

NIST Camp Fire Case Study Research and Outputs

NCST Advisory Committee Meeting
March 6–7, 2024

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Outline

- Introduction
- Camp Fire Case Study Overview
- Methodology Overview
- Camp Fire Case Study Findings and Outcomes

Range of Deployment / Response Paths

Reconnaissance

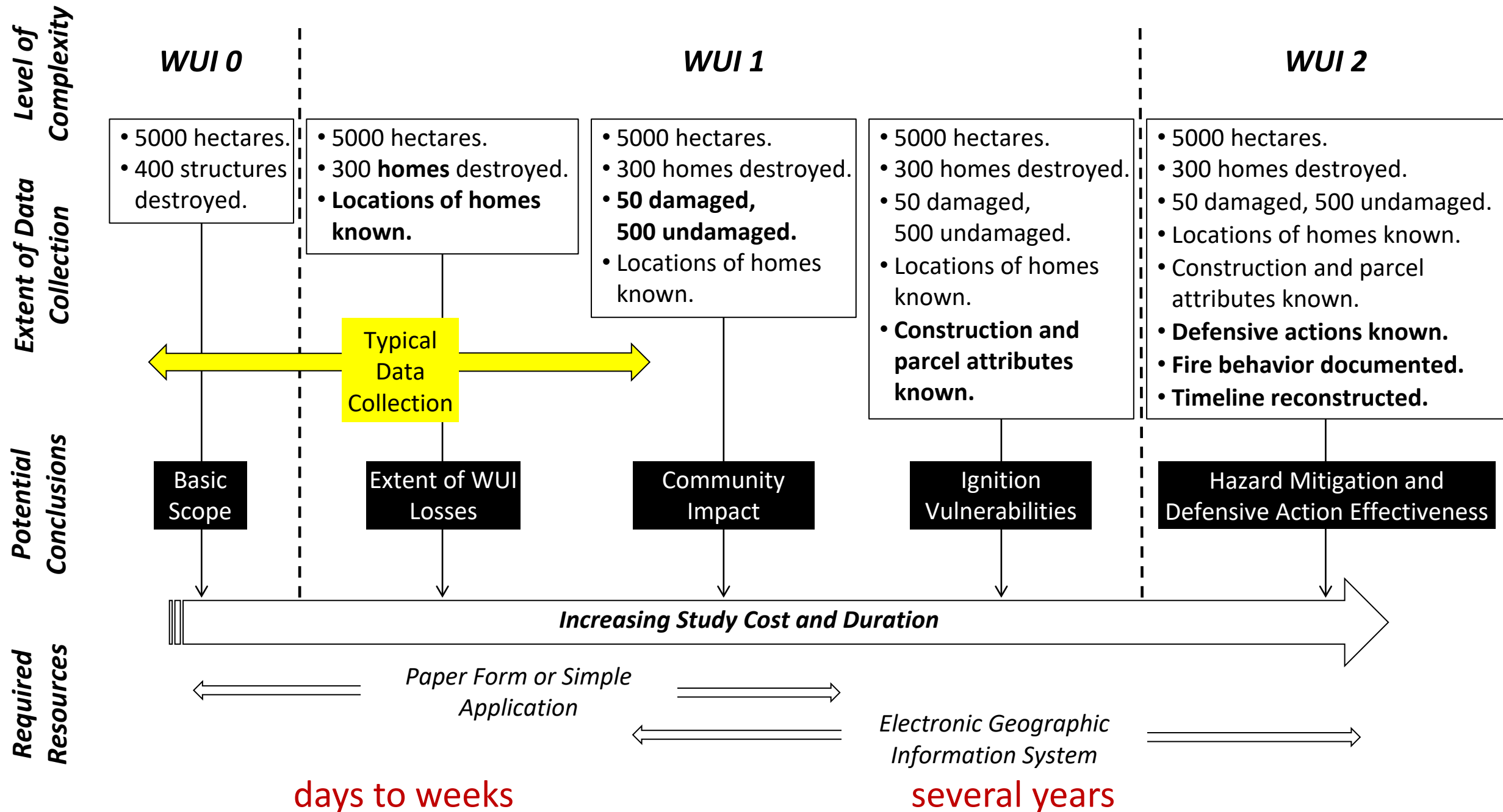
Case Study

Collaborative

Pre-fire Reconnaissance

WUI Fire Data Collection Continuum – Damaged Structures Example

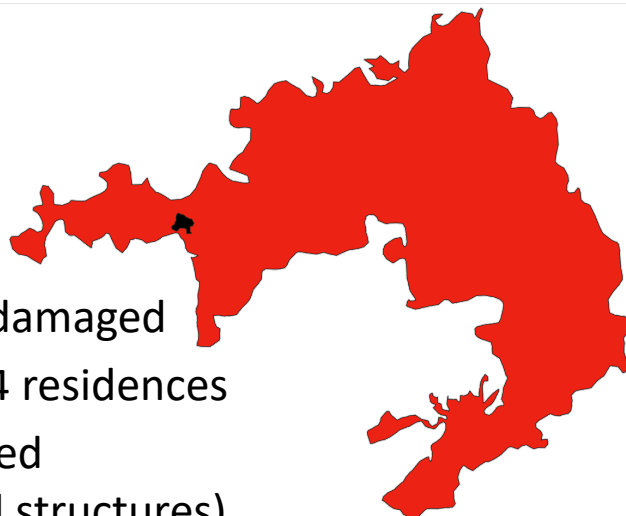
4



Adaptable Methodology

• Witch Fire

- Overall: 1125 destr., 77 damaged
- Focus: 1 community, 274 residences
74 destroyed, 16 damaged
(primary residential structures)



-  Entire fire perimeter
-  Case study WUI
“focus area”

• Tanglewood Complex

- Focus: entire WUI, entire fire, parcel-level data
- 35 destroyed, 10 damaged

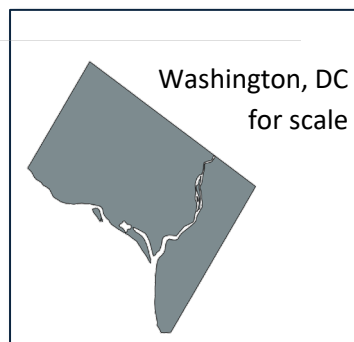


• Waldo Canyon Fire

- Focus: entire WUI, parcel-level data
- 344 destroyed, 103 damaged



0 10 20 km



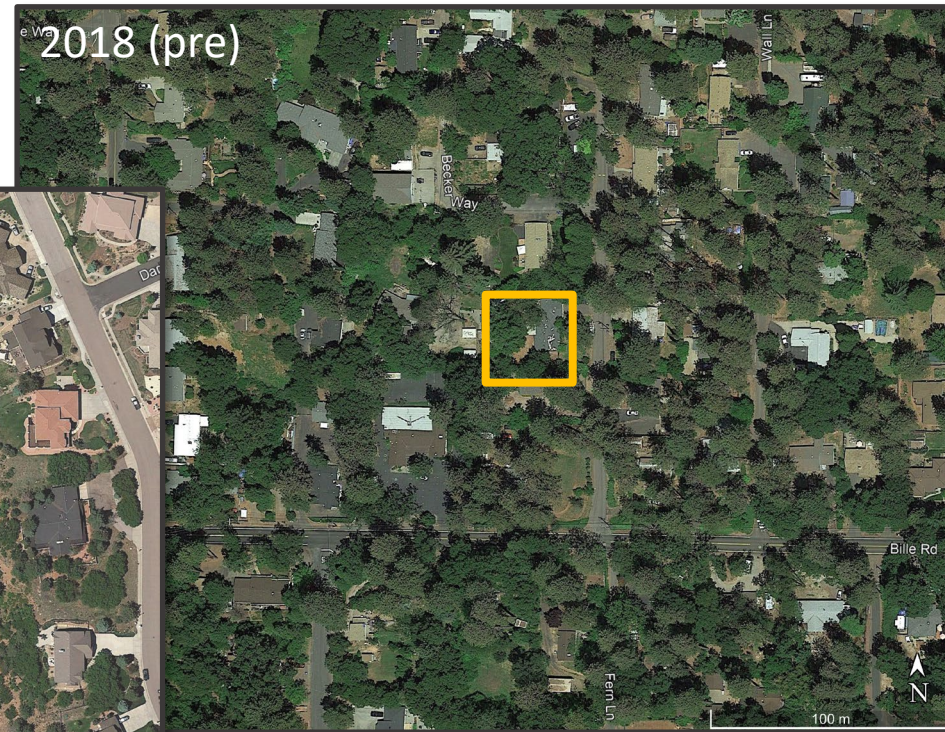
• Camp Fire

- Overall: 13696 destr.
489 damaged
- Focus: entire WUI (intermix), community-level data



Community Differences

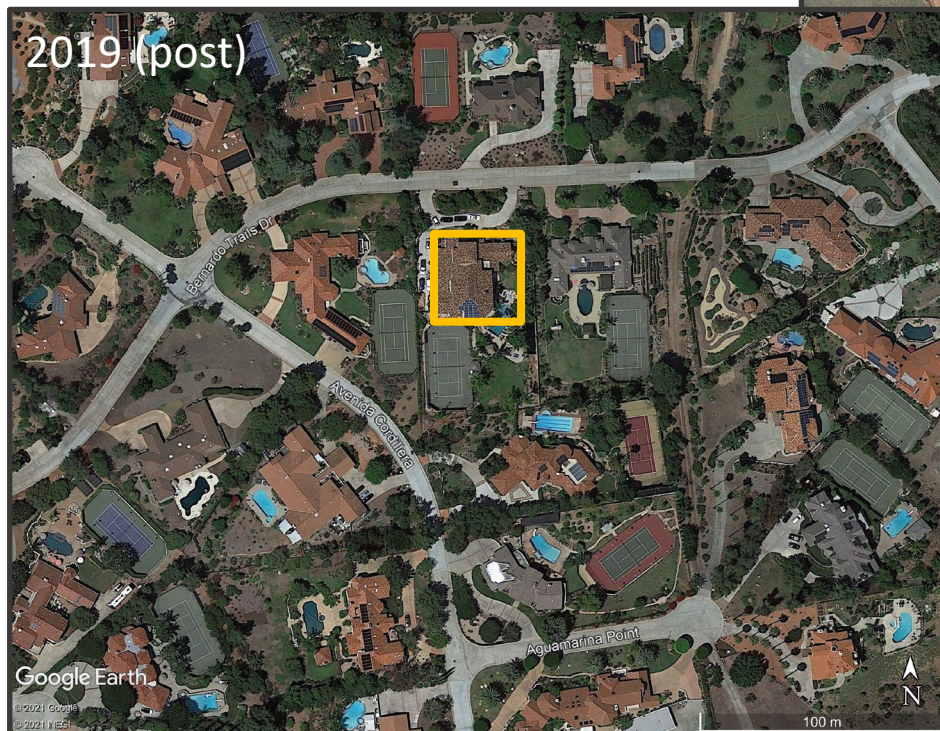
Interface/Intermix, housing density



Camp Fire, Intermix



Waldo Canyon Fire, Interface



Witch Fire, Interface

equal scale images

NIST Case Study Outcomes



<u>Witch and Guejito Fire</u> 2007 San Diego, CA	<u>Amarillo fires</u> 2011 Amarillo, TX	<u>Waldo Canyon Fire</u> 2012 Colorado Springs, CO	<u>Camp Fire</u> 2018 Paradise, CA
• Timeline reconstruction • Defensive actions • Structure ignitions • Exposure quantification • Effectiveness of mitigation • Methodology for future developments	• Deployment methodologies • Damage assessment summary • “Area/neighborhood” case studies • Detailed fire behavior reconstruction • Parcel-level attributes	• Timeline reconstruction • Fire behavior • Detailed assessment of defensive actions	• Timeline reconstruction • Intermix fire spread • Burnovers • Damage assessments • Notification, evacuation, traffic, and temporary refuge areas (NETTRA) • Link between timelines of evacuation and fire • Temporary refuge areas (TRAs) • Rescues

Camp Fire Timeline Reconstruction



Map created by NIST
Elevation: USGS | Fire Perimeter: NIFC
Boundaries, Places, Water: U.S. Census Bureau TIGER/Line Shapefiles

Goals:

- Timeline Reconstruction of the Camp Fire
- Focus on *first 24 hours* of the fire
- Document fire behavior, weather, emergency notification and evacuation, and defensive actions

Case Study Methodology



0. Pre-deployment training and proficiency maintenance
1. Pre-plan deployment
2. Integrate with IC and DINS
3. Field data collection
4. Technical discussions
 - Fire
 - Evacuation / notification
 - Defensive actions
5. Data integration
6. Analysis / summarization

IC: incident commander DINS: damage inspection

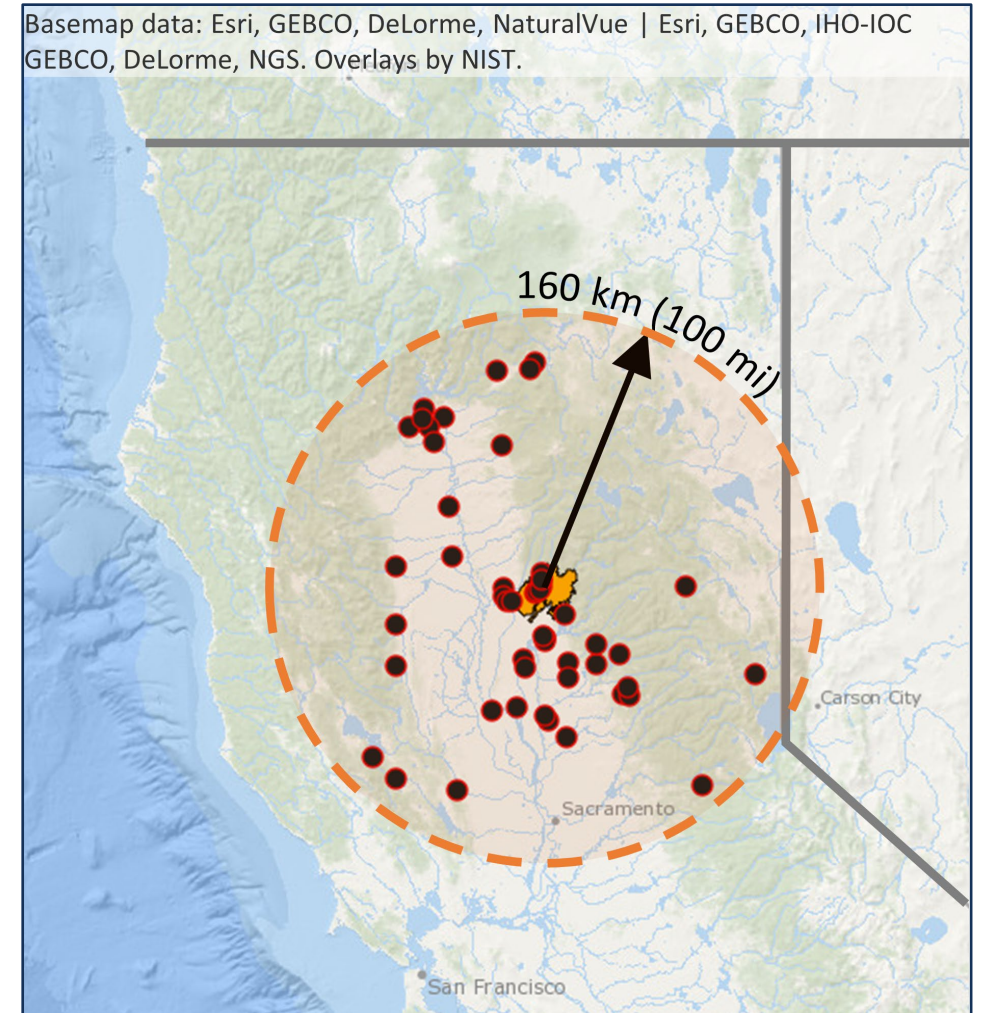
Contributors



Camp Fire Reconstruction Phase	Participants	Phase Total
Field Reconnaissance	Alex, Eric, Chris, Cartier, Ruddy, Erin, Steve, Mike, Will, David, DINS, OSFM	10 +
Shadow Team (supporting Field Recon.)	Nicole C, Becky, Sue, Nelson, Jiann, NIST Legal, NIST Library, Judy, Andrew, Carolyn	10
Field Data Collection Logistics	David, Danielle, Colette, Kirk	4
Field Data Collection	Alex, Eric, Chris, Cartier, Ruddy, Erin, Steve, Mike, Will, David, DINS, OSFM	10 +
Technical Discussions	Alex, Eric, Cartier, Lucy, Becky, Ryan, Bob, Nicole L	7
Data Analysis and Integration	Alex, Eric, Chris, Doug	4
Report Writing	Alex, Eric, Chris, Ruddy, Steve, Will, Bob, Doug	8
Report Review	Karen, Kathy, Jiann, Nelson, NIST Legal, Judy, Howard	7
Publication and Public Affairs	Vince, Jonathan, Jennifer	3
Technical Discussion Participants	First Responders, <i>et al.</i>	157
Individual Total		192 + DINS, OSFM

Technical Discussions with Initial Responders NIST

American Medical Response—Shasta County	NEU—Nevada City Forest Fire Station
B-Line Butte Regional Transit	Nevada County Consolidated Fire District
BTU Station 35—Paradise	Northern California Geographic Area Coordination Center
BTU Station 62—Harts Mill	Olivehurst Fire Department
BTU Station 63—Oroville	Paradise Fire Station 81—Paradise Fire Department
BTU—Butte Fire Center	Paradise Irrigation District
BTU—Unit Headquarters	Paradise Police Department
Burney Fire District Station 17	Shasta County Fire Station 33—Bella Vista
Butte County Emergency Command Center	Shasta Lake Fire Protection District
Butte County Fire Safe Council	SHU Station 14—Burney
Butte County Fire Station 33—Upper Ridge	SHU Station 22—Shingletown
Butte County Fire Station 42—North Chico	SHU Station 58—Shasta
Butte County Fire Station 44—South Chico	SHU Station 75—Hillcrest
Butte County Fire Station 55—Bangor	South Lake County Fire Prot. Dist. Station 63—Hidden Valley
Butte County Fire Station 73—Biggs	Sutter County Fire Department Station 6—Sutter
Butte County Fire Station 74—Gridley	TGU Station 12—Corning
Butte County Sheriff's Office	TGU Station 1—Red Bluff
CAL FIRE—Law Enforcement Division	TGU—Elk Creek Station
California Highway Patrol—Chico	TGU—Paskenta Station
Chico Fire Department—Headquarters	Town of Paradise
Del Oro Water Company	Town of Paradise—Department of Public Works
Grass Valley Emergency Command Center	USFS CA-ENF—Pacific Ranger District, Pollock Pines
Grass Valley Fire Department Station 2	USFS CA-MNF—Stonyford Work Center
Linda Fire Protection District	USFS CA-PNF—Beckwourth Ranger District, Blairsden
LNU—Brooks Forest Fire Station	USFS CA-PNF—Challenge Visitor Center, Challenge
LNU—Konocti Conservation Camp	USFS CA-PNF—Feather River Ranger District, Oroville
Meridian Fire Protection	USFS CA-TNF—Truckee Ranger District, Truckee
National Weather Service—Reno, NV	USFS CA-TNF—Yuba River Ranger District, Camptonville
NEU Station 61—Loma Rica	Wheatland Fire Authority
NEU—Dobbins Forest Fire Station	



Locations of technical discussions
across northern California

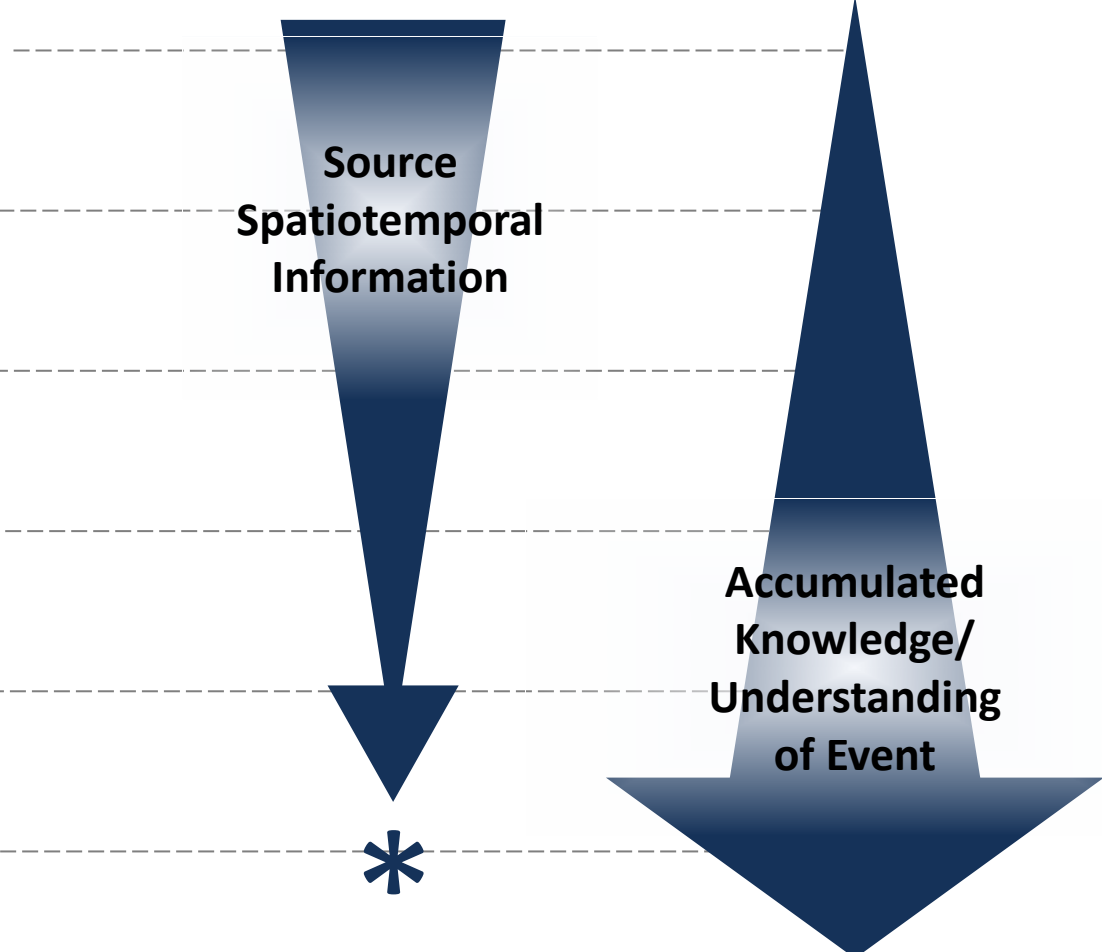
Data Collection – Data Types

Spatiotemporal Data

- 151 technical discussions
 - First responder photos/videos
 - Paradise Police Department body/dashboard camera videos
 - Automatic Vehicle Location GPS tracking (AVL) *Saved from loss by 48 hrs*
 - 9-1-1 Recordings
 - Evacuation notifications from Butte County Sheriff's Office
-
- CAL FIRE damage inspection data
 - 132 NIST Damage Inspection Reports *Saved from loss before recovery efforts*
 - Butte County Wildland Fuels Plan
 - Butte County Evacuation Plan

Integration Methodology Sequence

1. Event Overview (Recon, IC, etc.)
2. TD with AVL (photos)
3. PPD video, audio
4. TD with photos but no AVL
5. TD with no photos and no AVL
6. VTD



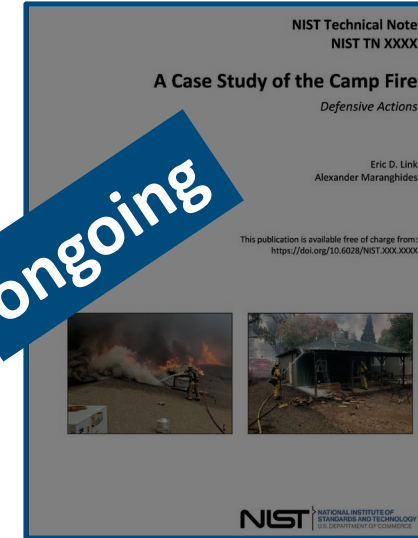
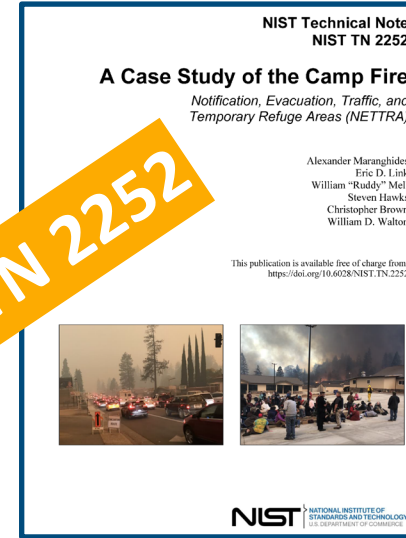
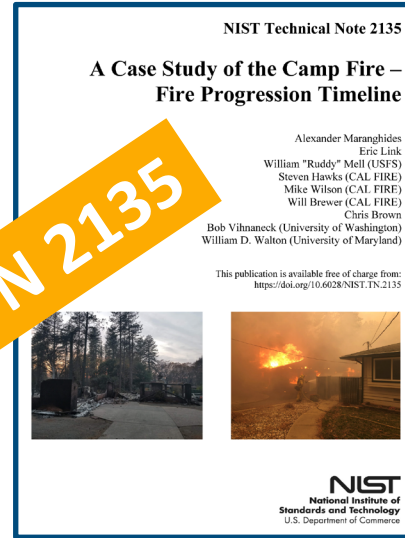
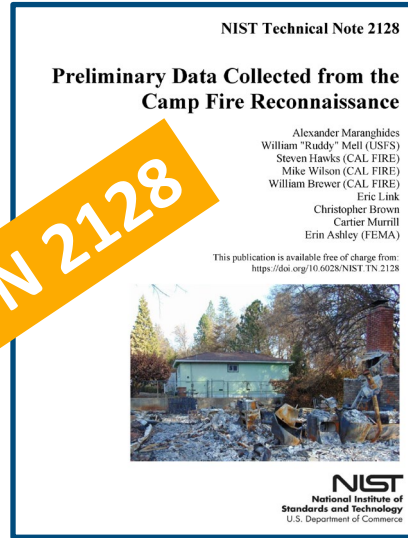
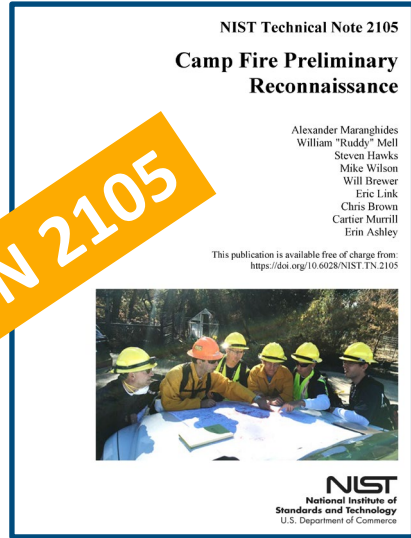
Source
Spatiotemporal
Information

Accumulated
Knowledge/
Understanding
of Event

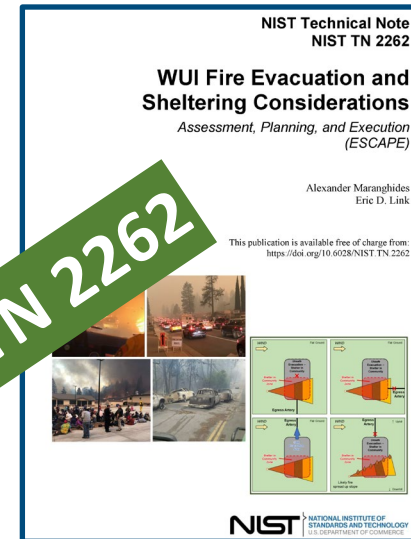


Camp Fire Case Study Reports

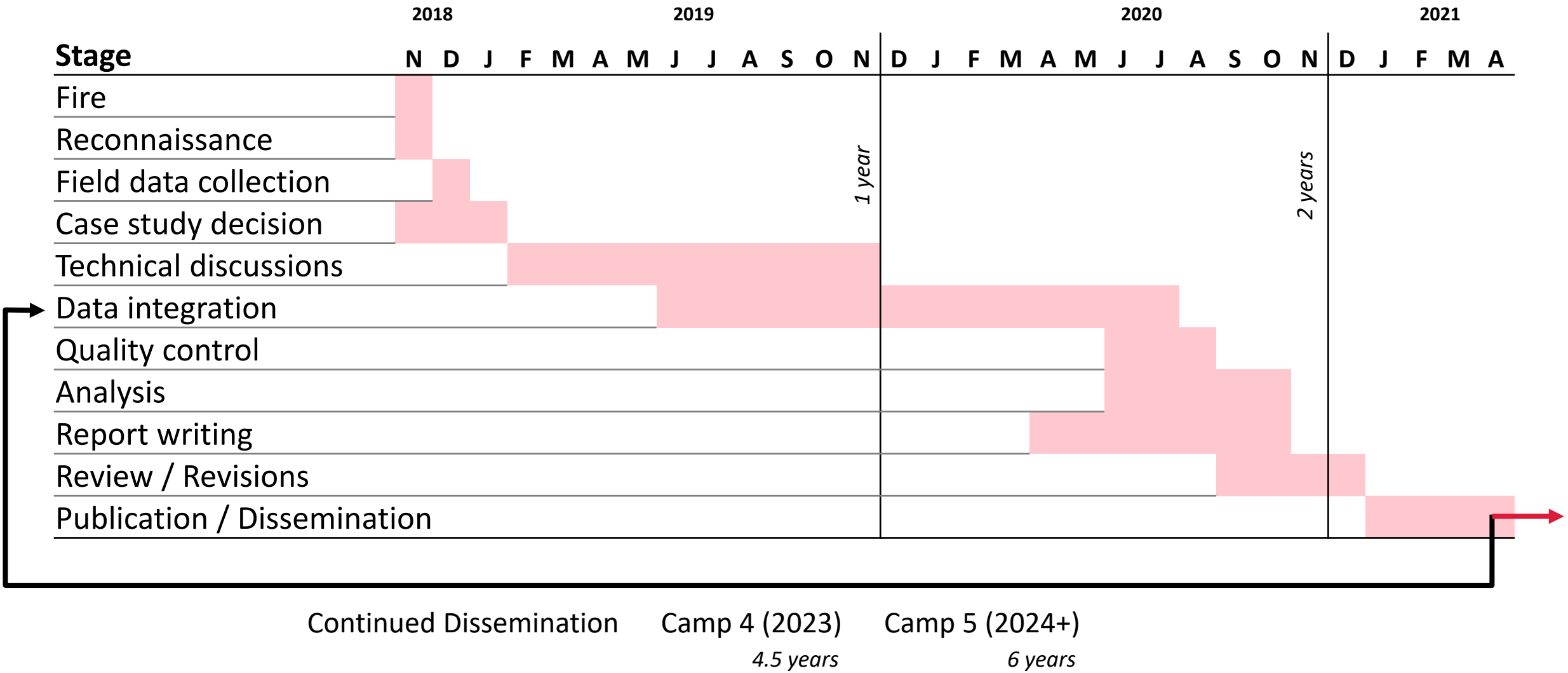
NIST



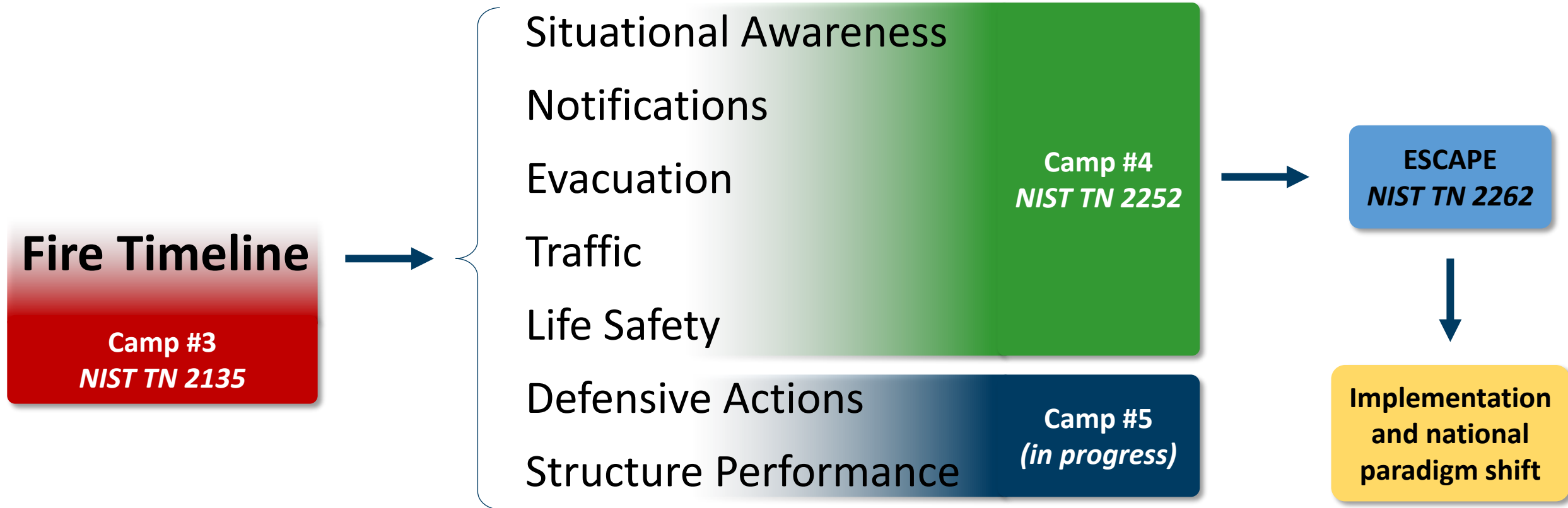
<https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-investigation-california>



Timeline



Camp Fire Reports Framework



Camp Fire Reports Framework

NIST

Fire Progression

Event foundation

*“where the fire was,
and when”*



Life Safety

NETTRA

**Notification, Evacuation,
Traffic, Temporary Refuge
Areas, Rescues, and
Fatalities**

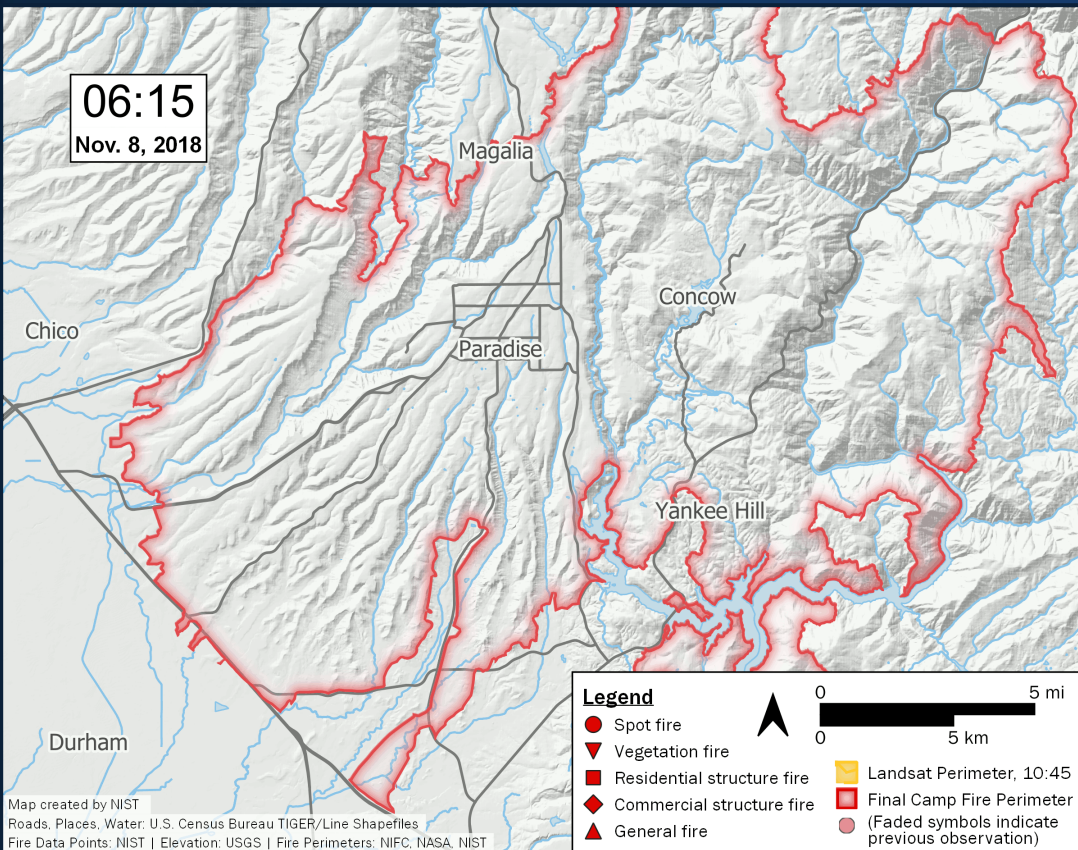


Defensive Actions

Resources on location

Residential, commercial, and
infrastructure protection

Fire Progression Findings



- Fire spread timeline reconstruction
 - Cross-parcel fire spread
 - Spot fires and burnovers
- ↓
- Foundation and context for NETTRA analysis



Photo courtesy of TD-101, 12:22. Used with permission.



Photo courtesy of TD-101, 12:01. Used with permission.

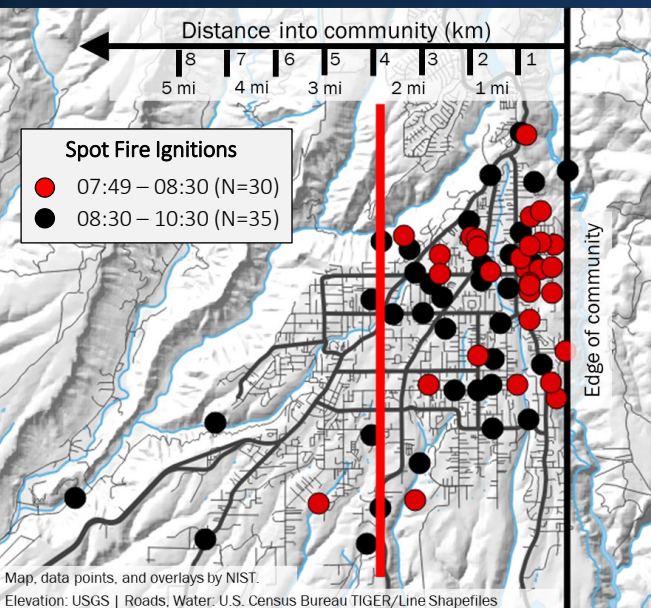


Video courtesy of TD-127, 10:17. Used with permission.



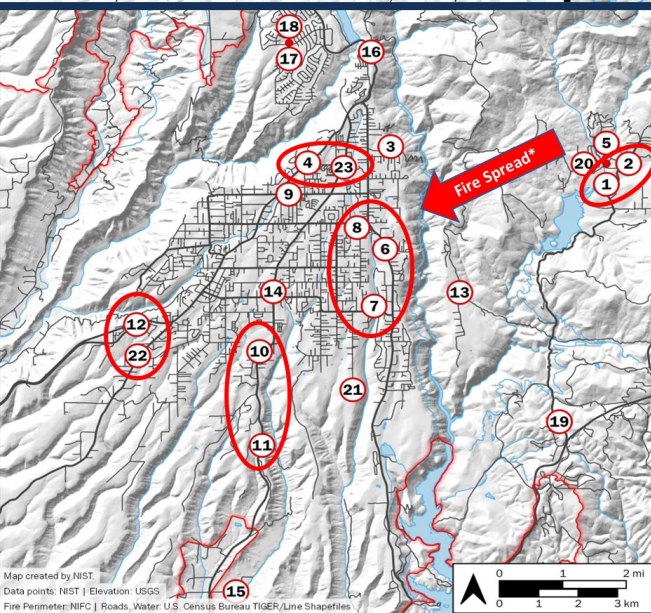
Photo courtesy of TD-141, 15:02. Used with permission.

Fire Progression Findings



• Spot Fires

- 30 ignitions within 40 minutes of fire front arrival
- 65 confirmed total spot fires before 10:30
- Initial spots up to 4 km into community



• Burnovers

- 23 identified incidents
- Most involved civilians attempting to evacuate on primary roadways

NETTRA Findings



Notifications

- Timeline of evacuation orders in context of fire progression

Evacuations

- Traffic flow reconstruction
- Impacts of fire
 - Roadway closures
 - Abandoned vehicles
 - Widespread use of TRAs

TRAs

- 31 different locations
- At least 1200–2100 civilians involved
- Response to high hazard and evacuee management

TRA – temporary refuge area

Rescues

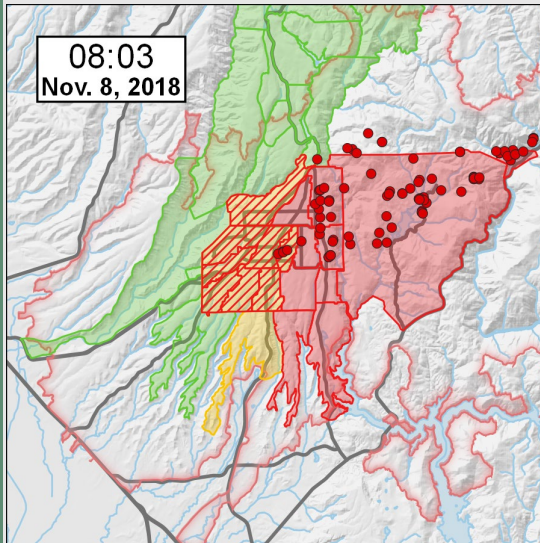
- New data type in WUI fire studies
- 198 events identified
- At least 1007 civilians involved

64 Technical Findings

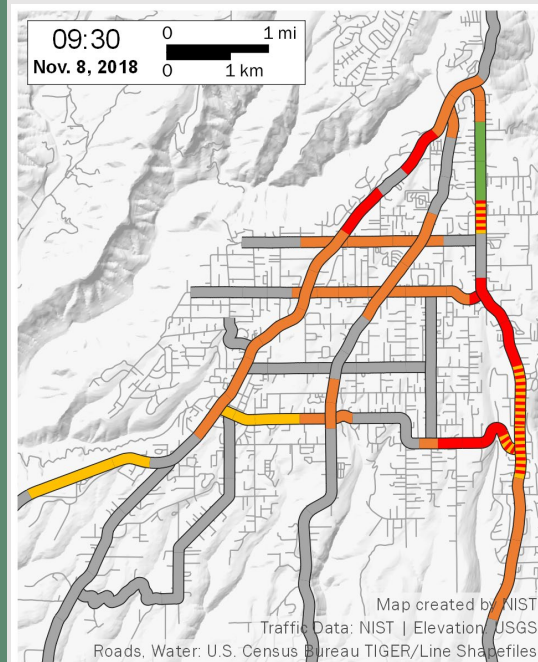
26 Recommendations

NETTRA Findings

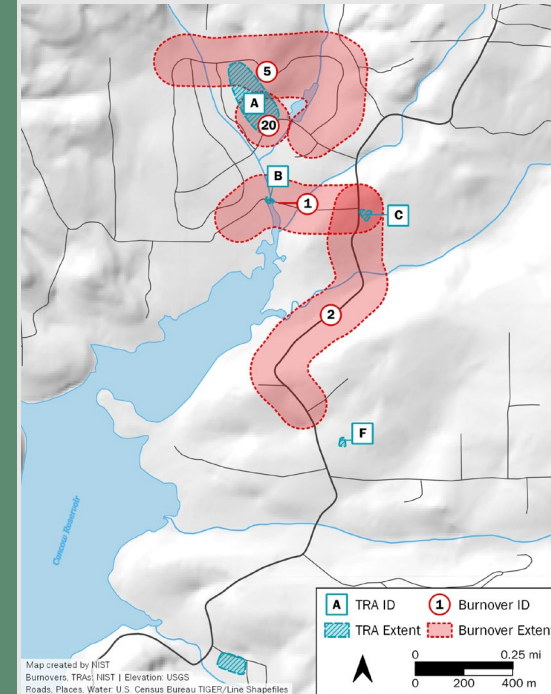
Notifications



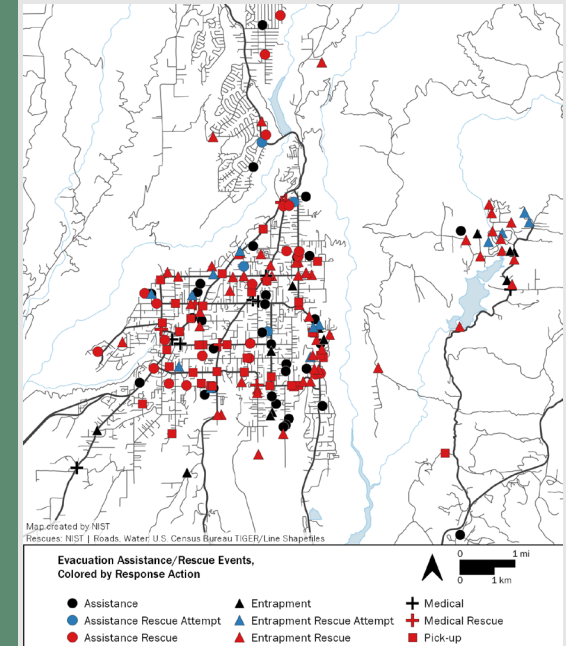
Evacuations



TRAs



Rescues



64 Technical Findings

26 Recommendations

Defensive Actions (Anticipated Findings)

- Identify and analyze defensive actions
- Contextualize defensive actions within fire and life safety aspects
- Analysis of structure assessments



Wildfire



Infrastructure



Residential

ESCAPE

NIST

NIST Technical Note
NIST TN 2262

WUI Fire Evacuation and Sheltering Considerations

*Assessment, Planning, and Execution
(ESCAPE)*

Alexander Maranghides
Eric D. Link

This publication is available free of charge from:
<https://doi.org/10.6028/NIST.TN.2262>



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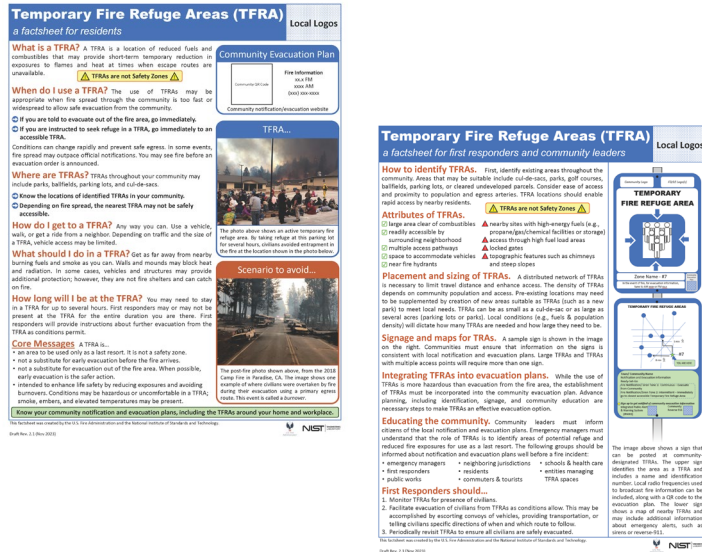
Distillation of lessons from the Camp Fire

Lays out current state of evacuation and sheltering considerations

Provides context for current incompatibility of incident timelines and evacuation requirements

Highlights complications to modeling

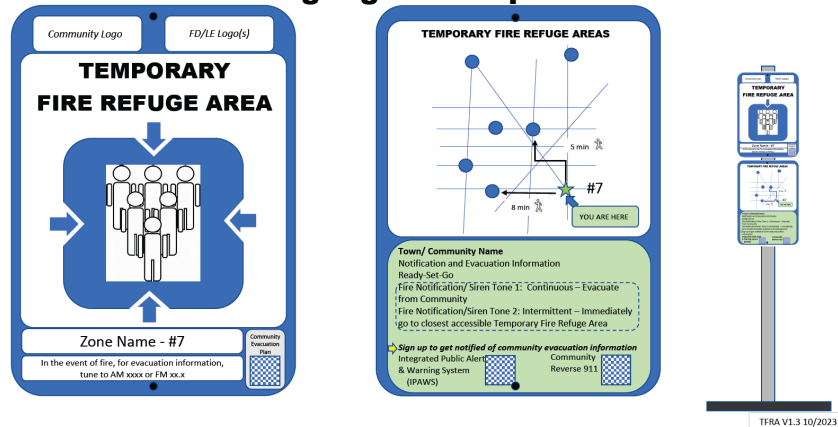
Temporary Fire Refuge Area Concept



- National-level campaign to increase awareness, planning, and response capacity for no-notice fire events
- Positive feedback from wide range of stakeholders

Factsheet for residents & first responders and community leaders

Temporary Fire Refuge Area (TFRA) Signage Concept



Camp Fire Case Study Outputs

1

Reports / Publications

Camp Fire – Fire Progression Timeline

23 technical findings

9 recommendations

+

Camp Fire – “NETTRA”

64 technical findings

26 recommendations

↓

ESCAPE

2

Direct Knowledge Transfer

- CALFIRE, USFA, FEMA, Fire Safe Councils
- NIST WUI Fire Days (seminar series)
<https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-wui-fire-days-2023>
- USFA Evacuation Roundtable
- Eastern Mediterranean WUI Fire Workshop (March)

3

Presentations and Recordings

Camp Fire Case Study Website

- Reports
- Presentation slides
- Recorded presentations

<https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-investigation-california>

Case Study Overview – Key Points

- Link methodology and level of detail to goals and desired outcomes
 - Defensive actions matter
 - There are no shortcuts with partial data
- Sufficient data availability, verification, and quality control ensure reliable findings
- Fire spread timeline is the technical foundation
- Post-study knowledge transfer is critical to learn from and implement findings and drive future research

Questions?

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[https://www.nist.gov/el/fire-research-division-73300/
wildland-urban-interface-fire-73305/nist-investigation-california](https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/nist-investigation-california)

NIST Technical Note 2135. A Case Study of the Camp Fire – Fire Progression Timeline <http://doi.org/10.6028/NIST.TN.2135>

NIST Technical Note 2252. A Case Study of the Camp Fire – Notification, Evacuation, Traffic, Temporary Refuge Areas (NETTRA) <http://doi.org/10.6028/NIST.TN.2252>

NIST Technical Note 2262. WUI Fire Evacuation and Sheltering Considerations – Assessment, Planning, and Execution (ESCAPE) <http://doi.org/10.6028/NIST.TN.2262>