Build Your Own Brigade

A FOXFIRE WUI CASE STUDY OF THE CAMP FIRE

Section I. Context and Timeline 1
1. Pertinent After Action Review (AAR) Findings 17
Evacuation Orders 17
The Importance of Capacity 17
Relevance to the SVI 18
2. A High and Awful Price: Lessons Learned from the Camp Fire 19
Section II. Social Vulnerability Breakdown 24
A. Age 24
B.Limited Mobility and Amputees 25
C.Economically Disadvantaged 25
D.Attempt to Flee (ATF)/ Attempt to Survive (ATS) 26
E.SVI Based on Evidence through Investigative Reports 26
Section III. The Map Data 27
A. Area of Interests 27
B. Original Area: 28
C. Extensions 28
D. The 5000 Block of Edgewood 29
Section IV. Topographical and Fire Behavior Contributing Factors 31
A. Rate of Spread 31
B. Historic Wildfire Activity and Evacuation Planning 34
Section V: The Aftermath 37
A. PG&E 37
B. The Logging Industry 38
C. Community Wildfire Protection Plan (CWPP) 40
D. Code Enforcement 41
E. Rebuild Paradise 42
Section VI: Evacuation Comparison- Marshall Fire vs. Camp Fire 43
Section VII: Conclusions, Discussions and Recommendations 45
A. Workforce Development and Wildland Firefighters 45
B. Evacuation Alert Systems 47
C.Other Significant Findings 48
D. Discussions 49
Is the WUI still relevant? 49
How do you predict the unpredictable? 49
E. Final Conclusions 50
Sources Cited 52
Acknowledgements 54

Section I. Context and Timeline

A. Context

The Camp Fire burned through the town of Paradise, California on November 18, 2018. Over 18,000 structures were destroyed, 153,336 acres burned, and the population was reduced from 26,218 (2010) to 8,285 (2023).[1]

This study is specific to California, but is not meant to be a solution for just California.

RATIONALE

This study is meant to provide a comprehensive overview of the events that took place on November 8, 2018, in Paradise, California. It looks at the response, the aftermath and explores community-driven solutions to reducing localized wildfire risk.

In 2021, Lucy Walker released her critically-acclaimed documentary, "Bring Your Own Brigade," which sought to understand the growing global wildfire crisis. What she uncovers is the various nuances that complicate wildfire suppression, prevention and planning.

Wildfire is a human problem, and it will require human solutions if we are going to start seeing real change. This study has been titled "Build Your Own Brigade," because it examines how one community fought to recover after being destroyed, includes the lessons learned, and focuses on how communities can start developing wildfire response and prevention capacity in meaningful, sustainable ways.

[1] Paradise town, California; United States. "QuickFacts." United States Census Bureau. Access: <https://www.census.gov/quickfacts/fact/table/paradisetowncalifornia,US/PST045223>.

B. The Camp Fire Timeline from Public Reports

This timeline was taken directly from The Camp Fire Public Report: A Summary of the Camp Fire Investigation[2], published by the Butte County District Attorney's Office on July 16, 2020.

- "On November 8, 2018 at 6:15 a.m., the PG&E Grid Control Center (GCC)3 in Vacaville documented an "interruption" on the energized Caribou-Palermo 115kV transmission line in the Feather River Canyon."
- "At approximately 6:20 a.m. on November 8, 2018, a PG&E Hydro Division employee driving eastbound on Highway 70 observed a "bright light" above a ridgeline as he approached the Pulga Bridge. Initially the employee believed the bright light to be the sun rising behind the ridgeline; however, as he continued driving, he realized the source of the bright light was a fire underneath the PG&E transmission lines on a ridge on the north side of the Feather River. The employee noted the fire appeared to be at the base of a transmission tower. In that area of the Feather River Canyon cell phone service is not available. The employee used his PG&E radio to contact PG&E employees at the Rock Creek Powerhouse and reported the fire. These employees then called 911 and were transferred to the CAL FIRE Emergency Communications Center (ECC) in Oroville. The 911 call from the Rock Creek Switching Station was received by CAL FIRE ECC at 6:25:19 a.m."
    - Cell phone coverage continues to be a challenge in rural areas. Lack of coverage and connectivity can lead to delays in ignition reporting, it is important to note that there has been a significant rise in utility-placed wildfire sensors throughout California and in other areas of the west, such as Colorado.
- "At approximately 6:30 a.m., an employee of the California Department of Transportation (Cal Trans) arrived at the Cal Trans Pulga Station for work. While in the parking lot of the Pulga Station he observed a fire under a PG&E transmission tower northeast of the Pulga Station and took a photograph of it. The photograph showed a fire emanating out from under transmission Tower :027/2225 (Tower 27/222) of the Caribou-Palermo 115kV transmission line (Caribou-Palermo line).
- "At 6:29:55 a.m., the initial CAL FIRE notification went out to Captain Matt McKenzie at the Concow/Jarbo Gap Station. By 6:35 a.m., two CAL FIRE engines from the Concow/Jarbo Gap Station were on Highway 70 headed eastbound toward Pulga. Captain McKenzie and his firefighters first observed the fire just before reaching the Pulga Bridge. The two engines continued on Highway 70 to the Poe Dam to assess the

[2] The Camp Fire Public Report: A Summary of the Camp Fire Investigation. Butte County District Attorney's Office. 16 June 2020. <https://www.buttecounty.net/DocumentCenter/View/1881/Camp-Fire-Public-Report---Summary-of-the-Camp-Fire-Investigation-PDF>.

fire and formulate a plan of attack. From above the Poe Dam on the south side of the Feather River, at 6:44 a.m., Captain McKenzie observed that the fire was burning under the electric transmission lines on the ridge on the north side of the Feather River. Based upon the location of the fire as well as the high wind speed and direction, Captain McKenzie concluded there was no available route to attack the fire. Captain McKenzie immediately realized that the community of Pulga was in danger and dispatched his second engine to evacuate the residents of that community. From his position on Highway 70, Captain McKenzie took measure of the fire and requested additional resources be deployed to the west to stop the fire at Concow Road. During his initial report to the ECC, based upon his observations of the fire, the topography, and the wind, Captain McKenzie warned, "this has the potential of a major incident." (An hour later, at 7:44 a.m., the fire reached the Town of Paradise, a distance of approximately seven miles.)"

- ➢ One of the most important take-aways from the Camp Fire was that the behavior was so intense it took only an hour for it to rage through 7 geographic miles of heavily timbered forest before it reached the Paradise WUI.[3] According to the Community Wildfire Protection Plan (CWPP) for Butte County, updated in 2025, "Butte County's diverse vegetation includes Sierran mixed conifer, montane hardwood, blue oak woodland, and grassland."
- ➢ One of the things that stood out about John Valliant's 2023 novel, "Fire Weather," was just how close the Fort McMurray Fire had to get to the town before evacuation orders were actually called. According to the novel, the fire got as close as a mile before the orders were finally made.[4] However, due to the nature of the town they had a very low Social Vulnerability Index (SVI) rate, which allowed residents to escape with enough time.
- ➢ Obviously, in the case of Paradise, the fire moved too quickly for there to be enough time for a proper evacuation order. The Fort McMurray Fire had been going on for multiple days. Still, a case can be made that evacuations are being ordered earlier when fires begin to exhibit concerning behavior, it is still important to remember the earlier the notification the better.

❖ "At approximately 6:48 a.m. fire watch cameras on Flea Mountain and Bloomer Hill recorded a plume of smoke east of Concow and west of Pulga. CAL FIRE monitors initially attributed the plume of smoke to the Camp Fire. Later CAL FIRE monitors and investigators determined the smoke plume was not associated with the Camp Fire and was caused by a separate and unrelated fire. Utilizing mapping tools CAL FIRE investigators determined the plume of smoke had arisen from an area near the

[3] Butte County Wildfire Protection Plan. *Fire Environment*. Butte County, California. Updated 2025. Access: <https://storymaps.arcgis.com/stories/e56239646fcb4ae88f091516fea56f28>.
[4] Vaillant, John. "Fire Weather: A True Story from a Hotter World." Chapter 10. First edition. New York, Alfred A. Knopf, 2023.

intersection of Concow Road and Rim Road in eastern Concow. The fire was named the Camp B Fire."

The remaining timeline was accounted for by the Butte County Office of Emergency Management Camp Fire Response County-Wide After Action Report, published in August of 2020 and completed by Constant Associates.

- At 6:54 AM, firefighters radio requests for resources and evacuation.
- By 7:07 AM, the fire reached the community of Concow.
- At 7:13 AM, an evacuation order was issued for Pulga and announced via Twitter.
- At 7:15 AM, an evacuation order was issued for Concow.
  - It is important to note, according to the timeline, that the fire reached the community of Concow before the evacuation order was called. However, resources were overwhelmed that day. Further, the fire moved at an alarming rate.
- At 7:46 AM, an evacuation order was issued for the Eastern quarter of Paradise (announced via radio notice).
  - Section III of the study breaks down fatality locations in further detail. However, one of the key takeaways from this study was that a high volume of fatalities occurred in the eastern areas of Paradise.
- By 8:00 AM, reports of fire had reached the community of Paradise. At 8:02, evacuation orders continued to go out for Paradise.
- 9:00 AM - The Sheriff's Office activated a staging area and the first shelter opened.
- At 9:15 AM, evacuation orders were initiated for Magalia.
- 9:30 AM- Law enforcement established an incident base command at Butte College.
- By 10:00 AM, the National Guard arrived with a team and 10 trucks of emergency supplies.
- At 10:06 AM, evacuation orders were extended to the Butte Valley area, and the Butte Creek area at 10:22 AM.
- At 13:02, SO recaps overall evacuation orders (announced via Twitter).

C. Timeline from the Camp Fire Dispatch Audio


Figure 1

Times highlighted in green represent known exact times, as communicated by dispatch. Times highlight in red represent the time of the audio. Mandatory evacuation orders and locations are noted in blue, warnings are noted in orange.

00:10 - Call goes out for all surrounding local resources, including, engines and fuel modules, transports (EMS), water tender and command staff. Dispatch states the RP came from Poe Dam, **Figure 1**, and that there is a possible power line hazard [down line]. Utility resources also respond to the incident.

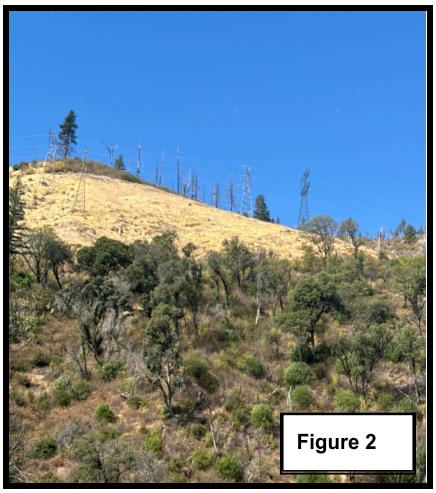
Figure 2

Poe Dam is owned and operated by Pacific Gas and Electric, as well as the Caribou Palamaro. The fire ignited below the line. The general area is pictured in **Figure 2.**

Figure 3

Camp Creek Rd. was identified as the general area of the fire, which is also how it got its name. **Figure 3** shows the intersection of Camp Creek Rd. and Pulga Rd.

0644 - Oroville engine reaches vegetation fire and reports access will be hard as Camp Creek Rd. is nearly inaccessible, **Figure 4**. Engine also notes the fire is on the west side of [North Fork Feather] river, with sustained wind gusts at 35 mph. Engine will continue to look for access routes, and discuss the possibility of making access through Concow Rd.

At that point, the reporting engine claims "this has the potential for a major incident." He then requests 15 additional engines, 4 additional dozers, 2 water tenders, 4 strike teams and hand crews. Dispatch notes the time at 6:44.

Figure 4

0645 - Engine 2176 is ordered to go down into the community of Pulga and evacuate it. Asks for the possibility of "getting early up on aircraft."

9:17 - Engine 2161 reported "10 acres from what I can see." Engine also reported it had a good, sustained wind on it and it will have a "critical rate of spread once it gets down into the maintained vegetation under the powerlines… once it gets into the brush and timber." They were still working on access. Up until Battalion 2118 assumes IC, 2161 acts as IC and will be noted as such until 2118 takes over.

11:00 - Dispatch orders resources to go to the Pulga area to assist CAL FIRE with evacuations. They "advised it was Pulga Road only." No staging area reported at the time, but they were directed it was near the Poe Dam area.


Figure 5

Figure 5 shows the burn scar and the community of Pulga, barely visible. This picture was taken southeast of North Fork Feather River, off of I-70.

14:01 - IC directs Battalion 2118 to go to Pulga and try to scout out Camp Creek Road since the apparatus is the smallest and has the best chance of gaining access.

14:22 - Dispatch calls Engine 2161, Oroville [IC] because "BTSO was

inquiring if the evacuation in the Pulga area were considered mandatory and if there was anywhere else that it should be extended to."

Response was to keep it mandatory only for Pulga because "there was still a lot of country to cover before it reached the Jarbo Gap area." The audio makes it difficult to distinguish what area he was referring to. However, Jennifer Goodlin, of the Rebuild Paradise Foundation, informed me the Jarbo Gap is an area that receives a lot of the heavy winds that impacted the rate of spread. She also informed me that based on where the fire started, there would be no reason to believe Paradise could have been impacted by the fire as quickly as it was.

Figure 6 shows the distance between the ignition point and the Jarbo Gap, via I-70, is 6.48 miles, with an overall ascent of 1,540 ft. As will be discussed later, not even the worst case scenario, or the current thresholds for the 97th Percentile could have predicted the rate of spread that day.

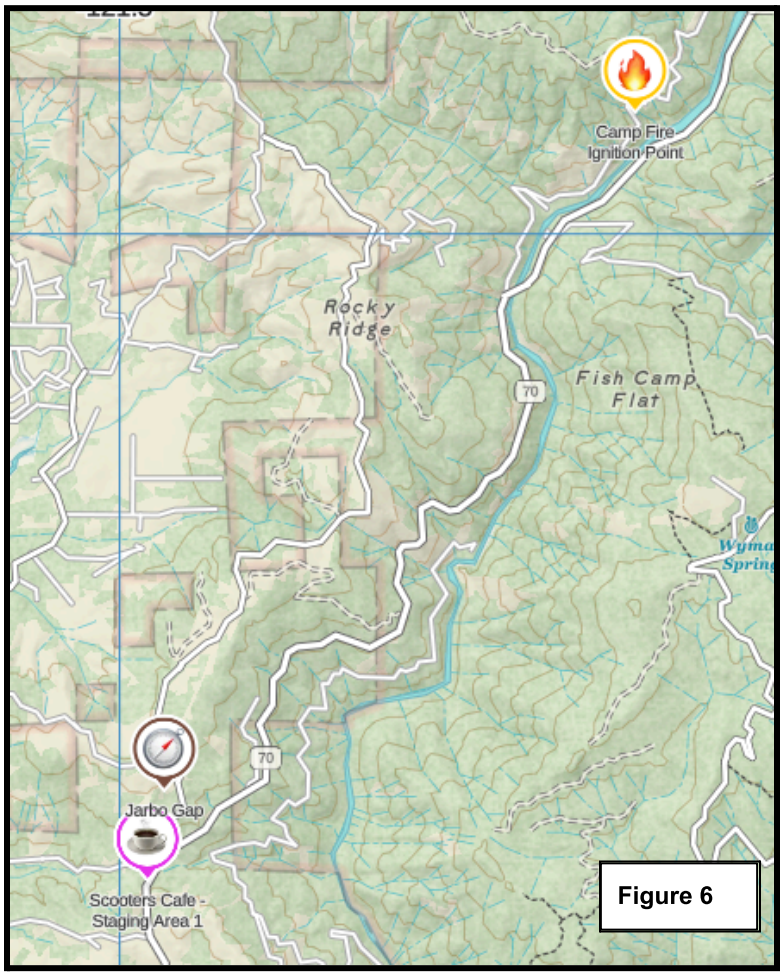

Figure 6

15:31 - Dispatch notifies responding agencies a staging area has been established at Scooters Cafe, along highway 70. As the map, right, demonstrates, Scooters is located just south of the Jarbo Gap. The fact that this was established as the staging area further suggests that IC thought it was a safe enough distance from the fire that resources and first responders would be out of harm's way.

23:35 - Dispatch informs IC that more local resources are on their way and asks about trying to get a resource to Camp Creek Rd. IC responds that access will still be an issue and that "if we get one engine up and there it gets stuck, we're in a bad spot." IC then directs engines 2186 and 2167 respond directly to Pulga as it will be the immediate threat for structure defense.

24:00, roughly 0708 - Dispatch informs engine 2161 (IC) that Fire Watch cameras have picked up a second possible fire in the area of Rim Road, just east of Concow Reservoir. At that point,

IC decides to keep engine 2186 and 2167 in that area to respond to Rim and Concow Roads to spot it out.

0709 - Utility 44 responds to Camp Incident.

0710 - 2161 reported coming out of the community of Pulga, estimating the fire to be 200 - 300 acres with a rapid rate of spread. Reports heading towards the area of Concow Lake.

34:55 - Battalion 2118 assumes Camp IC. 2161 and 2176 were assigned to structure protection in Pulga. IC reports the fire is already crossing through that area and heading towards the Concow area. All other resources are ordered to remain staged until Engine 2186 comes back with a report.

Dispatch copies and reports strike teams from Humboldt and Lassen are on their way, but have no ETA.

36:50 - An inaudible resource informs IC they have spoken with dispatch and asked them to complete a Code Red, and says "they're going to be accessing the staff list for anyone who needs help getting out up there." They also requested Search and Rescue be dispatched to help with evacuations. At that point, they were asking if they should start assessing Concow to be evacuated.

IC responds, "From the looks of it, I would say we need to start that process now."

Dispatch asks IC if any additional evacuation warning should be sent out.

IC responds the mandatory evacuation warning will remain for Pulga only, but informs Dispatch that Concow is being sized up and they will report back within 10 minutes. Does say there will likely be an evacuation warning.

41:15 - Camp IC request the Sheriff be advised Pulga has been evacuated by engine personnel and request they send a representative to meet IC at staging area and have resources start heading toward Concow. IC states they are probably going to have an evacuation in the Camelot area.

Dispatch asks IC if he wants any evacuation warning issues. IC affirms and says he is waiting to see which areas will be mandatory and which areas will be a warning.

45:15 - All overtime personnel are requested to come in, along with local agencies for mutual aid and Shasta County. This includes all off-duty personnel.

Dispatch announces the Investigations Unit is enroute.

46:44 - Camp IC requests Interstate Highway 70 be shut down, and orders additional resources.

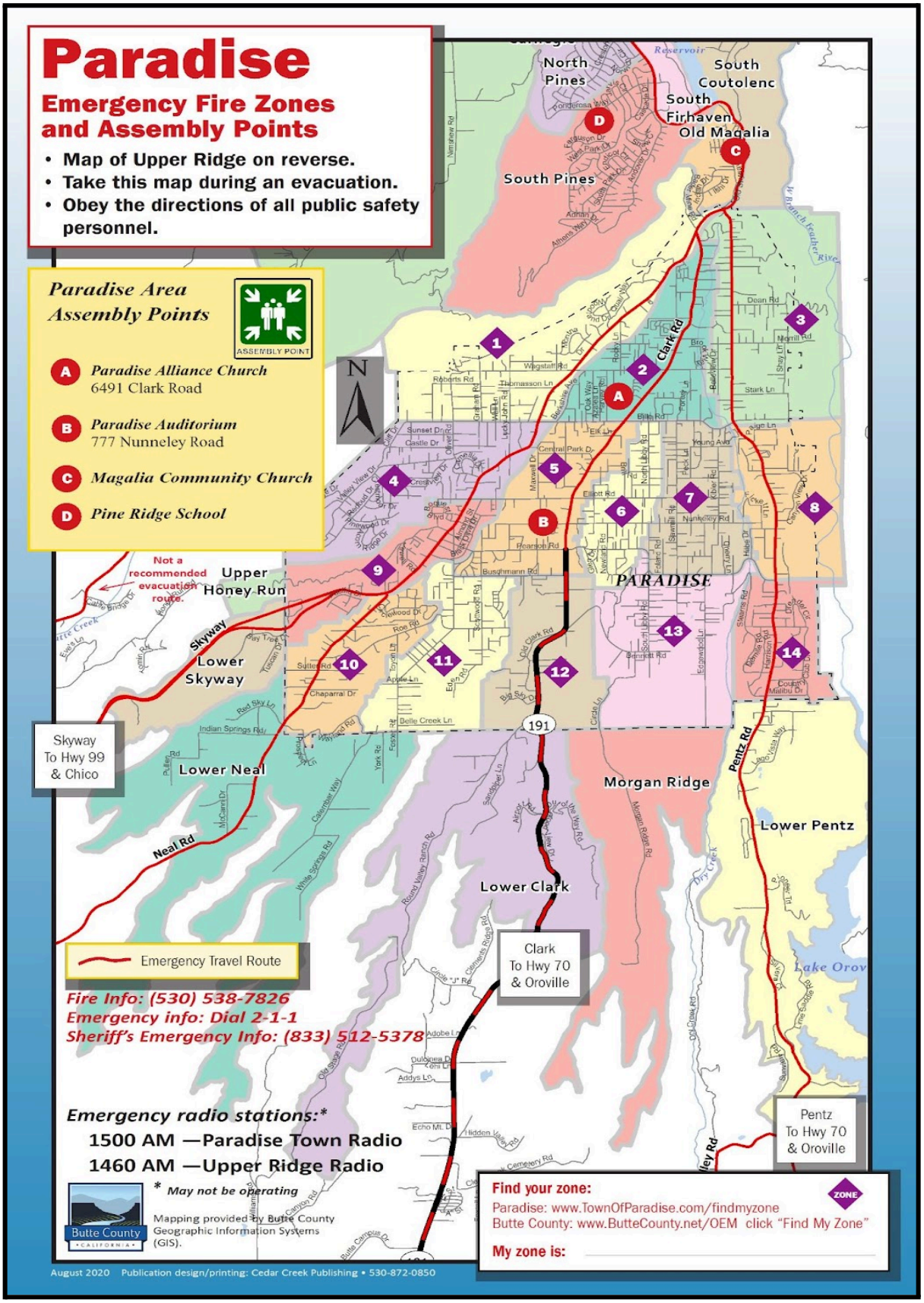

Figure 7. Taken from the Town of Paradise Community Page, under Evacuation Zone Map. This is the map prior to the update in 2020.

51:55 - Dispatch informs Camp IC of two large spots in residential yards in Concow. One of the addresses was off Hoffman Road.

52:43 - Utility 44 suggests an additional evacuation warning for west of Pentz Rd. in Paradise.

54:00 - Camp IC calls in additional resource order. Requests 15 Charlie Strike Team, 15 Golf Strike Teams, 10 Lima Strike Teams, with appropriate overhead. Those strike teams consisted of bulldozers, water tenders medical response units, Type 3 and Type 6 engines, appropriate overhead, etc.

54:49 - Dispatch informs Camp IC that CAL FIRE has called for an evacuation warning for all residents west of Pentz Road in Paradise. IC affirms.

55:18- Dispatch informs IC of fire moving through a structure on Hoffman Road in Concow.

55:20 - IC informs Dispatch that the Incident Command Post (ICP) and staging area is going to be moved to the Ace Hardware Store off of I-70.

56:46 - Dispatch asks IC if he wants to make the evacuation for Concow mandatory. IC affirms.

56:56 - Dispatch reports fire in the Cirby Creek Area in Concow.
It is that almost twenty minutes pass by between the first mention of evacuation of Concow and when the actual warning is told to go out. By the time the mandatory evacuation warning went out, fires had already been reported moving through areas of Concow. This is not a critique as much as an observation. The radio traffic begins to pick up significantly during that time, and it is possible the action was lost in the shuffle.

1:01:03 - 2107 informs Dispatch they have been trying to contact Camp IC. They are down on Hoffman Road, with multiple structures on fire. He requests 5 strike teams in the area.

1:02:00 - Dispatch follows up with CAL FIRE about the evacuation warning for Paradise. CAL FIRE confirms it's still a warning, and states they have started at Pentz and Skyway and began working their way south.

1:03:58, 0743 - A medical call comes in. Despite everything going on, an engine responds.

1:06:30, **0746** - Camp IC extends mandatory evacuation zone to east of Pentz Road, specifically, **zones 3,8, 14 and lower Pentz Rd.** It also extends to north of Highway 70, in Paradise.

1:07:23 - Dispatch asks if the mandatory evacuation warning should be extended to the town of Paradise itself. IC responds, "Affirmative at this point."

- This is the first time that a mandatory evacuation warning for Paradise is discussed.

1:09:08 - Fire is reported along the highways, with winds being reported at "at least 60 mph."

1:12:07 - An engine reports that traffic on Concow Rd. is getting "plugged" up between emergency response vehicles and people trying to evacuate.

1:12:52 - A report of a "fire that just started up from smoke on the ground" on the east end of Appleview, off of Pentz. This is the first mention of fire in Paradise. According to dispatch timelines known and given, it is roughly 0752.

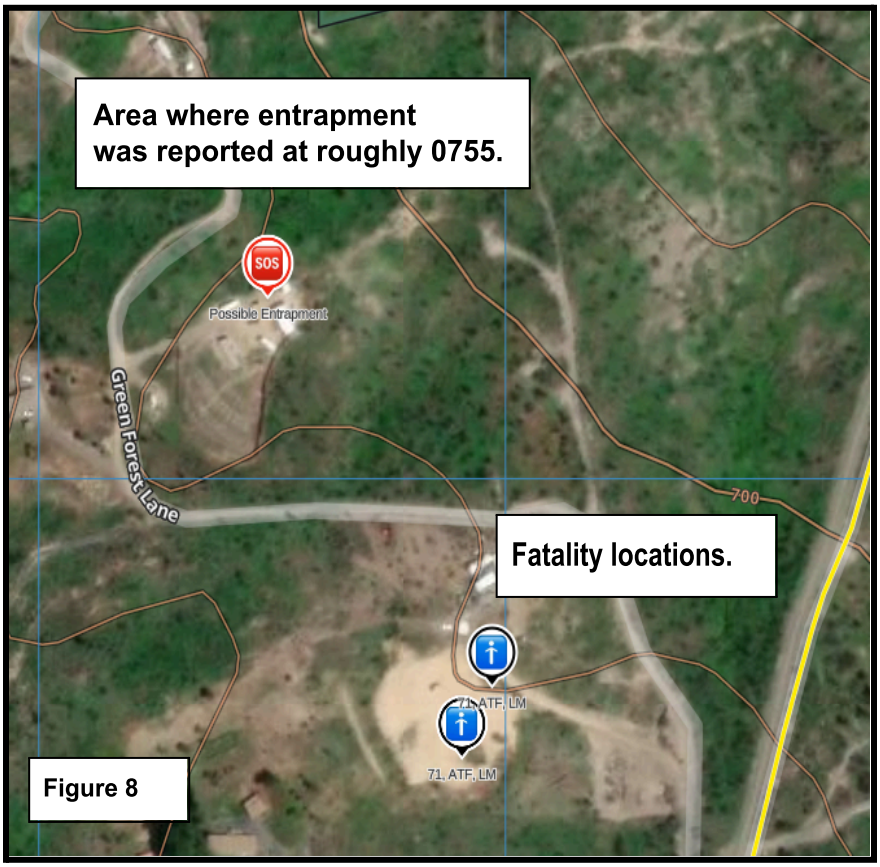

Figure 8

1:13:17 - Dispatch inform Camp IC that CAL FIRE is advising people to evacuate from the end of Apple View Way

1:15:40, roughly 0755 - **Figure 8.** Dispatch informs Camp IC of a possible entrapment on 13526 Green Forest Lane, in Concow.

1:16:11 - 93 informs dispatch they will start traffic detail on I-70.

1:16:30 - **Zones 3, 8, and 14 are mandatory evacuations.**
Zones 13, 7, and 2 are all evacuation warnings.

1:16:35 - Engine reports being "stuck down in Camelot. The winds are too strong. There's fire on the roadways all around [us].... People in here in the fire safety zone. Which is a large open area on Camelot lane. I think that's the only shot we have right now."

1:18:37- Air support plans to head to the Camelot area to assist.

1:18:42 - Company in Camelot reports "waiting for the grass to burn off. Once it's burned off, I'm going to move all these people, we're going to go sit out in the black and we're going to wait in our cars. I think we'll be alright." **Figure 9** shows the area that was burned to create the safety zone.

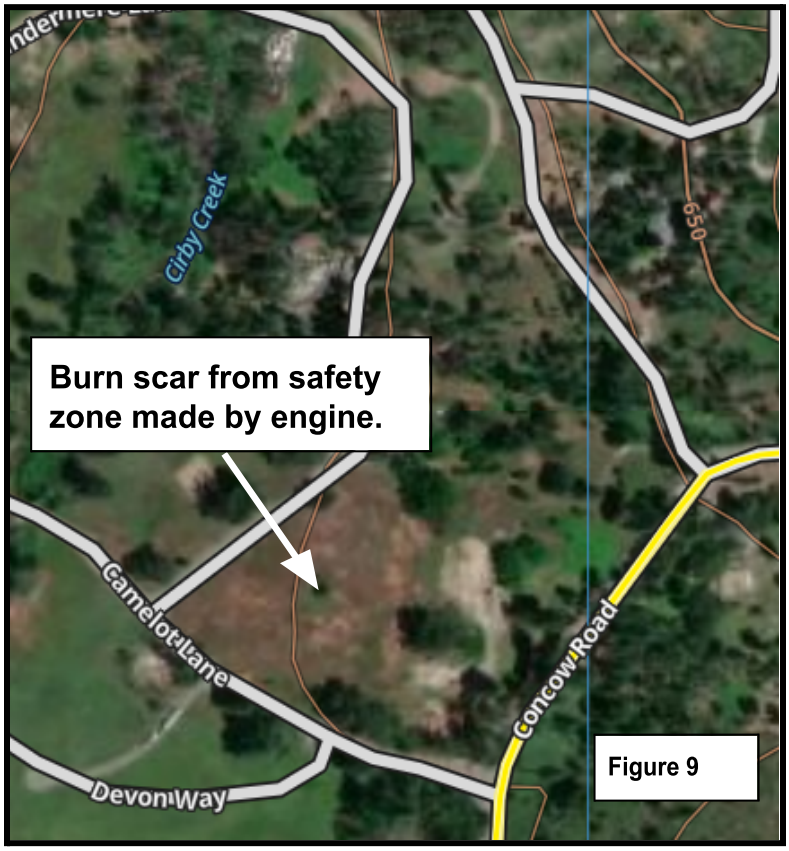

Figure 9

One thing that sticks out about this audio is that the responder has an elevated pitch and rapid speech, demonstrating how nervous the situation makes him. Ho wever, given the circumstances he was still acting in a calm, decisive and efficient manner.

They reported back at 1:22:45 that they had burned the area, "people were holding out in their cars." He repeats again he thinks they will be alright, and any prior hint of anxiety has dissipated from his voice.

1:24:00 - Fire is reported around Jubilee and Copeland. This is one of the first audible fires reported in Paradise.

1:24:55 - **Dispatch advises all units that the town of Paradise is under mandatory evacuation.**

1:27:00 - Engine reports fire up to the houses north of Lowery. **Figure 10** shows the areas of the two reported fires, providing evidence of ember cast. It should be noted that the fire on the right, was reported to be breaching property at roughly 0807, and it is close to the Feather River Hospital.

1:28:24 - Engine reports being trapped off Hoffman Road (Concow), with multiple residents taking refuge in a Creek. Requested SO be advised that the safety zones are inside Camelot.

1:31:58 - Engine reports making an attempt to access the creek off of Hoffman Road, but is unsuccessful because there is fire surrounding the area.

1:32:34 - Engine reports that Concow School is being evacuated.

1:32:45 - Camp IC makes a reference to the spot fire off Hoffman Road, where engines are holding "like 40 people," and doesn't believe he can make it through.

1:33: 20 - Engine reports "building spot fire in the backyard of Merrill and Pentz Rd. in Paradise."

1:34:40 - A request is made to IC to exchange information, and IC replies it's low priority at the moment. Respondent copies and informs it's just 10/20's, or to inform dispatch of where resources are located.

1:35:00 - Setting up a one-way evacuation route is discussed.

1:35:40 - Dispatch advises two more structures are now engulfed.

1:36:00 - IC advises mandatory evacuation zones are **2,6,7,13** with warnings in **12,11,5 and 1**.

1:37:40 - IC puts in an additional resource order that is significantly larger than the last ones.

1:38:27 - Clarification as to what was a warning and what was mandatory for Paradise is requested.
IC clarifies - mandatory evacuations for **3,2,7,8,14,13, Morgan Ridge Zone, Lower Pentz Zone**
Another person (presumably CAL FIRE), proposes additional orders for all of Pentz Rd. to Ponderosa Schools. Claims they will start an evacuation order just north of Merrill.

1:39:38 - IC informs dispatch that he will remain in his location because he's got "15 to 16 convoys of people going." Also says he will "stay here until CAL FIRE comes to us because I can't see what's burning past 100 yards."

1:40:07 - Mandatory evacuation orders for Lower Pentz Rd. and Morgan Ridge are reiterated and Lower Clark is added as a warning.

1:41:15 - Either a CAL FIRE or Oroville Engine reports fire in Paradise, along Pentz Rd. at Merrill and requests 10 of "your engines" immediate needs. IC is able to send 3 engines. It is reiterated that it's an immediate threat to structures.

1:42:00 - It begins to come through that the fire is burning up to the property line of Feather River Hospital and that immediate assistance is needed. This is roughly 27 minutes after fire was reported to be burning up residential property lines near that area.

1:42:42 - An engine volunteers to go to the area of Pentz and Wagstaff to assist with residents in the mobile home parks.

1:44:15 - It is mentioned that Dean Road, in the canyon, is also on fire.

1:45:03 - Division Delta reports pulling their shelters (fire shelters) to protect residents inside the Hoffman area and is confirming the power is shut off in the Concow area because they have multiple lines down.

1:46:58 - 5851 Ingalls refuses to evacuate because of animals. This person ultimately ended up surviving.

1:47:40 - Reporting party from inside Feather River Hospital says the building has been impacted by fire.

1:56:15 - Engine reports that the fire is about 100 feet north of the Paradise Ridge Mobile Home Park.

1:56:58 - Engine 39 advises, “Feather Canyon Retirement Home behind Feather River Hospital. The fire is approximately 20 yards across from the nearest residences. I was advised 148 people need evacuated.”

IC responds that he has “another 12 en route” to assist the engine.

1:58:10 - Spot fire is reported around Paradise Methodist Church, off of Clark Road. IC advises there are no available engines to respond.

1:58:30 - Engine advises Dispatch that there are 60 patients that need to be evacuated from the Feather River Hospital, and that SO and staff are helping with evacuations.

D. Lessons Learned

1. Pertinent After Action Review (AAR) Findings

Evacuation Orders

- According to the Butte County Camp Fire Response AAR, “On the morning of November 8, the lead staff member from the BCSO responsible for the mass notification process received a call from BCSO dispatch with a request to push out an evacuation order for the Community of Pulga due to fire threat. That message was sent out at 7:13 AM.1 Faced with limited staffing support, the same individual remained at the helm and pushed out over two dozen alert notifications during the initial 16 hours of the Camp Fire response.”
  - To further complicate matters, less than 40% of residents in the fire-affected area had signed up for the emergency alert systems. Overall, of the 52,000 people evacuated, only 7,000 received alerts from CodeRed (Butte County’s Alert Notification System).
- The AAR further found that Butte County had not practiced a “worst case scenario” test with its mass notification system prior to the fire. Specifically, the report states,

  “ It was explained, during a stakeholder interview, that in October 2017, the County had switched its primary mass notification software from Airbus to CodeRed, largely based on CodeRed’s ability to seamlessly integrate with and simultaneously push out messages through IPAWS. This decision to switch systems was prompted by a series of Vesta Communicator message failures the County had experienced with Airbus in February 2017 during the response to the Oroville Dam Spillway incident.

  While the County was proactive in switching its primary mass notification system, it did not dedicate the time and resources necessary to also ensure that the new software would support the mass notification needs of a large-scale, complex incident. In addition, the County did not leverage the system onboarding period as an opportunity to bolster its mass notification staffing capacity by training existing and new staff members in system use.”

The Importance of Capacity

- In this new normal, having staff and resources that have experience with large wildfire incidents can be monumental for creative problem solving and mitigating significant loss of life during fast-moving wildfires. According to the Camp Fire AAR, “Butte County staff had extensive experience in EOC operations from previous disasters to include the recent Oroville Dam Spillway incident, which also necessitated a mass evacuation. Employees had developed mutual trust and the ability to quickly mesh together as a team

in support of a common mission. These factors contributed to the speed and efficiency with which the EOC activated, organized, and became functional, even in the face the catastrophic events surrounding the Camp Fire."

- And, "The widespread and dynamic nature of the Camp Fire overwhelmed the same standard plans, processes, and procedures that had worked for Butte County in response to previous disasters. Creativity and innovation were required to successfully meet the unpredictable needs presented by the Camp Fire."

- One of the main findings for Areas of Improvement was the need for being properly equipped with the technology and resources to properly accommodate the scale and severity of the incident. The AAR specifically states, "The size and layout of the County EOC, while adequate for past emergencies, was not fully sufficient to support a large-scale, multi-jurisdictional, multi-operational period, and complex response such as the Camp Fire. In addition, the EOC was not equipped with the appropriate technology to support an efficient and effective response by the County. For instance, given the widespread and dynamic nature of the Camp Fire and all of the information it produced, there was no feasible way to adequately display critical incident-related information in support of a common operating picture in the County EOC. Informational displays within the EOC meant to project the common operating picture were inadequate, which hindered situational awareness."

Relevance to the SVI

These findings are relevant to the overall objective of this study because it further demonstrates the need for increased wildfire prevention and response capacity in rural and economically disadvantaged areas. Section VI of this study compares the evacuations between the Camp Fire and the Marshall Fire (2020, Colorado). Specifically, it provides evidence for correlation between the amount of resources available for response during the most critical times, at the beginning of the incidence, and low fatality rate.

What the Camp Fire demonstrated was a need for a more comprehensive wildland and general emergency management workforce at the community level that is capable of responding to incidents of this scale and severity.

2. A High and Awful Price: Lessons Learned from the Camp Fire

This section covers the mini-documentary released by Three Days in Paradise on December 30, 2019, called "A High and Awful Price: Lessons Learned from the Camp Fire." According to the description, the documentary was made in connection with Butte County. It was specifically made with the help of "Sheriff Kory Honea of Butte County, CAL FIRE Chiefs David Hawks and John Messina, Director of Butte County Department of Employment and Social Services Shelby Boston, the Chief Administrative Officer of Butte County, Shari McCracken, Emergency Services Officer, Cindi Dunsmoor, Retired Disaster Coordinator for the Paradise Unified School District (and PHS Principal after the fire Jeff Marcus) and Executive Director of California Vocations, Bob Irvine.."[5]

One of the first things mentioned in the mini-doc was that fire professionals knew Paradise was going to burn. In "Bring Your Own Brigade," the same sentiment is reiterated. Additionally, Mike Davis, author of "The Case for Letting Malibu Burn," makes the claim in "BYOB" that it is "easily imaginable that a fire could escape Laurel Canyon and end up on Hollywood or Sunset." Six years and two months later, his prediction came true.

Interestingly enough, "BYOB" also references the La Tune Fire (2017), which had a 99% structural survivability rating because Los Angeles County has such stringent code enforcement. As of June 1, 2025, over 16,000 structures have been counted as destroyed or damaged. Part of those fires burned in Los Angeles County. This shows the need to extend or delineate WUI's to start including urban conflagrations.

This ties into the next point Messina makes in "A High and Awful Price," which is potentially the most important takeaway for residents and communities. You have to accept the fact that something this big can and is happening to you. They discuss the idea of denial based on the mindset, "nothing this big ever happens to me." My supposition would be that this type of thinking greatly impacts our ability to prepare for wildfire and evacuate when we need to.

Paradise is the perfect case study for understanding how acceptance and preparation are equally important when responding to a disaster. In both "Bring Your Own Brigade" and "A High and Awful Price," it is reiterated that the town of Paradise had planned extensively for wildfires. Before the Camp Fire of 2018, there was the Camp Fire of 2008. That fire was part of the Lightning Complex. After evacuations from that fire resulted in people being stuck on long, narrow roads for up to twelve hours, the town realized it had to come up with a better plan. Specifically, they realized they needed to utilize evacuation zones to maximize the use of the only three roads that lead out of town.

---

[5] Three Days in Paradise. "A High and Awful Price: Lessons Learned from the Camp Fire." Youtube.com. Three Days in Paradise. Upload 30 December 2019. Access: <https://www.youtube.com/watch?v=bo0yBOCvuwU&t=3346s>.

Figure 11

Figure 11 shows an evacuation zone sign at the intersection of Oliver Rd. and Billie Rd. There is a waypoint saved on the Gaia map.

Paradise planners were aware of the vulnerability associated with having a limited number of roads that could lead out of the community. In order to maximize traffic flow during evacuation, they turned two-way highways into one-way routes.

County planners, first responders, EOC personnel and other various stakeholders had tabletop exercises and regular evacuation drills with the community. However, as Former Paradise Mayor Jones states in "BYOB", "What we didn't anticipate was evacuating the entire town all at once. It is not possible to build a roadway system that will take your entire population all at the same time. No city has that." On November 8, the fire moved too fast for the one-way evacuation method to be implemented in enough time.

The 2008 Lightning Complex also emphasized the importance of planning for populations with functional needs. They revamped the Special Needs Awareness Program (SNAP) by creating a registry that identified populations that would need extra help or assistance during an evacuation. It wasn't necessarily a guarantee for assistance, but it was helpful for planning measures.

Bob Irvine also practiced evacuation drills and plans regularly with the developmentally disabled adults he works with through his job as Executive Director of California Vocations. In the mini-documentary, he even discusses evacuations drills he would practice with residents in the middle of the night. On November 8, 2018, that training came in handy for Bob as he was trying to evacuate his residents. During the chaos that ensued that day, Bob discusses how much easier it was because he had established normality and procedures. Repetitive practice for emergency drills drives improved neuroplasticity and repetition helps rewire the brain in a targeted way so that way during an emergency the brain has experience in responding and fear responses can be decreased. These strategies are important in promoting a more efficient and resilient response in high stress events.

"It takes every citizen out there realizing they need to be as prepared as they can be for that risk." Elderly populations represent 25% of the population of Paradise, alone. As this study will demonstrate, 86% of the 85 accounted for fatalities were over the age of 60. It is mentioned early on in the dispatch audio that assisted living facilities were priorities for evacuation. During the Mountain Fire (2024), in Malibu, live coverage from local stations showed first responders

continuing to prioritize evacuating assisted living centers. While this is essential to reduce loss of life, it can delay early structure protection measures. This is dependent on the rate of spread and other uncharacteristic fire behavior. Either way, allowing socially vulnerable populations to shelter in place would allow resources to focus on other objectives within the first hours of an incident. It is also important to note that even with shelter-in-place options, resources are still assigned for protection. Looking for larger structures, such as schools and churches, that are centrally located in neighborhoods that can host more residents is another way to make shelter-in-place work better with limited resources.

Temporary Fire Refuge Areas (TFRA's), as outlined by the NIST's ESCAPE Report, are identified landscapes and natural objects that can be utilized for last-minute shelter-in-place protection. During the Camp Fire, multiple residential burnovers occurred in Concow. However, TFRA's had already been identified during the planning phase. It is hard to tell whether or not the burnovers would have resulted in more fatalities or injuries had they not priorly been identified. Still, an argument can be made that it is extremely valuable to start identifying TFRA's during the planning phases, especially ones that can help protect vulnerable populations in the event evacuation becomes impossible.

Even with the best planning and intentions, the documentary also points out a reality that is hard to grasp for the general public. There is an assumption of safety associated with first responders that has been deeply rooted in the hegemony of America. If you call 911 for help, a first responder will show up and save the day. However, this supposition has been challenged in recent years by natural disasters. "A High and Awful Price" claims, by the generous estimate, there were roughly 1,000 people available to respond to the incident on Paradise Ridge for 52,000 residents that needed to be evacuated during the same time. Sometimes it's a numbers game and residents have to be prepared to save themselves, and realize there is a strong possibility no one is coming.

"There is a very real chance you will need to ignore your disaster plan." For all intents and purposes, there was not a community in the United States that was better prepared for the threat of wildfire. The consensus in the aftermath of that planning was, "we were prepared for the worst case, we just couldn't imagine what that ended up looking like." Inevitably, the plan ended up going out the window due to several complications that day, including:

- No aerial support due to high winds
- Low visibility
- Difficulty with cell reception and communication systems
- A fire that was moving at 5-7 mph
    - All of the above meant that first responders were unaware of what was happening around. IC Messina stated in the dispatch audio and in "A High and Awful Price"

that he was unaware of what was happening outside of Concow, where he had become trapped (not an entrapment, but was unable to leave the area).

- Infrastructure that didn't support fire suppression apparatus. In the early moments of the fire, the first responders were repeatedly struggling to gain access to the fire area

Despite those complications, and the perfect storm, Butte County officials claim that the plan helped with improvising in the moment and being able to save more lives.

Figure 12 again demonstrates just how difficult access was around the ignition site. The road to the left is Camp Creek Road. I-70 is on the left, and there are only so many bridges that connect the two. It also shows how steep and rugged the terrain is, and the heavy fuel loads for the fire to consume. This picture was taken close to the 6-year anniversary of the Camp Fire.

When John Messina discusses wildfire preparedness in "A High and Awful Price," he says it's not just about hardening homes and creating evacuation plans. It's also about mental preparedness and being willing to accept the fact that the worst case is happening to you. Planners and first responders knew that it was plausible for a fire to come out of one of the drainages and down into the town of Paradise. They had models, predictions and plans that couldn't have predicted the way the fire behaved.

'No Notice Events' are incidents that happen so quickly it makes it difficult for alerts and warnings to get out early so residents can prepare. Put simply by the narrator, a 'No Notice Event' is what separates emergencies from disasters. Eighteen months before the Camp Fire hit Paradise, Butte County had a 'No Notice Event' when a tear opened in the spillway of the Oroville Dam after heavy rains. Essentially, they had an hour until residents were facing the possibility of a 30 ft. wall of water coming at them. With over 100,000 residents in possible danger, they had to quickly evacuate Oroville. Butt County Sheriff Korey Honea claims that the Oroville Dam Crisis in 2017 prepared emergency response personnel for the Camp Fire.

Undoubtedly, responding to that disaster also helped increase the mental resilience that helped save lives on November 8, 2018.

Still, one big difference between the Oroville Dam Crisis and the Camp Fire is that emergency personnel had an hour to work with before the potential for impact. During the Camp Fire, lack of visibility and aerial support made it hard for responders to know how fast the fire was moving, and where exactly it was spotting. "We thought we were hours ahead of it, and we were minutes behind it," Messina tells the camera.

The Emergency Operations Center (EOC) had to evacuate before it was opened. During the early moments of the Camp Fire, EOC personnel struggled without access to internet, email, landlines and spotty cell service. As previously stated, low visibility and fire intensity made it hard for IC to know what was going on around them. According to "A High and Awful Price," the only reports of fire spread were coming from 911 calls.[6] To further complicate matters, the cable lines were the first thing destroyed in the Camp Fire. In the documentary, the advice that comes is "Prepare to communicate like it's 1950." The benefits of having an operating siren is mentioned a few times.

IC John Messina makes another vital point in "A High and Awful Price" regarding how fire behavior is predicted. He states, "Fuel is anything that burns. It can be a vehicle, it can be a structure." By the county's admission, and stated several times throughout the documentary, the worst-case scenario predictions were not accurate of the fire behavior and intensity witnessed that day. According to an article published by Reuters, the Palisade and Eaton Wildfires were 10x bigger than what South California Edison's AI model predicted. These fires devastated LA in January 2025, becoming a major urban conflagration fire that communities were sorely underprepared for. Michael Wara, a wildfire policy expert at Stanford Law School, states, " The wildfire modeling may also have erred because it is better tuned to simulating fire in dense shrubs and woodlands, instead of blocks of homes and businesses."[7] Additionally, historical thresholds for modeling the 97th percentile, or worst-case scenario, are not reflective of the fire behavior repeatedly observed in the last decade.

[6] Paradise SVI Map Cross-Reference. Gaia Maps. Folder Link: <https://www.gaiagps.com/map/?loc=10.7/-121.5156/39.7673&pubLink=3pitdYZaPKjpTGphkRKhmPS5&folderId=ca36fa40-4c36-4a26-b04a-8feeac1b5342>.

[7] McLaughlin, Tim. Kearney, Laila. "Los Angeles wildfires were 10 times bigger than utility's AI forecast." Reuters. Updated 9 June 2025. Access: <https://www.reuters.com/business/environment/los-angeles-wildfires-were-10-times-bigger-than-utilitys-ai-forecast-2025-06-09>.

Section II. Social Vulnerability Breakdown

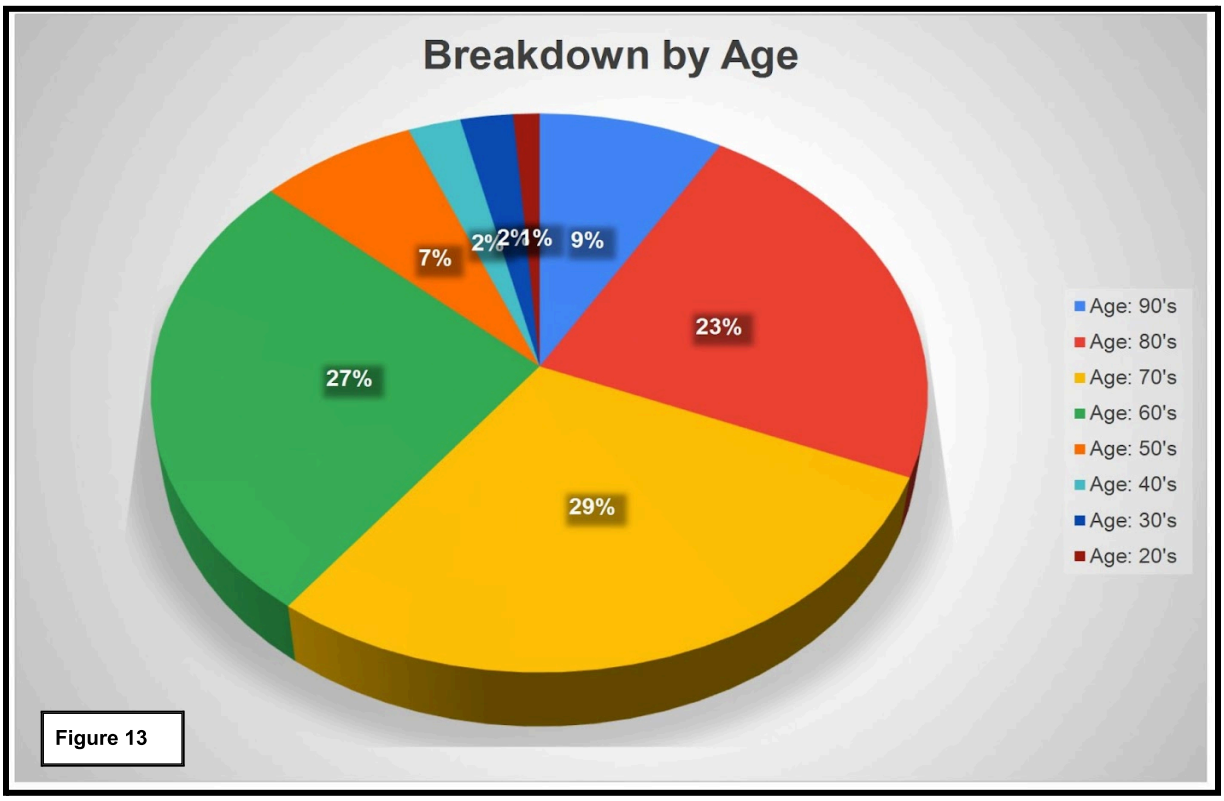

Figure 13

A. Age

- According to the research, approximately 86% of the fatalities were over the age of 60.
- Fatalities under the age of 60 were mostly made up of two categories:
  - Had a disability and/or limited mobility
  - Was caught in a common area where several victims were found, suggesting the fire overtook them because it was moving so fast.
- As you can see by the breakdown in the chart [above], victims in their 60's, 70's and 80's represented the largest population of fatalities.
- Victims under the age of 60:
  - Had limited mobility, including 2 victims that were amputees
  - Were attempting to rescue an elderly family member or community member
  - Were economically disadvantaged and did not have transportation

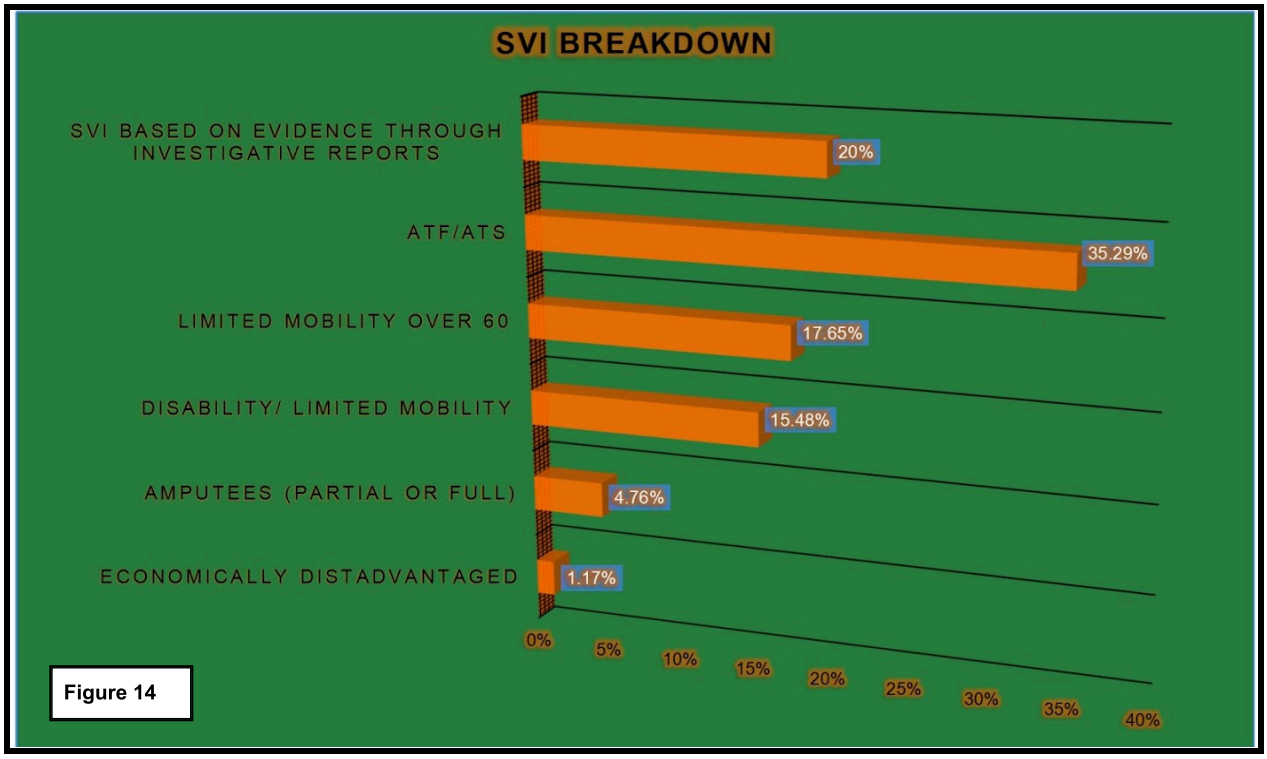

Figure 14

B.Limited Mobility and Amputees

This category represents fatalities where partial or full-amputations were noted in the investigative report as evidence. Most correlated with Attempt To Flee (ATF)/Attempt To Survive (ATS). ATF were categorized by victims being found in a car or outside of the home. ATS were categorized by victims being found within a bathtub, shower, basement or another area in the home that was being used to shelter in place within the house. These distinctions seemed necessary because there were elderly victims that were found sitting in chairs and recliners, next to their loved ones. The way they were found seems to suggest they had accepted the inevitability of the situation.

- Four of the total victims were partial or full amputees.
- Thirteen were cited as having limited mobility.

C.Economically Disadvantaged

This was one incident specifically tied to economic disadvantage: A 39-year old was unable to flee because he did not have a vehicle. Although technically the majority of the victims could be counted as economically disadvantaged, it is worth pointing out because it's worth thinking about. Other factors, such as age and/or reliance on public transportation that can impede a resident from being able to evacuate quickly. How many residents in your county don't have vehicles? What is a way we could possibly mitigate that?

D.Attempt to Flee (ATF)/ Attempt to Survive (ATS)

Attempting to Flee (ATF), Attempting to Survive (ATS): This category includes fatalities where evidence showed they either were trapped while attempting to flee. Attempting to survive includes fatalities that made attempts to shelter-in-place by getting into a bathtub or shower; and/or they had made documented calls to caregivers to ask for help.

- 30 fatalities were classified under ATF/ATS
- Accounted for 35.29% of the fatalities, calculated against 85

E.SVI Based on Evidence through Investigative Reports

This was based on fatalities that had no other information besides "Found in Residence." This suggests that these victims were limited in resources and capacity to leave, and/or did not have any documentation from friends or family the morning of the fire.

- 17 fatalities were classified under this category
- Accounted for 20% of all victims, calculated against 85

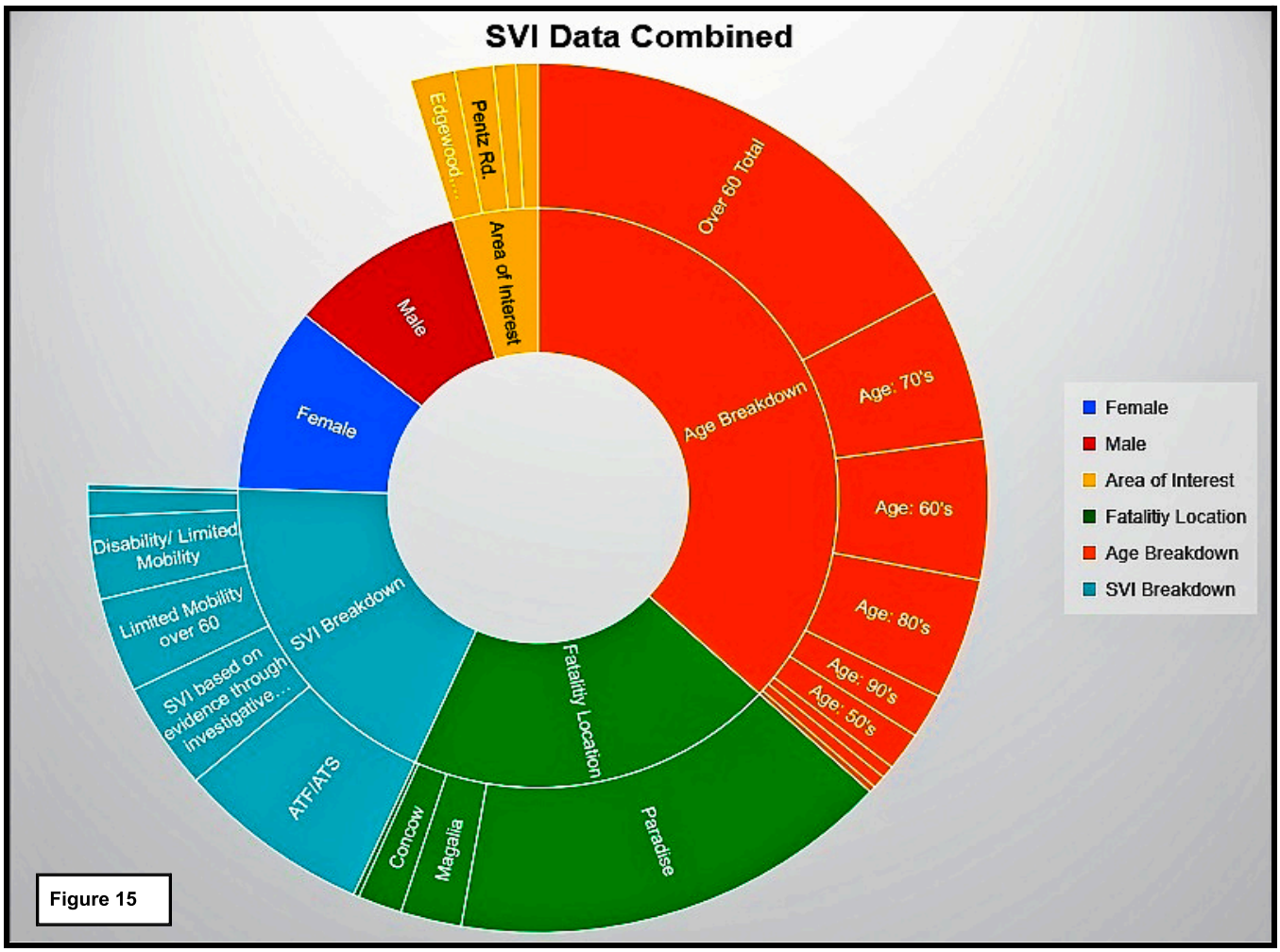

Figure 15

Section III. The Map Data

Resource: Link to Gaia GPS Map

Considerations:

- It is important to note that the map only accounts for 82 of the 85 victims. One victim was unidentified, and two victims' locations were not specified.

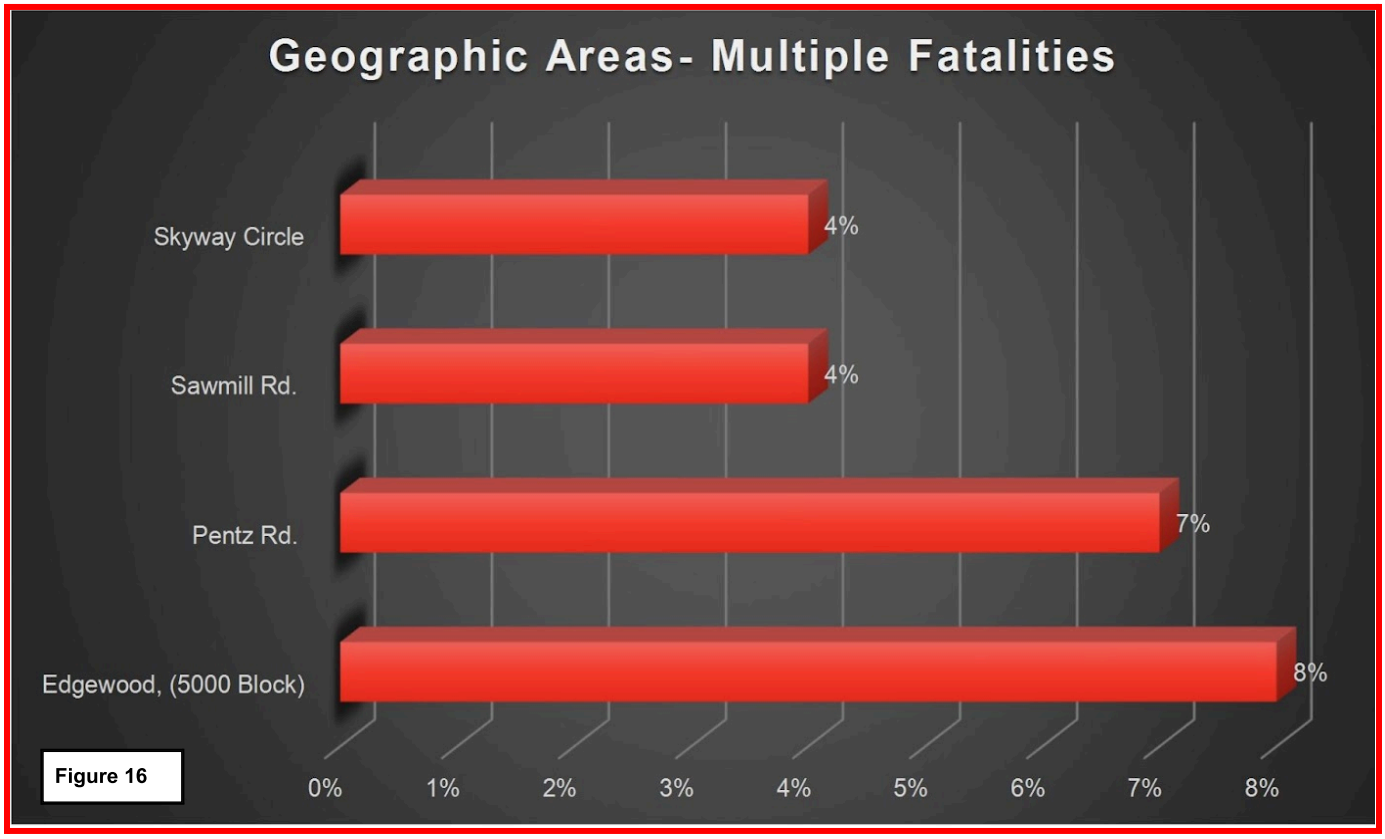

Figure 16. Represents the percentage of fatalities based on a single road. This was completed before the geospatial data was completed.

A. Area of Interests

Through prior research, I was already aware that Sawmill Rd. was considered an area of interest because of its location in the WUI. However, I was surprised to see how many fatalities surrounded the roads listed above, along with their proximity to one another. I lumped these areas together to see what the results were. The area layer can be found in the Gaia Map Folder, along with the other references and data points.

Area of Interest [Grouped]: S. Libby Rd., Sawmill Rd., Edgewood Lane, Pentz Rd.
This area accounted for the highest number of fatalities, at 30.59%, accounting for 26 total victims,

B. Original Area:

- The perimeter of the area is 5.87 miles.
- The area covers 1,084 acres.
- Mapped west from South Libby Road to .29 miles east of Pentz Rd.
- Mapped north from Pearson Rd. just beyond Malibu Lane (S) and .3 miles south of Sunny Acres Rd, on Edgewood Lane (S.)

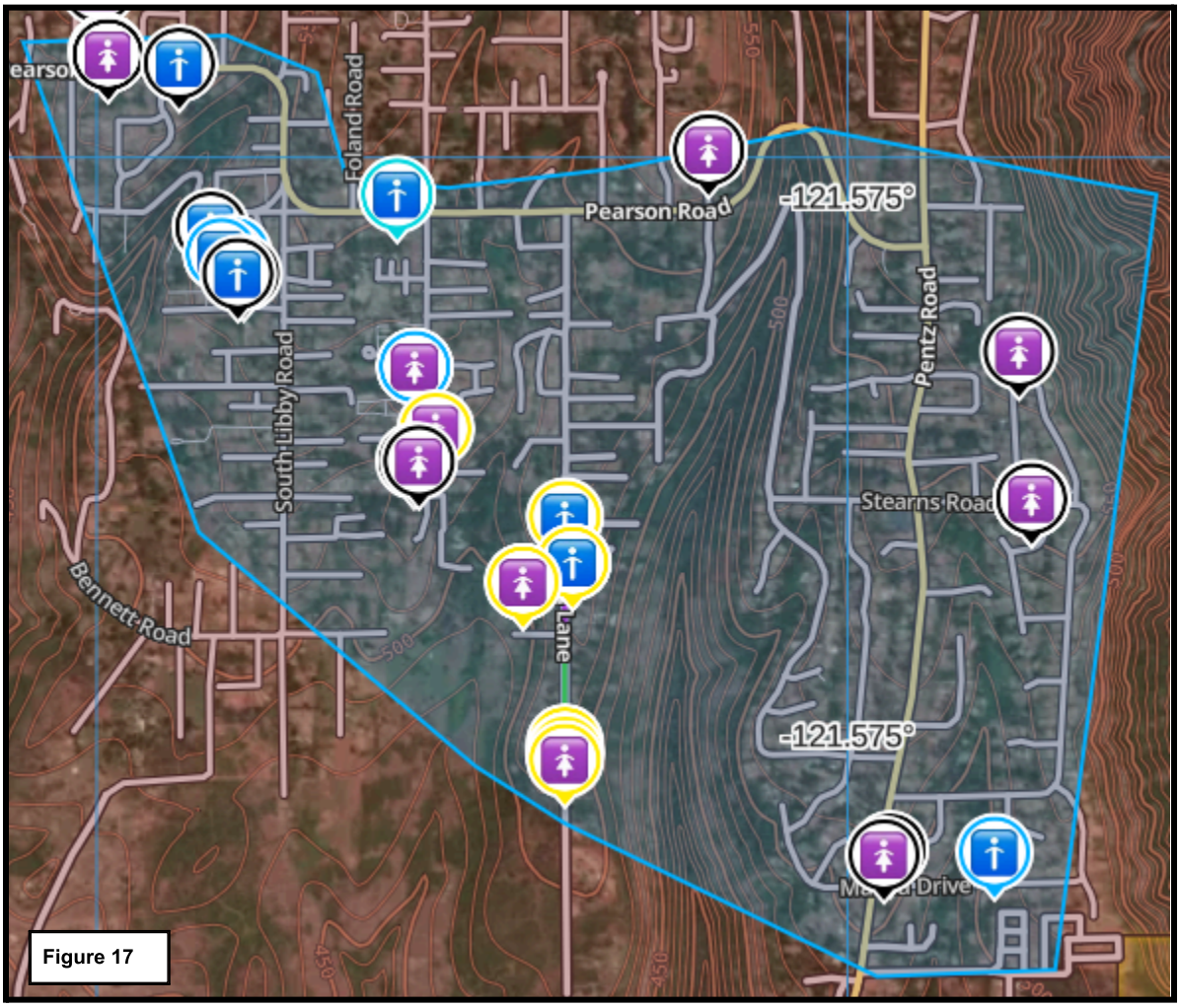

Figure 17. Represents the original area.

C. Extensions

- Extending the area 1.15 miles west from Pearson Rd. to Skyway, with an ascent of 57 ft., would have included an additional 8 fatalities.
- Extending the area 1.14 miles to the north from Pearson Rd. to Billie Rd., with an ascent of 215 ft, it would have included an additional 12 fatalities.
- With those extensions , it would increase the rate to 54.12%.
    - With the new dimensions for the Area of Interest being a 10.6 mile perimeter, and an area that covers 4,306 acres.

- The ascension is a significant variable in this comparison, because any increase in slope can result in a faster rate of spread (RoS). This will be discussed further in detail in the next section.
  - In this case, there were additional fatalities in the extended area that saw a higher increase in elevation.
  - Further, the majority of these residential neighborhoods were adjacent to narrow canyons, which were likely to contribute to fire spread.

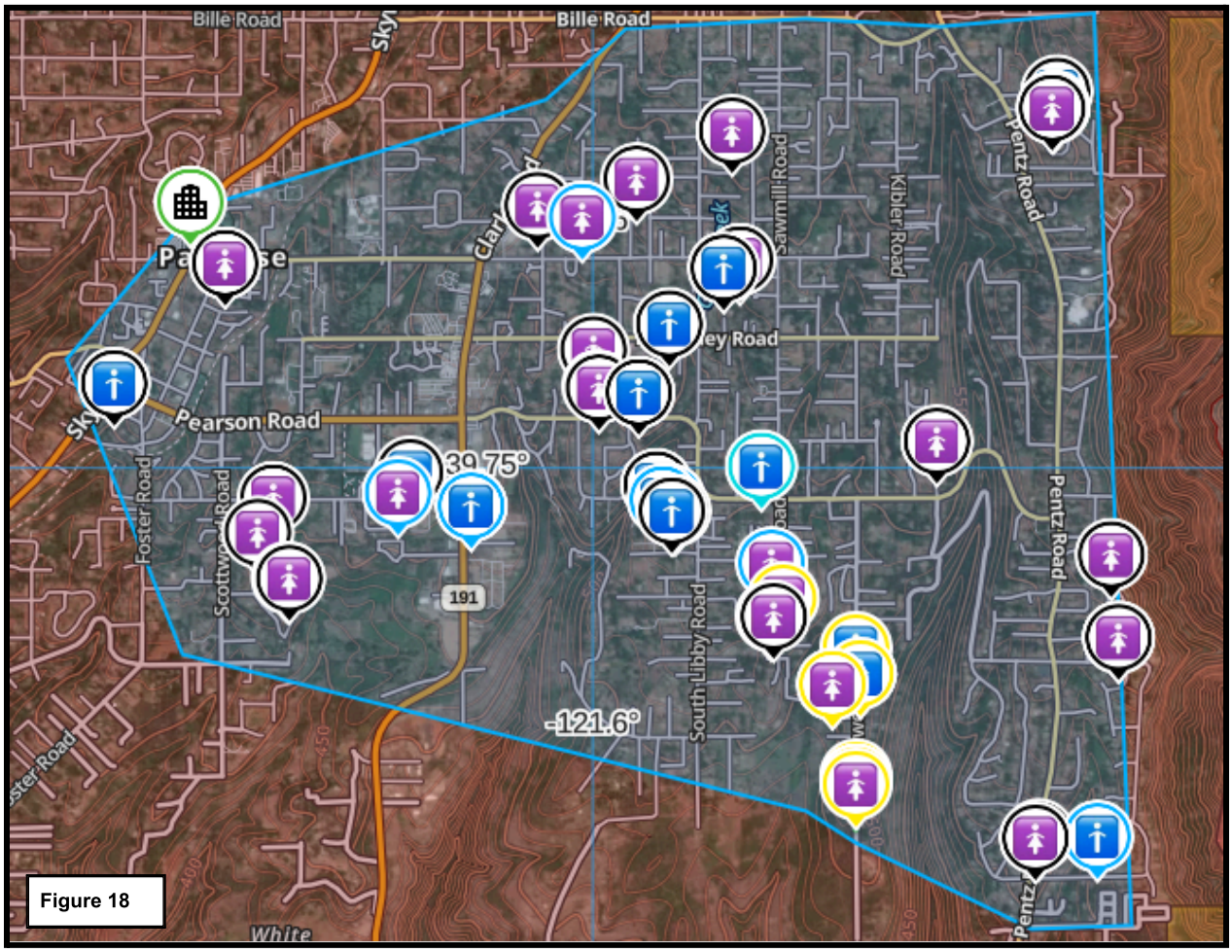

Figure 18. Represents the area extended.

D. The 5000 Block of Edgewood

The most intriguing location was an area that was labeled as the 5000 Block of Edgewood, according to the investigative report. In this instance, 7 fatalities were found amongst 4 cars. These residents were listed as being .3 miles south of their dwelling units, a mobile home park, but they were facing north. Upon further inspection, there were no connecting roads south of

their residence, begging the question, why did they decide to drive that way when the evacuation route was to the north?

One theory is that they saw how heavy traffic was to the north, and decided to try to find an evacuation route to the south. Considering the geography of the area, it is further possible they did not see the fire coming on from the south.

At some point, they either discovered there was no connecting route, or the fire was also approaching from the south. The fire overcame them after they had turned around to begin heading north.

Either way, this is a significant location to focus on because it demonstrates the need to establish primary and secondary evacuation routes that provide for multi-directional egress.

Section IV. Topographical and Fire Behavior Contributing Factors

A. Rate of Spread

The National Wildfire Coordinating Group (NWCG) defines Rates of Spread by the following, "The rate of spread is in chains per hour (ch/h) and is defined as the speed with which the fire is moving away from the site of origin. Wind, moisture, and slope drive the fire. The flaming zone, or fire head, moves away from the origin quickly with great intensity."[8] Wind can be one the single factor that determines whether a fire remains a small, controllable fire or transitions into a big incident with the possibility of fatalities, injuries and structure loss. Wind, along with fuel loading, are the two sides of the Weather, Topography, and Fuels triangle that determines fire behavior.

A wildfire's forward rate of spread (R) can be estimated as follows: R = 10% of the average 10-m open wind speed (e.g., for an open wind speed of 30 km/h, R = 3 km/h). When the fire first began, winds were sustained at 35 mph. However, there were moments when the winds moved at 50-70 mph. As previously stated, it took roughly an hour and a half for the fire to reach the town of Paradise. Therefore, the fire was moving at a rate of 5-7 mph. For context, when wildland firefighters take the Arduous Pack Test to be eligible for their red card, they have to walk at a minimum speed of 4 mph to meet the 45-minute time requirement. They also do this with 45 lbs. attached to their person. Even the most fit of firefighters could not outrun this fire. How do we expect the most vulnerable populations to be able to escape them without adequate assistance and time?

Additionally, the NWCG provides, "An easy guide for approximately the ROS due to changes in slope is as follows:

1. The first tripling of slope roughly increases the rate of fire spread by a factor of 2.
2. The second tripling of slope increases the rate of spread by a factor of 4 to 6, depending on fuel conditions."[9][10]

This data supports the problematic increase in rates of spread we are seeing that can severely complicate evacuation, suppression, and first responder safety.

---

[8] S-190: Introduction to Wildfire Behavior. Unit 8, Lesson 3 "Rate of Spread." National Wildfire Coordinating Group.

[9] S-190: Introduction to Wildfire Behavior. Unit 8, Lesson 7 "Slope Effect on Rate of Spread." National Wildfire Coordinating Group.

[10] The ten years in between the 2008 fire siege and the 2018 Camp Fire allowed the forest floor to accumulate additional ground litter that helped fuel the fire's front. Young tree plantations also had a significant role in combustibility.

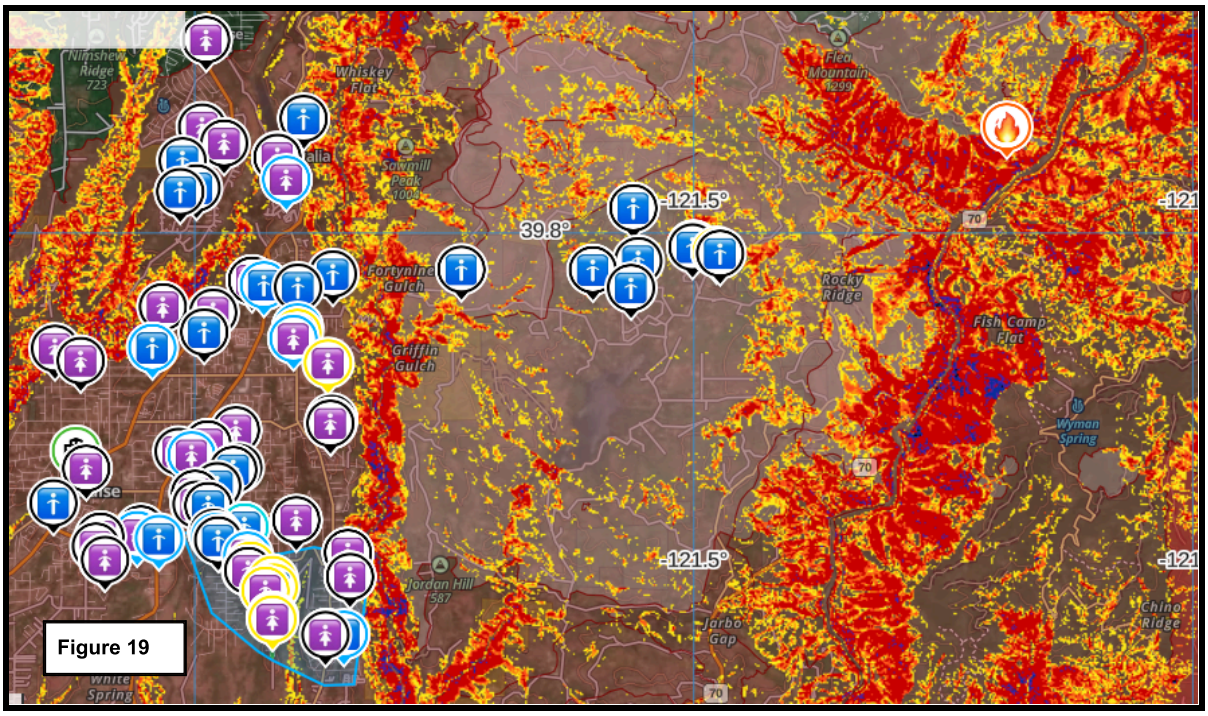

Figure 19. Represents the slope that was present from the ignition to Paradise's edge. Slope can have a significant impact on Rate of Spread (RoS).

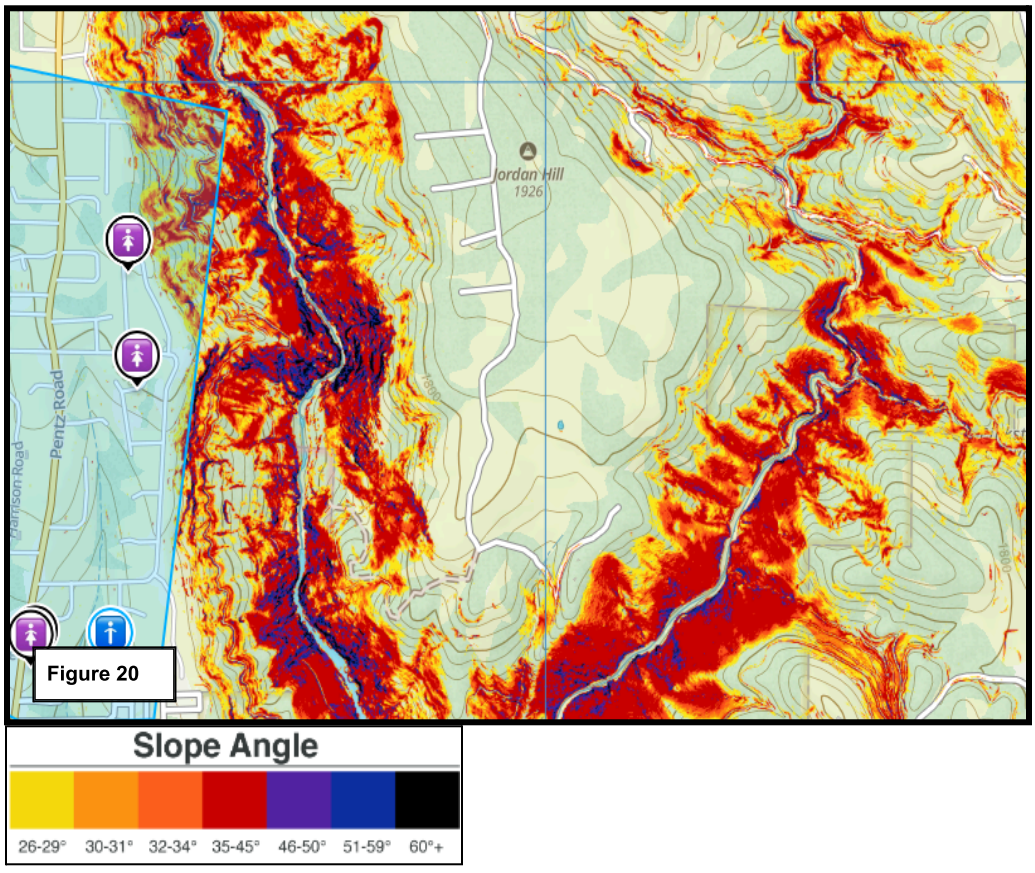

Figure 20. Demonstrates the slope of the two ridges the fire burned through before hitting the edge of Paradise.

As you can see, there are two ridges that have significant increases and decreases in slope, thus causing the fire to spread faster. Historically, downward slopes

would cause fire behavior to decrease. Unfortunately, an increase in nightly wind gusts has changed the way fires behave at night. For example, the Dragon Bravo Fire (Grand Canyon, AZ, 2025) was reported to be 29,000 acres and 25% contained as of Friday, July 25, 2025. By July 28, 2025, it exploded to 44,000 acres and containment dropped to 13%. Critical fire weather during the prior night, including nightly sustained wind gusts between 20-40 mph caused the fire to double in size within a very short timeframe.[11]

By NWCG calculations, and focusing on that area, we know there are two areas associated with that last ridge that have slope increases of at least 30°. Combining 60 mph winds with significant increases and decreases in slope caused the fire to move at unimaginable speeds. Figure 9, below, demonstrates those areas. A fire that was already moving quickly continued to gain momentum anytime it encountered a slope.

In one instance, the rise in between fatality locations was only 50 ft. However, given the short run, it means that any slope can intensify behavior for a wildfire that is raging. Therefore, when focusing on areas to mitigate hazardous fuels, mitigating fuel loads surrounding slopes of any kind should be an essential priority for planning.

[11] "White Sage and Dragon Bravo fires: The latest on the wildfires in Northern Arizona." 91.5 KJZZ Phoenix. Updated 28 July 2025. Access: <https://www.kjzz.org/live-updates/white-sage-fire-the-latest-on-the-wildfire-in-northern-arizona>.

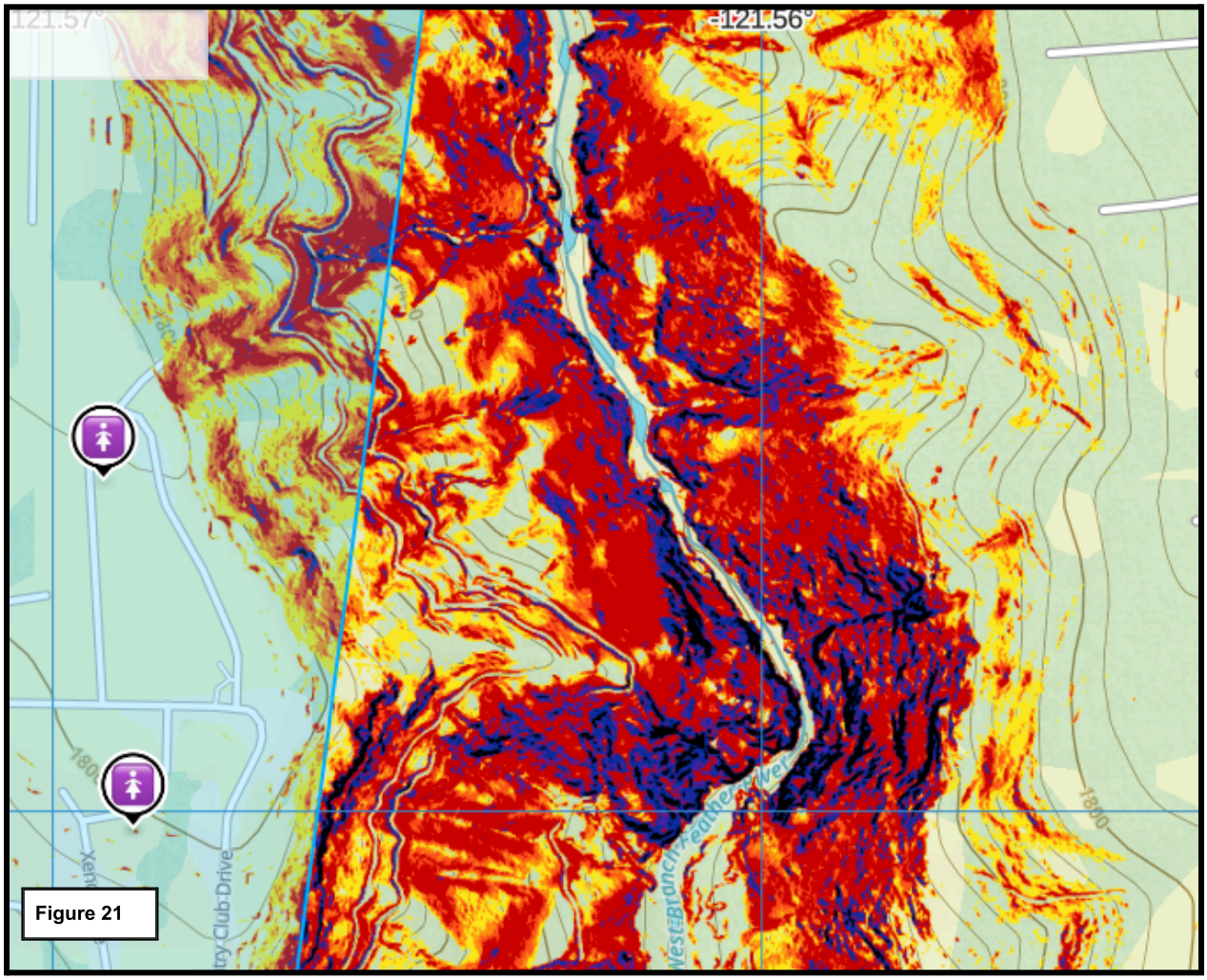

Figure 21. Zoomed in on that last ridge before the fire hit Paradise.

B. Historic Wildfire Activity and Evacuation Planning

It's important to consider an area's prior history with wildfire. Looking at the map, this area has experienced more than its fair share of wildfires. According to the San Francisco Chronicle, "Fire has scorched about 40% of Butte County since 2000. The unburned 60% mostly sprawls across the Sacramento Valley floor."[12] Specifically, the following fires have burned through this area with the last 24 years:

- Storrie Fire (2000) - Burned 5,6076 acres.
- Highway 70 Fire (2001) - Burned 1,692 acres.
- Poe Fire (2001) - Burned 8,333 acres.
- Skyway (2002) - Burned 2,141 acres.

[12] Johnson, Julia. Devulapalli, Sriharsha. "'Just crummy': Why California's Butte County keeps getting hit by big wildfires." Updated 5 August 2024. Access: < https://www.sfchronicle.com/california-wildfires/article/butte-county-fire-california-19613151.php>.

    - Burned on Skyway Rd, roughly 6.5 miles west of where the fatalities on Skyway Rd. were found in the 2018 Camp Fire.
- Butte Lightning Complex (2008) - Burned 49,836 acres.
- West Fire (2008) - Burned 5,161 acres.
- Camp Fire (2008) - Burned 4,163 acres.
    - Perimeter of this is roughly 2.37 miles north from where the 2018 Camp Fire ignited.
- Humboldt Fire, also known as the June 2008 California Fire Siege. (2008)
    - "The fire burned 23,334 acres, destroyed 87 homes and 167 other buildings, and caused an estimated $16.3 million in damages. The fire forced the evacuation of about 1,200 residents."[13]
- Flea Valley #2 (2008) - Burned 1,247 acres.
- Canyon Complex Fire (2008) - Burned 2,322 acres.
- French-Bear (2008) - Burned 1,066 acres.
- Lackerman (2008) - Burned 1,309 acres.
- Saddle Fire (2016) - Burned 739 acres.
- Camp Fire (2018) - Burned 153,335 acres.
    - California's deadliest fire to date.
- Claremont Fire (2020) - Burned 294,220 acres.
- Dixie Fire (2021) - Burned 963,309 acres.
    - California's largest fire to date.
- Park Fire (2024) - Burned 429,603 acres.
    - California's 4th largest fire.

Paradise and Butte County's history with fire is important to understanding why the events that took place on November 18th, 2018 were so significant. The Camp Fire occurred in an area that was extremely aware of its wildfire risk. In the Lucy Walker 2021 documentary, "Bring Your Own Brigade," Walker interviews several officials and council members associated with the community of Paradise. The following quotes were taken from that film.[14] In the film, one CAL FIRE firefighter claims that he has been on every major wildfire in California since 1990, and he had "never been in a community that had that much meticulous planning."

In the next frame, former Paradise Mayor Jody Jones says, "We had planned for fires. A fire very similar to this one happened in 2008, and we didn't have a real good system for evacuation so we came up with a new plan." For the new plan, the town and surrounding communities of Paradise are divided into zones and assigned an evacuation route. The community also then practiced the plan regularly. According to former Paradise Vice Mayor Greg Bolin, that plan worked on

[13] June 2008: California Fire Siege, Summary Report [Draft]. Various Authors. 28 January 2009. Accessed through PDF.
[14] "Bring Your Own Brigade." Lucy Walker. Paramount Productions. Released July 2021.

November 18th and he was impressed with how quickly they were able to evacuate the community, despite the high number of fatalities.

Additional information provided by Incident Commander (IC) John Messina, reiterates the notion, albeit indirectly. In the film, Messina says, “What if we were sitting here talking about 3,700 fatalities? We were that close to having that type of incident. I think about that quite a bit.” While I was conducting the research for this study, I managed to track down John Messina via LinkedIn to ask him about the quote, and to do so as respectfully as possible. John responded to my questions, and reiterated that in the early stages of the fire, they were afraid that they were facing a mass-casualty incident.

The residents of Paradise would argue the effectiveness of the evacuation, claiming it felt like the town had left them behind. Recordings from 911 dispatches demonstrate that several residents were told that no one was going to be able to assist them and that they should evacuate immediately.

Jones brings up a very valid point, and one that communities should be paying heightened attention to. If wildland/vegetation fires are moving faster than we can evacuate, it is time to start considering how we can increase shelter-in-place efforts in addition to defensible space and home hardening. Moreover, future planning documents should attempt to identify TFRA’s and incorporate them into community tabletop exercises.

Section V: The Aftermath

In the wake of any disaster comes the inevitable question, "who is going to pay for this?" This section dives into the aftermath of the fire and evaluates the impact litigation has had on the community and their ability to rebuild the town. While this started as an initial investigation to help determine what the Social Vulnerability Index is as it relates to wildfire, an argument can be made that we can't really understand the full scope of that vulnerability until we look at the long-term effects of wildfire devastation.

A. PG&E

According to legal documents, PG&E's criminal negligence came down to a hook, purchased in 1919, on the oldest transmission corridor in the state. The part had never been replaced, and by the time an investigation was done, the gap between the hook and the fitting was wide enough to stick a finger through.[15] The court documents further found faulty or missing maintenance records and inspections, indicating that the required time it took to properly inspect transmission equipment had been substantially reduced because of budget constraints.

This is not the only instance where criminal negligence on behalf of a utility company was found to be the cause of a disastrous or deadly fire. In fact, besides the Tubbs and Camp Fire, there are several fires that PG&E were found liable for (see Figure 10 on the next page).

PG&E filed for Chapter 22 bankruptcy on January 29th, 2019 as a result of its liability for the 2017 and 2018 fires. The disclosure statement was approved just over a year later. As part of the reorganization plan, $13.5 billion was put into a Victim's Trust Fund to compensate victims. Per the agreement, PG&E would NOT be allowed to raise residential rates to pay victim claims.

During all of this, PG&E was still being pushed to mitigate the risk of wildfire ignitions and restructuring their practices to be in compliance with new clean energy regulations. While they couldn't raise rates to compensate victims, they could raise rates to address these additional obligations. Subsequently, utility bills in California have skyrocketed in recent years and have been attributed to be part of the reason the state is experiencing a mass exodus by some experts.

For the sake of considering the whole impact of wildfire on the socially vulnerable, litigation is important to evaluate because of the ripple effect it can leave on the community, along with the state. In a conversation with a representative from *Rebuild Paradise*, one of the unseen consequences of litigation was a lump sum of money at once with no financial advice or guidance. Without it, residents struggled to save money for unforeseen costs during

[15] Blunt, Katherine. "California Burning: The Fall of Pacific Gas and Electric--and What It Means for America's Power Grid." [New York], Portfolio/Penguin, 2022.

reconstruction. Financial guidance when there has been a legal settlement should be a conversation while planning for recovery efforts.

More research will have to be completed to make accurate conclusions on the overall effectiveness of litigation after a disastrous wildfire. However, it is clear that it is an area that should be further explored.

Fire	Time	Acres Burned	Structures Destroyed	Deaths-Civil.	PG&E Legal Payout	CPUC Fines
Dixie Fire	September 2020	963,309	1,329		55 million (combined with Kincade)	45 million
Zogg Fire	September 2020	56,338	204	4	140 million	10 million
Kincade Fire	October 2019	77,000	347		55 million (combined with Dixie)	125 million
Butte Camp Fire	November 2018	154,000	18,000	85	522 million + 13.5 billion for claims	
Cascade Fire	October 2017	9,989	250	5	Lawsuit pending	
Redwood Valley Fire	October 2017	2,207	543	9		
Sulphur Fire	October 2017	8,417	162		415 million + 2.5 billion for claims	
Atlas Fire	October 2017	51,624	783	6	Part of above	
Butte Fire	September 2015	70,868	921	2	1 billion in claims, faced nearly 100 million of unresolved - filed for bankruptcy	

Figure 22. This table outlines the various lawsuits that led to PG&E filing Chapter 22.

B. The Logging Industry

There has been a lot of litigation surrounding fire ignitions. It is easy to assign blame to whomever started the fire, because it is fairly straightforward. However, little is mentioned about the factors that contribute to increased fire intensity. Every time we get into our car, we are igniting something. The problem doesn't come with the spark, it comes with the environment the

ignition is produced in. For example, dropping a match in a field in Michigan would not have the same effect as dropping one in a field in California.

In the case of the Camp Fire, specifically, it has been argued that significant logging activity in Butte County contributed to the fire intensity. According to the San Francisco Chronicle, "Since 2020, three of the 15 largest wildfires in state history have ignited in Butte County, and then burned across vast swaths of the Sierra and southern Cascades, collectively scorching nearly 1.7 million acres."[16] As you will see on the map of the next page, Sierra Pacific Logging and Timber owns a significant amount of land in Butte County. A lot of that land has burned multiple times in the last 24 years, producing the deadliest and largest wildfires in California history. It was discovered that the Camp Fire traveled through a young tree plantation shortly after it began.

California Forest Practice Rules require timber companies to plant a lot of trees when they clear cut, resulting in denser, thicker forest that have interlocked crowns. Additionally, the heavy equipment and machinery can help spread invasive species throughout the forest, which also increases wildfire risk. For example, cheat grass was and still is prevalent in the area the Camp Fire ignited.[17] Cheat grass is extremely combustible and is known to carry fire very fast. Furthermore, the forest floor can become littered and overcrowded, making it easier for a ground fire to get up into the canopy of the trees.

It is worth noting that Sierra Pacific faced litigation in 2007 for starting the Moonlight Fire (Plumas County), and in 2021 for starting the Cold Fire (El Dorado County). In both cases, Sierra Pacific agreed to pay settlements.

[16] Johnson, Julie. Devulapalli, Sriharsha. "Just crummy: Why California's Butte County keeps getting hit by big wildfires." San Francisco Chronicle. Updated 5 August 2024. Access: <https://www.sfchronicle.com/california-wildfires/article/butte-county-fire-california-19613151.php>.
[17] Walker, Lucy. "Bring Your Own Brigade."

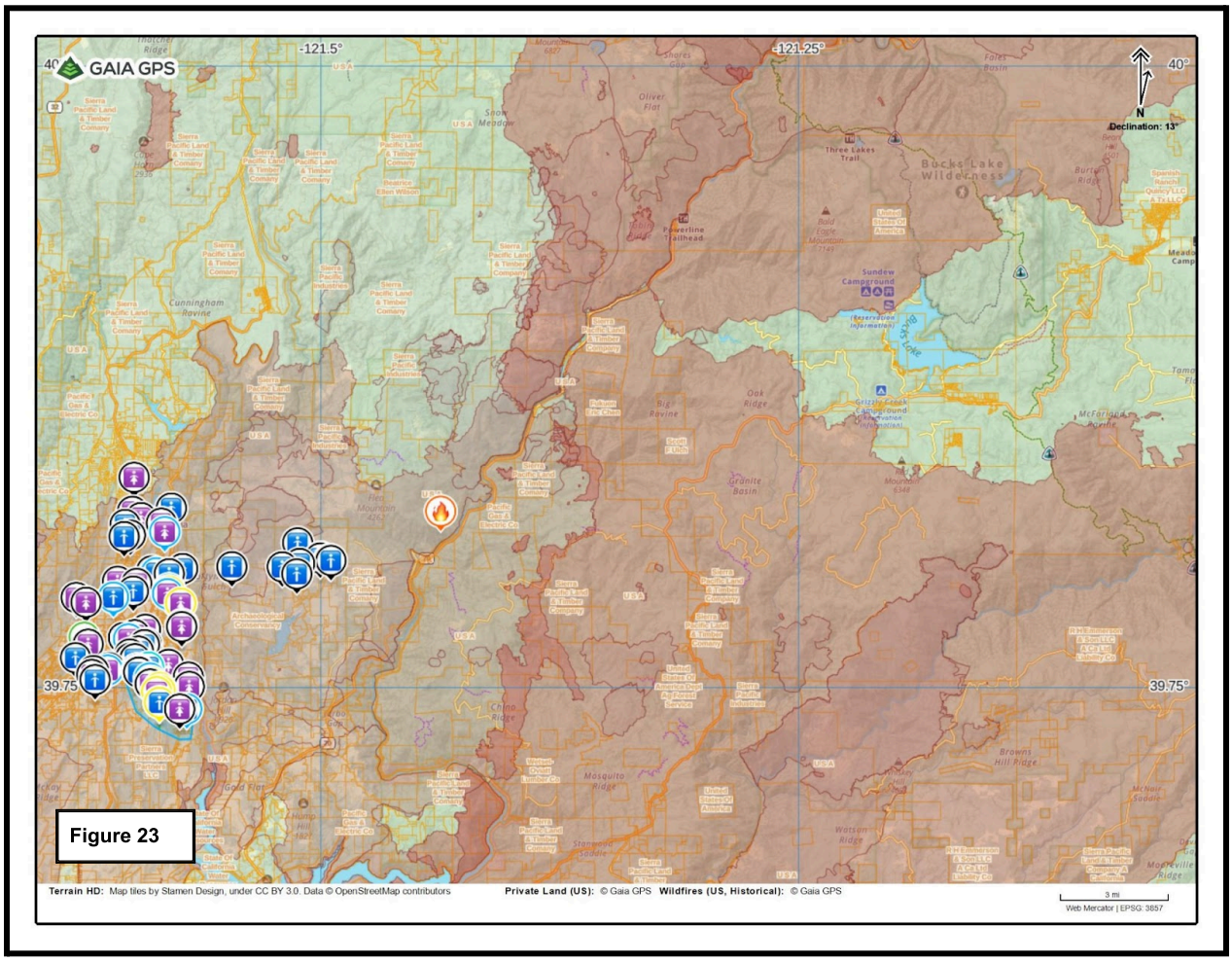

Figure 23. This map shows how much of the land that has been burned in Butte County is owned by Sierra Pacific Timber and Logging.

C. Community Wildfire Protection Plan (CWPP)

Community Wildfire Protection Plans (CWPP's) are planning documents that assess a community's regional wildfire risk and provide recommendations for mitigation. That is the abbreviated version of a very lengthy and complicated process that involves collaboration across multiple agencies and stakeholders, along with public opinion and comment and other guidelines laid out by federal and state agencies.

CWPP's are also expensive. They typically range anywhere from $70k - $175k, and can go as high as $250k. Communities often have to depend on federal grants to complete one. However, states such as California, Colorado, Arizona, Montana and many other western states have started allocating funding to CWPP creation as well. Additionally, the CWPP is a very technical document that requires a team of people with different capabilities and expertise.

According to FEMA, best-practices recommend that the documents be updated every 3-5 years. However, given these constraints, it is extremely hard for communities to stay within that timeframe. At the time of the Camp Fire, the wildfire emergency response plan had not been updated since 2010. Although it is worth noting that Paradise regularly practiced evacuations and conducted tabletop exercises. Despite not having an updated planning document, the community had prepared for a wildfire.

D. Code Enforcement

"In 2008, the WUI design codes came into play. 51% of the structures built after 2008 survived. 9% of structures built before 2008 survived," says Paradise Councilwoman Judy Jones. "What that tells me is that those building codes make a difference."

Having no prior knowledge of wildfire before making the film, Walker manages to capture some of the most nuanced obstacles that communities face when trying to reduce their risk to wildfire. One of them being defensible space and home hardening codes for residential dwellings. Of the structures that did survive the Camp Fire, #% of them that were built after 2008 with new fire safe codes survived. However, Paradise as a community did not have defensible space codes that could be enforced. In fact, a year after the fire, the community of Paradise shot down defensible space codes proposed by CAL FIRE, even the ones that were "free," according to Councilwoman Jones.[18] Several councilmembers cited a lack of feasibility surrounding enforcement as their reason for voting down codes that could make their community safer. That was in 2019.

In 2023, Butte County received a $6 million dollar grant from the United States Department of Agriculture (USDA), through the Community Wildfire Defense Grant (CWDG), for code enforcement. Seemingly, the county managed to navigate the obstacle of community resistance by prioritizing enforcement priorities at the county level.

As more communities begin to understand and prepare for their own wildfire vulnerabilities, code enforcement is worth considering. If your community seems resistant to wildfire prevention efforts, see if your county has any codes that could be enforceable. Collecting fees from violations is also a way to help generate program income for other prevention efforts, such as hazardous fuels reduction. Furthermore, it provides additional duties and tasks that wildland firefighters can be helping with during the offseason, or additional wildland-related activities that can be absorbed by traditional fire departments to help build their wildland capacity.

[18] Walker, Lucy. "Bring Your Own Brigade."

E. Rebuild Paradise

Despite successful litigation and the establishment of the Victim's Trust, the community of Paradise is still struggling to rebuild. At the time of the fire, Paradise had a population of 26,532, according to the US Census Bureau. In 2019, after the fire, the population was reduced to 4,171. As of 2023, it was up to 8,252.[19]

According to Rebuild Paradise, 70% of their septic system was destroyed, specifically the tank or leach lines. Thus, having to include a new system in their rebuilding costs was yet another expense that a lot of the residents of Paradise didn't see coming. As previously stated, without proper financial guidance or an understanding of how much it would cost to rebuild in Paradise, a lot of residents found themselves stagnant at various stages of reconstruction even after they were able to recover financial compensation due to unforeseen obstacles and costs. Put simply, the money wasn't enough.

In response, Rebuild Paradise was established with the objective of creating yearly grants that focused on providing homeowners with extra financial assistance with unforeseen rebuilding costs, such as new septic systems. According to the organization, the grants change often and reflect the common obstacle the community is facing at the time. Similar to the response during the incident, the innovative collaboration and resilience demonstrated by the town is something that everyone involved in wildfire should be paying attention to right now.

Rebuild Paradise also works with private homeowners to create aesthetically-pleasing landscapes that are aligned with the new California WUI Code requirements. In the spring of 2025, they worked with Mercury Insurance to help the residents of Paradise get home insurance again. They are truly doing some amazing work in the recovery space.

[19] Paradise Profile. *Quick Facts*. United States Census Bureau. Accessed, May 2025. Access site: <https://www.census.gov/quickfacts/fact/table/paradisetowncalifornia/POP060210>.

Section VI: Evacuation Comparison- Marshall Fire vs. Camp Fire

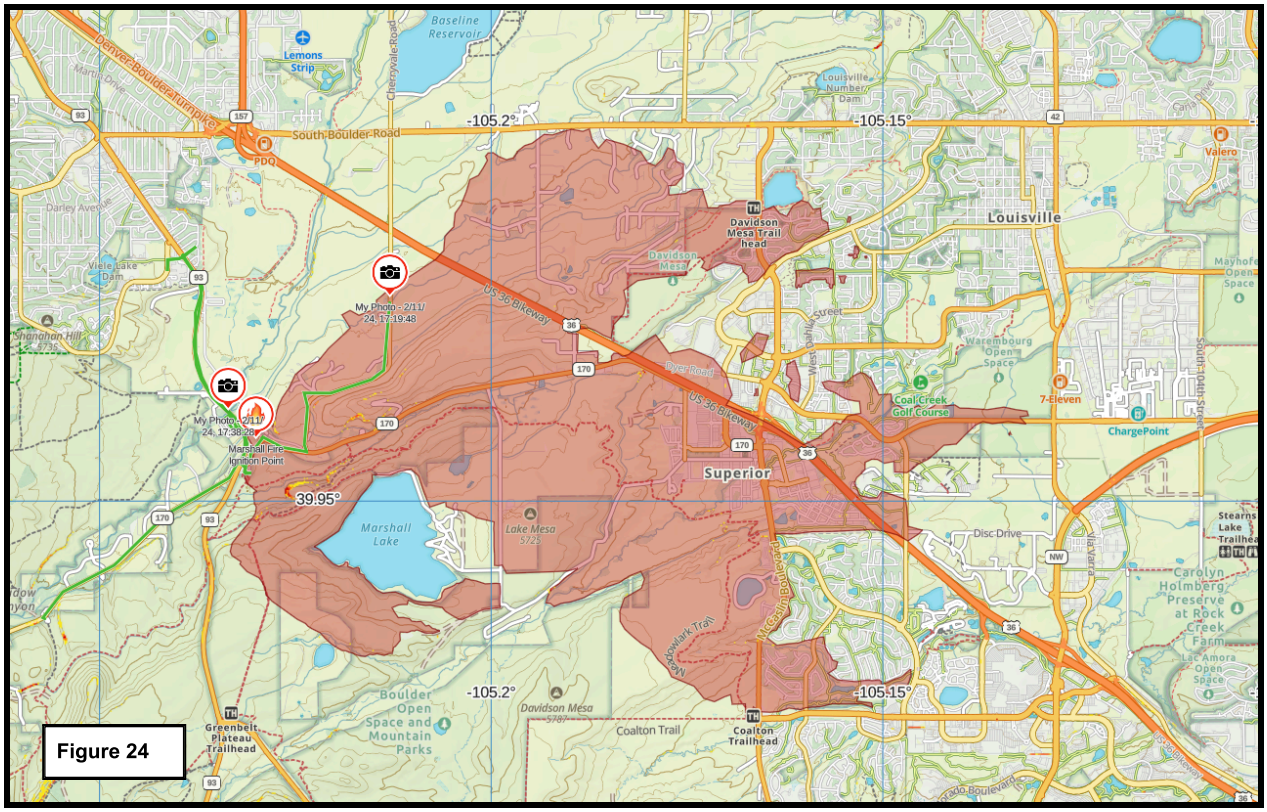

Figure 24. The map above shows the perimeter of the Marshall Fire.

The Marshall Fire ignited on December 30, 2021 and ran until January 1, 2022. It was responsible for burning 6,026 acres, destroying 1,084 structures and killing two people. It is currently the costliest wildfire in Colorado history. The fire ignited in the rolling plains, just east of mountain foothills in Boulder County, Colorado. Despite the economic destruction caused, the loss of life was significantly low compared to the Camp Fire. Both were wind-driven, fast-moving fires.

The map above demonstrates multiple routes (primary and secondary) for evacuation helped mitigate the potential for loss of life. As previously mentioned in the Section III, a lack of egress options played a role in the ability to outrun the Camp Fire on November 18, 2008. Out of all of the victims, only two of them were in their 30's. One was economically disadvantaged and did not have access to a car, nor could he be picked up in time; and the other was caught in the burnover along the 5000 Block of Edgewood. Thus, it is essential that evacuation successes are considered and compared to incidents that saw a higher number of fatalities; and can further be argued one of the reasons the Marshall Fire did not see a significant loss of life was the access to

multiple evacuation routes in all cardinal directions. A difference in fuel types and topography also accounted for a difference in rate of spread. Paradise has a more combustible landscape, and a more intense topography. The Marshall Fire spread mainly through a grass/shrub model.

Besides multiple egress routes, the resource response that was able to focus on door-to-door evacuations also played a significant role in the success. According to the Marshall Fire After Action Review, 37,500 people were successfully evacuated (without fatality during evacuation due to being trapped or caught by fire) within a 3-4 hour timeframe. the resources on scene that day included:

- 300 law enforcement agents doing door-to-door evacuations
- 74 fire agencies and “hundreds” of fire personnel
- Several dispatch agencies, along with the Incident Management Team
- A large incident base in the urban interface, providing multiple access points to resources

As previously stated from the Camp Fire AAR, the dispatch center was understaffed and the single dispatcher that was responsible for alerting the entire community was alone during the most critical minutes of the incident. Having quick access to resources that can help with evacuation efforts seems to be a key factor to mitigating loss of life in fast-moving fires.

Section VII: Conclusions, Discussions and Recommendations

A. Workforce Development and Wildland Firefighters

Currently, the wildfire fire workforce is facing monumental challenges. Most wildland fire jobs are considered seasonal, and don't provide year-round financial security, at the public or private level. The most secure position is one with a career department. However, wildfires typically represent a very small number of calls. The departments that can afford to be all paid/career usually rely on a large tax base, meaning they are typically urban departments. Moreover, these departments rarely handle fuels mitigation and management.

One benefit to developing a robust wildland workforce is that the same individuals can be reducing the risk in their communities while the fire is not burning. Specifically, they can reduce hazardous fuel loads in open spaces and on private lots, along with prescribed burning. They can also lead the community's wildfire preparedness and prevention initiatives. Wildland firefighters are the biggest untapped resource for wildland fire risk reduction efforts, including planning. No one understands fire behavior better than those on the front lines.

Lastly, the three burnovers that were referenced in the Camp Fire dispatch audio provides the biggest rationale for why we need to build a robust wildland fire workforce. Further, considering wildfire is becoming an increasing problem everywhere, an argument can be made that S-130 and S-190 Introduction to Wildfire Courses should be included in the traditional fire academies and curriculums.

Figure 25

The safety zones and survival tactics used by first responders in the Camp Fire were specific to wildland fire training, and were the reason the number of fatalities were not higher. The first burnover mentioned in the dispatch audio occurred in the community of Concow, specifically in the Camelot Homeowners Association area. The responding engine told dispatch the plan was to burn the grass field, creating a safety zone for residents to park their cars in and wait out the

burnover. In order to successfully and efficiently complete a blackburn operation on an active, wind-driven wildfire, a certain level of knowledge and skill is needed. Had the firefighters lit the fire too early, they risked strong wind gusts and changes turning the fire back on them and creating a bigger issue. Had the firefighters lit it too late, the fire would have burned them and the residents they were trying to protect. **Figure 25** shows the area the first responders burned to make the safety zone.

The second burnover that occurred, according to the dispatch audio timeline involved residents in the same general area. The engine responding reported that they were holding residents in a nearby creek. Creeks and rivers can provide excellent safe zones, or as NIST has recently coined, "Temporary Fire Refuge Areas" (TFRAs).[20] Thanks to their training, wildland firefighters are already familiar with objects and locations in the natural environment that can help them survive a burnover. **Figure 26** shows the locations of the area that was burned by first responders to create a safety zone, as well as the creek they used as a temporary shelter. Yellow markers represent safety zones. These locations are not far apart, but several references were made throughout the audio about how low visibility was in the area. In fact, at one point IC requested CAL FIRE start making their way to him because he was unaware of what was burning beyond his visibility, which he quoted at 100 yards in front of him.

The third burnover was mentioned briefly, towards the end of the dispatch audio. In fact, it was so brief it took listening to the audio several times before catching it. In it, the responding engine advises dispatch that they have deployed their shelters over residents to try to keep them safe. Therefore, one of the biggest reasons traditional structure departments need increased wildfire capacity is because their engines will have the resources that can help prevent loss of life during an active wind-driven wildfire incident.

[20] Maranghides, Alexander; Link, Eric D. "WUI Fire Evacuation and Sheltering Considerations: Assessment, Planning and Execution (ESCAPE)." *National Institute of Standards and Technology*. United States Department of Commerce. NIST TN 2262r1. Published March 2025. Access: <https://doi.org/10.6028/NIST.TN.2262r1>.

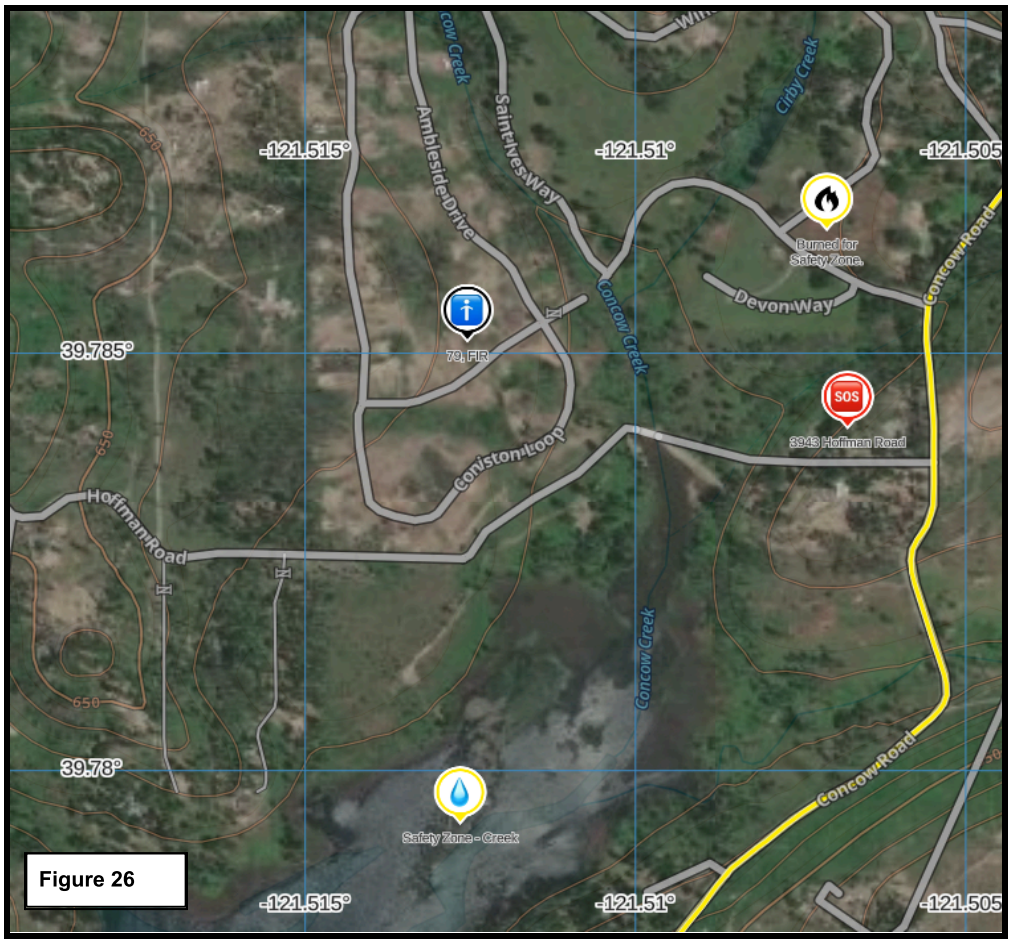

Figure 26

B. Evacuation Alert Systems

Emergency management evacuation warning systems are still a work in progress for every natural disaster. Unfortunately, an increase in severity and occurrence has significantly increased and complicated that need. While there is a need to explore more shelter-in-place options, especially for the elderly and socially vulnerable, it will be interesting to see what kind of data comes out about the effect Watch Duty had on evacuation efforts during the 2024 fire season, along with the LA Fires of early 2025. While its innovation is commendable, it shares the same obstacles associated with connectivity. Essentially, its efficacy is based on residents having cell phone reception, which is rare in rural areas that carry high fire risks.

As we saw throughout 2024, social media became more prevalent for alerting community members about the threat of wildfire. Sole reliance on text messages and phone calls are not always liable, mainly because:

- Residents may not be signed up through alert systems
- They may not have a cell phone or internet connectivity

According to FEMA, “The Integrated Public Alert & Warning System (IPAWS) is FEMA’s national system for local alerting that provides authenticated emergency and life-saving information to the public through mobiles phones using Wireless Emergency Alerts, to radio and televisions via the Emergency Alert System, and on the National Oceanic and Atmospheric Administration’s Weather Radio.”[21] Currently, this resource is free and the most comprehensive emergency alert notification system.

Still, glitches can happen and delays can occur. Communities can cover additional bases by making sure emergency sirens in rural communities are operable and tests are conducted.

C. Other Significant Findings

- Fire was moving at 80 football fields a minute
- 22 students, 2 teachers, and 1 bus driver were stranded in gridlocked traffic. They were about to be burned over when a CAL FIRE Dozer Operator heard about the bus over the radio and cleared a path for them in the knick of time.
  - The bus was carrying the students that were stranded at the school. They had not been picked up by guardians. The school they left was burned over.
  - Further, 8 schools in the Paradise Unified School District were destroyed by the fire.
  - Historically, wildfire season has been considered a threat during the summer months, when school buildings are typically empty. However, the Camp, Marshall, Smokehouse Creek, Palisade and Eaton Fires all happened between November and February.
  - The conversation around school protection has risen significantly in the last year, but this is another example where intersectional collaboration amongst public services industries and districts could be extremely beneficial. As previously stated, a brick and mortar, or concrete school building can be a shelter-in-place option.
- “Carolyn Nava, who lived for years in Paradise and works in Chico at the Disability Action Center, pointed out that some elderly and infirm don't have smartphones and that cell service around Paradise is notoriously spotty. "If you weren't standing in a certain

[21] Integrated Public Alert & Warning System. FEMA. Access: <https://www.fema.gov/emergency-managers/practitioners/integrated-public-alert-warning-system>.

spot, facing the east with your foot pointing to the north, you wouldn't even have gotten wireless anyway."[22]

- ❖ The Incident Commander felt that once the fire entered Paradise, it transitioned from a wildfire to a mass casualty incident. In the early stages, and until they were able to verify the location of the missing, they felt it was plausible that hundreds may have perished.

D. Discussions

Where do we go from here?

If you put blame and politics to the side, the bottom line is that wildfire is a macro problem that requires micro, community-driven solutions. Federal and state budgets cannot continue to fund prevention, suppression, and recovery efforts for the destruction wildfires are causing. It is important to remember that wildfire is just one disaster. Flooding, tsunamis, hurricanes and tornadoes have all increased in severity, occurrence and location. According to Scientific American, "For decades, most of the largest outbreaks occurred across northeastern Texas, eastern Oklahoma, and western Arkansas and Missouri. But between 1989 and 2019, the focus shifted eastward by 400 to 500 miles, covering western Kentucky and Tennessee plus northern Mississippi and Alabama."[23] Wildfire is just one of the many climate-related realities communities around the globe are contending with.

As it's pointed out in "A High and Awful Price," residents need to start being their own heroes. Going further, communities have to start operating under the same assumption by building their own wildfire brigades beyond volunteer and/or fire department capacity. This can be done by using the wildfire industry to build local workforce and economic development. It starts by breaking up community stakeholders, financial capacity, and differentiating between short-term and long-term needs.

Homeowner and Property Owner Associations are eligible grant applicants for wildfire prevention and risk reduction efforts in almost every state and federal-funded program. It is important to note that grant funding should be used to plan, develop, and implement pilot and capacity-building projects. They are not meant to sustain an entire wildfire program long-term. Still, HOA's and POA's can apply to develop their own brigade to respond to regional threats and reduce fuel loads. If funding a full-time crew is not a sustainable option, then neighborhoods can explore creating a volunteer program and use grant funding to outfit and train a neighborhood crew.

---

[22] "Many of the dead in Camp fire were disabled. Could they have been saved?" The Sacramento Bee. 6 December, 2018. Access: <https://www.heraldnews.com/story/news/2018/12/06/many-dead-in-camp-fire/7100366007/>.

[23] Fischette, Mark. Visser, Dean. "The New Tornado Alley Has Been Hyperactive This Year." Scientific American. 21 April, 2025. Access: <https://www.scientificamerican.com/article/the-new-tornado-alley-has-been-hyperactive-this-year/>.

Communities have to start thinking outside the box in terms of resources. For example, public education collaborations can be the easiest path to helping spread community awareness and education. More importantly, they have the infrastructure and the resources to help plan and implement community events.

Additional community-driven and led recommendations include:

1. Have community members complete Residential Risk Perception Surveys that focus on:
    a. Common misconceptions pertaining to safety and wildfire prevention/mitigation
    b. The level of community involvement
    c. An economic range that residents are willing to pay for mitigation efforts.
2. Get a parcel risk assessment based on SVI vulnerabilities. You can get the information by doing the following:
    a. Using word of mouth and Social Media
    b. Talking to Fire and EMS Departments. They usually know exactly who these residents are and where they are located.
    c. Community health networks, mental health providers, and community non-profits are a similar place to find this information. However, the same requirements will have to be met and permission will have to be granted to include the parcels in the assessment.
    d. Have community members download Watch Duty.
3. Once a parcel risk assessment has been completed, I STRONGLY recommend including an allotted amount of defensible space and fuels management treatments for private lots for the identified SVI population. SVI residents residing in the WUI are usually not able to complete the hazard fuels mitigation treatments, due to economic and/or physical restrictions. This will also be a competitive request for funding, I believe.
4. Besides fuels management treatment and defensible space treatments, home hardening techniques such as ember-resistant vents should be considered. These items can be requested in grants, and similarly be offered to SVI residents. They could also be given away to qualifying residents during a community outreach event. The installation fees will need to be included in the funding request.
5. For assisted living communities and apartments, there are several recommendations.
    a. Complete structural hardening that complies with Chapter 7a, at minimum.
    b. Vegetation management and hazardous fuels removal.
    c. Create fuel breaks to slow down the fire, or give first responders a strategic place for backburning.
    d. Collaborative planning efforts and a committee devoted to maintaining and sustaining wildfire prevention and mitigation efforts.
    e. It is extremely important to note that these activities should be taken together to help ensure maximum efficiency. There is no one-size-fits-all solution for wildfire prevention.

6. Community Emergency Response Teams (C.E.R.T.'s) can also be an excellent solution for assisting the socially vulnerable in extreme natural-weather events. This team would work together with all of the organizations mentioned above to help SV residents make a plan and execute it.
7. Identify local and regional stakeholders that can help privately fund wildfire prevention objectives. Especially ones that have a financial stake in wildfire prevention.

How do we talk about the WUI in this new normal?

In the last ten years, wildfires have extended to areas with low risk, including tropical islands, the boreal forests and the urban conflagration. In 2025 alone, states like New Jersey, North Carolina, Minnesota, Oklahoma, Georgia, and Florida have experienced uncharacteristic and unprecedented wildfire behavior. Communities such as Lahaina, Boulder and Los Angeles have experienced devastating wildfires in residential areas that were priorly assumed to be safe. These areas all have a categorically lower risk of wildfire behavior, but environmental factors are changing that are leading to an increase in occurrence and intensity.

Take Los Angeles County for example. In 2017, the La Tuna Fire had a 99% structure survivability rating. According to experts, it was because the county had such stringent code enforcement. Yet, fast forward to January 2025, and the urban areas of Los Angeles County have been devastated by the Palisade and Eaton Fires.

Incidents like these leave us wondering, how do we delineate the WUI? Can we plan for fuels reduction in high-risk areas without it? If insurance carriers are making decisions based on their own risk modeling, are we using antiquated planning methods and verbiage that enables communities to under exaggerate their risk? For example, if a community is hesitant to delineate their WUI in an updated CWPP because they are worried about it increasing insurance rates, then their ability to apply for funding to get high risk areas mitigated is significantly decreased. Yet, that is an issue planners are running into.

How do you predict the unpredictable?

One of the biggest lessons from the Camp Fire planners should take away was that the best laid plans, based on the worst case scenario, went out the door on November 8, 2018. The town of Paradise had done extensive evacuation planning and table top exercises in between the 2008 fires and the 2018 Camp Fire. Had they not done those things, the fire could have claimed a lot more lives that day.

Still, what first responders and emergency managers said in the aftermath was that the worst case scenario could not have predicted what happened that day. The 97th percentile is based on historical observations. An argument can be made that relying on historical observations can be tricky because we are seeing unprecedented behavior with every new megafire. With that in

mind, what would the 97th percentile look like if it were based on higher thresholds that were calculated using localized Remote Automatic Weather Stations (RAWs) data.

The standard weather-related thresholds for fire behavior modeling are often based on:

- 30 mph wind gusts
- Relative humidity below 30-25%

However, that wind gusts were repeatedly blowing above 40-50 mph, with the top speed recorded at 72 mph. Similarly, extreme and uncharacteristic wind speeds were detected during the Marshall Fire (2021). Relative humidity during peak fire behavior times were in the single digits.
During an initial wildfire assessment Foxfire WUI conducted on a peninsula community, it found that at least 36% of days in 2024 displayed weather trends that could increase wildfire spread and intensity. It is important to further note that the wind thresholds were based on 20 mph winds. The threshold for relative humidity was also slightly increased based on trends observed during the Marshall and Palisade Fire. Specifically in the Marshall Fire, relative humidity did not go below 30% while the fire was active, according to the Sugarloaf Canyon RAWs data station.

If we go the extra mile, can we make more accurate predictions based on localized extreme thresholds? Can an increase in perception help prepare for ember cast? Most importantly, with the rise in new technology and understand-
Can we predict the unpredictable?

Sources Cited

1. Paradise town, California; United States. “QuickFacts.” United States Census Bureau. Access: <https:// www.census.gov/quickfacts/fact/table/ paradisetowncalifornia, US/PST045223>.

2. The Camp Fire Public Report: A Summary of the Camp Fire Investigation. Butte County District Attorney’s Office. 16 June 2020. <https://www.buttecounty.net/DocumentCenter/View/1881/Camp-Fire- Public-Report---Summary-of-the-Camp-Fire-Investigation-PDF>.

3. Butte County Wildfire Protection Plan. Fire Environment. Butte County, California. Updated 2025. Access: <https://storymaps.arcgis.com/stories/e56239646fcb4ae88f091516fea56f28>.

4. Vaillant, John. “Fire Weather: A True Story from a Hotter World.” Chapter 10. First edition. New York, Alfred A. Knopf, 2023.

5. EngineCo16 Channel. “Radio traffic - The first 2 hours of the Camp Fire in Paradise.” Youtube.com. EngineCo16. Uploaded 19 March 2019. Access: <https://youtu.be/vPgZch5HW9o?si=wE9BmzSafivximYS> .

6. Three Days in Paradise. “A High and Awful Price: Lessons Learned from the Camp Fire.” Youtube.com. Three Days in Paradise. Upload 30 December 2019. Access: <https://www.youtube.com/watch?v=bo0yBOCvuwU&t=3346s>.

7. Paradise SVI Map Cross-Reference. Gaia Maps. Folder Link: <https://www.gaiagps.com/map/?loc= 10.7/-121.5156/39.7673& pubLink= 3pitdYZaPKjpTGphkRKhmPS5&folderId=ca36fa40-4c36-4a26-b04a-8feeac1b5342>.

8. McLaughlin, Tim. Kearney, Laila. “Los Angeles wildfires were 10 times bigger than utility’s AI forecast.” Reuters. Updated 9 June 2025. Access: <https://www.reuters.com/business/environment/ los-angeles-wildfires-were-10-times-bigger-than-utilitys-ai-forecast-2025-06-09>.

9. S-190: Introduction to Wildfire Behavior. Unit 8, Lesson 3 “Rate of Spread.” National Wildfire Coordinating Group.

10. S-190: Introduction to Wildfire Behavior. Unit 8, Lesson 7 “Slope Effect on Rate of Spread.” National Wildfire Coordinating Group.

11. “White Sage and Dragon Bravo fires: The latest on the wildfires in Northern Arizona.” 91.5 KJZZ Phoenix. Updated 28 July 2025. Access: <https://www.kjzz.org/live-updates/white-sage-fire-the-latest-on- the-wildfire-in-northern-arizona>.

12. Johnson, Julia. Devulapalli, Sriharsha. "'Just crummy': Why California's Butte County keeps getting hit by big wildfires." Updated 5 August 2024. Access: < https:// www. sfchronicle.com/california-wildfires/article/butte-county- fire-california-19613151.php>.

13. June 2008: California Fire Siege, Summary Report [Draft]. Various Authors. 28 January 2009. Accessed through PDF.

14. "Bring Your Own Brigade." Lucy Walker. Paramount Productions. Released July 2021.

15. Blunt, Katherine. "California Burning: The Fall of Pacific Gas and Electric--and What It Means for America's Power Grid." [New York], Portfolio/Penguin, 2022.

16. Johnson, Julie. Devulapalli, Sriharsha. "Just crummy: Why California's Butte County keeps getting hit by big wildfires." San Francisco Chronicle. Updated 5 August 2024. Access: <https://www.sfchronicle. com/california-wildfires/article/butte-county-fire-california-19613151.php>.

17. Walker. "BYOB"

18. Walker. "BYOB"

19. Paradise Profile. *Quick Facts*. United States Census Bureau. Accessed, May 2025. Access site: <https://www.census.gov/quickfacts/fact/table/paradisetowncalifornia/POP060210>.

20. Maranghides, Alexander; Link, Eric D. "WUI Fire Evacuation and Sheltering Considerations: Assessment, Planning and Execution (ESCAPE)." National Institute of Standards and Technology. United States Department of Commerce. NIST TN 2262r1. Published March 2025. Access: <https://doi.org/ 10.6028/NIST.TN.2262r1>.

21. Integrated Public Alert & Warning System. FEMA. Access: <https://www.fema.gov/emergency-managers/practitioners/integrated-public-alert-warning-system>.

22. "Many of the dead in Camp fire were disabled. Could they have been saved?" The Sacramento Bee. 6 December, 2018. Access: <https://www.heraldnews.com/story/news/2018/12/06/many-dead-in-camp-fire/7100366007/>.

23. Fischette, Mark. Visser, Dean. "The New Tornado Alley Has Been Hyperactive This Year." Scientific American. 21 April, 2025. Access: <https://www.scientificamerican.com/article/the-new-tornado-alley-has-been-hyperactive - this-year/>.

24. "A Case Study of the Camp Fire: Notification, Evacuation, Traffic, and Temporary Refuge Areas (NETTRA)". *National Institute of Standards and Technology*. United Stated Department of Commerce. NIST.TN.2252. July 2023. Access: <https://doi.org/10.6028/NIST.TN.2252>.

Acknowledgements

I would like to thank the Town of Paradise, and all of those impacted by the Camp Fire. Thank you for sharing your story with us. As hard as it may feel, we need you more than ever right now. Your guidance can help similar communities prepare for their wildfire risk.

I would like to thank John Messina for responding to a stranger's LinkedIn Message, and for being willing to share the lessons learned on November 8, 2018.

I would specifically like to thank Jen Goodlin, with Rebuild Paradise. RP is the epitome of community resilience and dedication. They continue to show us that rebuilding is possible, even with WUI codes and insurability challenges.

I would like to thank Christina North for being an incredible mentor, peer reviewing my ramblings, and always reminding me to stay positive.

I would like to thank Lucy Walker for making "Bring Your Own Brigade," and bringing the difficult conversation to our living room. Lucy and her team created something truly remarkable with "BYOB." As fast as wildfire has evolved and changed since the film was made, it is still one of the best and most accessible resources for understanding the wildfire problem.

I would also like to thank the following people, who graciously lended their time to peer review this paper:
Kathleen Courier - Partner, NetNew Group
Elizabeth Pearce - Vice President of Business Development, Athena Intelligence
Tom Marsh, CEO - Bintel, Inc.
Nicole Henningfeld - Wildfire Consultant, Adaptive Firescapes, LLC
Mark Novak, Fire Chief at Vail Fire and Emergency Services

This study was paid for and funded by Foxfire WUI. It is copyrighted under the Foxfire Jr. WUI Workforce Readiness Curriculum, Unit 8. The opinions reflected in this document are my own.