

Minimizing the Impacts of Wildfire Smoke on Cattle

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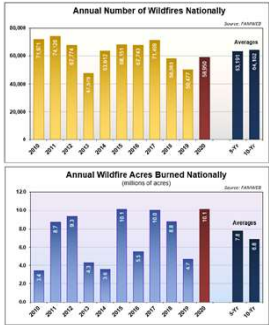
Impacts of wildfire smoke on dairy cattle and opportunities to minimize harm

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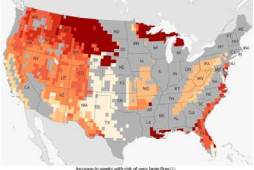
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Why are wildfires a concern?



- Wildfires becoming more frequent, severe
- In 2021 - 58,985 fires, 7.1 million acres burned
- In 2022 - 59,441 fires, 7.2 million acres burned
- 74% to 118% increase in wildfire area burned by next century
- Land/structures burned and air toxics released



(NOAA, based on data from Barbera et al., 2015.)

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Particulate matter (PM)

- PM₁₀ - particles between 2.5 – 10 μm
- PM_{2.5} - particles smaller than 2.5 μm in diameter
- PM inhaled into lungs, deposit in airways
- PM_{2.5} particles are especially harmful
- PM_{2.5} can enter bloodstream
- U.S. EPA - PM_{2.5} emissions as a criteria pollutant

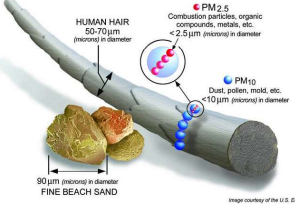



Image courtesy of the U.S. EPA

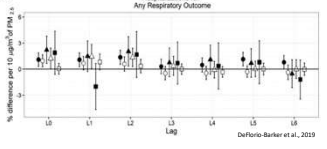
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Effects of wildfire PM in humans



- Pulmonary effects**
 - ↑ Lung disease/damage
 - ↓ Lung function
 - ↑ Pulmonary hospitalizations
- Cardiovascular effects**
 - ↑ Cardiovascular hospitalizations
 - ↓ Cardiovascular health
- Death**
 - ↑ Premature mortality
 - ↑ Positive association between mortality and smoke-affected days

Effects largely attributable to inflammation and oxidative stress

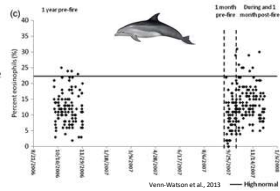


Johnston et al., 2012; Reid et al., 2016; DeFlorio-Barker et al., 2019

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Effects of PM in animals

- Captive bottle nose dolphins - wildfire PM changes blood composition
- Orangutans – wildfire PM decrease energy expenditure & negative energy balance
- PM₁₀ increase risk of pulmonary lesions in pigs

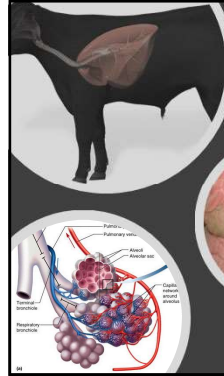


Verni-Watson et al., 2013; Michiels et al. 2015; Erb et al., 2018

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Bovine pulmonary system

- Fewer pulmonary capillaries per alveolar section
- Lower lung compliance and greater resistance
- Longer trachea and bronchi
- Lower lysozyme levels
- Fewer alveolar macrophages

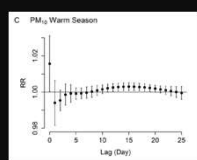
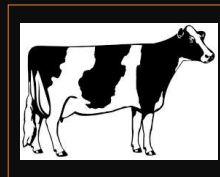


Mariassy et al., 1975; Veit & Farrell 1978; Kirschvink, 2008; Terry and Traystman, 2016

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Effects of PM in cattle

- PM exposure ↑ dairy cattle mortality
- Air pollution ↑ dairy calf mortality
- PM associated with elevated lung neutrophil and epithelial cell count and pneumonia in dairy calves
- Ambient PM_{2.5} and THI ↓ milk yield and ↑ SCC
- Our preliminary study – Wildfire-derived PM_{2.5} associated with general illness in cows and mortality in calves

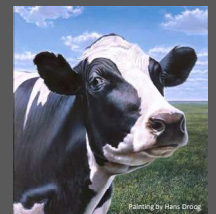
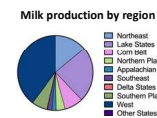
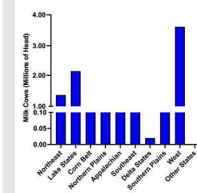


Cox et al., 2016; Egberts et al., 2019; Anderson et al., 2020; van Leeman et al., 2021; Beaupied et al., 2021

Cox et al., 2020

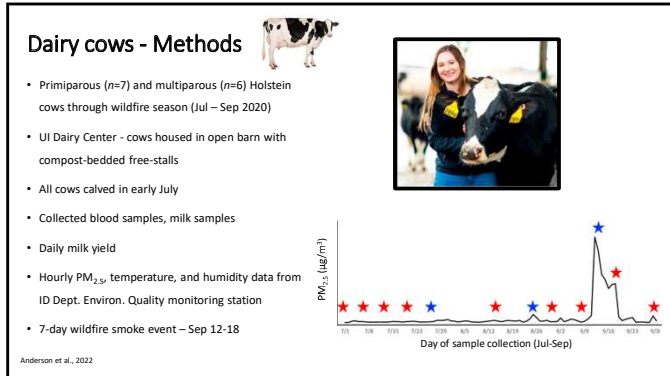
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Dairy industry in the western U.S.

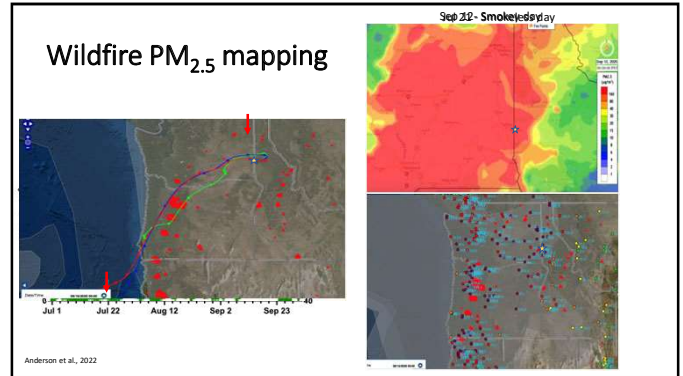


Painting by Hans Grogg

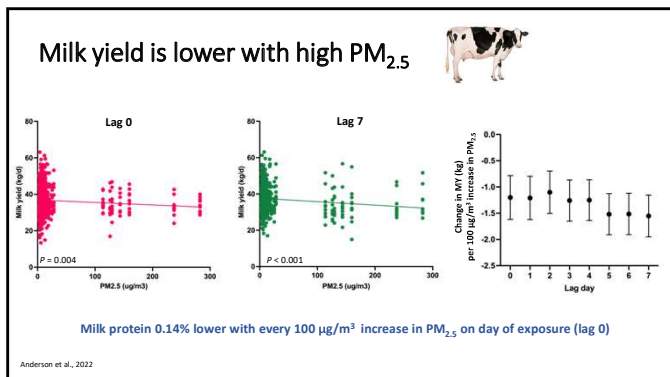
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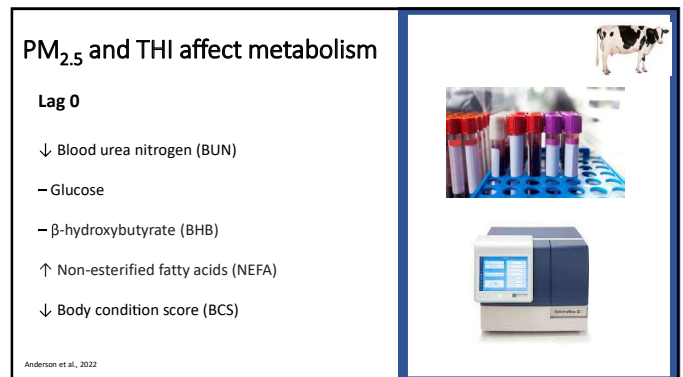
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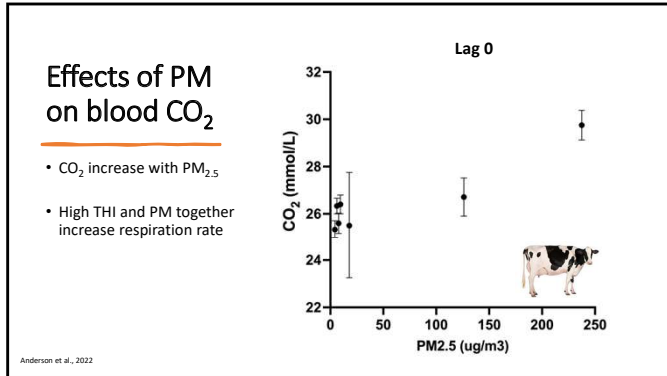
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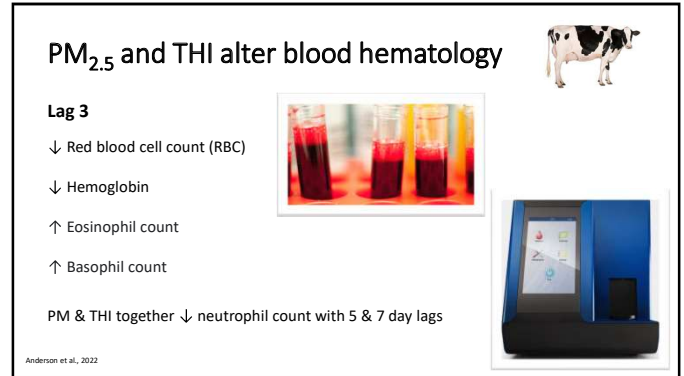
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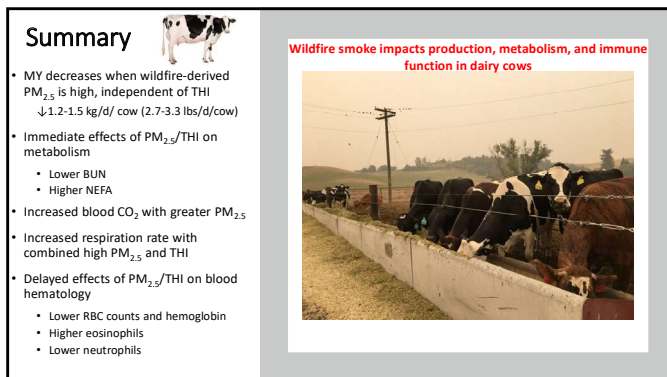
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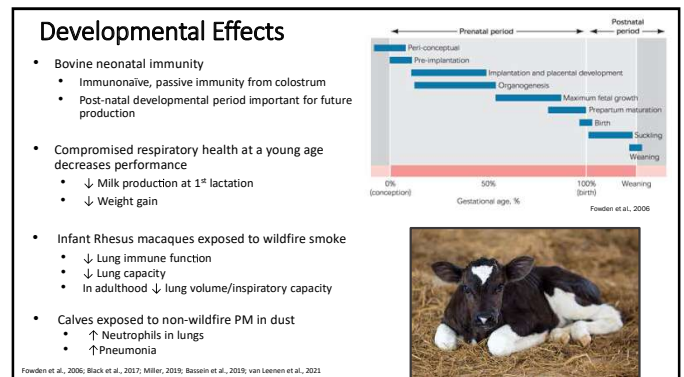
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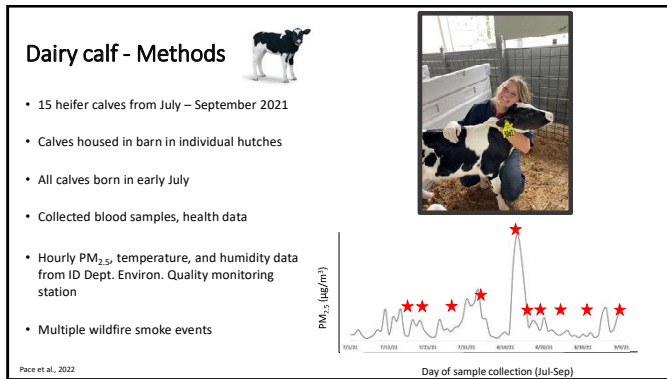
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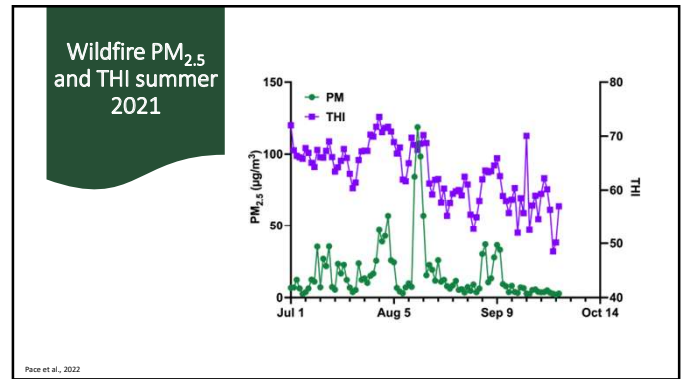
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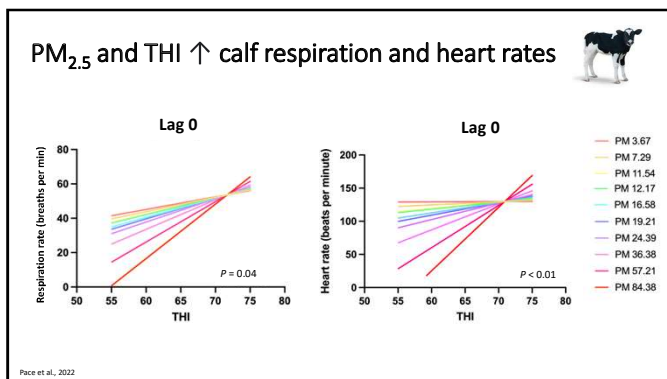
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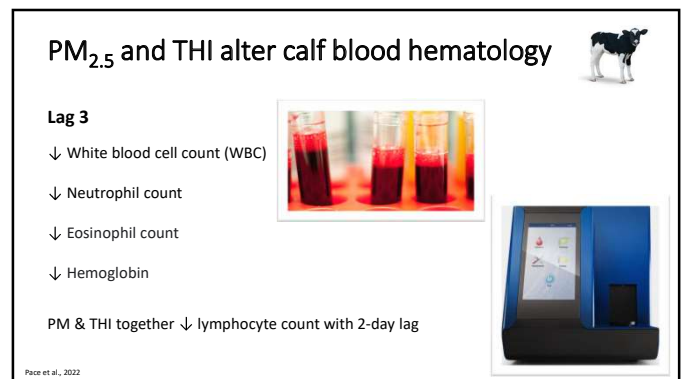
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PM_{2.5} and THI impacts calf health scores

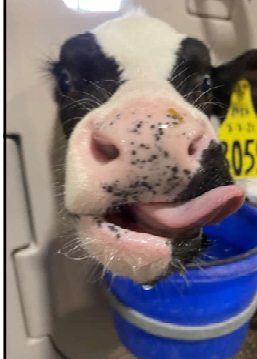


- Scoring system**
 - Nasal score** (0 to 3; 0 = normal discharge, 1 = small amount of cloudy discharge, 2 = bilateral cloudy/mucus discharge, 3 = copious bilateral discharge)
 - Eye score** (0 to 3; 0 = normal discharge, 1 = small amount of discharge, 2 = moderate amount of bilateral discharge, 3 = heavy discharge)
 - Fecal score** (0 to 3; 0 = normal, 1 = semi-formed and pasty, 2 = loose, but stays on top of bedding, 3 = watery, sifts)
 - Cough score** (0 = None, 1 = induced single cough, 2 = induced repeated coughs, 3 = repeated spontaneous coughs)
- Results**
 - 3-4 d lag, increased THI and PM_{2.5} increase eye score
 - 3 d lag, increased THI and PM_{2.5} increase cough score

Pace et al., 2022

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Summary & Conclusions: PM_{2.5} effects on calves



- Total WBC count and specific WBC populations reduced with combination of high THI and PM_{2.5}
 - Lower hemoglobin
 - Lower white blood cells
- Elevated respiration and heart rates with increases in both THI and PM_{2.5}
- Increase eye discharge and cough with greater THI and PM_{2.5}

Wildfire smoke impacts calf immune status and health

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Conclusions and Future Directions

- Important to understand how wildfire smoke events affect cattle health and performance
- In western U.S. addressing heat stress only will not obviate reduced milk production in summer
- Management strategies/interventions to improve productivity?

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Tips for protecting livestock



- Monitor animals
- Limit exercise during periods of smoke
- Make sure animals have adequate water
- Keep animals indoors
- Allow animals time to heal
- Good barn and field maintenance
- Have an evacuation plan
- Check out <https://livestockwildfirehub.org>

AVMA <https://www.avma.org/resources/pet-owners/emergencycare/wildfire-smoke-and-animals>
Ranches, 2020 <https://extension.oregonstate.edu/animals/livestock/beef/how-protect-pets-livestock-wildfire-smoke>

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