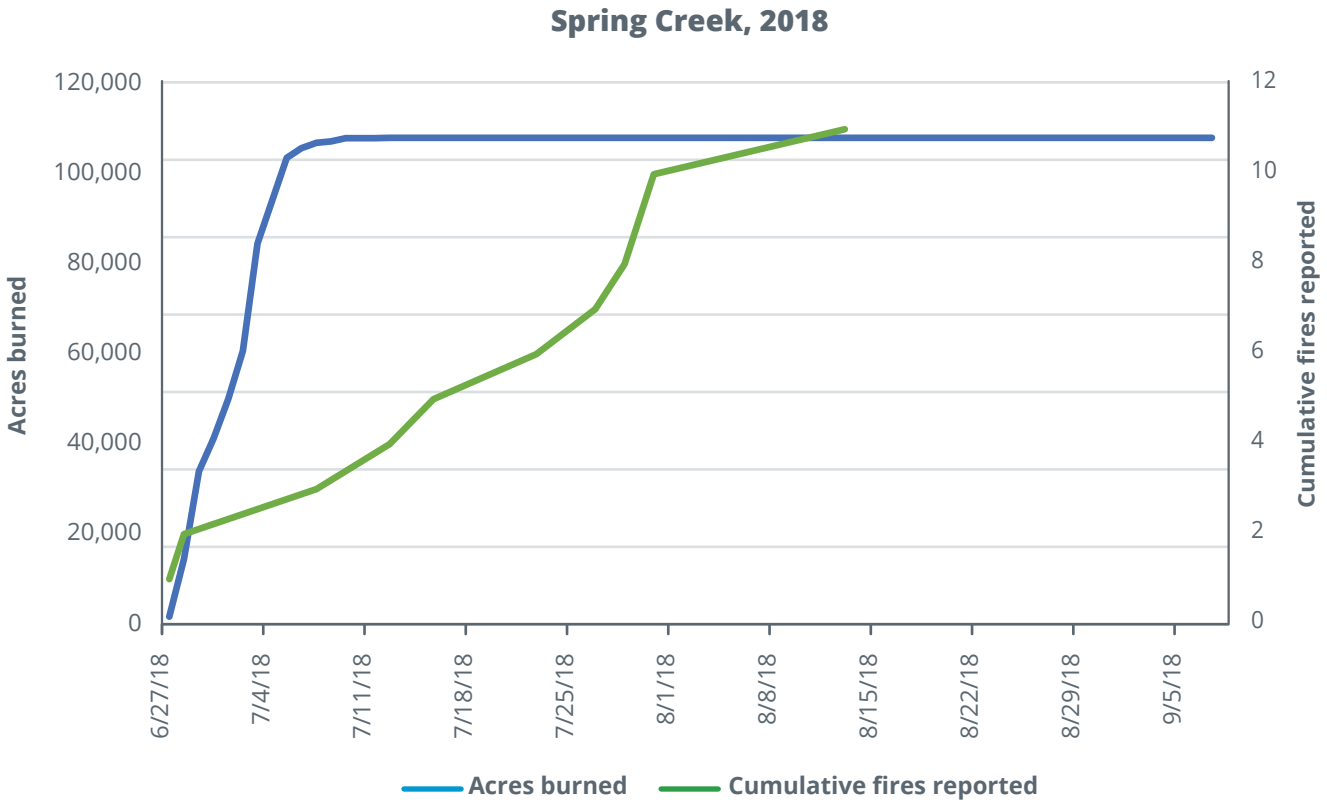
Overall, 69% of NFIRS-reported incidents for the Spring Creek wildfire were geocoded to the center of ZIP codes, while 23% were geocoded to addresses. The remaining incidents were geocoded to the center of named roads.

[32]Brown, J., & Blevins, J. (2018, November 1). Wildfires in Colorado cost $130 million in 2018. Here are the details, down to the $40 daily rate on portable toilets. *Colorado Sun.* coloradosun.com/2018/11/01/wildfire-costs-colorado-2018/
[33]The Denver Channel. (2018, July 4). Spring fire now the 3rd largest in Colorado history at more than 94,000 acres. www.thedenverchannel.com/news/local-news/spring-fire-now-the-3rd-largest-in-colorado-history-at-more-than-94-000-acres
[34]Minor, N. (2018, September 13). In the Spring Creek fire's wake, heartbreak before a long recovery. *CPR News.* www.cpr.org/2018/09/13/in-the-spring-creek-fires-wake-heartbreak-before-a-long-recovery/

Because geocodes were used to determine whether NFIRS incidents occurred within the wildfire boundary or within a 10-kilometer buffer area, the lack of precise location information and geocodes should be considered when examining the wildfire.

Figure 8 shows the cumulative number of fires reported in the NFIRS and acres burned for the Spring Creek wildfire. This figure does not include fires that were not reported to the NFIRS, which are believed to be numerous.

Figure 8: Spring Creek cumulative acres burned and fires reported by date



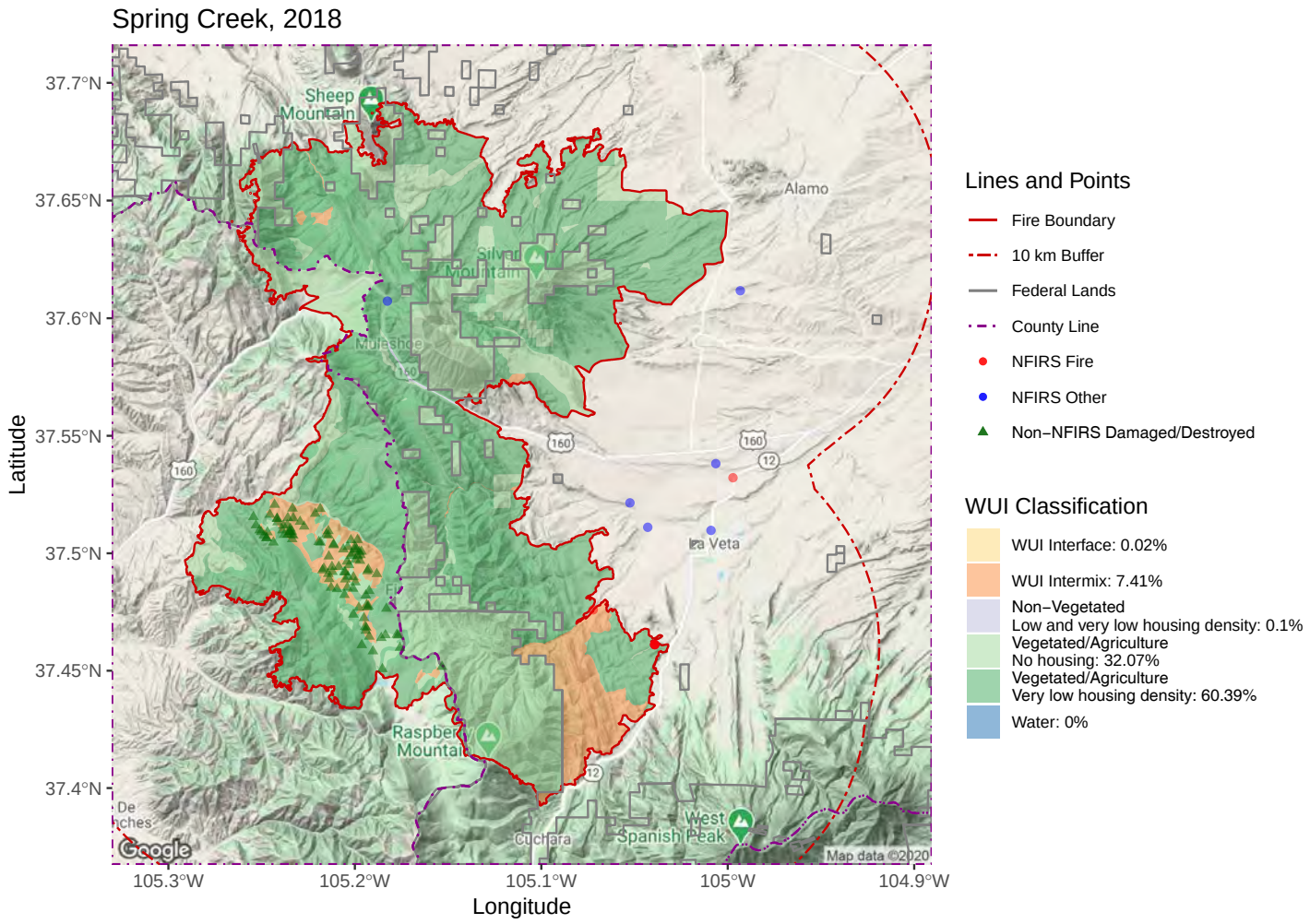
Sources: USFA analysis of NFIRS and NIFC data; National Fire and Aviation Management Web Applications. (2019). ***SIT/209 Historical, CY 2018*** [Data set]. Incident Number CO-CTX-001266. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Figure 9 is a map of the affected area. The green triangles in the southwest section of the affected area represent homes in Costilla County that were damaged or destroyed by the wildfire, as reported by the Costilla County Assessor.[35] These incidents were not in the NFIRS; the Costilla County Fire Protection District (CO 02310) has not reported any incidents to the NFIRS since 2015.

Some portions of the 10-kilometer buffer around the wildfire boundary are not included in the map, and some incidents in the Beyond Buffer area are not shown. This includes 13 NFIRS incidents approximately 15 kilometers east of the wildfire boundary, near Walsenburg, Colorado. These incidents are plotted at the center of a ZIP code because the location information provided was not complete enough to geocode them with greater precision. They may have occurred anywhere within the ZIP code.

[35]Assessor, Forbes Park, Costilla County, Colorado. (2018, July 5). F.P. Final Damage Assessment - July 5 Notification. drive.google.com/file/d/1XVWySYeV-Jp_VuLc6qIt4z3baj9g_IWQ/view

Figure 9: Spring Creek wildfire



Sources: USFA analysis of NFIRS, NIFC, Costilla County Assessor, University of Wisconsin-Madison, U.S. Census and BLM data.

Losses

Table 43 summarizes the losses from the Spring Creek fire from both public sources and from the NFIRS incidents that were determined to be associated with this event.

Table 43: Spring Creek loss metrics

Metric	Public sources	ICS-209[a]	NFIRS Within Boundary	NFIRS Within Buffer	NFIRS Beyond Buffer
Deaths	0	0	0	0	0
Injuries	0	10	0	0	0
Dollar losses	$8.2 M[b]	n/a	0	0	0
Imputed dollar losses	n/a	n/a	$3,200	$400	$1,000
Acres burned	108,045[c]	108.045	0	0	0
Structures damaged or destroyed	140[d]	344	n/a	n/a	n/a
Fire incidents	n/a	n/a	4	2	5
Nonfire incidents	n/a	n/a	2	5	8

Sources: USFA analysis of NFIRS and NIFC data.

[a]National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CO-CTX-001266. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]Craddock, M. (2018, July 26). Property losses in Huerfano County top $8.2 million from Spring fire. *World Journal.* worldjournalnewspaper.com/property-losses-in-huerfano-county-top-8-2-million-from-spring-fire/
[c]KOAA News5. (2018, September 10). Spring fire now officially 100 percent contained. www.koaa.com/news/covering-colorado/2018/09/10/spring-fire-now-officially-100-percent-contained/
[d]KOAA News5. (2018, September 10). Spring fire now officially 100 percent contained. www.koaa.com/news/covering-colorado/2018/09/10/spring-fire-now-officially-100-percent-contained/

No casualty reports were found in a search of public sources, and none were reported in NFIRS. There were no Civilian Casualty, Firefighter Casualty or EMS modules filed as a result of the Spring Creek wildfire.

The $8.2 million in property losses attributed to the Spring Creek wildfire are from Huerfano County and do not include firefighting or other indirect costs. The wildfire also burned portions of Costilla County, and those property losses are undetermined. Firefighting costs for the overall incident were estimated at $32 million.[36]

News articles typically reference 140 damaged or destroyed structures from the Spring Creek wildfire, likely because the person who started the campfire has been charged with 140 counts of arson. The Costilla County Assessor's Office surveyed damage in a neighborhood called Forbes Park and identified 142 structures that were partially or completely destroyed.[37] However, NFIRS only contains 9 reported fires and only 2 of those were within the first week of the fire, when most of the structure damage took place.

NFIRS data for the wildfire

Only 26 incidents related to the Spring Creek fire were reported to NFIRS — 11 fires and 15 other incidents. 2 fires and 2 other incidents were reported in the first week after the fire began — the week when most of the structure damage and property loss occurred. The remaining incidents were reported through the containment date (Table 44).

[36]Brown, J., & Blevins, J. (2018, November 1). Wildfires in Colorado cost $130 million in 2018. Here are the details, down to the $40 daily rate on portable toilets. *Colorado Sun.* coloradosun.com/2018/11/01/wildfire-costs-colorado-2018/
[37]Assessor, Forbes Park, Costilla County, Colorado. (2018, July 5). F.P. Final Damage Assessment - July 5 Notification. drive.google.com/file/d/1XVWySYeV-Jp_VuLc6qIt4z3baj9g_IWQ/view

Table 44: Spring Creek reported incidents by type, date and location

Location	When	Fire	Hazmat	Service	Good Intent	False Alarm	Total
All associated incidents	6/27/18-7/6/18	2	0	0	1	1	4
	7/7/18-9/10/18	9	1	2	9	1	22
Within Boundary	6/27/18-7/6/18	2	0	0	0	0	2
	7/7/18-9/10/18	2	0	0	2	0	4
Within Buffer	6/27/18-7/6/18	0	0	0	1	1	2
	7/7/18-9/10/18	2	0	0	2	1	5
Beyond Buffer	6/27/18-7/6/18	0	0	0	0	0	0
	7/7/18-9/10/18	5	1	2	5	0	13

Sources: USFA analysis of NFIRS and NIFC data.

All of the reported fires were natural vegetation fires (Incident Type 140 series) (Table 45).

Table 45: Spring Creek fire incidents by Incident Type and location

Incident Type	Within Boundary	Within Buffer	Beyond Buffer
141 — Forest, woods or wildland fire	2	2	0
142 — Brush or brush-and-grass mixture fire	1	0	2
143 — Grass fire	1	0	3

Sources: USFA analysis of NFIRS and NIFC data.

For reported fires, the most common property use was highway (Table 46).

Table 46: Spring Creek fire incidents by property use

Incident Type	669 — Forest, timberland, woodland	931 — Open land or field	938 — Graded and cared-for plots of land	961 — Highway or divided highway	Not recorded
141 — Forest, woods or wildland fire	1	0	1	0	2
142 — Brush or brush-and-grass mixture fire	0	1	0	1	1
143 — Grass fire	1	0	0	3	0

Sources: USFA analysis of NFIRS and NIFC data.

Fire departments submitted incident reports using the Wildland Fire module for 8 of these fires. The remaining 3 fires were Aid Given incidents where neither the Fire nor the Wildland Fire module is required.

Responding fire departments

As shown in Table 47, 5 fire departments reported incidents associated with the Spring Creek wildfire. 15 of the 26 incidents were reported by the Huerfano County Fire Protection District, and 6 were reported by the La Veta Fire Protection District.

Table 47: Spring Creek responding fire departments

All 5 departments			Primary				Aid Given			
State	FDID	Fire department name	June 27 - July 6		July 7 – Sept. 10		June 27 – July 6		July 7 – Sept. 10	
			Fires	Other	Fires	Other	Fires	Other	Fires	Other
CO	05520	Huerfano County Fire Protection District	0	0	5	9	1	0	0	0
CO	05530	La Veta Fire Protection District	0	1	2	3	0	0	0	0
CO	07130	Hoehne Fire Protection District	0	0	0	0	1	0	1	0
CO	07156	Purgatoire River Volunteer Fire Department	0	0	1	1	0	0	0	0
CO	07160	Trinidad Fire Department	0	1	0	0	0	0	0	0

Sources: USFA analysis of NFIRS and NIFC data.

Exposures

None of the fires reported in NFIRS were reported as exposure fires.

Completeness of NFIRS reporting

Completeness is a measure of how many NFIRS reports contained valid, known values for all data elements in the Basic, Fire and Wildland Fire modules. For the Spring Creek wildfire, the overall completeness of the Basic module was slightly better for incidents outside the wildfire boundary. The completeness metric for the Wildland Fire module declined with distance. No NFIRS incidents were submitted using the Fire module (Table 48).

Table 48: Spring Creek completeness of NFIRS reporting

Module		Within Boundary	Within Buffer	Beyond Buffer	Overall
Basic module	Number of reports	6	7	13	26
	% valid and known	56	61	57	58
Fire module	Number of reports	0	0	0	0
	% valid and known	n/a	n/a	n/a	n/a
Wildland Fire module	Number of reports	1	2	5	8
	% valid and known	24	19	8	13

Sources: USFA analysis of NFIRS and NIFC data.

Selected NFIRS data elements

Among 11 NFIRS-reported fire incidents, the Wildland Fire module was submitted for 8. (The remaining incidents were unduplicated Aid Given incidents that do not require supplemental modules.) Values reported for Actions Taken are consistent with natural vegetation fires. Cause-related values from the Wildland Fire module, when populated, suggest fires caused by natural sources such as lightning storms (Table 49).

Table 49: Spring Creek selected NFIRS data elements

Variable	Descriptions	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
ACT_TAK1	Actions Taken #1	6	11	Extinguish-ment by fire service personnel	1	14	Contain fire (wildland)	1	73	Provide manpower
ACT_TAK2	Actions Taken #2	9	(blank)		1	13	Establish fire lines (wildfire)	1	16	Control fire (wildland)
ACT_TAK3	Actions Taken #3	11	(blank)							
AREA_TYPE	Area Type	5	1	Rural, including farms > 50 acres	3	(missing module)		2	3	Rural/ urban or suburban
FACT_IGN1	Factors Contributing to Ignition #1	4	UU	Undeter-mined	3	(missing module)		2	62	Storm
FIRE_CAUSE	Wildland Fire Cause	4	1	Natural source	4	U	Undeter-mined	3	(missing module)	
HEAT_SOURC	Heat Source	4	UU	Undeter-mined	3	73	Lightning discharge	3	(missing module)	
SUPP_FACT1	Fire Suppression Factors #1	7	(blank)		3	(missing module)		1	721	Fog
SUPP_FACT2	Fire Suppression Factors #2	8	(blank)		3	(missing module)				
SUPP_FACT3	Fire Suppression Factors #3	8	(blank)		3	(missing module)				

Sources: USFA analysis of NFIRS and NIFC data.

Virtually all of the optional fields in the Wildland Fire module were not completed for the 8 fire incidents where the module was submitted. Those fields would provide a more complete picture of the incident, including information about weather conditions (Weather Type, Wind Direction, Wind Speed, Air Temperature, Relative Humidity), fire behavior (Flame Length, Rate of Spread), terrain (Aspect, Relative Position on Slope, Elevation), fuels (NFDRS Fuel Model at Origin, Primary Crop Burned #1/#2/#3) and impacted structures (Buildings Involved, Buildings Threatened).

Wildland urban interface

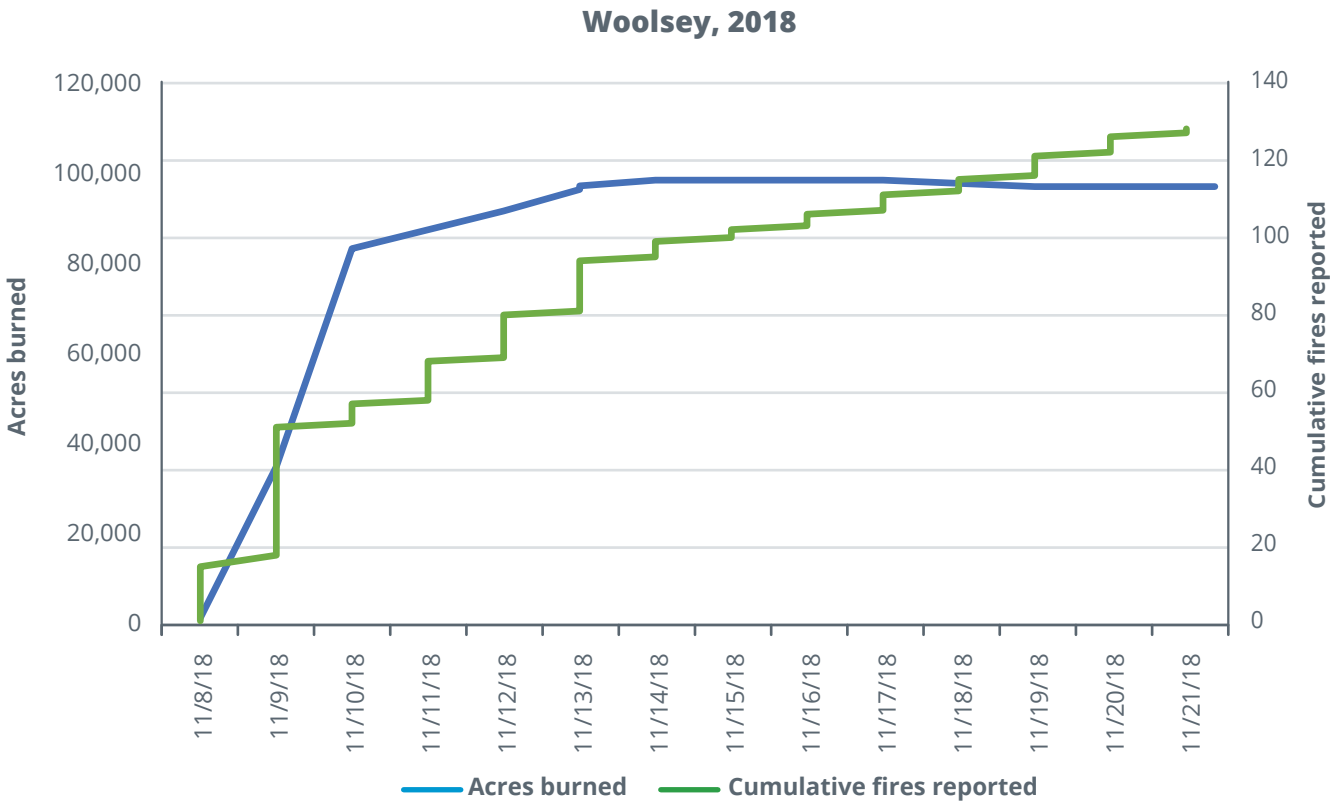
Slightly more than 7.4% of the area affected by the Spring Creek wildfire was WUI. However, only 4 fires within the wildfire boundary were reported to the NFIRS. It appears that some incidents in WUI areas were recorded by the Costilla County Assessor (see Figure 9), but these incidents were not reported to the NFIRS.

Woolsey, California (Southern), 2018

The Woolsey wildfire started on Nov. 8, 2018, on the grounds of the Santa Susana Field Laboratory; the cause is currently under investigation.[38] Santa Ana winds pushed the fire southward toward Malibu; most of the structure damage from the fire occurred within the first 24 hours. The fire was declared to be contained on Nov. 21, 2018, after burning nearly 100,000 acres (Figure 10).

Location information for 71% of the NFIRS incidents associated with the Woolsey fire was sufficient for the incidents to be geocoded to an address. Most of the remaining NFIRS incidents contained location information that allowed the incidents to be geocoded to either the center of a ZIP code or to the center of a named street. A small share (3%) of incidents were geocoded to the City Mean, which means that the city name provided in NFIRS was not unique within the state, and the geocoder returned the midpoint between two cities with the same name. The precision of location information and geocodes has a direct relationship on the identification of incidents associated with the wildfire and should be considered when examining the event.

Figure 10: Woolsey cumulative acres burned and reported fires by date



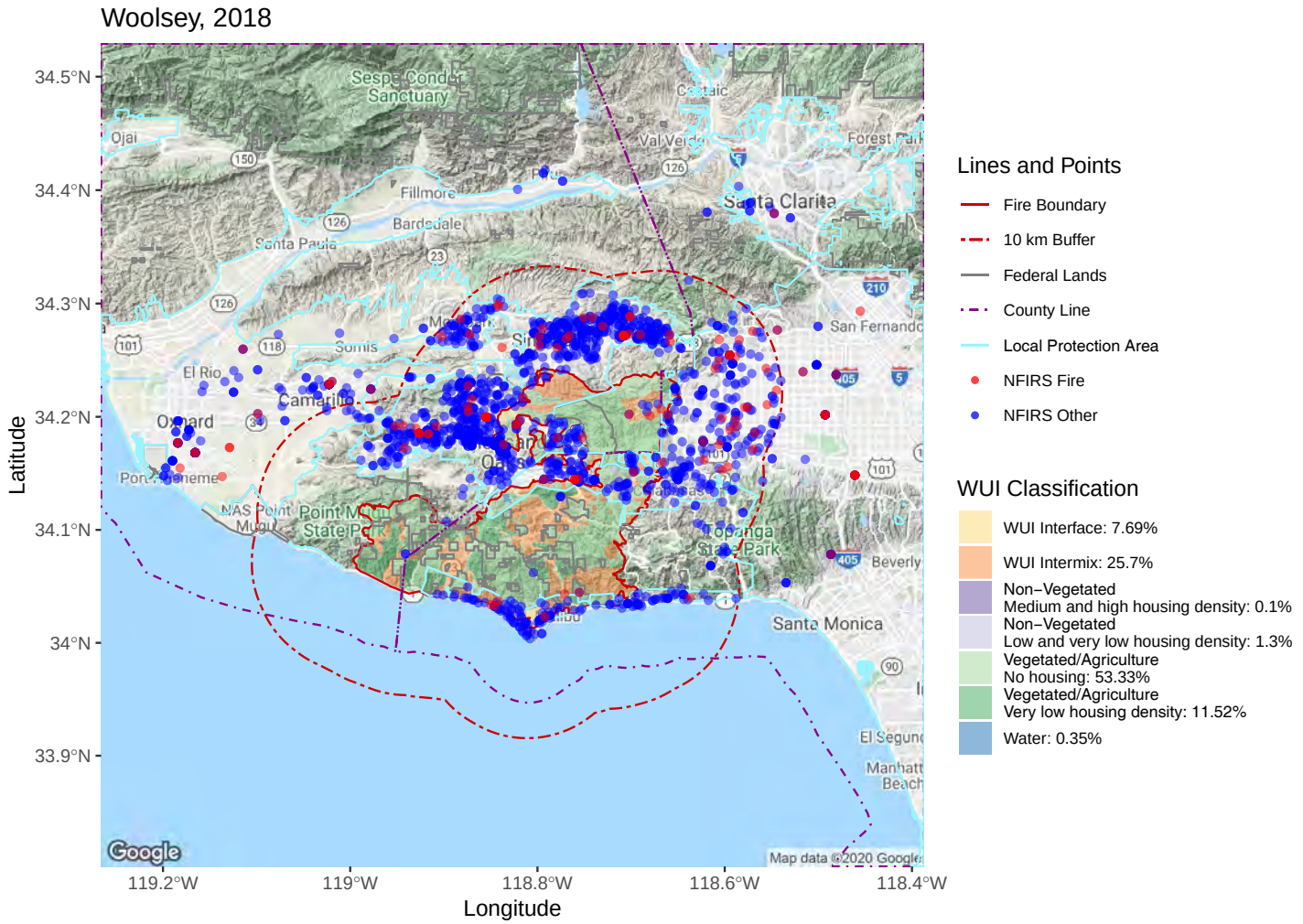
Sources: USFA analysis of NFIRS and NIFC data; National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CA-VNC-091023. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Figure 11 depicts the area affected by the Woolsey fire. In California, responsibility for direct protection is divided between federal, state and local authorities. The light blue lines in the map surround areas where local authorities are responsible for direct protection. Most of the reported NFIRS incidents are located within the local direct protection areas.

The map depicts an area between the coast and the Santa Susana mountains above Malibu with a significant amount of WUI intermix area where very few incidents were reported. This area is split between state and federal direct protection areas.

[38] CAL FIRE. (2019, October 25). *2018 Incident Archive — Woolsey Fire.* www.fire.ca.gov/incidents/2018/11/8/woolsey-fire/

Figure 11: Woolsey wildfire



Sources: USFA analysis of NFIRS, NIFC, University of Wisconsin-Madison, U.S. Census and BLM data.

Losses

Table 50 summarizes the losses from the Woolsey fire from both public sources and from the NFIRS incidents that were determined to be associated with this event.

Table 50: Woolsey loss metrics

Metric	Public sources	ICS-209[a]	NFIRS Within Boundary	NFIRS Within Buffer	NFIRS Beyond Buffer
Deaths	3[b]	3	0	0	0
Injuries	3[c]	3	0	0	0
Dollar losses	$2.93 B[d]	n/a	$6.05 M	$0.85 M	$0.05 M
Imputed dollar losses[e]	n/a	n/a	$6.08 M	$0.35 M	$0.11 M
Acres burned	96,949[f]	96,949	97,000	280,307	1
Structures damaged or destroyed	2,007[g]	2,007	n/a	n/a	n/a
Fire incidents	n/a	n/a	14	87	27
Nonfire incidents	n/a	n/a	199	186	1,388

Sources: USFA analysis of NFIRS and NIFC data.

[a]National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CA-VNC-091023. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[c]Holland, E. (2018, November 28). $6 billion in real estate destroyed in Woolsey fire: Report. *Patch.* patch.com/california/malibu/6-billion-real-estate-destroyed-woolsey-fire-report
[d]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[e]Imputed dollar losses in the wildfire buffer are lower than reported dollar losses because the imputation methodology discards reported losses where aid is given and substitutes the appropriate median. Reported losses include $700,000 from a single aid-given incident, which is changed to $1,000 for the imputed dollar loss. Imputed dollar losses also include estimates for other incidents for which no dollar losses were reported.
[f]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf
[g]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf

Public sources reported 3 deaths and 3 firefighter injuries as a result of the Woolsey wildfire. There were no NFIRS reports of casualties, though 2 EMS incidents were reported using the EMS module.

Dollar losses reported by public sources include property and contents lost due to the wildfire and exclude the costs of fighting the fire. An after-action report commissioned for Los Angeles County estimated firefighting costs of $52 million,[39] which does not include costs incurred in Ventura County or by federal agencies. Other estimates of dollar losses ranged from $4 billion to $6 billion, including indirect costs.[40] Related incidents in the NFIRS contained a total of $6.9 million in property and contents losses, and 90% of that was within the wildfire boundary.

Public sources reported the number of structures destroyed or damaged by the fire was between 1,500[41] and 2,000.[42] The number of fires reported to NFIRS in the time and region of the Woolsey wildfire was 128, which may include fires unrelated to the wildfire. An NFIRS report from Imperial County Fire Department (CA 13025) reported a natural vegetation fire with 616 buildings involved.

The Woolsey wildfire was officially measured at 98,969 acres burned. 4 incident reports in NFIRS reported at least 90,000 acres burned, but it is unlikely that any of those incident reports was intended to be for the entire wildfire.

[39]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf
[40]Holland, E. (2018, November 28). $6 billion in real estate destroyed in Woolsey fire: Report. *Patch.* patch.com/california/malibu/6-billion-real-estate-destroyed-woolsey-fire-report
[41]Foley, M. (2019, November, December). The high cost of wildfire in 2018. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Wildfire-Sidebar
[42]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf

NFIRS data for the wildfire

A total of 1,901 NFIRS incidents may be associated with the Woolsey wildfire, including 128 fires (Table 51). Over half (989) of these incidents are EMS incidents, 90.5% of which were reported within 10 kilometers of the wildfire boundary. A large number of incidents (22.4%) were Good Intent Calls, and 248 of those were INC_TYPE 611 (canceled en route).

Table 51: Woolsey reported incidents by type, date and location

	When	Fire	Explosion	EMS	Hazmat	Service	Good Intent	False Alarm	Weather	Special	Total
All associated incidents	11/8/2018	15	0	44	4	11	38	10	0	1	123
	11/9/2018-11/21/2018	113	4	945	46	139	388	132	2	9	1,778
Within Boundary	11/8/2018	0	0	9	0	3	3	1	0	0	16
	11/9/2018-11/21/2018	14	1	78	5	38	43	16	0	2	197
Within Buffer	11/8/2018	13	0	28	4	8	32	7	0	1	93
	11/9/2018-11/21/2018	74	3	780	34	91	301	91	2	6	1,382
Beyond Buffer	11/8/2018	2	0	7	0	0	3	2	0	0	14
	11/9/2018-11/21/2018	25	0	87	7	10	44	25	0	1	199

Sources: USFA analysis of NFIRS and NIFC data.

Of the 128 NFIRS-reported fires, 54 were natural vegetation fires, 22 were structure fires, and 15 were outdoor rubbish fires. 21 other fires were classified as "Other" (Table 52).

Table 52: Woolsey fire incidents by Incident Type and location

Incident Type	Within Boundary		Within Buffer		Beyond Buffer	
	11/8/2018	11/9/2018-11/21/2018	11/8/2018	11/9/2018-11/21/2018	11/8/2018	11/9/2018-11/21/2018
100 — Fire, other	0	3	2	10	0	6
110 series — Structure fire	0	4	1	13	0	4
120 series — Fire in mobile property used as fixed structure	0	0	0	1	0	0
130 series — Mobile property fire	0	0	0	7	0	6
140 series — Natural vegetation fire	0	6	7	34	1	6
150 series — Outside rubbish fire	0	1	2	9	1	2
160 series — Special outside fire	0	0	1	0	0	1

Sources: USFA analysis of NFIRS and NIFC data.

NFIRS fires recorded for the Woolsey wildfire include a diverse set of property uses (Table 53). 28 fires occurred on residential property. The Outside/special category for property use included 22 fires in open land/fields and 34 fires on roads and highways.

Table 53: Woolsey fire incidents by property use

Incident Type	Assembly	One- or two- family dwelling	Other residential	Business	Industrial	Storage	Outside/ special	Unknown
100 — Fire, other	0	2	0	2	0	0	14	3
110 series — Structure fire	2	7	6	1	0	0	5	1
120 series — Fire in mobile property used as fixed structure	0	1	0	0	0	0	0	0
130 series — Mobile property fire	0	0	0	0	0	1	11	1
140 series — Natural vegetation fire	1	3	1	0	5	0	33	11
150 series — Outside rubbish fire	0	6	2	0	0	0	6	1
160 series — Special outside fire	0	0	0	0	0	0	2	0

Sources: USFA analysis of NFIRS and NIFC data.

Responding fire departments

The Ventura and Los Angeles County fire departments reported the most incidents due to the wildfire (Table 54). A total of 29 departments reported incidents related to the wildfire, including departments from Arizona, Nevada and Washington. The Woolsey fire started a couple of hours after another wildfire, the Hill wildfire, also in the Santa Susana mountains. It also started on the same day as the Camp wildfire in Northern California, which also required aid resources. The after-action report created for the Los Angeles County Fire Department noted that in the early hours of the fire, approximately half of the requests for fire engines, helicopters and tankers could not be filled because of resource constraints.[43]

Table 54: Woolsey responding fire departments

Top 10 departments			Primary				Aid Given			
			Nov. 8		After Nov. 8		Nov. 8		After Nov. 8	
State	FDID	Fire department name	Fires	Other	Fires	Other	Fires	Other	Fires	Other
CA	56020	Ventura County Fire Department	8	72	36	1,046	0	0	4	2
CA	19110	Los Angeles County Fire Department	0	24	8	351	1	0	0	2
CA	19105	Los Angeles City Fire Department	2	8	34	199	1	0	1	0
CA	56010	Oxnard Fire Department	0	3	4	56	0	0	0	2
CA	56025	Ventura Fire Department	0	0	0	0	0	0	2	2
CA	56555	CAL FIRE Ventura	0	0	4	0	0	0	0	0
CA	19165	San Gabriel Fire Department	0	0	0	0	1	0	2	0
CA	15010	Kern County Fire Department	0	0	0	0	1	0	1	0
CA	19100	Long Beach Fire Department	0	0	0	0	1	0	1	0
CA	19200	Torrance Fire Department	0	0	0	0	0	0	2	0
		All Others	0	1	1	2	0	0	13	3

Sources: USFA analysis of NFIRS and NIFC data.

[43]Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf

Exposures

None of the fires reported in NFIRS were reported as exposures from other fires.

Completeness of NFIRS reporting

Completeness is a measure of how many NFIRS reports contained valid, known values for all data elements in the Basic, Fire and Wildland Fire modules. For the Woolsey wildfire, the overall completeness of the Basic and Fire modules was similar regardless of location. The completeness metric for the Wildland Fire module declined with distance (Table 55).

Table 55: Woolsey completeness of NFIRS reporting

Module	Metric	Within Boundary	Within Buffer	Beyond Buffer	Overall
Basic module	Number of reports	213	1,475	213	1,901
	% valid and known	64	64	66	64
Fire module	Number of reports	8	60	14	82
	% valid and known	20	17	19	17
Wildland Fire module	Number of reports	1	2	3	6
	% valid and known	12	10	6	8

Sources: USFA analysis of NFIRS and NIFC data.

Selected NFIRS data elements

For the 128 fires reported in NFIRS associated with the Woolsey wildfire, Table 56 shows the most common values for selected data elements from the Basic module. ACT_TAK1, INC_TYPE and PROP_USE contain a fair degree of variation.

Table 56: Woolsey selected NFIRS data elements, Basic module

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
ACT_TAK1	Actions Taken #1	55	11	Extinguish-ment by fire service personnel	15	10	Fire control or extinguish-ment, other	11	86	Investigate
ACT_TAK2	Actions Taken #2	102	(blank)		7	12	Salvage and overhaul	3	11	Extinguish-ment by fire service personnel
ACT_TAK3	Actions Taken #3	114	(blank)		3	12	Salvage and overhaul	3	16	Control fire (wildland)
CONT_ LOSS	Contents Loss	76	0		41	(blank)		2	100	
HAZ_REL	Hazardous Material Released	79	(blank)		49	N	No hazmat involved			
INC_TYPE	Incident Type	27	142	Brush or brush-and-grass mixture fire	21	100	Fire, other	15	141	Forest, woods or wildland fire

Table 56: Woolsey selected NFIRS data elements, Basic module (continued)

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
MIXED_USE	Mixed Use	123	(blank)		3	40	Residential use	2	NN	Not mixed use
PROP_LOSS	Property Loss	74	0		34	(blank)		4	2000	
PROP_USE	Property Use	22	931	Open land or field	19	419	One- or two-family dwelling	13	(blank)	

Sources: USFA analysis of NFIRS and NIFC data.

The NFIRS Fire module was submitted for 82 incidents, and the NFIRS Wildland Fire module was submitted for an additional 6 incidents. Neither module was required for 27 incidents because the incident was reported as Aid Given (where no corresponding Aid Receiving report was identified), and both modules were missing for 13 incidents where either should have been reported.

Table 57 shows the most-commonly reported values for select variables from the Fire module, based on the 82 incidents for which it was reported. The values for many of the variables are undetermined, none and other.

Table 57: Woolsey selected NFIRS data elements, Fire module

Variable	Description	Most common			Second most common		
		Incidents	Code	Definition	Incidents	Code	Definition
AREA_ORIG	Area of Origin	31	UU	Undetermined	12	90	Outside area, other
CAUSE_IGN	Cause of Ignition	30	2	Unintentional	24	U	Cause undetermined after investigation
FACT_IGN_1	Factors Contributing To Ignition #1	32	UU	Undetermined	18	NN	None
FACT_IGN_2	Factors Contributing To Ignition #2	4	12	Heat source too close to combustibles			
FIRE_SPRD	Fire Spread	7	4	Confined to building of origin	3	2	Confined to room of origin
FIRST_IGN	Item First Ignited	43	UU	Undetermined	9	72	Light vegetation - not crop, including grass
HEAT_SOURC	Heat Source	39	UU	Undetermined	16	43	Hot ember or ash
STRUC_STAT	Structure Status	8	2	In normal use			
STRUC_TYPE	Structure Type	8	1	Enclosed building	1	0	Structure type, other
SUP_FAC_1	Suppression Factors #1	2	NNN	None			
SUP_FAC_2	Suppression Factors #2	1	711	Drought or low fuel moisture			
SUP_FAC_3	Suppression Factors #3	1	775	Urban-wildland interface area			
TYPE_MAT	Type of Material	30	UU	Undetermined	24	(blank)	

Sources: USFA analysis of NFIRS and NIFC data.

Table 58 shows selected variables from the Wildland Fire module for the 6 incidents where the module was submitted.

Table 58: Woolsey selected NFIRS data elements, Wildland Fire module

Variable	Description	Most common			Second most common		
		Incidents	Code	Definition	Incidents	Code	Definition
AREA_TYPE	Area Type	4	4	Urban-wildland interface area	2	2	Urban, heavily populated areas
FACT_IGN1	Factors Contributing to Ignition #1	4	UU	Undetermined	1	71	Exposure fire
FIRE_CAUSE	Wildland Fire Cause	6	U	Undetermined	n/a	n/a	n/a

Sources: USFA analysis of NFIRS and NIFC data.

The NFIRS reports for the Woolsey wildfire do not provide a comprehensive view of the impact of the fire. A plurality of fire incident reports associated with the Woolsey wildfire are for natural vegetation fires, but most of the losses from the event are from structure fires. The number of fire incident reports is very small relative to the number of destroyed and damaged structures, and the value of property and contents losses reported in NFIRS is a small fraction of public estimates.

Wildland urban interface

Over one-third of the area burned by the Woolsey fire was WUI. However, most of the NFIRS-reported fires for the Woolsey fire were from within 10 kilometers of the wildfire boundary (Table 59). Very few of the NFIRS-reported fires were for structures. As depicted in the incident map, significant areas of WUI for the Woolsey fire are direct protection areas for federal and state authorities, which do not report to the NFIRS.

Table 59: Woolsey fires inside/outside of WUI

Location	Fires		Structure fires	
	Number	% of total	Number	% of total
In WUI, Within Boundary	12	9.4	3	13.0
Outside WUI, Within Boundary	2	1.6	1	4.3
Within Buffer	87	68.0	15	11.7
Beyond Buffer	27	21.1	4	3.1
Total	128	100.0	23	100.0

Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

Camp, California (Northern), 2018[44]

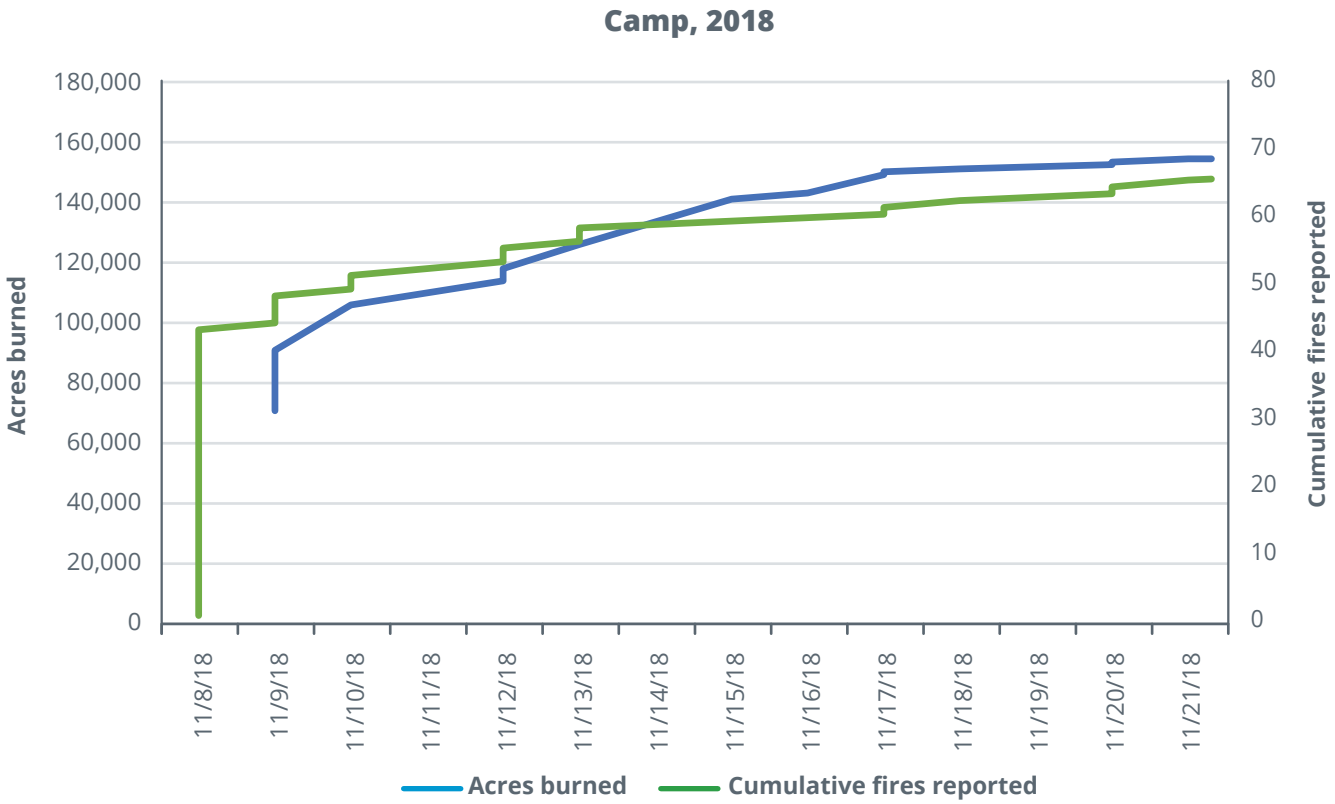
The Camp wildfire started early in the morning of Nov. 8, 2018, due to a downed power line.[45] High winds rapidly pushed the fire through the town of Paradise, California, causing extensive loss of life and property. The Camp wildfire is the deadliest in California history with 85 confirmed fatalities. It eventually consumed over 153,000 acres before being completely contained on Nov. 25, 2018 (Figure 12).

Most (84%) of the NFIRS incidents associated with the Camp fire provided sufficient location information to be geocoded to an address. Most of the remaining incidents were geocoded to the center of a ZIP code (14%) or named

[44]See Appendix A for information regarding additional NFIRS-reported incidents that may be related to the Camp wildfire.
[45]Gabbert, B. (2019, May 16). CAL FIRE confirms — the Camp fire that destroyed most of Paradise, CA was started by a PG&E powerline. *Wildfire Today.* https://wildfiretoday.com/2019/05/16/cal-fire-confirms-the-camp-fire-that-destroyed-most-of-paradise-ca-was-started-by-a-pge-powerline/

street (2%). Because geocodes were used to determine which incidents were associated with the wildfire and where they were located in relation to the wildfire boundary, the imprecision of geocoding should be considered when examining the event.

Figure 12: Camp cumulative acres burned and fires reported by date

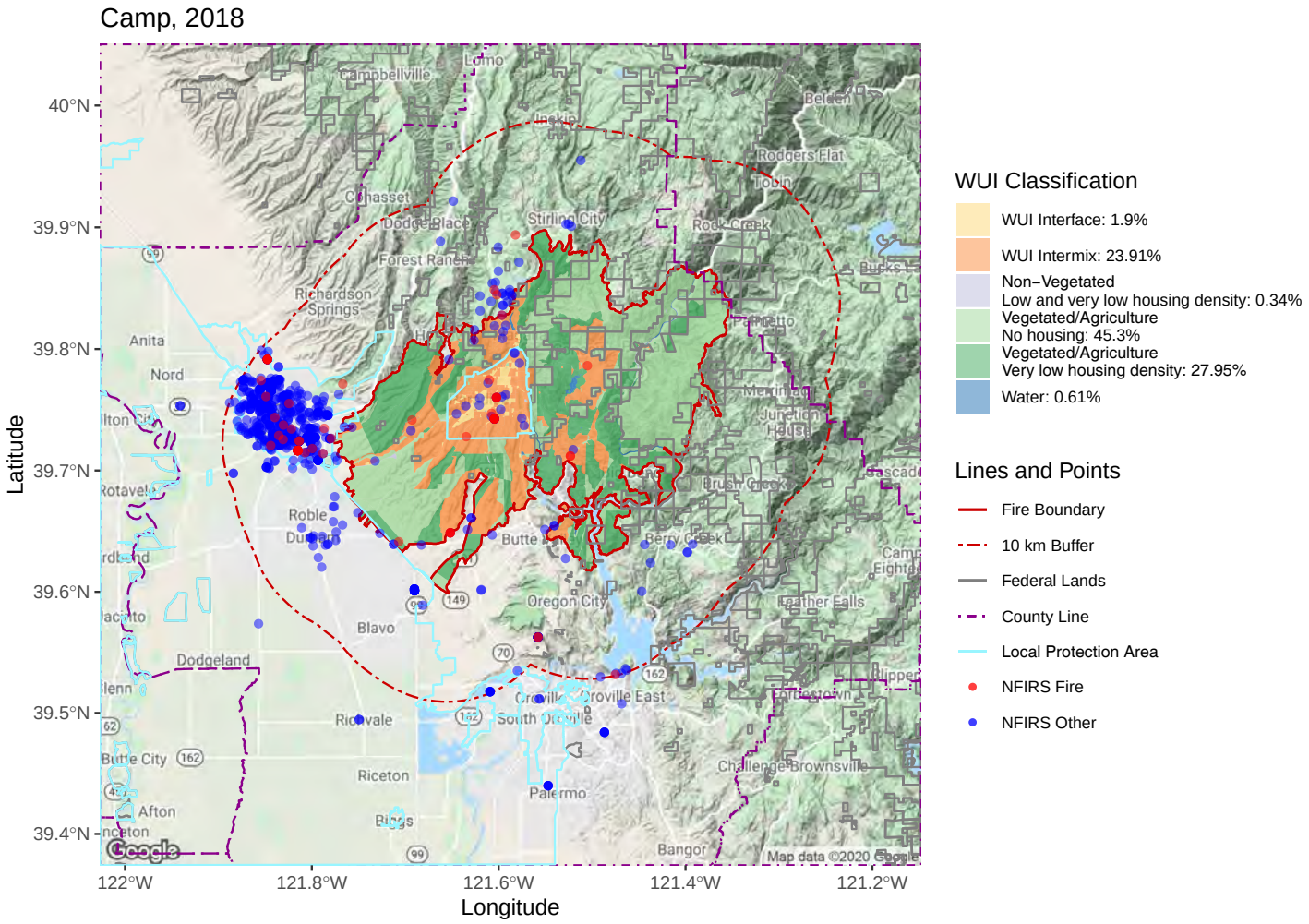


Sources: USFA analysis of NFIRS and NIFC data; National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CA-BTU-016737. https://famit.nwcg.gov/applications/SIT209/historicalSITdata

Figure 13 is a map of the area affected by the Camp wildfire. WUI areas comprise nearly one-quarter of the affected area, but most of the reported incidents are clustered to the west of the fire boundary, in and around the city of Chico, California.

Within the fire boundary, the local direct protection area covering the town of Paradise, California, is clearly visible in the center of the image. A number of NFIRS incidents were reported in this area.

Figure 13: Camp wildfire



Sources: USFA analysis of NFIRS, NIFC, University of Wisconsin-Madison, U.S. Census and BLM data.

Losses

Table 60 summarizes the losses from the Camp fire from both public sources and from the NFIRS incidents that were determined to be associated with this event.

Table 60: Camp loss metrics

Metric	Public sources	ICS-209[a]	NFIRS Within Boundary	NFIRS Within Buffer	NFIRS Beyond Buffer
Deaths	85[b]	85	0	0	0
Injuries	13[c]	3	8	1	0
Dollar losses	$8.47 B[d]	n/a	$430 K	$398 K	$0
Imputed dollar losses	n/a	n/a	$446 K	$431 K	$0
Acres burned	153,336[e]	153,336	153,020	455,674	0
Structures damaged or destroyed	18,793[f]	19,531	n/a	n/a	n/a
Fire incidents	n/a	n/a	18	49	0
Nonfire incidents	n/a	n/a	34	697	18

Sources: USFA analysis of NFIRS and NIFC data.

[a]National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CA-BTU-016737. https://famit.nwcg.gov/applications/SIT209/historicalSITdata
[b]CAL FIRE. (2019, November 15). *2018 Incident Archive — Camp Fire.* www.fire.ca.gov/incidents/2018/11/8/camp-fire/
[c]Sernoffsky, E. (2018, November 15). Five firefighters among dozen-plus patients burned in Camp fire. *San Francisco Chronicle.* www.sfchronicle.com/california-wildfires/article/Five-firefighters-among-dozen-plus-patients-13396604.php
[d]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[e]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents
[f]National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents

Public sources for casualties from the Camp wildfire have the benefit of being able to compare and integrate data from multiple sources. The final number of deaths took some time to determine, as victims had to be discovered and identified. The number of injuries, even from public sources, may be understated as the death toll received considerably more attention. The 9 injuries reported in NFIRS were all for firefighters.

Similarly, the public estimate of dollar losses has the benefit of extensive analysis by authoritative sources and reflects only direct property and contents losses. Estimates from the insurance industry include indirect losses and range from $11 billion[46] to $16.5 billion.[47] The number of damaged and destroyed structures is similarly authoritative. The 67 fires reported in NFIRS is a very small number compared to the number of affected structures.

The Camp wildfire burned 153,336 acres. Figures from NFIRS are derived from multiple incident reports that reported a similar figure.

NFIRS data for the wildfire

There are 816 incident reports in the NFIRS associated with the Camp fire. 111 incidents, including 43 fires, were reported on the first day of the wildfire when most of the casualties and property losses occurred (Table 61). 64% of the fire incidents reported in the NFIRS occurred on the first day of the wildfire. The majority of incidents associated with the Camp fire were EMS incidents that occurred outside the wildfire boundary itself but within 10 kilometers of the active wildfire area and were reported after the first day of the wildfire.

Given the large loss of life and property associated with the Camp wildfire, it is notable that only 3% of NFIRS incident reports are from within the wildfire boundary on the first day of the wildfire. Fire departments that do not participate in NFIRS (including federal and state agencies as well as local departments) may have responded to more incidents than were recorded in the NFIRS.

[46]Holland, E. (2018, November 28). $6 billion in real estate destroyed in Woolsey fire: Report. patch.com/california/malibu/6-billion-real-estate-destroyed-woolsey-fire-report
[47]Reyes-Velarde, A. (2019, January 11). California's Camp fire was the costliest global disaster last year, insurance report shows. *Los Angeles Times.* www.latimes.com/local/lanow/la-me-ln-camp-fire-insured-losses-20190111-story.html

Table 61: Camp reported incidents by type, date and location

Location	Date	Fire	Explosion	EMS	Hazmat	Service	Good Intent	False Alarm	Weather	Special	Total
All associated incidents	11/8/2018	43	0	35	2	10	7	7	1	6	111
	11/9/2018-11/25/2018	24	1	443	27	80	49	76	2	3	705
Within Boundary	11/8/2018	12	0	4	0	4	2	0	0	4	26
	11/9/2018-11/25/2018	6	0	9	3	3	0	2	2	1	26
Within Buffer	11/8/2018	31	0	30	2	6	5	7	1	2	84
	11/9/2018-11/25/2018	18	1	423	23	76	47	72	0	2	662
Beyond Buffer	11/8/2018	0	0	1	0	0	0	0	0	0	1
	11/9/2018-11/25/2018	0	0	11	1	1	2	2	0	0	17

Sources: USFA analysis of NFIRS and NIFC data.

Of the 67 fires reported in NFIRS associated with the Camp wildfire, 48 (71.6%) were natural vegetation fires, 7 were structure fires, and the remaining were a mixture of incident types (Table 62).

Table 62: Camp fire incidents by Incident Type and location

Incident Type	Within Boundary		Within Buffer	
	11/8/2018	11/9/2018-11/25/2018	11/8/2018	11/9/2018-11/25/2018
100 — Fire, other	1	0	1	1
110 series — Structure fire	0	2	0	5
120 series — Fire in mobile property used as a fixed structure	0	0	0	1
130 series — Mobile property fire	0	0	3	1
140 series — Natural vegetation fire	10	4	26	8
150 series — Outside rubbish fire	0	0	1	2
160 series — Special outside fire	1	0	0	0

Sources: USFA analysis of NFIRS and NIFC data.

The property use associated with 27 fires was either omitted or was reported as "None." For 9 fires, the property use was open field or vacant lot. 10 fires were reported on residential property including 8 in one- or two-family dwellings and 2 in other kinds of residential property (Table 63).

Table 63: Camp fire incidents by property use

Incident Type	Assembly	One- or two-family dwelling	Other residential	Business	Industrial	Outside/ special	Unknown
100 — Fire, other				1		0	2
110 series — Structure fire		5	2			0	
120 series — Fire in mobile property used as a fixed structure		1				0	
130 series — Mobile property fire		0				3	1
140 series — Natural vegetation fire	3	1			1	19	24
150 series — Outside rubbish fire		0				3	
160 series — Special outside fire		1				0	

Sources: USFA analysis of NFIRS and NIFC data.

Responding fire departments

The Chico, California and Butte County fire departments reported the most incidents related to the Camp wildfire (Table 64). A total of 56 departments submitted NFIRS reports for the fire, including departments from Colorado, Nevada, Oregon and Texas.

Table 64: Camp responding fire departments

Top 10 departments			Primary Incident Type				Aid Given Incident Type			
			Nov. 8		After Nov. 8		Nov. 8		After Nov. 8	
State	FDID	Fire department name	Fires	Other	Fires	Other	Fires	Other	Fires	Other
CA	04010	Chico Fire Department	6	29	7	474	0	0	0	0
CA	04035	Butte County Fire Department	0	20	3	164	0	0	0	0
CA	04555	CAL FIRE Butte	0	2	4	18	0	0	0	0
CA	04030	Paradise Fire Department	0	7	2	5	0	0	0	0
CA	04015	Gridley Fire Department	0	1	0	10	0	0	0	0
CA	16015	Kings County Fire Department	0	0	0	0	4	0	1	0
CA	34020	Elk Grove Community Services District	0	0	0	0	2	1	0	0
CA	39050	Manteca Fire Department	0	0	0	0	1	0	2	0
CA	49115	Petaluma Fire Department	0	0	0	0	2	0	0	1
CA	10005	Clovis Fire Department	0	0	0	0	1	0	1	0
		All Others	1	2	1	4	26	6	3	5

Sources: USFA analysis of NFIRS and NIFC data.

Exposures

None of the NFIRS-reported fires were reported as exposure fires from another incident.

Completeness of NFIRS reporting

Completeness is a measure of how many NFIRS reports contained valid, known values for all data elements in the Basic, Fire and Wildland Fire modules. For the Camp wildfire, the overall completeness of the Basic and Wildland Fire modules was best for incidents within 10 kilometers of the wildfire boundary. The completeness of the Fire module was highest for incidents within the wildfire boundary (Table 65).

Table 65: Camp completeness of NFIRS reporting

Module	Metric	Within Boundary	Within Buffer	Beyond Buffer	Overall
Basic module	Number of reports	52	746	18	816
	% valid and known	63	67	60	66
Fire module	Number of reports	3	19	0	22
	% valid and known	29	25	n/a	25
Wildland Fire module	Number of Reports	1	3	0	4
	% valid and known	23	32	n/a	30

Sources: USFA analysis of NFIRS and NIFC data.

Selected NFIRS data elements

For the 67 fires reported in NFIRS associated with the Camp wildfire, Table 66 shows the most common values for selected data elements from the Basic module. Of note is that 43 of the fires were reported by departments giving aid. These fires are included in the analysis because there were no incident reports from other departments indicating that they were also combating a fire in the same area at the same time.

Table 66: Camp selected NFIRS data elements, Basic module

Variable	Description	Most common			Second most common			Third most common		
		Incidents	Code	Definition	Incidents	Code	Definition	Incidents	Code	Definition
ACT_TAK1	Actions Taken #1	23	11	Extinguish-ment by fire service personnel	14	10	Fire control or extin-guishment, other	6	73	Provide manpower
ACT_TAK2	Actions Taken #2	43	(blank)		5	12	Salvage and overhaul	3	13	Establish fire lines (wildfire)
ACT_TAK3	Actions Taken #3	56	(blank)		3	12	Salvage and overhaul	2	86	Investigate
AID	Aid Given or Received	39	3	Mutual aid given	20	N	None	4	4	Automatic aid given
FF_INJ	Fire Service Injuries	65	0		2	4				
HAZ_REL	Hazardous Material Released	34	N	No hazmat involved	32	(blank)		1	6	Household/ office solvent or chemical spill
INC_TYPE	Incident Type	39	141	Forest, woods or wildland fire	6	140	Natural vegetation fire, other	5	111	Building fire
PROP_USE	Property Use	25	(blank)		8	419	One- or two-family dwelling	8	900	Outside or special property, other

Sources: USFA analysis of NFIRS and NIFC data.

The NFIRS Fire module was submitted for 22 incidents, and the NFIRS Wildland Fire module was submitted for an additional 4 incidents. Neither module was required for 41 incidents because the incident was reported as Aid Given (where no corresponding Aid Receiving report was identified). (1 department giving aid submitted a Fire module, and 1 department giving aid submitted a Wildland Fire module.)

Table 67 shows the most commonly reported values for select variables from the Fire module, based on the 22 incidents for which it was reported. The values for many of the variables are undetermined, none and other. The Factors Contributing to Ignition #2 and Fire Spread variables suggest that some of the fires may not have been associated with the Camp wildfire despite meeting the criteria used to identify them.

Table 67: Camp selected NFIRS data elements, Fire module

Variable	Variable description	Most common			Second most common		
		Incidents	Code	Definition	Incidents	Code	Definition
AREA_ORIG	Area of Origin	7	UU	Undetermined	3	90	Outside area, other
CAUSE_IGN	Cause of Ignition	5	U	Cause undetermined after investigation	4	1	Intentional
FACT_IGN_1	Factors Contributing To Ignition #1	8	UU	Undetermined	5	NN	None
FACT_IGN_2	Factors Contributing To Ignition #2	21		n/a	1	40	Design, manufacture, installation deficiency, other
FIRE_SPRD	Fire Spread	2	2	Confined to room of origin	2	4	Confined to building of origin
FIRST_IGN	Item First Ignited	8	UU	Undetermined	2	17	Structural member or framing
HEAT_SOURC	Heat Source	10	UU	Undetermined	3	13	Electrical arcing
STRUC_STAT	Structure Status	16		n/a	5	2	In normal use
STRUC_TYPE	Structure Type	5	1	Enclosed building	1	2	Fixed portable or mobile structure
SUP_FAC_1	Suppression Factors #1	16		n/a	6	NNN	None
SUP_FAC_2	Suppression Factors #2	22		n/a	n/a	n/a	n/a
SUP_FAC_3	Suppression Factors #3	22		n/a	n/a	n/a	n/a
TYPE_MAT	Type of Material	10	UU	Undetermined	8		n/a

Sources: USFA analysis of NFIRS and NIFC data.

Table 68 displays selected variables from the Wildland Fire module for the 4 incidents where the module was submitted.

Table 68: Camp selected NFIRS data elements, Wildland Fire module

Variable	Description	Most common			Second most common		
		Incidents	Code	Definition	Incidents	Code	Definition
AREA_TYPE	Area Type	2	4	Urban-wildland interface area	1	1	Rural, including farms > 50 acres
					1	3	Rural/urban or suburban
DANGR_RATE	Fire Danger Rating	3		n/a	1	3	High fire danger
FACT_IGN1	Factors Contributing to Ignition #1	2	NN	None	2	UU	Undetermined
FIRE_CAUSE	Wildland Fire Cause	3	U	Undetermined	1	5	Debris, vegetation burn
HEAT_SOURC	Heat Source	3	UU	Undetermined	1	65	Lighter: cigarette, cigar
SUPP_FACT1	Fire Suppression Factors #1	3	NNN	None	1	412	Delayed reporting of fire
SUPP_FACT2	Fire Suppression Factors #2	4		n/a	n/a	n/a	n/a
SUPP_FACT3	Fire Suppression Factors #3	4		n/a	n/a	n/a	n/a

Sources: USFA analysis of NFIRS and NIFC data.

There are not many NFIRS reports for incidents associated with the Camp wildfire, especially compared to the scale of the damage that occurred. NFIRS reports related to fires reflect a combination of structure and natural vegetation fires, but required and nonrequired variables do not provide much additional detail.

Wildland urban interface

Slightly more than one-quarter of the area burned by the Camp fire was WUI (Table 69). However, most of the NFIRS-reported fires for the Camp fire were from within 10 kilometers of the wildfire boundary. Very few of the NFIRS-reported fires were for structures. As depicted in the incident map, significant areas of WUI for the Camp fire are direct protection areas for federal and state authorities, which do not report to the NFIRS.

Table 69: Camp fires inside/outside of WUI

Location	Fires		Structure fires	
	Number	% of total	Number	% of total
In WUI, Within Boundary	17	25.4	2	25.0
Outside WUI, Within Boundary	1	1.5	0	0.0
Within Buffer	49	73.1	6	75.0
Beyond Buffer	0	0.0	0	0.0
Total	67	100.0	8	100.0

Sources: USFA analysis of NFIRS, NIFC and University of Wisconsin-Madison data.

Appendix A: Incidents in Expanded Time Range

In addition to the incidents in the preceding discussion, NFIRS contains some incidents that began before the time the wildfire was reported as well as incidents that ended after the wildfire was contained. For the following incidents, the ignition date and time is 6 hours earlier than the preceding analysis, and the containment/extinguishment date and time is the latest value for LU_CLEAR (Last Unit Cleared) reported by any fire department that reported an incident within the first 24 hours of the wildfire, or the original containment/extinguishment date, whichever is later.

Chimney Tops 2

Original time range: Nov. 23, 2016, at 5:30 p.m. to Dec. 22, 2016, at 11:59 p.m.

New time range: Nov. 23, 2016, at 11:30 a.m. to Dec. 22, 2016, at 11:59 p.m.

1 fire, a grass fire (INC_TYPE 143), was reported at 3:51 p.m. on Nov. 23, 2016, at a location approximately 17 miles north-northwest of the wildfire's point of origin. This point is within the 10-kilometer buffer of the eventual wildfire perimeter, but it is unlikely to be related to the wildfire.

4 other incidents, including 2 EMS incidents (medical assistance, INC_TYPE 311; and vehicle accident without injuries, INC_TYPE 324), 1 Service Call (service call, other, INC_TYPE 500), and 1 false alarm (false alarm, other, INC_TYPE 700) were reported between 11:37 a.m. and 4:43 p.m. on Nov. 23, 2016. All of these incidents were within the 10-kilometer buffer of the wildfire perimeter.

Northwest Oklahoma Complex

Original time range: March 6, 2017, at 10:00 a.m. to March 21, 2017, at 7:00 a.m.

New time range: March 6, 2017, at 4:00 a.m. to March 21, 2017, at 7:00 a.m.

No additional incidents were reported during the expanded time range for this wildfire.

West Mims

Original time range: April 6, 2017, at 12:00 a.m. to June 11, 2017, at 11:59 p.m.

New time range: April 5, 2017, at 6:00 p.m. to June 11, 2017, at 11:59 p.m.

No additional incidents were reported during the expanded time range for this wildfire.

Spring Creek

Original time range: June 27, 2018, at 12:00 a.m. to Sept. 10, 2018, at 11:59 p.m.

New time range: June 26, 2018, at 6:00 p.m. to Sept. 10, 2018, at 11:59 p.m.

No additional incidents were reported during the expanded time range for this wildfire.

Woolsey

Original time range: Nov. 8, 2018, at 2:15 p.m. to Nov. 21, 2018, at 11:59 p.m.

New time range: Nov. 8, 2018, at 8:15 a.m. to Nov. 21, 2018, at 11:59 p.m.

4 fires were reported in the expanded time range:

- 10:42 a.m. (natural vegetation fire, other, INC_TYPE 140).
- 11:41 a.m. (brush or brush and grass mixture fire, INC_TYPE 142).
- 12:38 p.m. (outside rubbish, trash or waste fire, INC_TYPE 151).
- 12:59 p.m. (brush or brush and grass mixture fire, INC_TYPE 142).

They occurred between 5 and 13 miles from the point of origin within the 10-kilometer buffer surrounding the wildfire perimeter. These fires are unlikely to be related to the wildfire.

47 other incidents were reported in the area of the wildfire in the expanded time range. Of these, 3 occurred within the wildfire perimeter, 39 occurred within the 10-kilometer buffer of the wildfire perimeter, and 5 were reported by fire departments that participated in the response but did not contain sufficient location information to be geocoded other than to a ZIP code. 23 of these incidents were EMS incidents (INC_TYPE 300 to 381); 1 was a gas leak (natural gas or LPG, INC_TYPE 412); 4 were Service Calls (INC_TYPE 500 to 561); 15 were Good Intent Calls (INC_TYPE 600 to 672); and 4 were false alarms (INC_TYPE 700). These incidents are unlikely to be related to the wildfire.

Camp

Original time range: Nov. 8, 2018, at 6:30 a.m. to Nov. 25, 2018, at 11:59 p.m.

New time range: Nov. 8, 2018, at 12:30 a.m. to Dec. 20, 2018, at 9:24 a.m.

1 fire was reported at 6:29 a.m. on Nov. 8, 2018. This NFIRS report may be a summary of the overall Camp wildfire, as its LU_CLEAR (Last Unit Cleared) time is 9:24 a.m. on Dec. 20, 2018. (Note: The end of the original time range is the date that CAL FIRE reported that the wildfire was contained.) This NFIRS report included property and contents losses of $1,999,999,998 (the maximum value that may be entered for PROP_LOSS and CONT_LOSS is $999,999,999) as well as ACRES_BURN (NFIRS Wildland Fire module) of 153,336. The location of the fire was reported as near Pulga Road, northeast of Paradise, California, which was identified by CAL FIRE as the location where the fire began. No civilian or firefighter casualties were reported for this incident. The NFIRS report also indicates that the equipment involved in ignition (EQ_INV_IGN, NFIRS Wildland Fire module) was an electrical power (utility) line (EQ_INV_IGN 211).

8 other incidents were reported prior to the beginning of the original time range. 5 were EMS incidents (INC_TYPE 300 to 381), 2 were hazardous materials incidents (INC_TYPE 400 to 482), and 1 was a report of a smoke scare, or an odor of smoke (INC_TYPE 651). These incidents are unlikely to be related to the wildfire.

6 fires and 9 other incidents were reported after the beginning of the original time range but had a LU_CLEAR (Last Unit Cleared) time that was after the end of the original time range, so they were not included in the analysis. These incidents are summarized in Table 70.

Table 70. Additional Camp fire incident in expanded time range

Incident Type	Alarm	Last unit cleared	Casualties	Dollar losses	Other information
142 (Brush or brush-and-grass mixture fire)	11/08/2018 11:22 a.m.	11/28/2018 10:36 a.m.	4 firefighter injuries	$1000 (imputed)	
800 (Severe Weather or Natural Disaster, other)	11/08/2018 12:33 a.m.	12/07/2018 2:10 p.m.	None	None	
141 (Forest, woods or wildland fire)	11/08/2018 1:00 p.m.	11/26/2018 10:00 p.m.	None	$1000 (imputed)	
141 (Forest, woods or wildland fire)	11/08/2018 4:22 p.m.	11/26/2018 10:57 a.m.	None	$1000 (imputed)	
141 (Forest, woods or wildland fire)	11/08/2018 6:26 p.m.	11/26/2018 2:30 p.m.	None	$1000 (imputed)	
141 (Forest, woods or wildland fire)	11/09/2018 5:26 a.m.	11/26/2018 10:00 p.m.	None	$1000 (imputed)	153,000 acres burned
900 (Special Type of Incident, other)	11/09/2018 11:16 a.m.	12/04/2018 8:06 a.m.	None	None	

Table 70. Additional Camp fire incident in expanded time range (continued)

Incident Type	Alarm	Last unit cleared	Casualties	Dollar losses	Other information
141 (Forest, woods or wildland fire)	11/09/2018 11:16 a.m.	12/04/2018 8:06 a.m.	None	$1000 (imputed)	
340 (Search for lost person, other)	11/17/2018 5:00 a.m.	11/26/2018 10:00 p.m.	None	None	Within the wildfire perimeter
350 (Extrication, rescue, other)	11/17/2018 5:30 a.m.	11/26/2018 10:00 p.m.	None	None	
341 (Search for person on land)	11/22/2018 3:11 p.m.	11/27/2018 5:34 p.m.	None	None	
341 (Search for person on land)	11/23/2018 1:45 a.m.	11/26/2018 11:00 a.m.	None	None	
571 (Cover assignment, standby, moveup)	11/23/2018 3:45 a.m.	11/26/2018 1:17 p.m.	None	None	
551 (Assist police or other governmental agency)	11/23/2018 4:52 a.m.	11/27/2018 8:25 p.m.	None	None	
321 (EMS call, excluding vehicle accident with injury)	11/25/2018 11:49 p.m.	11/26/2018 12:09 a.m.	None	None	

Sources: USFA analysis of NFIRS and NIFC data.

8 of these incidents, including 6 fires, were reported within the first 2 days of the wildfire, and 12, including 5 fires, reported their Last Unit Cleared within 3 days of the original end date of the wildfire. Only 1 incident was reported within the wildfire perimeter; the remaining incidents occurred within the 10-kilometer buffer surrounding the wildfire perimeter. Property and contents losses were not reported for any of these fires, but imputed losses total $6,000. 1 NFIRS report indicated that 4 firefighters were injured; another reported 153,000 acres burned.

20 fires and 1,039 other incidents were reported after the CAL FIRE containment date of Nov. 25, 2018. It is possible, but not likely, that these fires were related to the wildfire — the earliest of the fires was reported on Nov. 29, 2018. However, it is plausible that some of the nonfire incidents may have been related to the aftermath of the wildfire; 709 of the 1,039 other incidents were EMS incidents, 35 were hazardous material incidents, and 290 were Service Call, Good Intent or false alarm incidents.

Additional recommendations

The USFA should provide a way for fire departments to submit incident reports that are summaries of large events such as wildfires. This could be accomplished through the use of the Special Study blocks in the NFIRS incident report, or through the creation of 1 or more distinct Incident Types (in the 900 series, Special Type of Incident, other) that could be used to distinguish an NFIRS report as a summary of a large event.

The USFA should also modify the NFIRS specification to allow entry of values for PROP_LOSS and CONT_LOSS greater than $999,999,999.

Finally, the USFA should consider an exploration of the types of incidents that occur after a wildfire and the impact that these requests have on local fire departments. The volume of requests for service after the containment date of the Camp wildfire is noteworthy, and further exploration may yield valuable insights for communities in areas prone to wildfire.

Appendix B: Correspondence with Responding Fire Departments

USFA contacted some of the fire departments that reported incidents related to wildfires via email to gather additional information regarding how those incidents were reported to NFIRS. The questions and answers are reproduced below.

Chimney Tops 2, Gatlinburg Fire Department (TN 78113)

For the Chimney Tops 2 fire, your department reported many exposure fires. How was this data collected? Was your department being alerted to or responding to each exposure incident as it occurred or was the data compiled afterward? If compiled afterwards, from what sources?

The data for the exposure fires were collected afterwards. Once the fires were out, we sent crews out to the area to see the extent of the damage. We were not dispatched on each incident because our dispatch wasn't notified of every incident due to evacuations. Using maps, we were able to show the fire path and mark what structures were damaged or destroyed. We used this information to compile and generate a report of the fire.

Did the wildfire cause interruptions in your dispatch and record management (fire incident data) systems? If yes, how did this impact your ability to capture records in NFIRS?

The fire did cause interruption with our dispatch and fire records. The power and internet service was out for several days. We kept a log of our runs during this time. Once services were restored, we were able to use these logs to get our reports completed.

Does your fire department respond to all wildfires in your jurisdiction? If not, who does?

We respond to all wildfires in our jurisdiction except for wildfires inside the National Park. We provide medical services for the National Park but they have their own fire services.

Does your fire department report all wildfires in your jurisdiction? If not, who does and by what method?

We report all wildfires in our jurisdiction.

Northwest Oklahoma Complex, Ashland Fire (KS CA402)

For the Northwest Oklahoma Complex fire, your department reported many exposure fires. How was this data collected? Was your department being alerted to or responding to each exposure incident as it occurred or was the data compiled afterward? If compiled afterwards, from what sources?

Did the wildfire cause interruptions in your dispatch and record management (fire incident data) systems? If yes, how did this impact your ability to capture records in NFIRS?

I have only been the fire chief for about 8 months. I'm not sure about your first 2 questions.

Does your fire department respond to all wildfires in your jurisdiction? If not, who does?

We do respond to all wildfires in our district.

Does your fire department report all wildfires in your jurisdiction? If not, who does and by what method?

I also reported all fires in the NFIRS system.

Woolsey, Los Angeles County Fire Department (CA 19110)

Did the wildfire cause interruptions in your dispatch and record management (fire incident data) systems? **No.** If yes, how did this impact your ability to capture records in NFIRS?

Does your fire department respond to all wildfires in your jurisdiction? **Yes.** If not, who does?

The Department responds to all fires within our local Direct Protection Area and State Responsibility Area as a contract county for CALFIRE. The United States Forest Service responds to wildfires on federal land, but we are responsible for emergency medical responses, structure fires, vehicle fires, etc.

Does your fire department report all wildfires in your jurisdiction? **Yes.** If not, who does and by what method?

Camp, Butte CFD (CA 04555)

Did the wildfire cause interruptions in your dispatch and record management (fire incident data) systems? If yes, how did this impact your ability to capture records in NFIRS?

No it did not.

Does your fire department respond to all wildfires in your jurisdiction? If not, who does?

All areas except within the city limits of Oroville and Chico.

Does your fire department report all wildfires in your jurisdiction? If not, who does and by what method?

Report as in an NFIRS report? If so, then yes we do report them.

Bibliography

10News Staff. (2020, September 9). Judge rules lawsuits against federal government in 2016 wildfire disaster can continue. *10News*. https://www.wbir.com/article/news/local/wildfire/victims-insurance-companies-square-off-against-government-in-2016-wildfire-lawsuits/51-599a8127-dd70-4f93-81b0-4261022e1f132016 Great Smoky Mountains wildfires. (2020, October 22). In Wikipedia. https://en.wikipedia.org/w/index.php?title=2016_Great_Smoky_Mountains_wildfires&oldid=992414213

Ahillen, S. (2017, August 9). Tennessee mountain community getting back on its feet after devastating wildfire. *Insurance Journal.* www.insurancejournal.com/news/southeast/2017/08/09/460619.htm

Assessor, Forbes Park, Costilla County, Colorado. (2018, July 5). F.P. Final Damage Assessment — July 5 Notification. https://drive.google.com/file/d/1XVWySYeV-Jp_VuLc6qIt4z3baj9g_IWQ/view

Associated Press. (2017, March 7). Officials: Harper County woman died while fighting fire on her farm. *Fox 25.* okcfox.com/news/local/officials-harper-county-woman-died-while-fighting-fire-on-her-farm

Badger, S. G. (2017, November, December). Large-loss fires in the United States in 2016. *NFPA Journal.* https://www.nfpa.org/News-and-Research/Publications-and-Media/NFPA-Journal/2017/November-December-2017/Features/Large-Loss-Fires-2016

Badger, S. G., & Foley, M. (2019, September 1). Large-loss fires and explosions in the United States during 2018. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss

Bates, C. (n.d.). *Wildfire damage assessment for the West Mims fire.* Georgia Forestry Commission. https://gatrees.org/wp-content/uploads/2020/02/Wildfire-Damage-Assessment-for-the-West-Mims-Fire.pdf

Bivand, R. S., Pebesma, E., & Gómez-Rubio, V. (2013). *Applied spatial data analysis with R* (2nd ed.). Springer-Verlag. https://asdar-book.org/

Bivand, R., Keitt, T., Rowlingson, B., Pebesma, E., Summer, M., Hijmans, R., Baston, D., Rouault, E., Warmerdam, F., Ooms, J., & Rundel, C. (2019, September 16). *rgdal: Bindings for the 'Geospatial' Data Abstraction Library. R package version 1.4-8.* CRAN.R-project.org/package=rgdal

Brown, J., & Blevins, J. (2018, November 1). Wildfires in Colorado cost $130 million in 2018. Here are the details, down to the $40 daily rate on portable toilets. *The Colorado Sun.* https://coloradosun.com/2018/11/01/wildfire-costs-colorado-2018/

CAL FIRE. (2019, November 15). *2018 Incident Archive — Camp Fire.* https://www.fire.ca.gov/incidents/2018/11/8/camp-fire/

CAL FIRE. (2019, October 25). *2018 Incident Archive — Woolsey Fire.* https://www.fire.ca.gov/incidents/2018/11/8/woolsey-fire/

CAL FIRE. (n.d.). Fire progression map: Camp incident: CA-BTU-016737: Final. https://www.fire.ca.gov/media/10167/progression_e_land_final_20181124_camp_cabtu016737_opt.pdf

Carr, A. (2016, December 4). Gatlinburg residents get first look at destruction left behind by wildfire. *The Weather Channel.* https://weather.com/news/news/tennessee-gatlinburg-sevier-fires

Citygate Associates, LLC. (2019, November 17). *After action review of the Woolsey fire incident.* https://lacounty.gov/wp-content/uploads/Citygate-After-Action-Review-of-the-Woolsey-Fire-Incident-11-17-19.pdf

County of Los Angeles Fire Department. (2018, November 10). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1110PM.pdf

County of Los Angeles Fire Department. (2018, November 11). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1111PM.pdf

County of Los Angeles Fire Department. (2018, November 12). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1112PM.pdf

County of Los Angeles Fire Department. (2018, November 13). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1113PM.pdf

County of Los Angeles Fire Department. (2018, November 14). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1114PM.pdf

County of Los Angeles Fire Department. (2018, November 15). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1115PM.pdf

County of Los Angeles Fire Department. (2018, November 17). *Woolsey fire incident update.* fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1117PM.pdf

County of Los Angeles Fire Department. (2018, November 18). Woolsey fire incident update. fire.lacounty.gov/wp-content/uploads/2020/08/WOOLSEY1118PM.pdf

County of Ventura California. (2020, January). The Hill & Woolsey fires emergency response after-action review. vcportal.ventura.org/BOS/District2/Hill_Woolsey_Fires_Emergency_Response_After_Action_Review_01.21.2020.pdf

Craddock, M. (2018, July 26). Property losses in Huerfano County top $8.2 million from Spring fire. *World Journal.* worldjournalnewspaper.com/property-losses-in-huerfano-county-top-8-2-million-from-spring-fire/

The Denver Channel. (2018, July 4). Spring fire now the 3rd largest in Colorado history at more than 94,000 acres. www.thedenverchannel.com/news/local-news/spring-fire-now-the-3rd-largest-in-colorado-history-at-more-than-94-000-acres

Dickson, T. (2017, June 22). West Mims fire is out, Okefenokee Swamp returns to normal after heavy rains. *Florida Times-Union Jacksonville.com*: https://www.jacksonville.com/story/news/2017/06/22/west-mims-fire-out-okefenokee-swamp-returns-normal-after-heavy-rains/15760617007/

Dowle, M., Srinivasan, A., Gorecki, J., Chirico, M., Stetsenko, P., Short, T., Lianoglou, S., Antonyan, E., Bonsch, M., Parsonage, H., Ritchie, S., Ren, K., Tan, X., Saporta, R., Seiskari, O., Dong, X., Lang, M., Iwasaki, W., Wenchel, S., … Shwen, B. (2019). data.table: Extension of 'data.frame'. *R package version 1.12.8*. https://CRAN.R-project.org/package=data.table

Foley, M. (2019, November, December). The high cost of wildfire in 2018. *NFPA Journal.* https://www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Wildfire-Sidebar

Frazier, I. (2018, October 29). The day the great plains burned. *The New Yorker.* https://www.newyorker.com/magazine/2018/11/05/the-day-the-great-plains-burned

Gabbert, B. (2018, July 4). Spring Creek fire becomes third largest in state history. *Wildfire Today.* https://wildfiretoday.com/tag/spring-creek-fire/

Gabbert, B. (2018-2020). Camp fire (archives). *Wildfire Today.* https://wildfiretoday.com/tag/camp-fire/

Gabbert, B. (2019, May 16). CAL FIRE confirms — the Camp fire that destroyed most of Paradise, CA was started by a PG&E powerline. *Wildfire Today.* https://wildfiretoday.com/2019/05/16/cal-fire-confirms-the-camp-fire-that-destroyed-most-of-paradise-ca-was-started-by-a-pge-powerline

Guthrie, V. H., Finucane, M. J., Keith, P. E., & Stinnett, D. B. (2017, December). *After action review of the November 28, 2016, firestorm.* ABS Group. https://wildfiretoday.com/documents/AAR_ChimneyTops2.pdf

Holland, E. (2018, November 28). $6 billion in real estate destroyed in Woolsey fire: Report. *Patch.* https://patch.com/california/malibu/6-billion-real-estate-destroyed-woolsey-fire-report

Jacobs, D. (2017, May 23). Park didn't heed Gatlinburg firestorm 'call to action'. *Knox News.* https://www.knoxnews.com/story/news/local/2016/12/30/park-didnt-heed-gatlinburg-firestorm-call-action/95797456/

Kahle, D., & Wickham, H. (2019, June). ggmap: Spatial visualization with ggplot2. *The R Journal, 5*(1), 144-161. https://journal.r-project.org/archive/2013-1/kahle-wickham.pdf

Knoxville News Sentinel. (2016, December 28). By the numbers: Gatlinburg fire. *Knox News.* https://www.knoxnews.com/story/news/local/tennessee/2016/12/28/numbers-gatlinburg-fire/95847766/

KOAA News5. (2018, September 10). Spring fire now officially 100 percent contained www.koaa.com/news/covering-colorado/2018/09/10/spring-fire-now-officially-100-percent-contained/

Lakin, M. (2017, November 24). 1 year ago, a 'whole mountain on fire' forever changed Gatlinburg. *Knox News.* https://www.knoxnews.com/story/news/2017/11/19/gatlinburg-wildfire-one-year-later-smoky-mountains-horror-heroism/859695001/

Lakin, M. (2017, November 22). Air attacks, big box couldn't cage fire's surge toward Gatlinburg. *Knox News.* https://www.knoxnews.com/story/news/2017/11/22/gatlinburg-wildfire-one-year-later-chimney-tops-pigeon-forge/856268001/

Lakin, M. (2017, November 22). 'No way out': Sacrifice and survival in the final desperate hours of the Gatlinburg fire. *Knox News.* https://www.knoxnews.com/story/news/2017/11/22/gatlinburg-wildfire-one-year-later-victims-deaths-damage/856273001/

Lakin, M. (2017, November 24). 'Like Armageddon': How the Gatlinburg fire became unstoppable and swarmed a city. *Knox News.* https://www.knoxnews.com/story/news/2017/11/22/gatlinburg-wildfire-one-year-later-911-calls-evacuation-orders-communications-failures/856270001/

Lakin, M. (2017, November 24). Mountaintop spark, rising wind lit the fuse for Gatlinburg firestorm. *Knox News.* https://www.knoxnews.com/story/news/2017/11/22/gatlinburg-wildfire-one-year-later-chimney-tops-trail/856267001

Legislative Division of Post Audit. (2018, June). *Legislative post audit performance audit report highlights: Kansas wildfire management: Evaluating the adequacy of Kansas' wildfire suppression system.* State of Kansas. https://www.kansasforests.org/fire_management/fire_docs/Highlights.pdf

Legislative Division of Post Audit. (2018, June). P*erformance audit report: Kansas wildfire management: Evaluating the adequacy of Kansas' wildfire suppression system.* State of Kansas. https://www.kansasforests.org/fire_management/fire_docs/Final_Report.pdf

Lindley, T. T., Speheger, D. A., Day, M. A., Murdoch, G. P., Smith, B. R., Nauslar, N. J., & Daily, D. C. (2019, July 12). Megafires on the Southern Great Plains. *Journal of Operational Meteorology, 7*(12), 164-179. https://doi.org/10.15191/nwajom.2019.0712

Minor, N. (2018, September 13). In the Spring Creek fire's wake, heartbreak before a long recovery. *CPR News.* https://www.cpr.org/2018/09/13/in-the-spring-creek-fires-wake-heartbreak-before-a-long-recovery/

Mitchell, K., & Nicholson, K. (2018, June 28). Hundreds evac ahead of fast-moving CO blaze. *Firehouse.* www.firehouse.com/operations-training/wildland/news/21011450/forbes-park-costilla-county-co-spring-fire-evacuation-firefighters

Moran, J. (2017, April 22). March fires in Oklahoma. *Gaylord News.* https://gaylordnews.net/2566/newscrowd/march-fires-in-oklahoma/

Morrison, O. (2017, June 16). Damage from historic wildfires more than $80 million. *The Wichita Eagle.* https://www.kansas.com/news/state/article156506309.html

National Aeronautics and Space Administration. (2017, April 26). *West Mims fire on Florida/Georgia border.* https://www.nasa.gov/image-feature/goddard/2017/west-mims-fire-on-floridageorgia-border

National Fire and Aviation Management Web Applications. (n.d.). *SIT/209 Historical* [Data set]. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire and Aviation Management Web Applications. (2017). *SIT/209 Historical, CY 2016* [Data set]. Incident Number TN-GSP-016062. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire and Aviation Management Web Applications. (2018). *SIT/209 Historical CY 2017* [Data set]. Incident Number GA-OKR-017006. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire and Aviation Management Web Applications. (2018). *SIT/209 Historical, CY 2017* [Data set]. Incident Number OK-OKS-000529. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CA-BTU-016737. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CA-VNC-091023. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire and Aviation Management Web Applications. (2019). *SIT/209 Historical, CY 2018* [Data set]. Incident Number CO-CTX-001266. Retrieved March 11, 2021 from https://famit.nwcg.gov/applications/SIT209/historicalSITdata

National Fire Protection Association. (2019, November, December). Selected large-loss fire incident reports. *NFPA Journal.* www.nfpa.org/News-and-Research/Publications-and-media/NFPA-Journal/2019/November-December-2019/Features/Large-Loss/Large-Loss-incidents

National Interagency Fire Center. (2020, March 31). *Interagency fire perimeter history – All years.* data-nifc.opendata.arcgis.com/datasets/interagency-fire-perimeter-history-all-years?geometry=-169.197%2C-9.831%2C-74.978%2C74.202

National Interagency Fire Center. (n.d.). *Spring Creek fire information: Fire progression.* https://nifc.maps.arcgis.com/apps/MapSeries/index.html?appid=d41a9791b0a24a05bcd5ec543c5aebec

National Park Service. (2016, December 22). Great Smoky Mountains: Chimney Tops 2 fire. https://www.nps.gov/grsm/learn/chimney-tops-2-fire.htm

National Park Service. (2017, August 31). *Chimney Tops 2 fire review: Individual fire review report.* U.S. Department of the Interior, Division of Fire and Aviation. https://www.wildfirelessons.net/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=2291b1f9-d65a-4915-2257-d76919c16132&forceDialog=0

National Weather Service. (n.d.). *West Mims fire 2017.* National Oceanic and Atmospheric Administration. www.weather.gov/jax/WestMimsFire_Apr_thru_Jul_2017

Oklahoma Forestry Services. (2017, March 19). *Fire Situation report – March 19, 2017.* Oklahoma Department of Agriculture, Food and Forestry. www.forestry.ok.gov/fire-situation-report-–-march-19-2017

Oklahoma Forestry Services. (2017, March 20). *Fire Situation report – March 20, 2017.* Oklahoma Department of Agriculture, Food and Forestry. www.forestry.ok.gov/fire-situation-report-–-march-20-2017

Oklahoma Forestry Services. (2017, March 21). *Fire situation report – March 21, 2017.* Oklahoma Department of Agriculture, Food and Forestry. www.forestry.ok.gov/fire-situation-report-–-march-21-2017

Oklahoma Farm Report. (2017, March 25). Oklahoma state extension says over sixteen million dollars in losses to agriculture as a result of Northwest Oklahoma Fire Complex. *Radio Oklahoma Network.* www.oklahomafarmreport.com/wire/news/2017/03/01349_OSUExtensionCostEstimate03252017_112959.php#.YFOQpC2cbOQ

Pampuro, A. (2018, July 23). Veterans help clean up Colorado town after historic wildfire. *Courthouse News Service.* www.courthousenews.com/veterans-help-clean-up-colorado-town-after-historic-wildfire/

Pebesma, E. (2018, July). Simple features for R: Standardized support for spatial vector data. *The R Journal, 10*(1), 439-446. https://doi.org/10.32614/RJ-2018-009

Pebesma, E., & Bivand, R. (2005). *Classes and methods for spatial data in R*. https://cran.r-project.org/web/packages/sp/vignettes/intro_sp.pdf

Phillips, K. (2018, July 13). A man told authorities he started a fire to grill his food. He's now facing 141 counts of arson. *The Washington Post.* www.washingtonpost.com/news/post-nation/wp/2018/07/13/a-man-told-authorities-he-started-a-fire-to-grill-his-food-hes-now-facing-141-counts-of-arson/

Pohl, J. (2017, May 11). Video: DC-10 makes drop on West Mims fire [Video]. *Fire Aviation.* fireaviation.com/tag/west-mims-fire/

Pohl, J. (2017, May 22). West Mims Fire headlines fade away; firefight and drought continues. *Wildfire Today.* wildfiretoday.com/2017/05/22/west-mims-fire-headlines-fade-away-firefight-and-drought-continues/

Potter, T. (2017, April 1). Girlfriend, trucker killed in wildfire were talking, then the phone went silent. *The Wichita Eagle.* https://www.kansas.com/news/state/article142050069.html

Prickett, A. (2017, March 13). Northwest Oklahoma Complex fire 42 percent contained; winds bring back elevated fire risk. *Fox 25.* https://okcfox.com/news/local/northwest-oklahoma-complex-fire-42-percent-contained-winds-bring-back-elevated-fire-risk

Reyes-Velarde, A. (2019, January 11). California's Camp fire was the costliest global disaster last year, insurance report shows. *Los Angeles Times.* www.latimes.com/local/lanow/la-me-ln-camp-fire-insured-losses-20190111-story.html

Satterfield, J. (2017, July 5). Attorney: Arson charges against teens in fatal Gatlinburg wildfire dropped. *Knox News.* www.knoxnews.com/story/news/local/tennessee/gatlinburg/2017/06/30/attorney-arson-charges-against-teens-fatal-gatlinburg-wildfire-dropped/442706001

Satterfield, J. (2020, April 6). Gatlinburg's former fire chief lambasts National Park Service in deadly wildfires lawsuit. *Knox News.* www.knoxnews.com/story/news/crime/2020/04/06/gatlinburg-fire-chief-blames-national-park-service-deadly-wildfires/5116729002/

Sernoffsky, E. (2018, November 15). Five firefighters among dozen-plus patients burned in Camp fire. *San Francisco Chronicle.* www.sfchronicle.com/california-wildfires/article/Five-firefighters-among-dozen-plus-patients-13396604.php

Stewart, S. I., Radeloff, V. C., Hammer, R. B., & Hawbaker, T. J. (2007, June). Defining the wildland–urban interface. *Journal of Forestry,* 201-207. silvis.forest.wisc.edu/wp-content/uploads/2018/10/Stewart-et-al-JOF-2007.pdf

Tennessee Department of Commerce & Insurance. (n.d.). *2016 structure fire fatalities.* https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/2016_Fire_Fatalities_Report.pdf

Tennessee State Fire Marshal's Office. (n.d.). *Tennessee State Fire Marshal's Office Commissioner's Annual Report for 2016.* https://www.tn.gov/content/dam/tn/commerce/documents/fire_prevention/posts/Fire_2016_Commissioners_Annual_Report_2-7.pdf

University of Wisconsin-Madison. (n.d.). *Wildland-urban interface (WUI) change 1990-2010: 2010 data, all classes.* Silvis Lab: Spatial Analysis For Conservation and Sustainability. silvis.forest.wisc.edu/data/wui-change/

U.S. Census Bureau. (2017). *2017 TIGER/Line® Shapefiles: States (and equivalent).* www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2017&layergroup=States+(and+equivalent)

U.S. Census Bureau. (2019). *2019 TIGER/Line® Shapefiles: Counties (and equivalent)*. www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2019&layergroup=Counties+(and+equivalent)

U.S. Census Bureau. (n.d.). Service annual survey methodology: Two types of response rates. www.census.gov/programs-surveys/sas/technical-documentation/methodology.html#par_textimage_20

U.S. Department of Agriculture U.S. Forest Service. (2017). *California direct protection areas.* www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3806036.zip

U.S. Department of the Interior Bureau of Land Management. (n.d.). *BLM national data.* From Metadata and Downloadable Data: gis.blm.gov/EGISDownload/LayerPackages/BLM_National_Surface_Management_Agency.zip

U.S. Fire Administration, National Fire Data Center. (2015, January). *National Fire Incident Reporting System: Complete reference guide.* FEMA. https://www.usfa.fema.gov/downloads/pdf/nfirs/NFIRS_Complete_Reference_Guide_2015.pdf

U.S. Fire Administration, National Fire Data Center. (2016-2018). National Fire Incident Reporting System: Public data release. Emmitsburg, MD. https://www.fema.gov/about/openfema/data-sets/fema-usfa-nfirs-annual-data

U.S. Fish & Wildlife Service. (n.d.). *Southeast Region Fire Division report FY2017.* www.fws.gov/southeast/pdf/report/fire-report-2017-508.pdf

Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis.* Springer-Verlag.

Wickham, H. (2019). stringr: Simple, consistent wrappers for common string operations. *R package version 1.4.0*. CRAN.R-project.org/package=stringr

Wickham, H., François, R., Henry, L., & Müller, K. (2021, June 18). dplyr: A grammar of data manipulation. *R package version 1.0.7.* CRAN.R-project.org/package=dplyr

Wildland Fire Decision Support System. (n.d.). *Boundaries/responsible agency (protection)* [Data set]. wfdss.usgs.gov/wfdss/WFDSS_Data_Downloads.shtml

Zenteno, R., Hanna, J., & Park, M. (2016, December 5). 14 confirmed dead in Tennessee wildfires. *CNN.* www.cnn.com/2016/12/05/us/tennessee-gatlinburg-wildfires/index.html

Acronyms

BLM Bureau of Land Management

EMS emergency medical services

FDID fire department identification

FWS U.S. Fish and Wildlife Service

GACC Geographic Area Coordination Center

IMT Incident Management Team

NFDC National Fire Data Center

NFIRS National Fire Incident Reporting System

NIFC National Interagency Fire Center

PDR Public Data Release

USFA U.S. Fire Administration

WUI wildland urban interface

This report is submitted to the U.S. Fire Administration National Fire Data Center by PG Public Services, LLC in accordance with the Performance Work Statement under contract 70FA2019P00000035.