

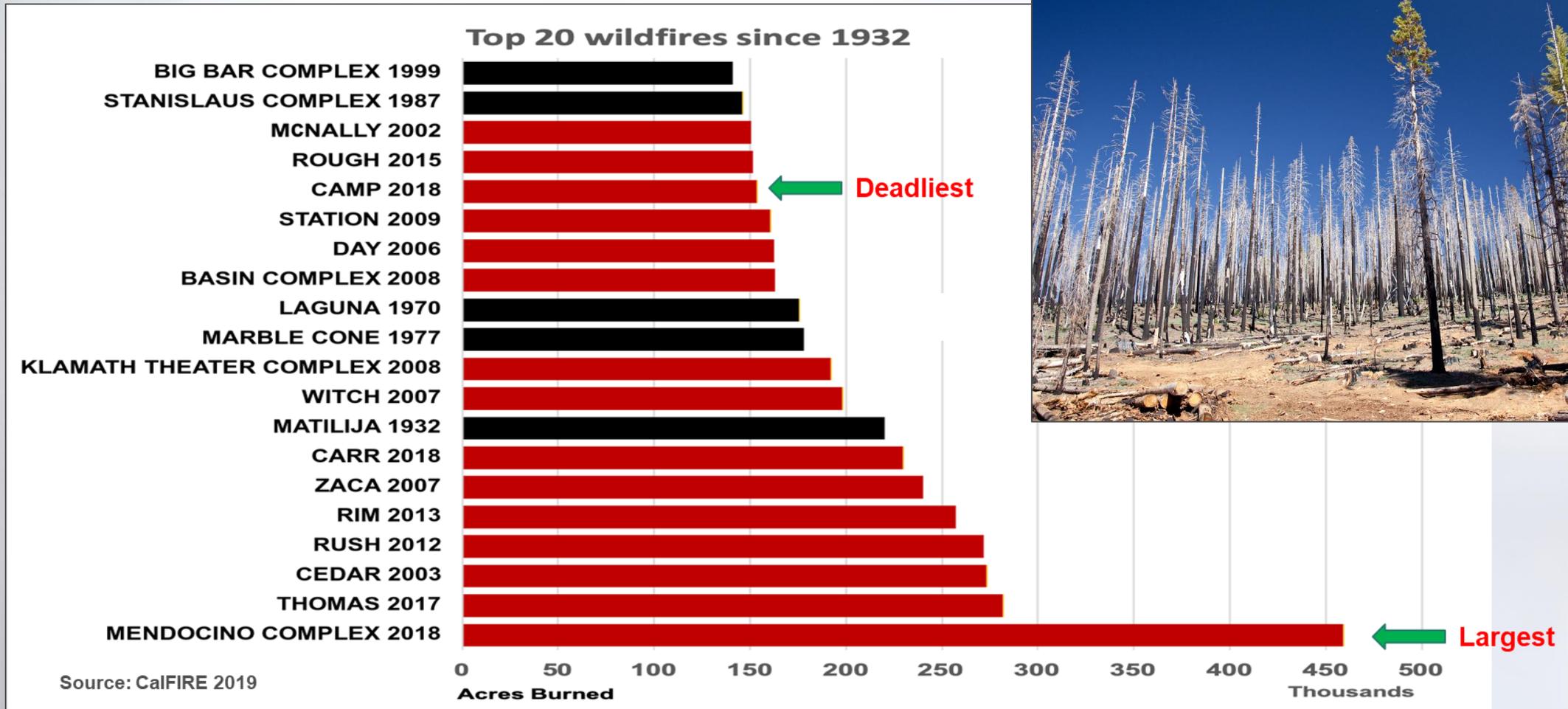


# Air Quality Impacts of Wildfires: PM<sub>2.5</sub> from Wildfire Smoke

Mena Shah

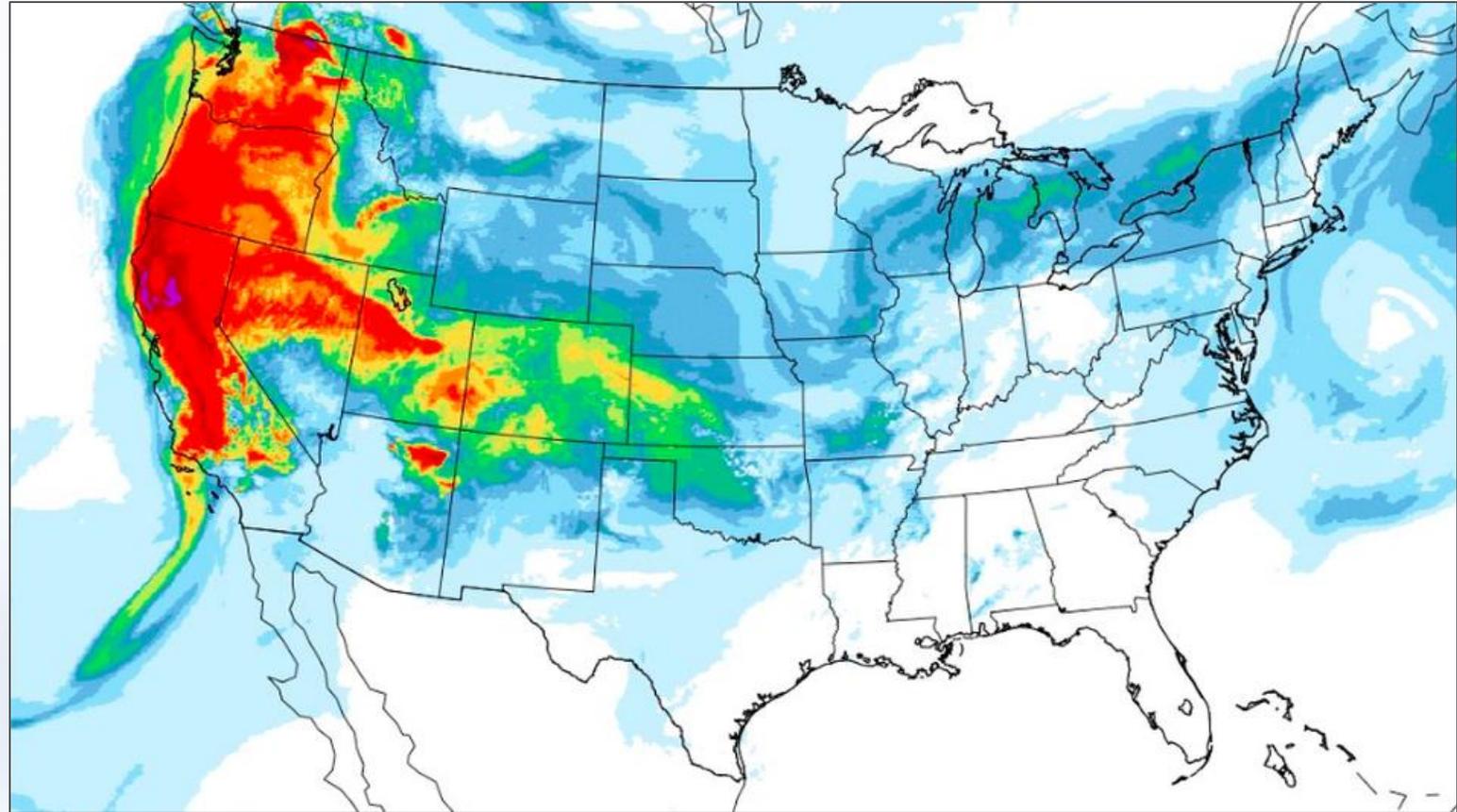
CIHC Professional Development Seminar  
December 6, 2019

# California Wildfires



# Pollution from Wildfires

- Smoke – mixture of gases and particle pollution (PM)
- Smoke may travel thousands of miles, impacting millions of people
- Even when the fire stops, smoke can remain in the air and affect health
- Wildfire events in California are becoming more frequent and the wildfire season is now extending into the winter months



Wildfire smoke concentrations on August 8, 2018  
(National Weather Service)

# Wildfire Smoke Poses Major Public Health Risk

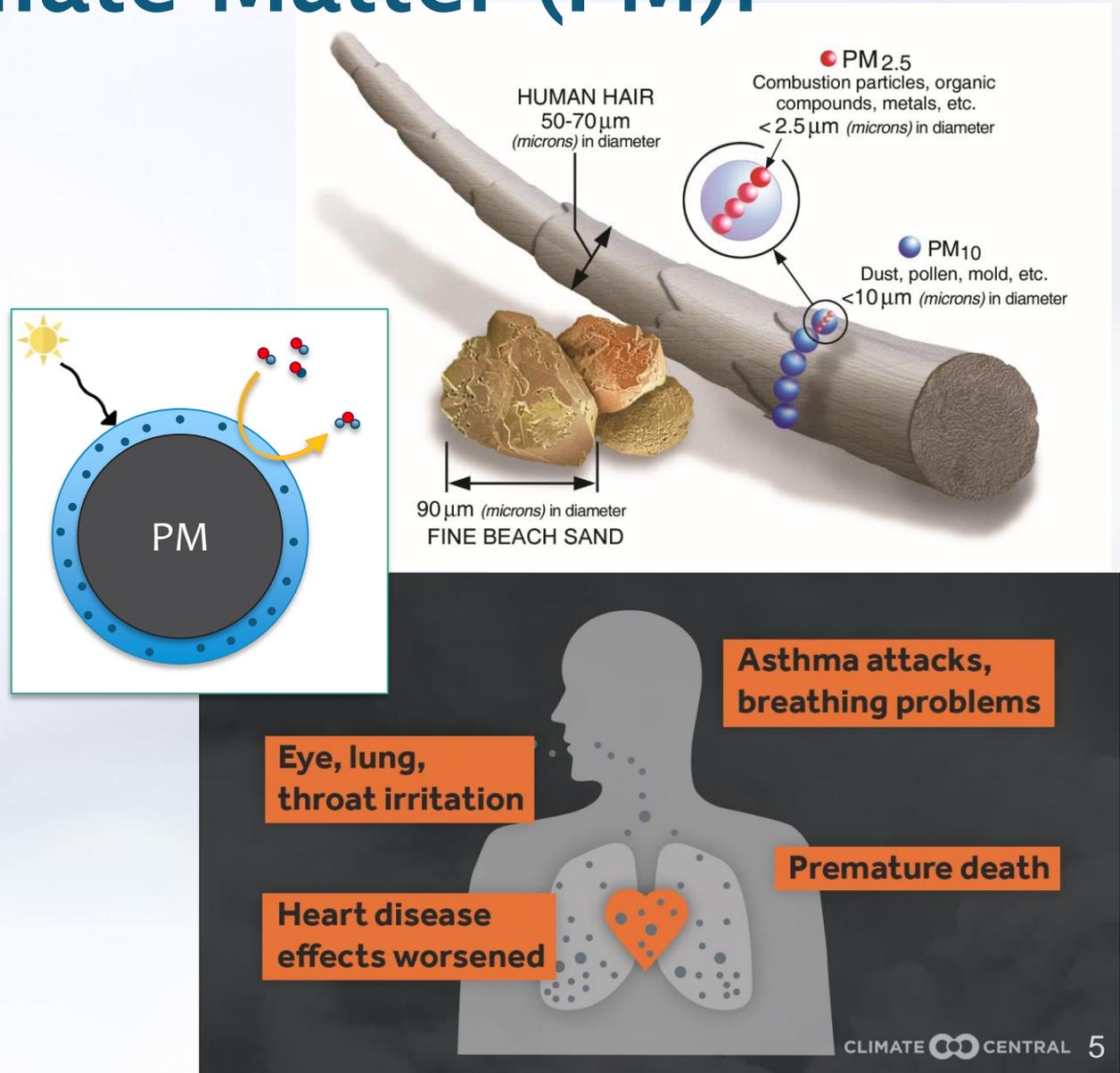
- Greatest health threat from smoke - fine particle pollution ( $PM_{2.5}$ ) can penetrate deep into the lungs and cause serious health effects
- Coarse particles ( $PM_{10}$ ) in smoke are of lesser concern, but can still irritate the eyes, nose and throat
- Smoke also includes VOCs and  $NO_x$  from burning vegetation, which leads to ozone formation
- Wildfire smoke includes toxic substances from burning homes, businesses, and vehicles
- Many toxics will stick to particles in the smoke, compounding the health risks of particle pollution



Smoke from the 2015 Rocky Fire in Lake County, CA  
(Justin Sullivan / Getty Images)

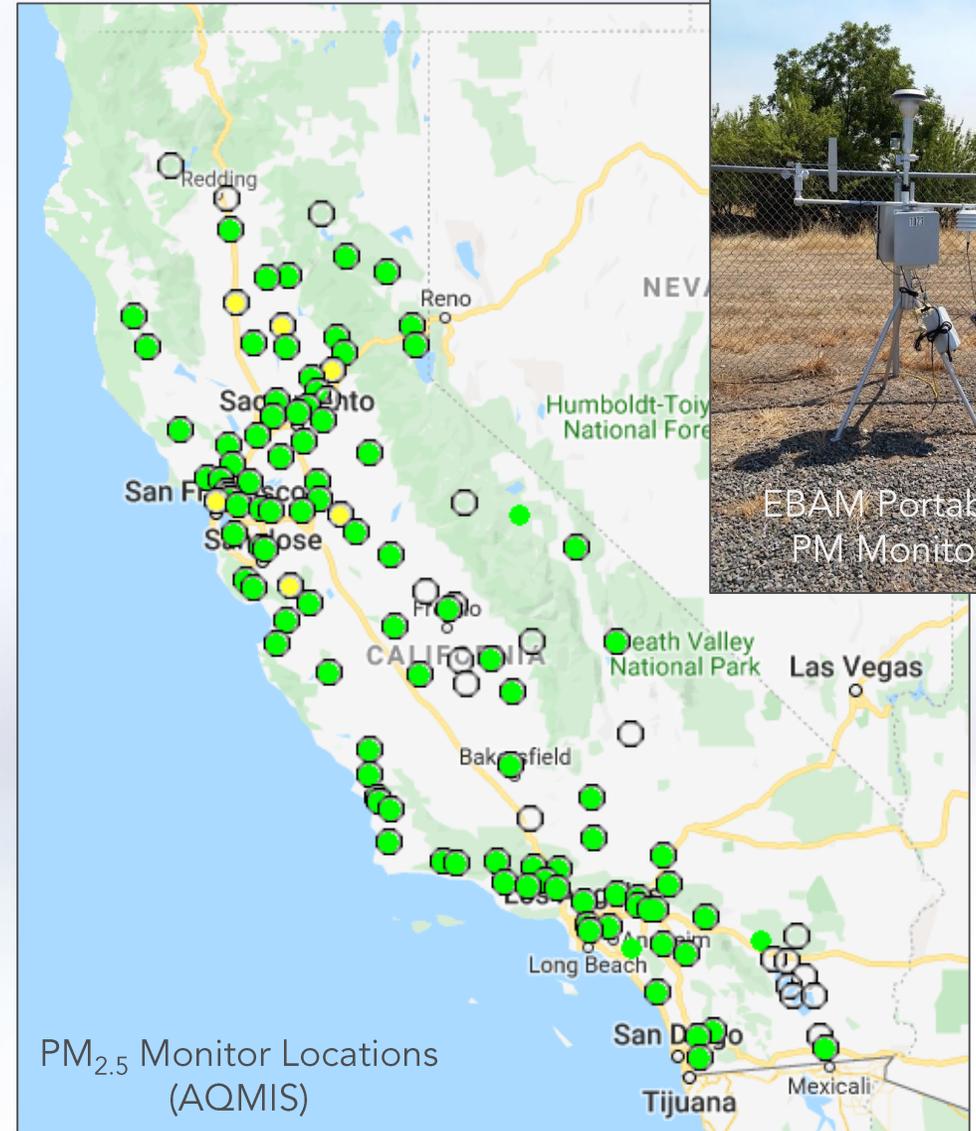
# What is Particulate Matter (PM)?

- PM<sub>2.5</sub> – particles less than 2.5 μm in diameter
  - Composed of small droplets of liquid, dry solid fragments, and solid cores with liquid coatings
  - Major constituent of smoke
- Smaller and lighter particles:
  - Stay in the air longer
  - Have greater surface area and therefore greater potential to carry toxic substances
  - Can penetrate more deeply into the lungs or even the bloodstream



# PM Monitoring Network

- **PM Monitors**
  - 233 PM<sub>2.5</sub> Monitors in California
  - 305 PM<sub>10</sub> Monitors in California
  - 538 Total PM Monitors in California
  - 38 PM Monitors in Mexico (4 PM<sub>2.5</sub>, 34 PM<sub>10</sub>)
- The California PM monitoring network is composed of both continuously sampling monitors that report hourly and filter-based monitors that report on a daily or less frequent basis
- Portable monitors may also be deployed during emergencies and events, such as wildfires
- Due to recent innovations in sensor technology, CARB, local agencies, individuals, and private companies are also deploying low-cost PM<sub>2.5</sub> sensors
- **Meteorological Monitors**
  - >1000 in California



# Messaging PM<sub>2.5</sub> Concentrations

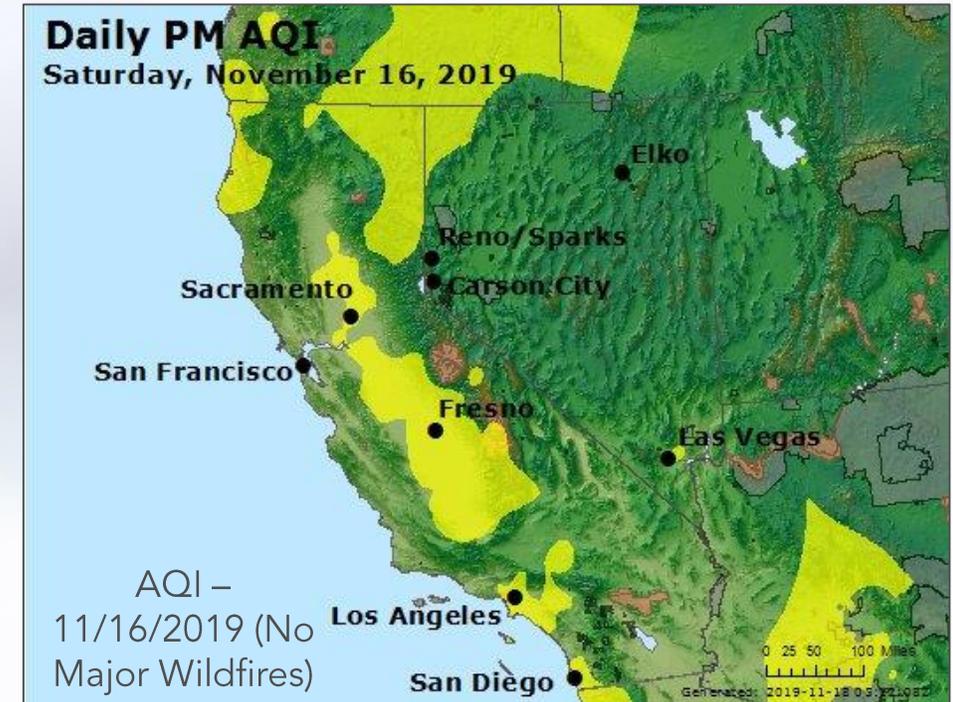
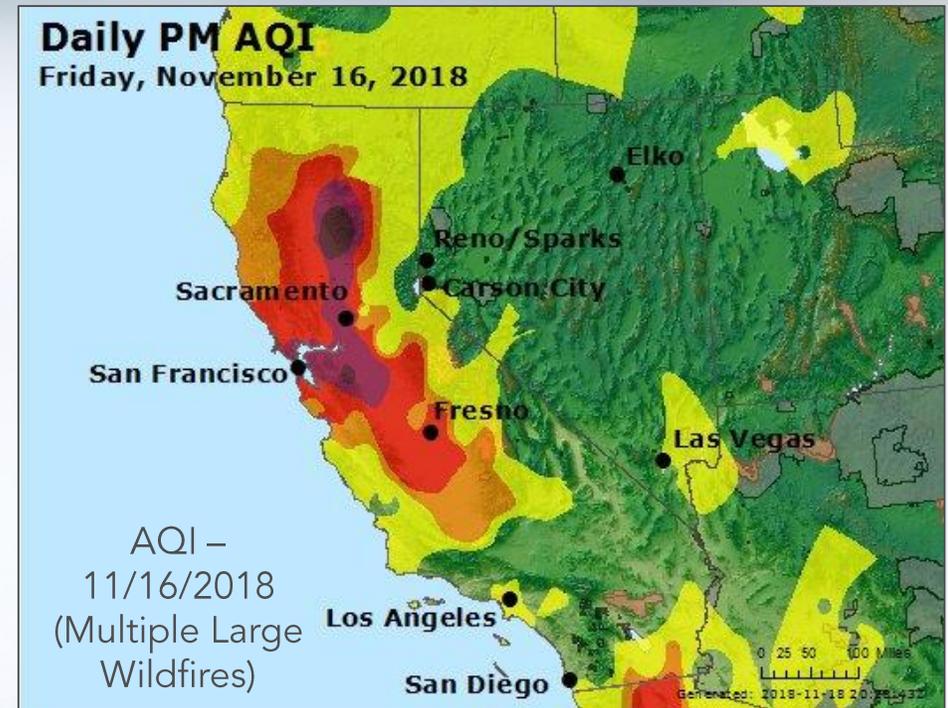
How do we message PM<sub>2.5</sub> concentrations and add meaning for the public?

- Color-code for easy interpretation
- Relate to health information
- Recommend Activity modification recommendations

Most air quality scales are based on the U.S. EPA's Air Quality Index (AQI)

# What is the Air Quality Index (AQI)?

- AQI – U.S. EPA’s index for reporting daily air quality to public
  - Converts concentrations to a number that can be categorized based on color-coded scale
  - Tells how clean or unhealthy the air is
  - Informs what associated health effects might be of concern
  - Provides some cautionary guidance
  - Standard AQI values are based on daily pollutant concentration averages
  - The critical pollutant is used to determine daily AQI
- U.S. EPA AirNow site provides the *NowCast* AQI, which is the current AQI based on a weighted moving average of the past 12 hours of PM<sub>2.5</sub> concentrations
- AirNow provides current and forecasted AQI (U.S. EPA’s Public AQI Website): <https://www.AirNow.gov>

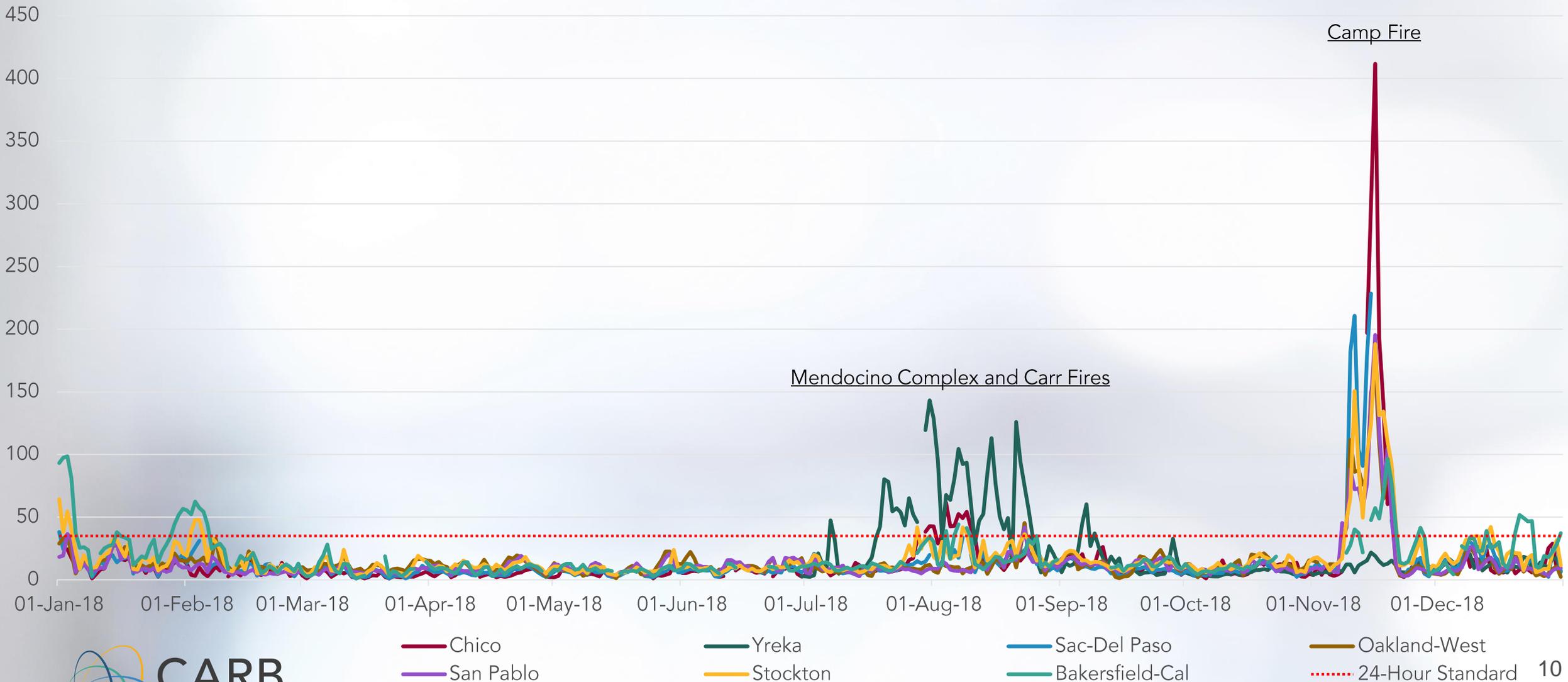


# AQI Levels & Messaging

24-hr Avg. [PM <sub>2.5</sub> ] (µg/m <sup>3</sup> )	AQI Value	AQI Category	Health Message	AQI Color
0 – 12.0	0-50	Good	None	Green
12.1 – 35.4	51-100	Moderate	Unusually sensitive people should reduce prolonged or heavy exertion	Yellow
35.5 – 55.4	101-150	Unhealthy for Sensitive Groups	Sensitive groups should reduce prolonged or heavy exertion	Orange
55.5 – 150.4	151-200	Unhealthy	Sensitive groups should avoid prolonged or heavy exertion; general public should reduce prolonged or heavy exertion	Red
150.5 – 250.4	201-300	Very Unhealthy	Sensitive groups should avoid all physical activity outdoors; general public should avoid prolonged or heavy exertion	Purple
250.5 - 500.4	301-500	Hazardous	Everyone should avoid all physical activity outdoors	Maroon

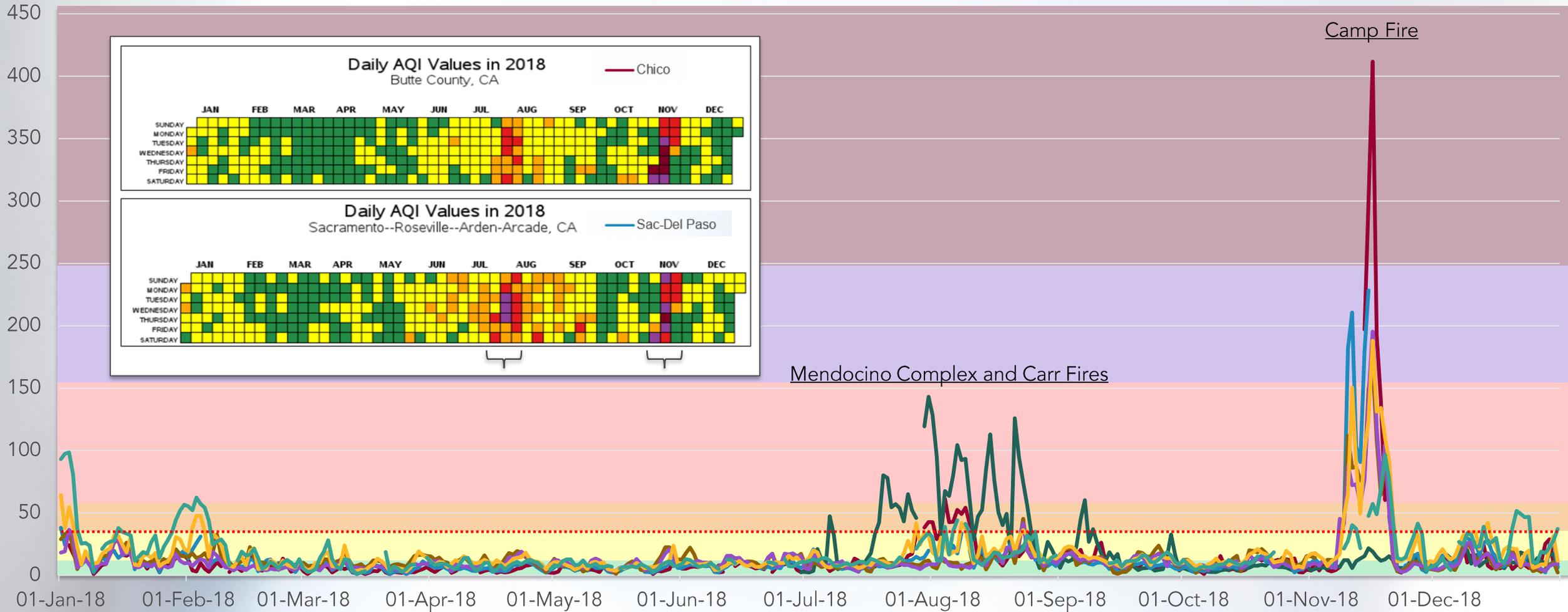
# Impacts from Fires – 2018 PM<sub>2.5</sub>

2018 Daily Average PM<sub>2.5</sub> Concentrations



# Impacts from Fires – 2018 PM<sub>2.5</sub>

2018 Daily Average PM<sub>2.5</sub> Concentrations



# The 2018 Camp Fire

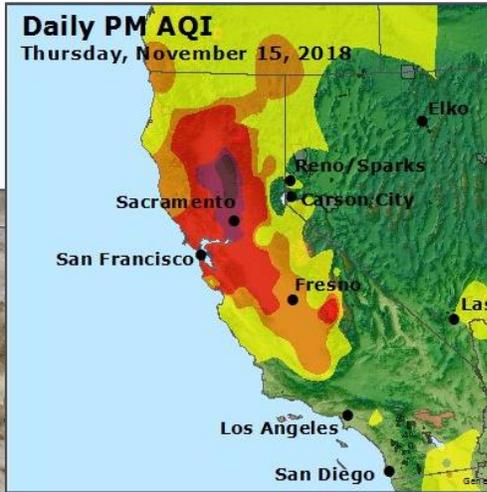
Deadliest and Most Destructive California Wildfire to Date

153,336 Acres  
(Nov 8 – Nov 25, 2018)

18,804 Structures Destroyed  
85 Fatalities

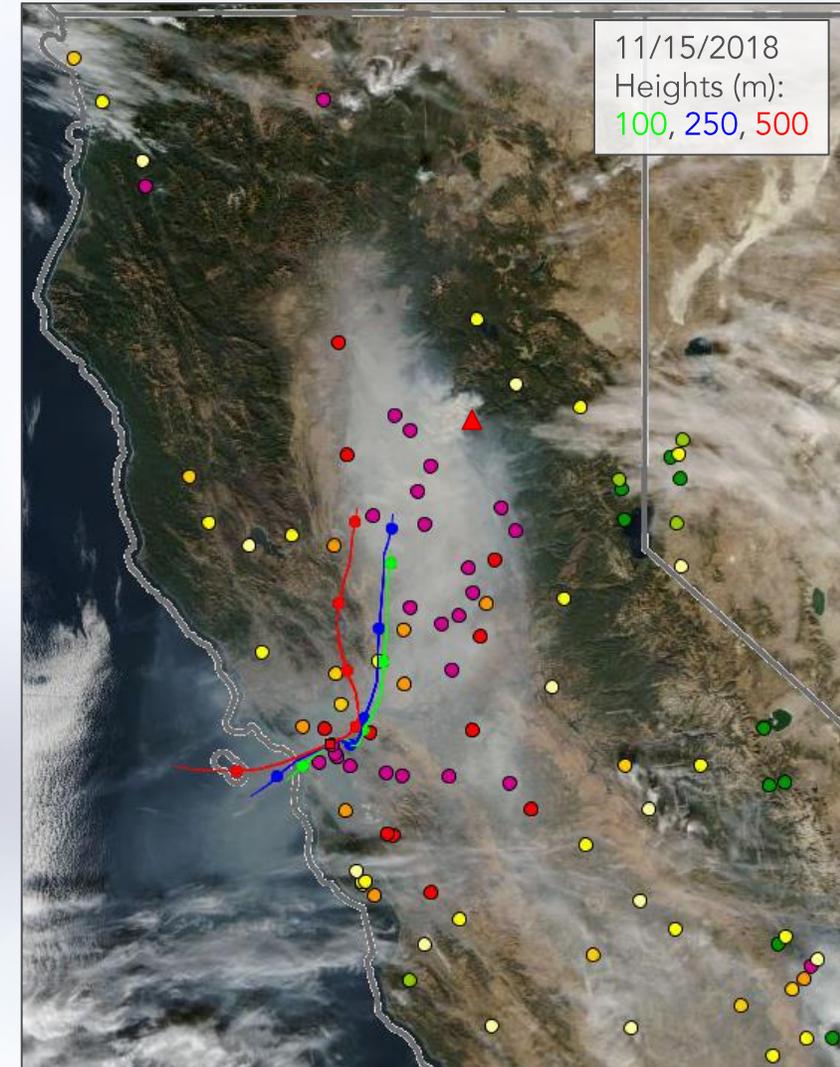
9 Agencies  
1,065 Fire Personnel  
11 Crews  
  
2 Helicopters  
73 Engines  
3 Dozers  
3 Water Tenders

# Air Quality During the 2018 Camp Fire



- Hazardous conditions affected a large portion of California
- Satellite imagery shows California's central valley filled with smoke

- Back trajectories can be used to trace smoke back to the Camp Fire
- Forecasting can help predict where to deploy additional monitoring resources

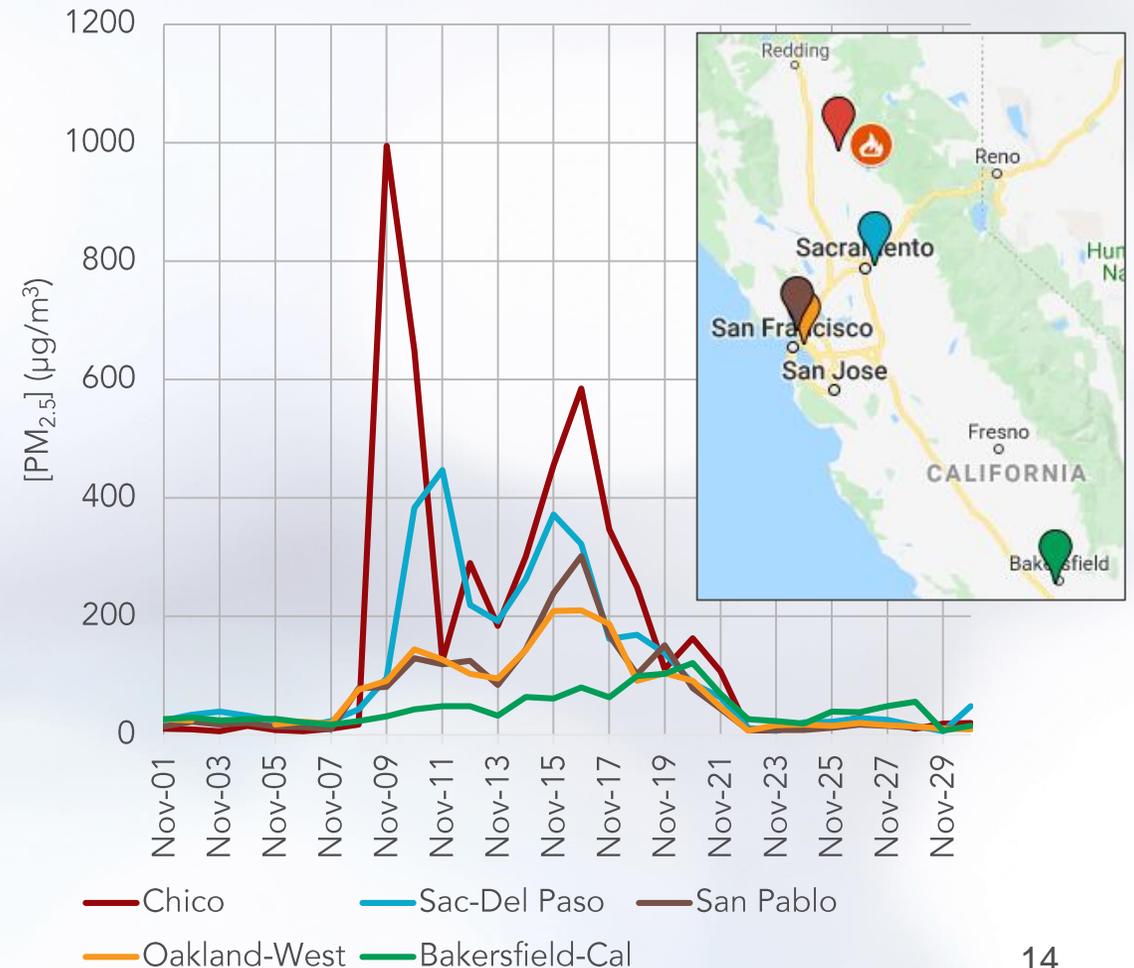


24-Hour Back Trajectories and 8-Hour Forecast for a Bay Area PM<sub>2.5</sub> Monitor (AirNowTech)

# PM<sub>2.5</sub> Measurements during the Camp Fire

- Typical November maximum hourly concentrations at the Chico site are <math><100 \mu\text{g}/\text{m}^3</math>
- During the Camp Fire, maximum hourly PM<sub>2.5</sub> concentrations >500  $\mu\text{g}/\text{m}^3$  were measured
- Average daily PM<sub>2.5</sub> concentrations near the fire exceeded 400  $\mu\text{g}/\text{m}^3$
- Many northern California monitors showed 24-hour average PM<sub>2.5</sub> concentrations considered unhealthy for nearly the duration of the Camp Fire

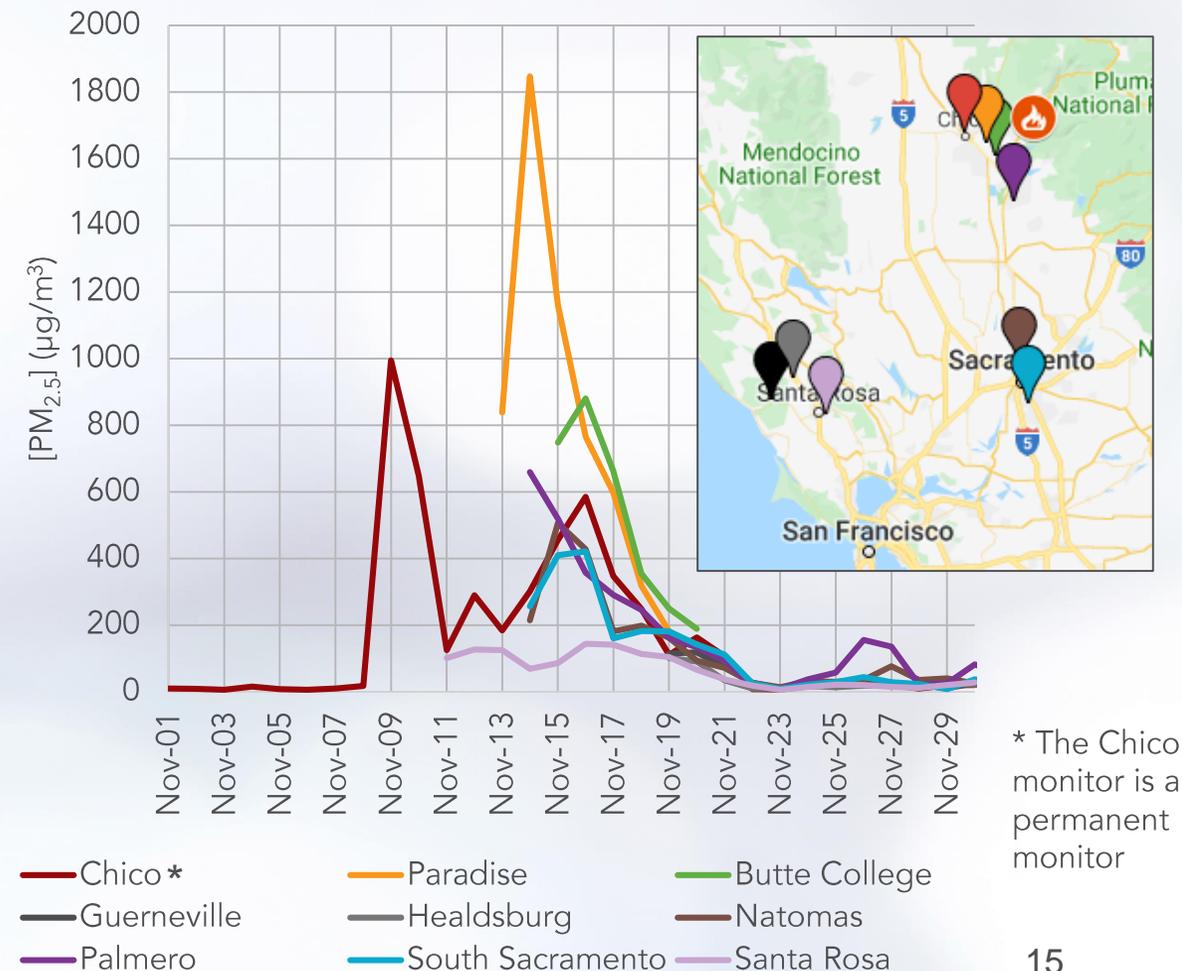
Daily Maximum 1-Hour PM<sub>2.5</sub> Concentrations during the Camp Fire



# EBAM PM<sub>2.5</sub> Measurements during the Camp Fire

- 8 portable PM<sub>2.5</sub> monitors (EBAMs) were deployed to augment monitoring during the Camp Fire
- The EBAM deployed in Paradise showed greater maximum concentrations than were observed at the permanent monitor in Chico
- PM<sub>2.5</sub> concentrations >1800 µg/m<sup>3</sup> were observed in Paradise

EBAM Daily Maximum 1-Hour PM<sub>2.5</sub> Concentrations during the Camp Fire



# Air Quality Impacts on People

- Air quality at a monitor does not necessarily equal what you are exposed to during a fire
  - Smoke may all be aloft and not at the ground level where we breathe
  - Smoke may be at the ground level but an elevated air quality monitor (e.g., on top of a building) may make things look better than they actually are
  - The closest air quality monitor may be too far to accurately represent your local conditions
- Expanding the monitoring network:
  - Agencies deploy temporary monitors to better represent conditions at the ground level where we breathe
  - Low cost sensors to supplement gaps in the regulatory air quality monitoring network



Smoke effects on San Francisco  
(James R Morrin Jr)



Fighting the Camp Fire  
(Reuters)

# Summary – Air Quality During Wildfires

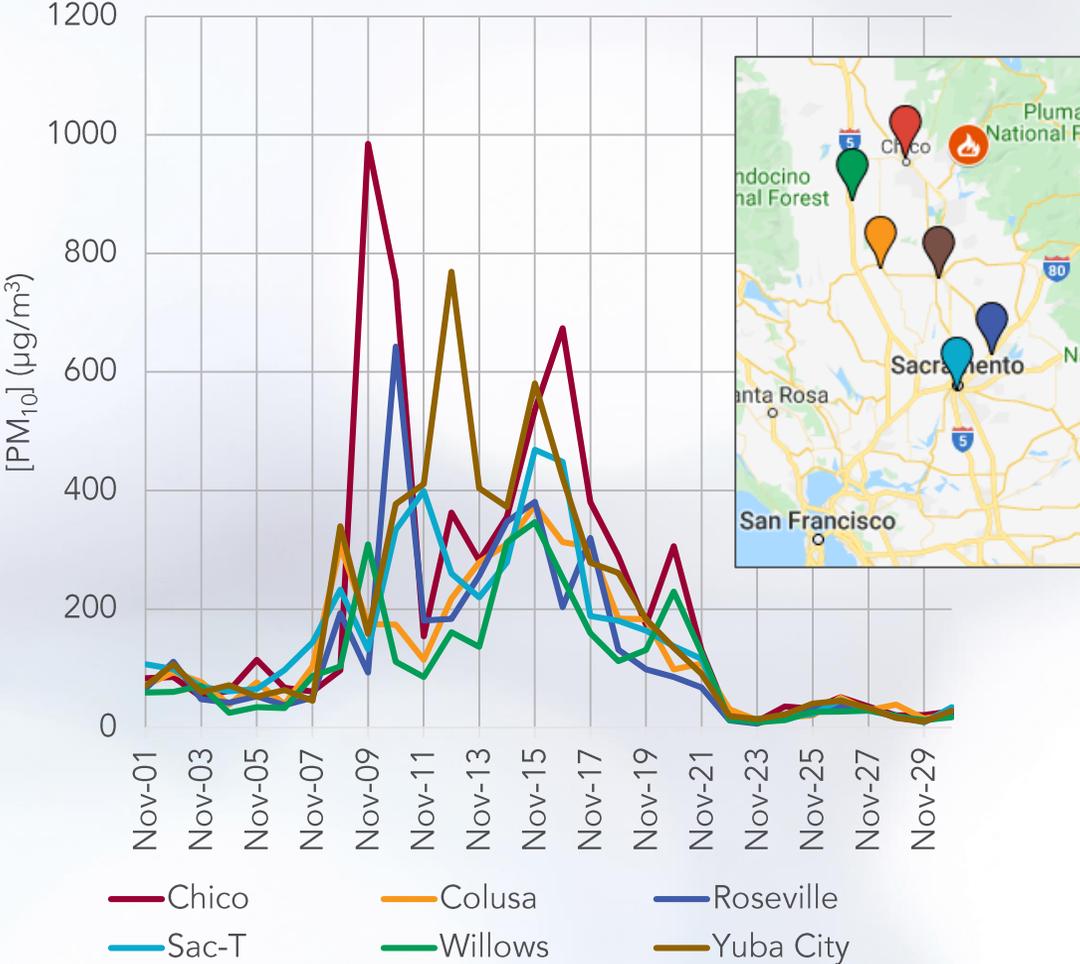
- Wildfire smoke contains a complex mixture of particle pollution, gases, and toxic air contaminants, and can produce ozone
- PM<sub>2.5</sub> in smoke can penetrate deep into the lungs and cause serious health effects
- During wildfires, particle pollution can reach hazardous levels, even many miles from the fire source
- The U.S. EPA's AQI can serve as a general guide for air quality conditions, but keep in mind air quality may differ between you and the monitor

# EXTRA SLIDES

# PM<sub>10</sub> Measurements during the Camp Fire

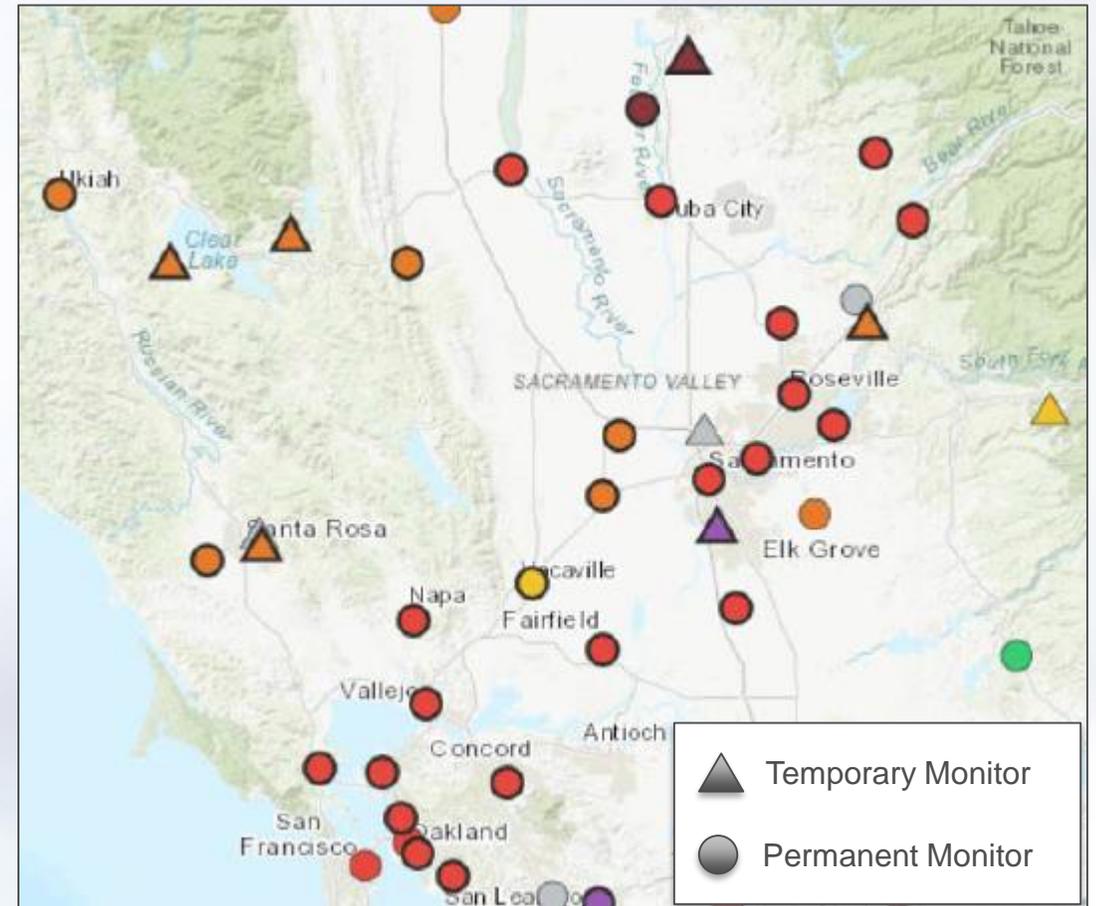
- Typical November hourly concentrations at the Chico site are <100 µg/m<sup>3</sup>
- During the Camp Fire, hourly PM<sub>10</sub> concentrations >600 µg/m<sup>3</sup> were measured
- Average daily PM<sub>10</sub> concentrations near the fire exceeded 300 µg/m<sup>3</sup>

Daily Maximum 1-Hour PM<sub>10</sub> Concentrations during the Camp Fire



# Temporary Monitors During the Camp Fire

- 11/9
  - CARB delivered 2 portable air monitors and 11 air quality sensors to Butte County AQMD.
- 11/12
  - CARB deployed 1 monitor to the city of Santa Rosa in Sonoma County.
- 11/13
  - Butte County AQMD deployed 1 monitor to the community of Chico-Tuscan Ridge.
- 11/14
  - CARB deployed 1 monitor to the community of Palermo, which is located in Butte County.
  - CARB deployed 2 portable monitors in Sacramento County, in the communities of South Sacramento and Natomas.
  - A U.S. Forest Service Air Resource Advisor was assigned to assist the Camp Fire's incident management team with predicting smoke impacts and forecasting air quality impacts.
- 11/15
  - Sacramento AQMD picked up 1 monitor from the Sacramento cache to deploy if additional monitoring is required in the Sacramento area.
- 11/19
  - CARB plans to deploy 2 monitors to the communities of Healdsburg and Guerneville at the request of Northern Sonoma County APCD.



PM<sub>2.5</sub> Monitor Locations During the Camp Fire (AirFire)

# Regulatory Perspective

- Air quality is monitored for purposes of meeting health-protective National Ambient Air Quality Standards (NAAQS) set by the U.S. EPA
- Exceptional events - unusual or naturally occurring events that affect air quality but are not reasonably controllable
- Done to avoid placing unreasonable planning requirements on air quality agencies due to these events that are unpredictable and largely uncontrollable and difficult/impossible to prevent
- Lengthy, involved process where agencies must prove the event could not be reasonably predicted or avoided



Smoke from the Camp and Woolsey Fires on November 10, 2018  
(NASA EOSDIS)

# Regulatory Perspective (continued)

What elements must be shown to prove an exceptional event in California?

1. The event, and resulting emissions, affected air quality and there exists a clear causal relationship between the event and the exceedance
2. The event was not reasonably controllable, and the event was not reasonably preventable
3. The event was a human activity that is unlikely to recur at a particular location OR was a natural event

How are these elements demonstrated?

- A narrative conceptual model that describes the event
- Analysis of a clear causal relationship between the event and the concentrations at the monitor
- Demonstration that the “not reasonably controllable and not reasonably preventable” criteria are satisfied
- Demonstration that the “unlikely to recur at a particular location or a natural event” criteria is satisfied
- Determination that event meets the definition of wildfire
- Determination that the mitigation criteria are satisfied
- Proof that the public comment and review process was followed

The PM data from the Camp Fire are considered impacted by an *Exceptional Event* for State designation purposes per CCR, title 17, chapter 1, subchapter 1.5, Appendix 2.

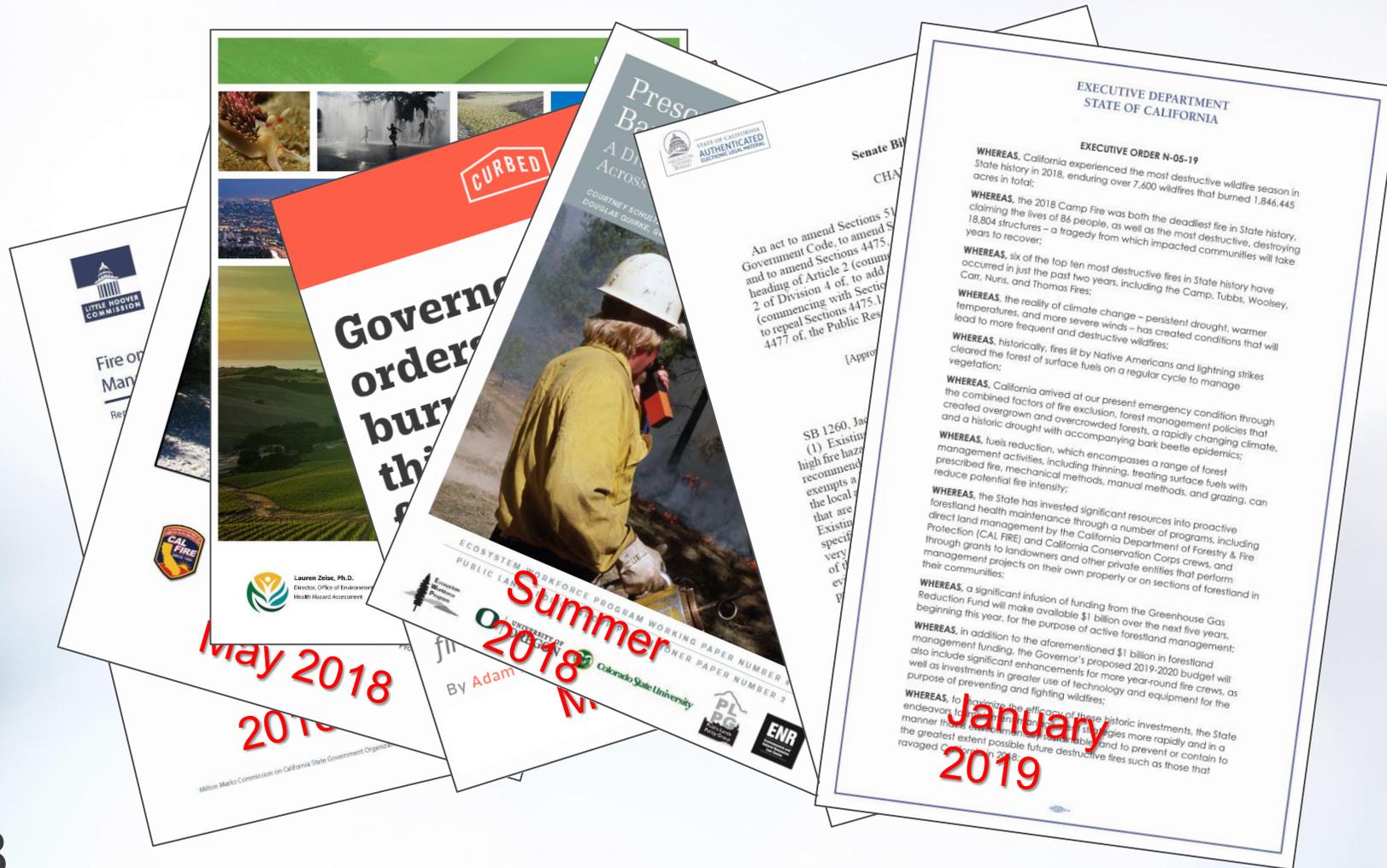
Actions are being taken to improve controlled burn strategies and prevent future disastrous wildfires.

# Prescribed Burning Reduces Risk of Wildfire



- ❑ Prescribed fire has been used for many years by Native Americans and land managers to reduce vegetation and risk of future wildfire.
- ❑ Conducted under controlled conditions and optimal meteorology.
- ❑ Less smoke exposure for the public than uncontrolled wildfires.
- ❑ Improves forest health and return to more natural ecosystem.
- ❑ Healthier, less dense forest stores more carbon, less susceptible to disease and future megafires.

# Recent Wildfires Trigger Reports and Legislative Action



# Common Recommendations

- ❑ Significantly increase the number of acres treated with prescribed fire.
  - ❑ Improve coordination between land management, air quality, and other agencies.
  - ❑ Allocate more resources to allow for more prescribed fire.
  - ❑ Streamline regulatory and permitting processes.
  - ❑ Educate the public about forest resiliency and the need for fire on the landscape.

