



Research Brief for Resource Managers

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Wildland Firefighter Exposure to Hydrocarbons

Navarro, Kathleen, Ricardo Cisneros, Elizabeth Noth, John R. Balmes, and S. Katharine Hammond. 2017. Occupational Exposure to Polycyclic Aromatic Hydrocarbon of Wildland Firefighters at Prescribed and Wildland Fires. Environmental Science & Technology. DOI: [10.1021/acs.est.7b00950](https://doi.org/10.1021/acs.est.7b00950)

Wildland firefighters suppressing wildland fires or conducting prescribed fires work long shifts and are exposed to high levels of smoke with no respiratory protection. Inhalation of smoke is a safety concern for wildland firefighters and can potentially impair their performance and cause short and long term health impacts.

What is in Smoke? How can it affect health?

Wildland fires emit large amounts of air pollutants known to cause adverse health effects. Previous studies of wildland firefighters have shown that smoke exposure is associated with increases in airway responsiveness, decreases in lung function, and a significant increase in inflammation markers in the body. Past assessments of wildland fires have measured levels of fine and respirable particulate matter (PM2.5 - PM4), acrolein, benzene, carbon dioxide, carbon monoxide, formaldehyde, crystalline silica, total particulates, and polycyclic aromatic hydrocarbons (PAHs), all of which have adverse health implications.

For this study, we focused on PAHs, which are a class of hazardous compounds that are known to cause cancer and are associated with cardiopulmonary mortality and decreased immune function (also called hydrocarbons).

Management Implications

- Both wildland and prescribed fires exposure firefighters to harmful air pollutants, include hydrocarbons or PAHs.
- Small changes in fire operations may have significant, positive effects on the long-term health of fire fighters.
- Holding and patrol have the highest exposure to PAHs.
- Prescribed fire operations result in less exposure to PAHs than wildland fire operations.



Figure 1 – Sampling equipment on line gear

Project Goals

The objective of our study was to characterize exposures of wildland firefighters suppressing wildland fires and conducting prescribed fires to

17 different PAH compounds. We also examined how exposures to PAHs were different for the various firefighter job tasks performed at wildland and prescribed fires.

Measuring Firefighter Exposures

We measured PAHs on 21 wildland firefighters while suppressing two wildland fires and 4 wildland firefighters conducting prescribed burns in California. Firefighters were asked to wear small sampling devices that were attached to their line gear while constructing fire breaks (fire line), operating fire engines (engine operator), inspecting the active fire perimeter (holding), patrolling the fire perimeter (patrol) and extinguishing burning material post-fire (mop-up).

Samples were analyzed for 17 PAHs following standard analysis methods accounting for quality control of samples.



Figure 2 – Firefighter performing firing at a prescribed fire

Project Findings

We found measurable concentrations of 17 PAHs in personal samples on firefighters at prescribed and wildland fires.

Naphthalene, a PAH that can cause cancer in animals, was consistently the highest measured PAH. In our study, firefighters working on wildland fires were exposed to higher concentrations of PAHs compared to the

firefighters working on prescribed burns. Of the job tasks that were sampled, holding and patrol at wildland fires and firing/holding at prescribed fires consistently had the highest measured concentrations of PAHs. Holding often involves standing in high smoke situations to ensure that the fire does not spread outside of containment lines. While firefighters performing firing operations can be exposed to PAHs from the smoke from the fire they are igniting, the task also involves the combusting of a diesel/gasoline fuel mixture.

Conclusions

Our study demonstrated that although concentrations do not exceed current occupational exposure limits, wildland firefighters are exposed to PAHs not only on the fire line at wildland fires, but also while working prescribed burns. PAH concentrations were highest for wildland firefighters during job tasks that involve the most direct contact with smoke near an actively burning wildland fire. Determining exposures from wildland fires is important to better understand any potential long or short-term health effects, especially since wearing respiratory protection is not feasible for wildland firefighters due to their extreme work conditions.

Reducing Exposure to Smoke - Mitigation Strategies

- Firing – rotate individuals between firing and other crew duties being performed
- Mop-up – when conditions allow, mop-up only enough to secure fire line (50 vs. 300ft)
- Holding – if possible rotate crews or individuals in and out of areas with higher smoke exposure

These strategies may only lower exposure to smoke by a small amount each day. However, if used, they may reduce total smoke exposure throughout a firefighter's career which may contribute to a lower risk of developing adverse health effects associated with smoke exposure.