Nutrients in smoke: Is there a link with algal blooms in downwind waterbodies?

Nicole Olson and Stephen LeDuc

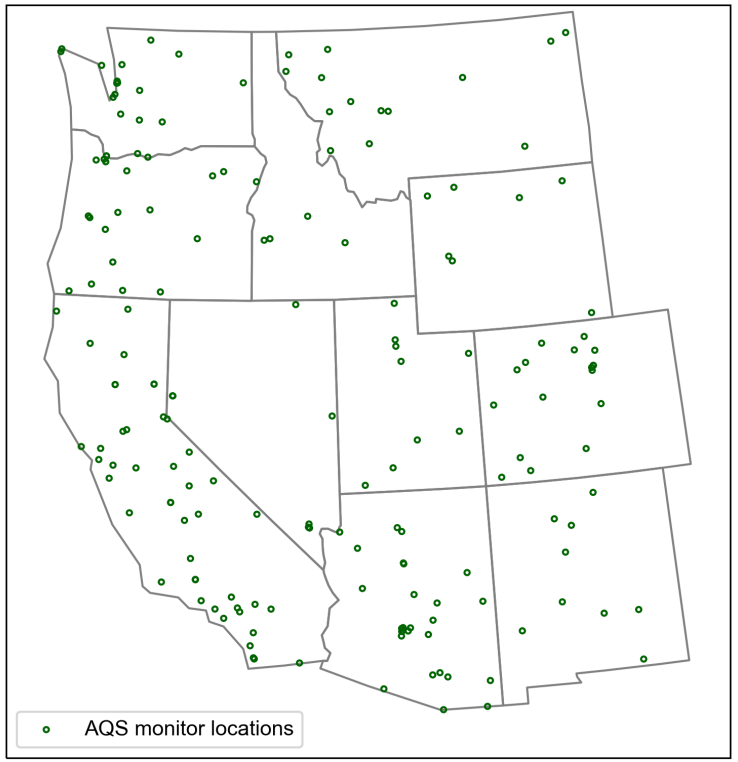
US Environmental Protection Agency, Office of Research and Development

(olson.nicole@epa.gov; leduc.stephen@epa.gov)

United States Environmental Protection Agency

Questions & Scope

1. What are the concentrations of atmospheric phosphorus (P) and other nutrients on smoke days compared to non-smoke days in the western US?
   - Used 15 years of $PM_{2.5}$-nutrient concentration data from over 300 air quality system (AQS) stations (over 2 million measurements)
   - Identified smoke days using NOAA's hazard mapping system
2. Are there cases where nutrients in wildfire smoke are associated with cyanobacteria abundance in downwind lakes?
   - Cyanobacteria are blue-green algae, detectable via remote sensing, often are P limited, and can produce cyanotoxins
   - Blooms identified in a limited number of lakes (10) downwind of several case study fires using EPA's CyAN



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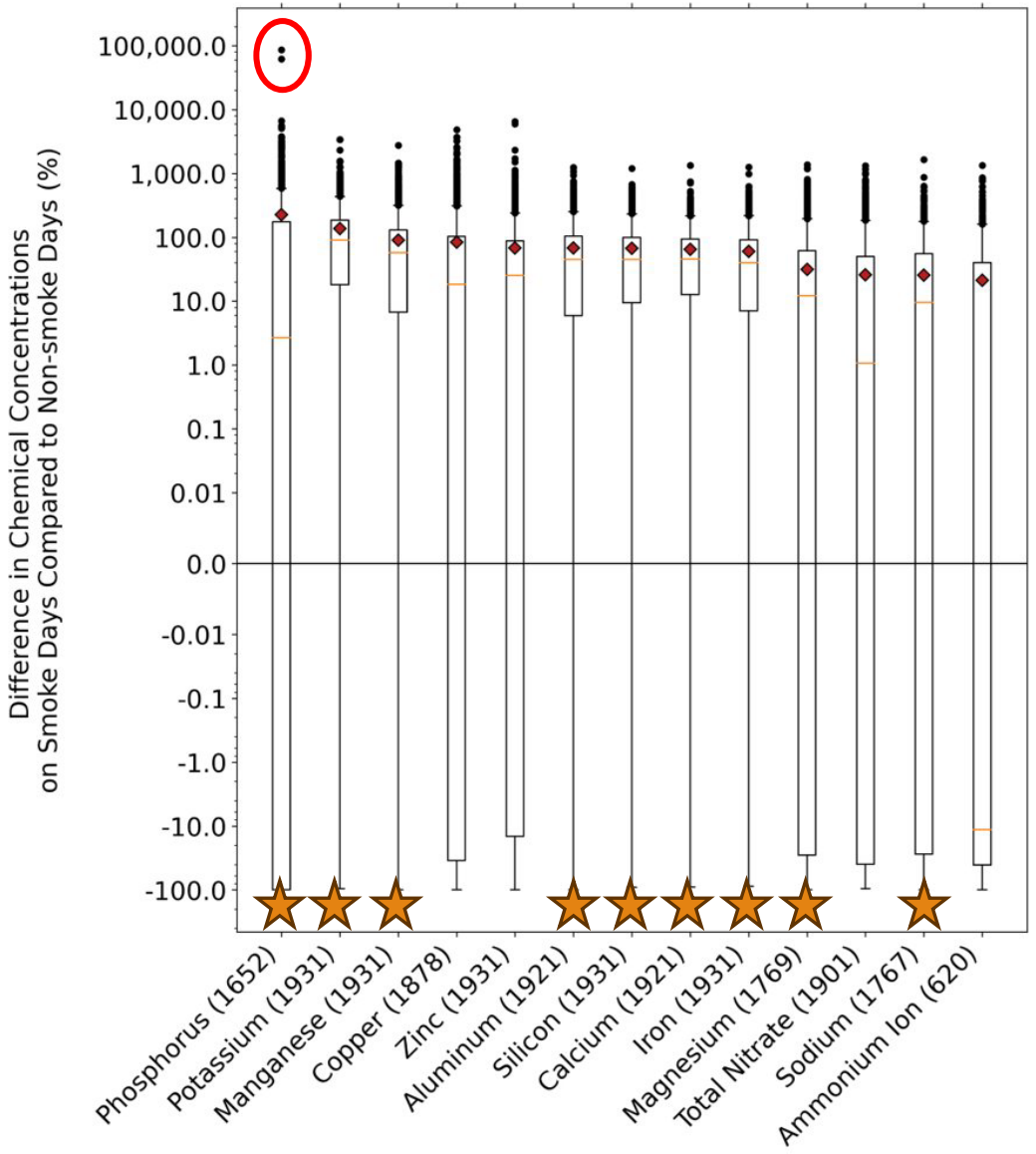
Results – Question 1

- Median nutrient concentrations were higher on smoke impacted days for all species except ammonium.
- Shown are the percent differences on smoke vs. non-smoke impacted days
- Orange stars denote species significantly elevated on smoke days.



Species	Max % Change
Phosphorus	85,907.3
Potassium	3,414.2
Manganese	2,751.9
Copper	4,871.9
Zinc	6,467.9
Aluminum	1,244.0
Silicon	1,201.1
Calcium	1,334.8
Iron	1,264.3
Magnesium	1,364.7
Nitrate	1,328.6
Sodium	1,640.8
Ammonium	1,343.4

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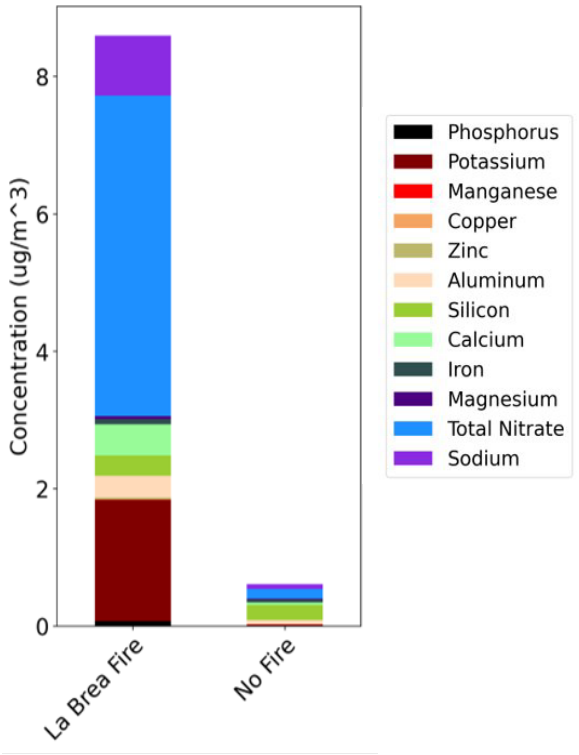
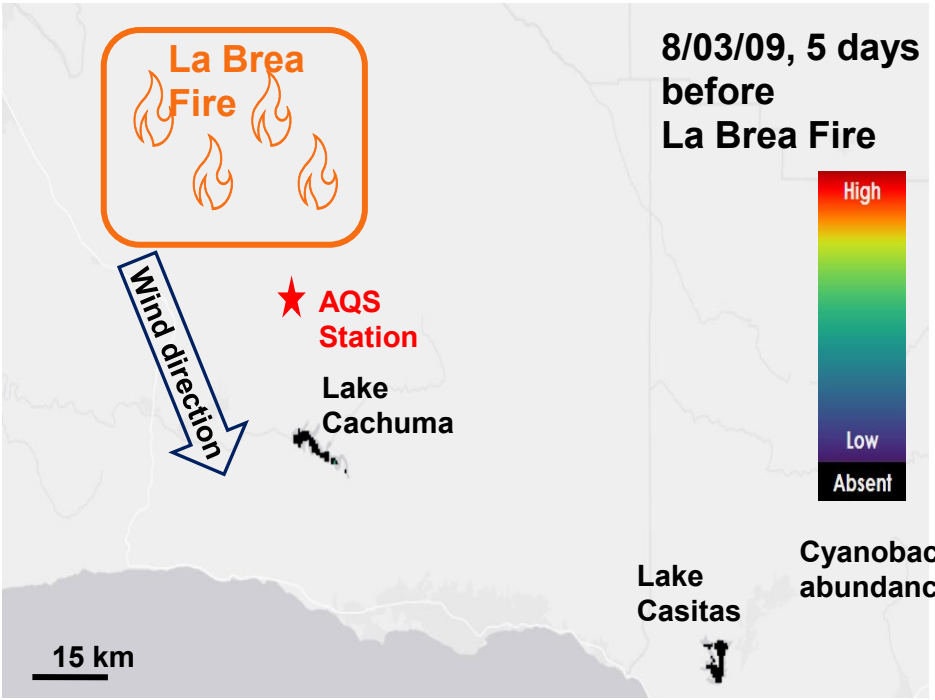
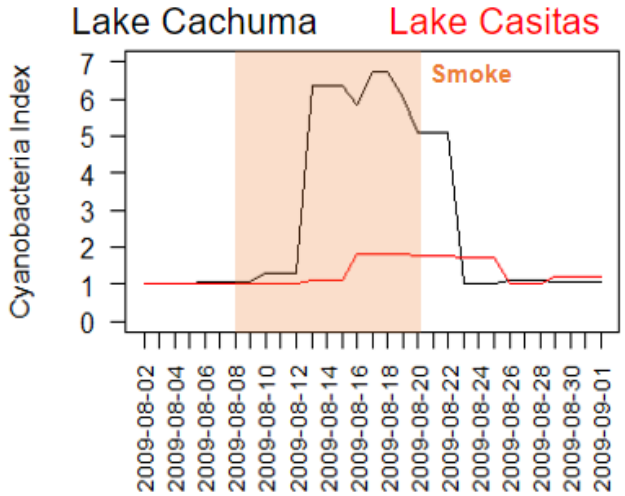
Results – Question 2

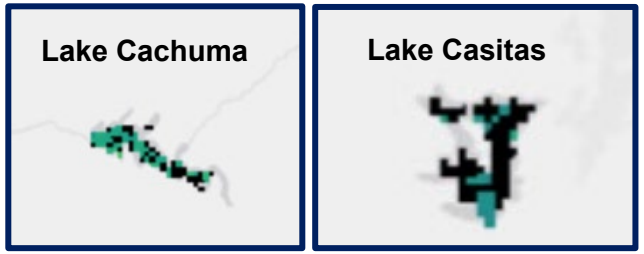
- We explored lakes downwind of several case study fires, and found 10 lakes where cyanobacteria abundance in downwind lakes was associated with wildfire smoke (e.g. La Brea Fire near Santa Barabara, CA in 2009)
- Now examining this potential relationship using statistical techniques across the entire lower 48, including the PNW outside of Alaska, using remote sensing data for 2000+ lakes
- Looking particularly at mountain lakes and lakes with otherwise low nutrient inputs







8/13/09, 5 days after start of La Brea Fire



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Questions or Comments?

For more information, see:

- Olson NE, Boaggio KL, Rice RB, Foley KM, LeDuc SD. 2023. Wildfires in the western United States are mobilizing PM 2.5-associated nutrients and may be contributing to downwind cyanobacteria blooms. *Environmental Science: Processes & Impacts*

Image from Jeff Peterson (Retired, EPA)