Living with wildfires: Understanding direct & indirect impacts from the Wheeler to the Caldor Fires

Dr. Sudeep Chandra

TSAC
Tahoe Science Advisory Council

Global Water Center
University of Nevada, Reno
Solutions for sustainability℠

Outline for today's presentation

Fire as a natural process, fire regimes historically, humans (ignition and suppression), and our changed mountain ecosystems.

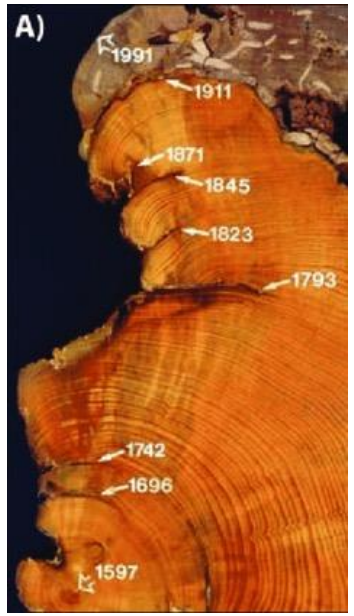
Tahoe fire related research (1985 to present) -> we are intimately connected to burns from far away and with the direct burning of our watershed.

Caldor and other wildfires -> initial responses from the Tahoe Science Advisory Council and member institutions

TSAC
Tahoe Science Advisory Council

A natural process, historically we had low intensity fires

- Prior to colonization, fires burned through the east shore of Lake Tahoe in MOST years but only all watersheds in 3 years
  - Frequent LOW INTENSITY fire
- Washoe tribe would spend summers near the lake and burn areas as they moved down in winter



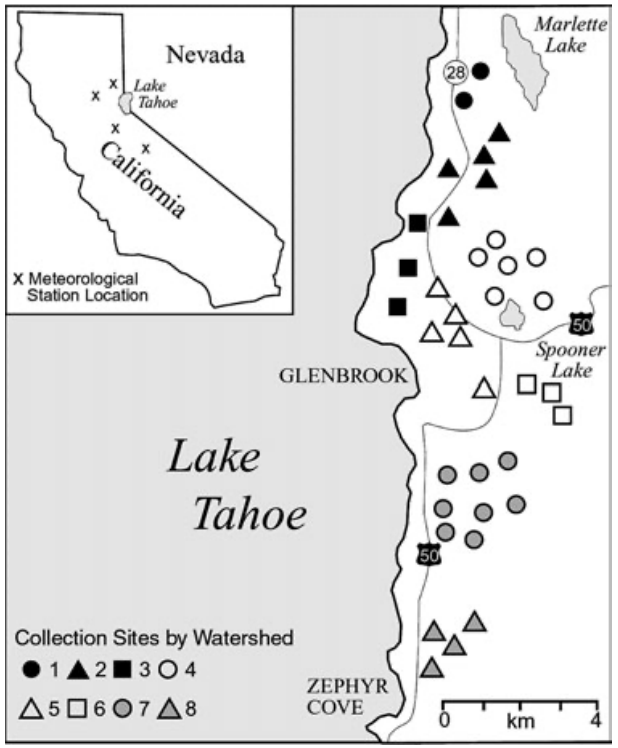
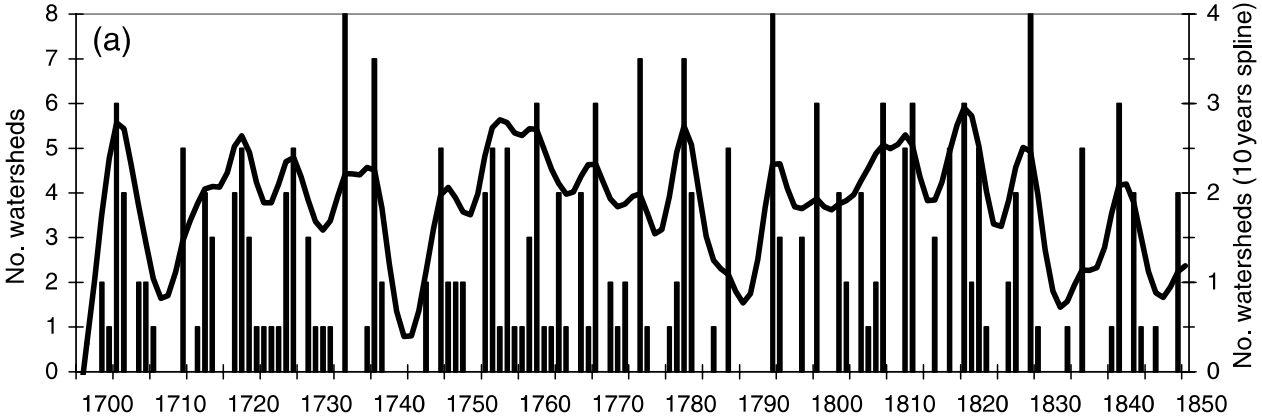


Figure 1 Location of fire scar collection sites by watershed unit, northern Sierra Nevada, Lake Tahoe, NV, USA.



Journal of Biogeography (J. Biogeogr.) (2005) **32**, 425–438

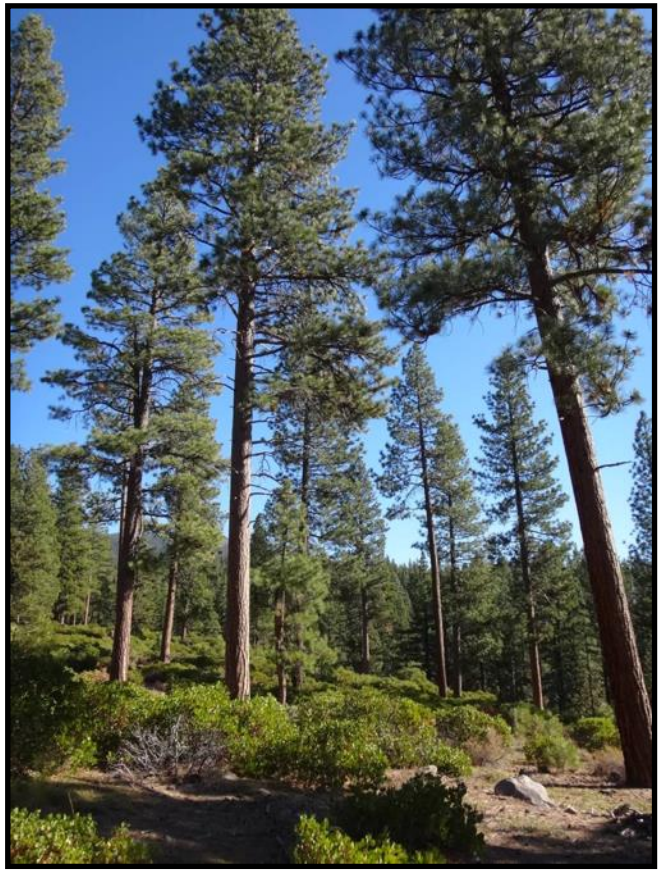
ORIGINAL ARTICLE

Climatic influences on fire regimes in the northern Sierra Nevada mountains, Lake Tahoe Basin, Nevada, USA

A. H. Taylor* and R. M. Beaty

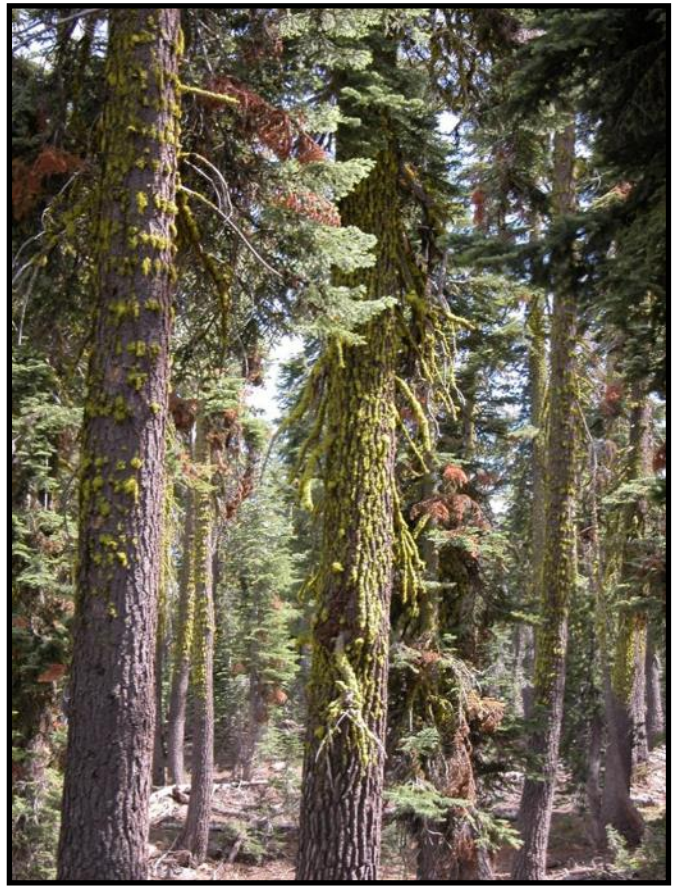
Sierra Nevada fire regimes vary by elevation and forest type

Eastside Woodland & Forest (Yellow Pine Forest)



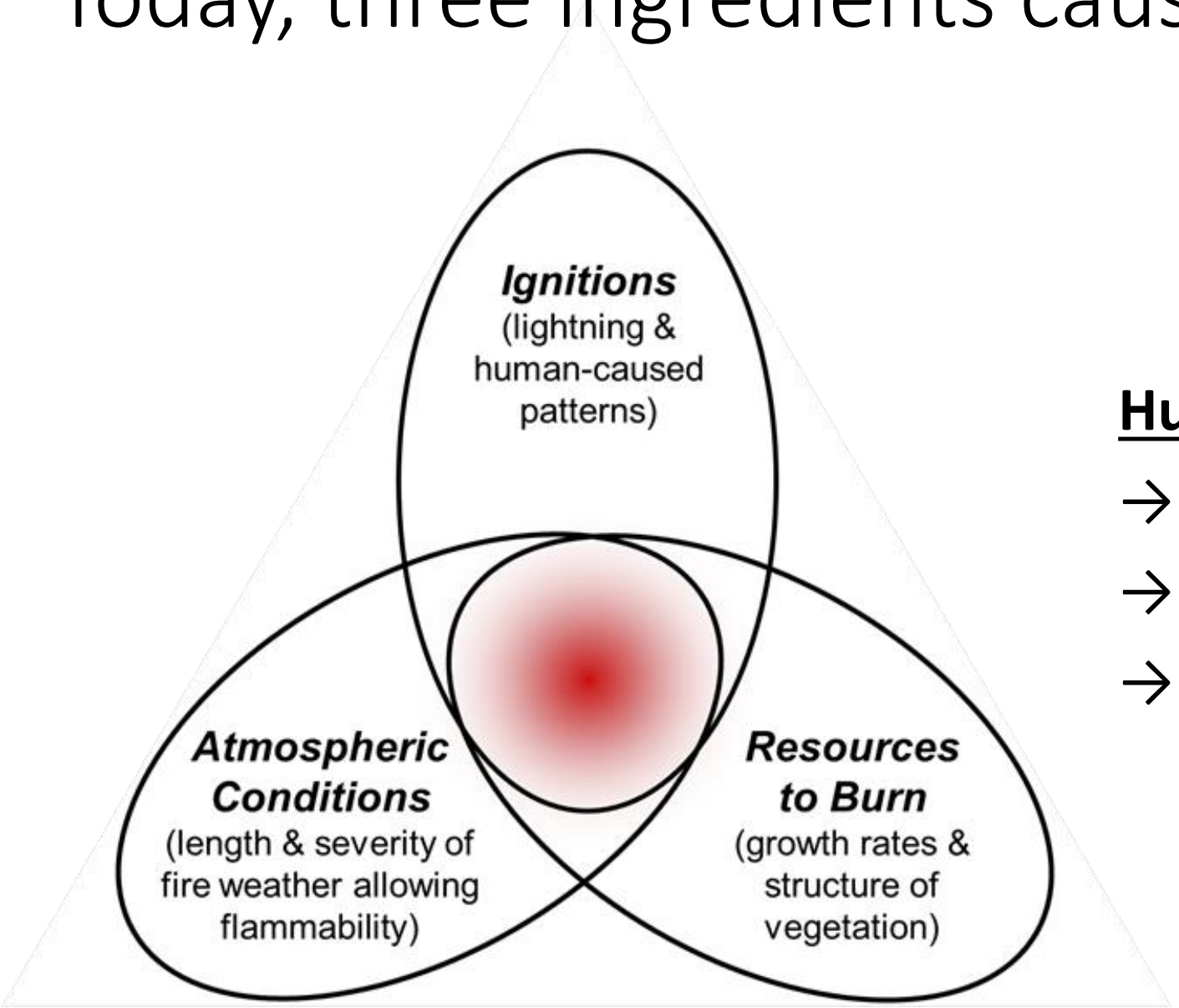
Mean fire return interval: 11 years
Range: 5-40 years

Upper Montane Forest (Red Fir Forest)



Mean fire return interval: 40 years
Range: 15-140 years

Today, three ingredients cause large fires



<u>Human disruptions</u>

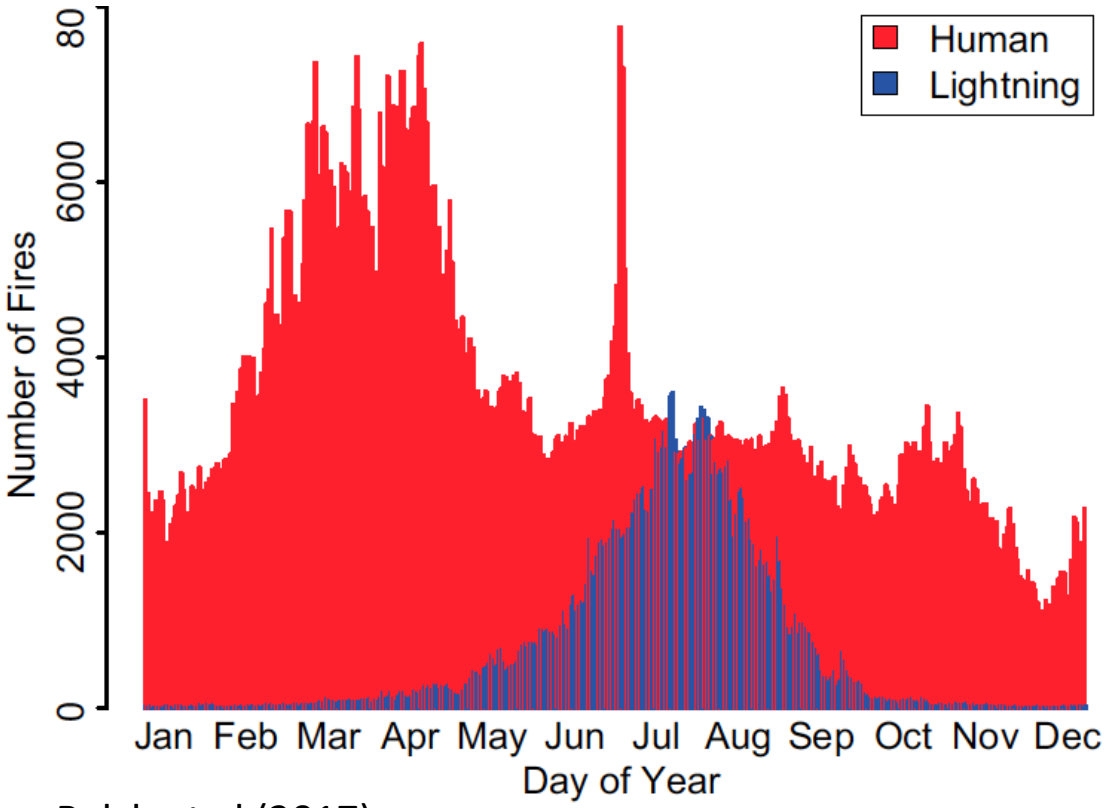
→ Too many ignitions

→ Change timing of ignitions

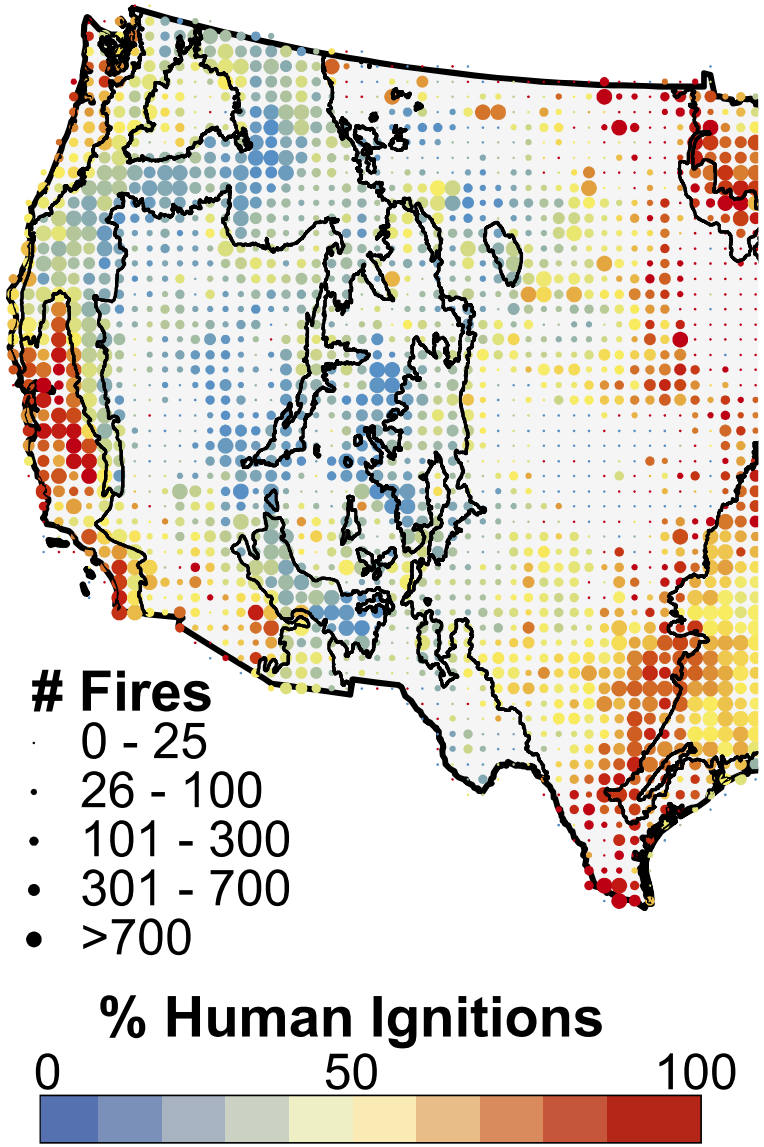
→ Suppress fires and increase fuels

Humans are a major source of ignitions in the Sierra Nevada

- Increased human caused ignitions from more people
- Lengthened fire seasons increases the chance of ignitions



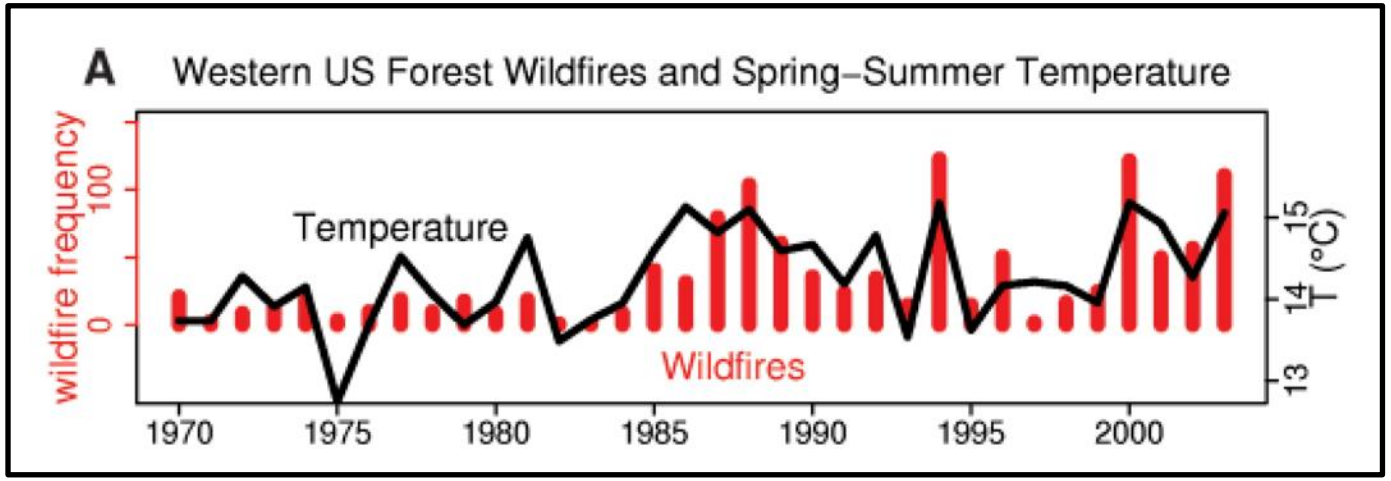
Balch et al (2017)



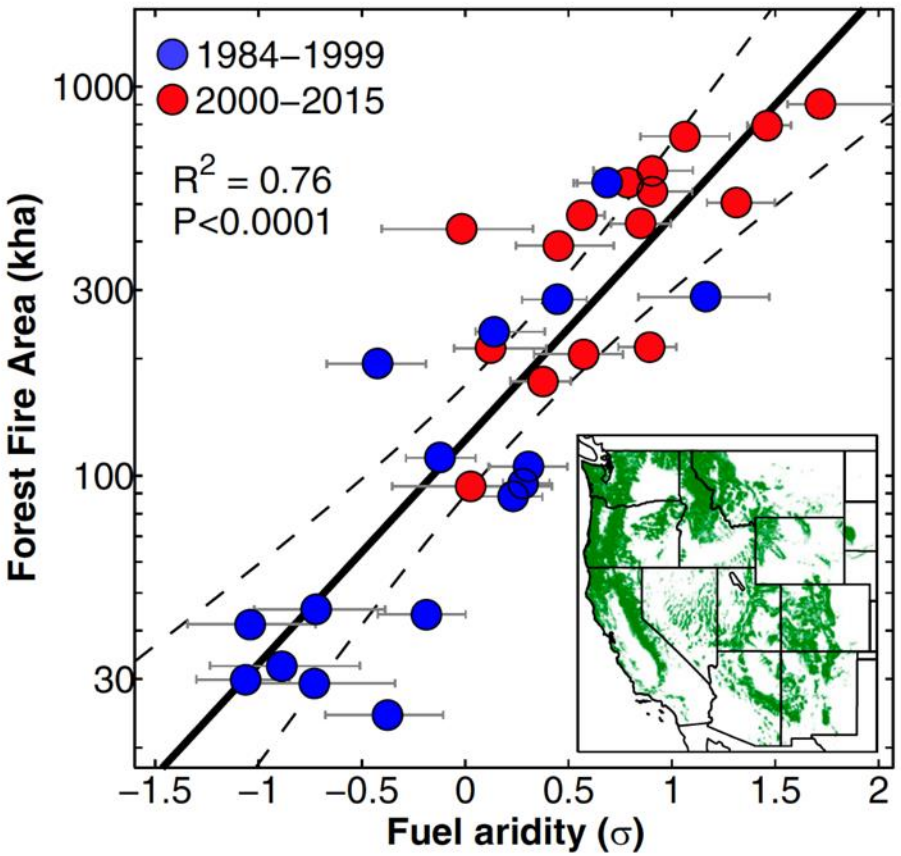
Climate change is worsening fire weather

- Climate change are increasing vapor pressure deficit (low humidity), which increases fire behavior
- Drier fuels from earlier snowmelt and warmer temperature lead to increased fire behavior

Climate change => ↑Fuel aridity => ↑Large fires



Westerling et al (2006)



Abatzoglou & Williams (2016)

Fire suppression have increase surface and ladder fuels

Fire suppression leads to:

Overstocked forests | Dead material | Ladder fuels

Outline for today's presentation

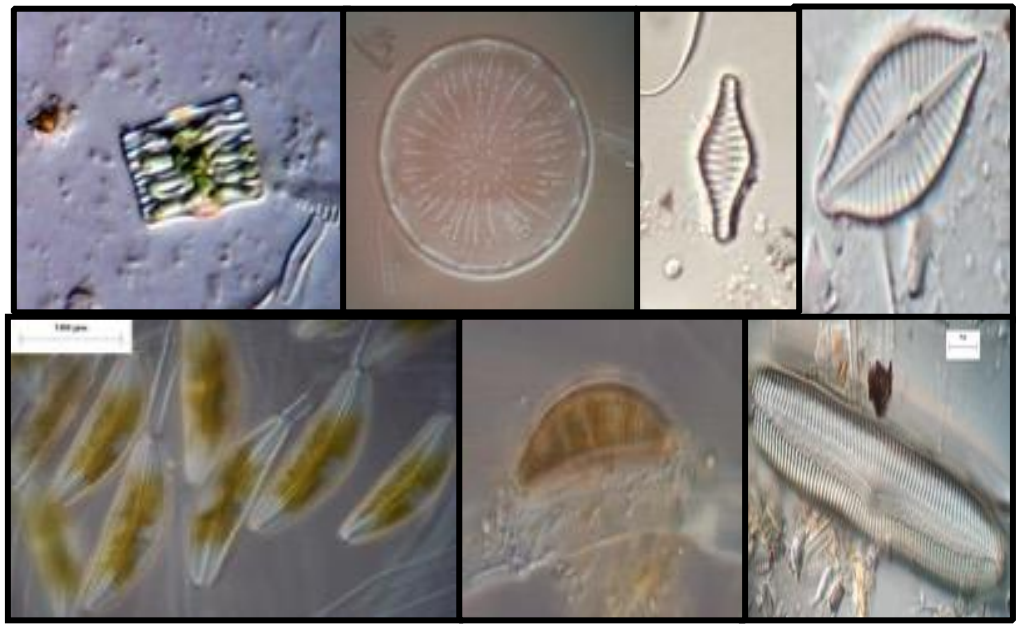
Fire as a natural process, fire regimes historically, humans (ignition and suppression), and our changed mountain ecosystems.

Tahoe fire related research (1985 to present) -> we are intimately connected to burns from far away and with the direct burning of our watershed.

Caldor and other wildfires -> initial responses from the Tahoe Science Advisory Council and member institutions

TSAC
Tahoe Science Advisory Council

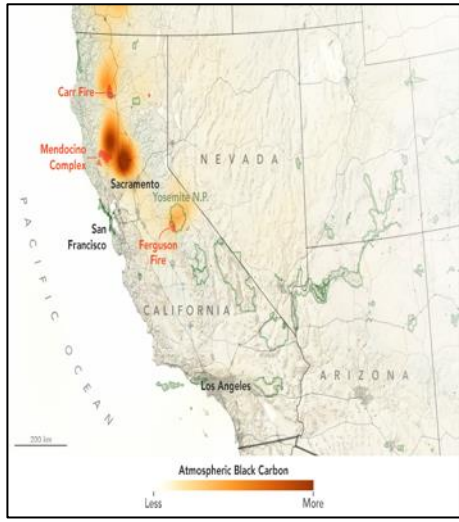
REMINDER- Lake Tahoe's clarity loss -> partly from the tiniest of algae and from inorganic (sediment) particles delivered from the watershed or atmosphere



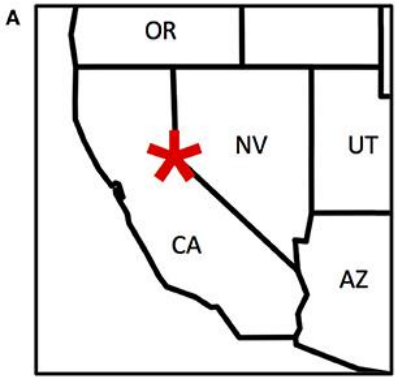
Wildfires are diverse in nature so key questions remain -> how do wildfires influence the growth of algae or delivery of nutrients and particles to the lake?

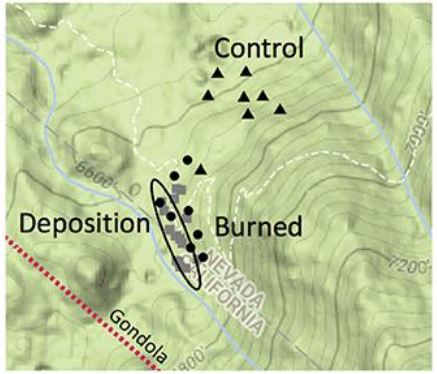
Limited focus to understand wildfire influences on streams and to Lake Tahoe, direct & indirect impacts

- Gondola Fire (2002) -> watershed and soil run off
- Angora Fire (2007) -> direct influences of fires to a stream
- So Cal's Wheeler Fire (1985), Central Sierra's King Fire (2014) and many 2018 California fires -> indirect impacts from smoke



Gondola fire of 2007 -> Direct impacts of wildfire leads to erosion carbon after 10 years





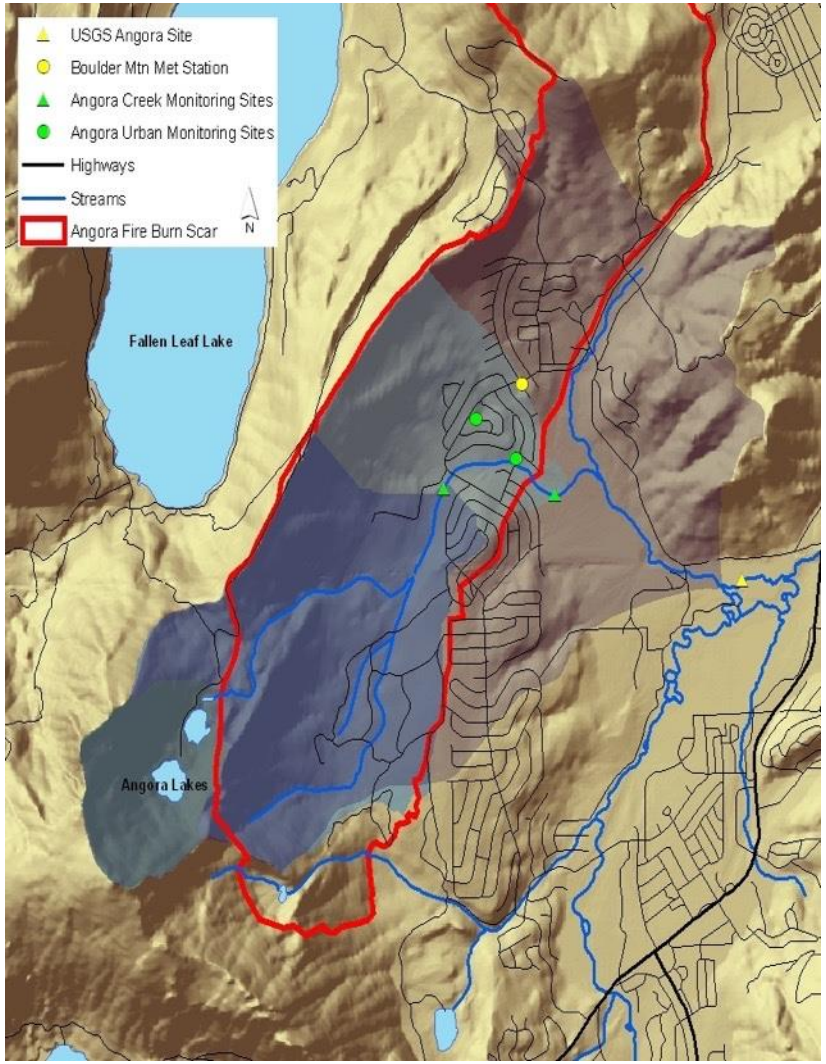
A) Major ash flow occurred after the fire in 2002.

B) The hydrophobic layer created during the fire persists through November 2012

C) No canopy is left in portions of this moderate severity fire in May 2013.

RB Abney et al. 2017. *Front. Earth Sciences*

Angora Fire of 2007 -> Direct impacts of wildfire to stream water quality and health



Some recovery of loading of nutrients and sediments over time with no evidence of massive sediment or nutrient inputs from the burned urban area into Angora Creek. We got lucky though, post fire storm conditions were mild.

However, urban runoff contributed to higher concentrations in the lower Angora Creek site, compared to the upper Angora Creek site.

Wet meadow restoration areas provided stormwater treatment to runoff from the surrounding catchment.

Angora urban runoff and Angora Creek conditions after the fire were generally much better than has been observed at other urban sites around the Tahoe Basin.

Info. Courtesy of Dr. Alan Heyvaert, Desert Research Institute

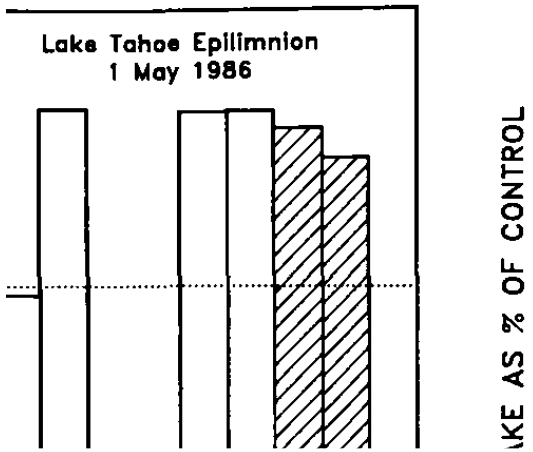
Wildfire smoke from far distances (So Cal's Wheeler Fire, 1985) -> increases algae in Lake Tahoe in July

mains suggest an increase in algal production and a change in Cladoceran community composition in response to fires in the watershed (Baas & Bouchelle (Schindler et al. 1980). Tarapchak & Wright (1986) examined the influence of a 1971 fire on Meander Lake, Minnesota, that destroyed about 50 % of the overstory trees in its watershed. Although phosphorus loading may have increased, no effects on water chemistry or phytoplankton biomass and composition could be observed (see also McColl & Grigal 1975, Wright 1976). The lack of any limnological data prior to the burn, were shown to be responsible for most of the year-to-year changes in annual primary productivity, a considerable amount of residual variability in production at Lake Tahoe productivity to these remote brush fires and consider the implications for its interannual variability.

Lake Tahoe is located in a graben at the crest of the Sierra Nevada Range (39 °N, 120 °W, elevation 1898 m). It has a surface area of about 500 km², a maximum depth of 505 m, and a mean depth of 313 m. The lake is ultra-oligotrophic, warm monomictic, and ice-free throughout the year. Lake Tahoe is in the earliest

- A little bit of smoke from far away, can go a long way to stimulating Lake Tahoe's algae growth in July.
- Likely culprit for increasingly algae is the fertilization of the water due to smoke particles.

III. Lakes. 1. North America



stimulation was similar in extent to
nutrient spiking (Fig. 4). Note that t
say was performed with samples co
(1986); stimulation by nutrient spiki
typically is less than in July, presu
the nutrient depletion of the mixed
earlier stages. Third, bioassays conc
showed no stimulation by atmosphe
collected in the absence of forest a
even though a combination of phosp

"We also should remain alert to the effects of more numerous smaller fires that might not have such a dramatic visible effect on the atmosphere but, nonetheless, contribute to the variability in annual [algae] production or seasonal patterns."

Wildfire smoke in ”thick and large” atmospheric concentrations can affect light transparency in Lake Tahoe

Sentinel responses to droughts, wildfires, and floods: effects of UV radiation on lakes and their ecosystem services

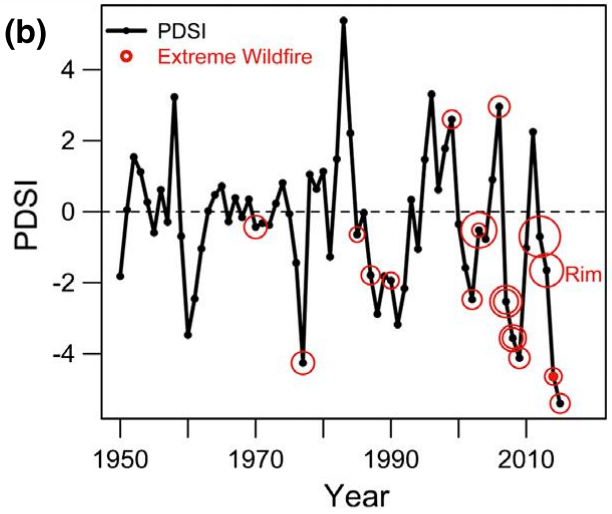
Craig E Williamson[1*], Erin P Overholt[1], Jennifer A Brentrup[1], Rachel M Pilla[1], Taylor H Leach[1], S Geoffrey Schladow[2], Joseph D Warren[3], Samuel S Urmy[3], Steven Sadro[4], Sudeep Chandra[5], and Patrick J Neale[6]

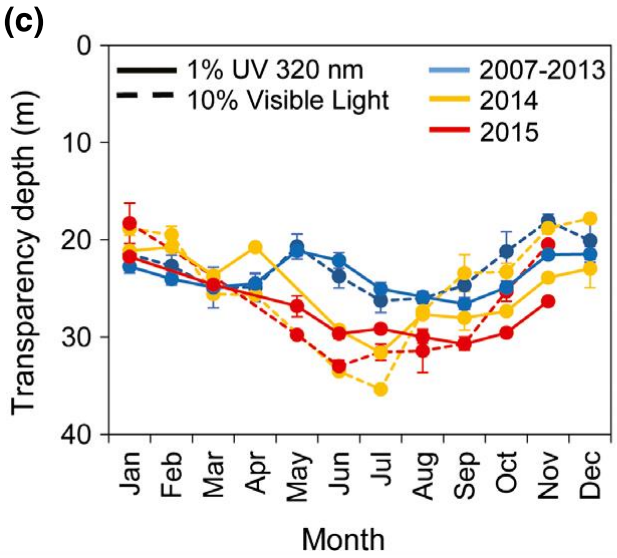
Front Ecol Environ 2016; 14(2): 102-109, doi:10.1002/fee.1228

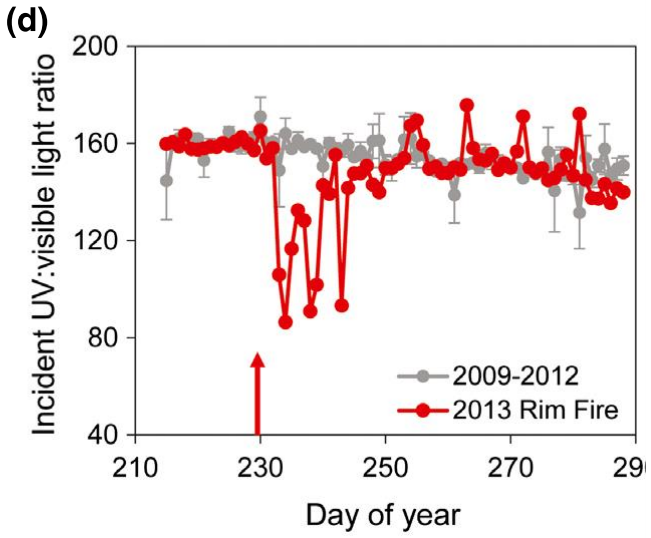
Extreme events related to climate change and other environmental drivers vary greatly among regions; for example, droughts and wildfires dominate in the western US, whereas heavy precipitation and floods are more common in the eastern US

These extreme events transform and transport organic carbon and particulates in ways that alter exposure to ultraviolet (UV) radiation and visible light, with important implications for lakes and the ecosystem services they provide

S Ellsworth





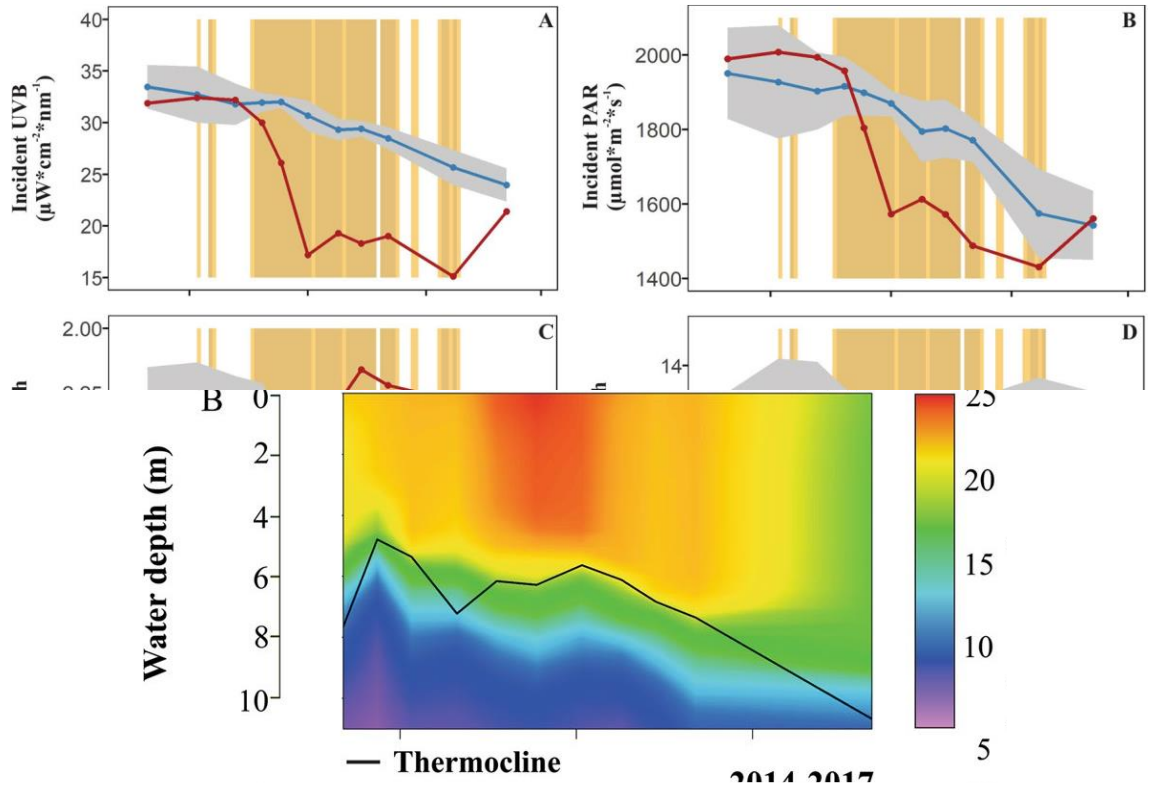


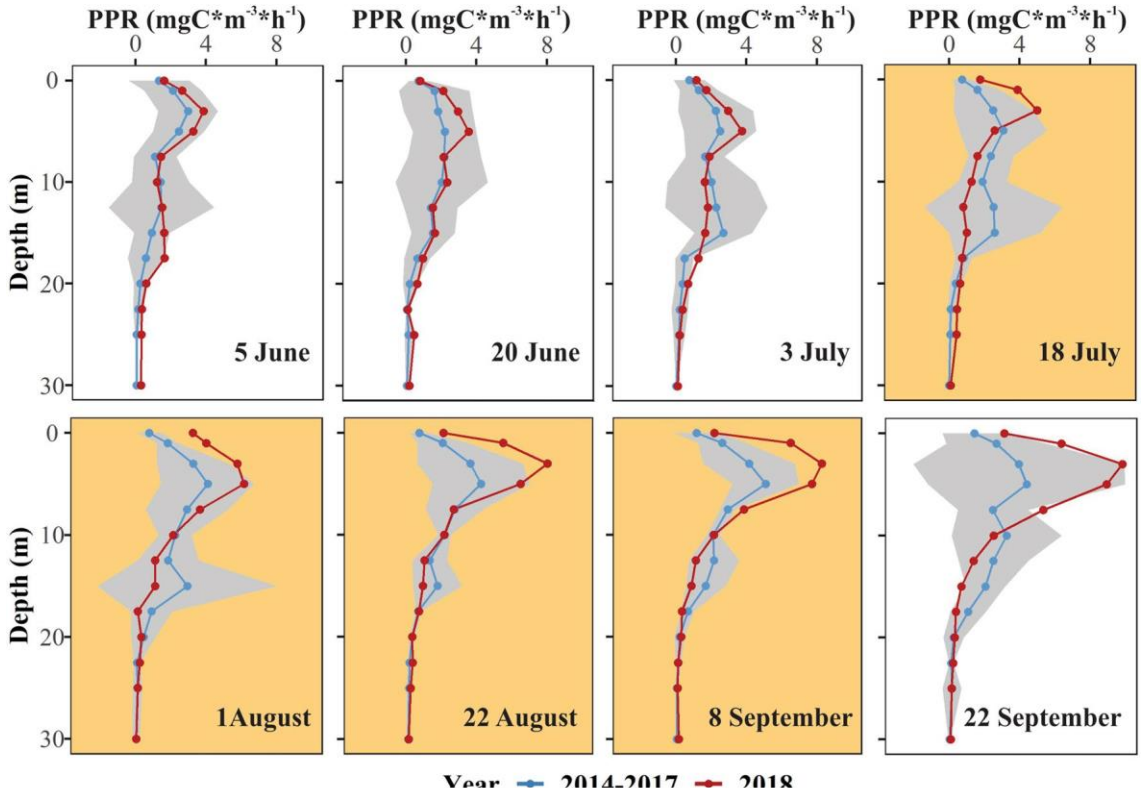
Wildfire smoke -> cools lakes, changes light conditions, increases algae in the upper layer and eliminates deep water production, and causes trout to select less optimal food habitats for feeding

Smoke from regional wildfires alters lake ecology

www.nature.com/scientificreports

Facundo Scordo[1]✉, Sudeep Chandra[1], Erin Suenaga[1], Suzanne J. Kelson[1], Joshua Culpepper[1,2], Lucia Scaff[3], Flavia Tromboni[1], Timothy J. Caldwell[1], Carina Seitz[1], Juan E. Fiorenza[4,5], Craig E. Williamson[6], Steven Sadro[7], Kevin C. Rose[8] & Simon R. Poulson[9]





Outline for today's presentation

Fire as a natural process, fire regimes historically, humans (ignition and suppression), and our changed mountain ecosystems.

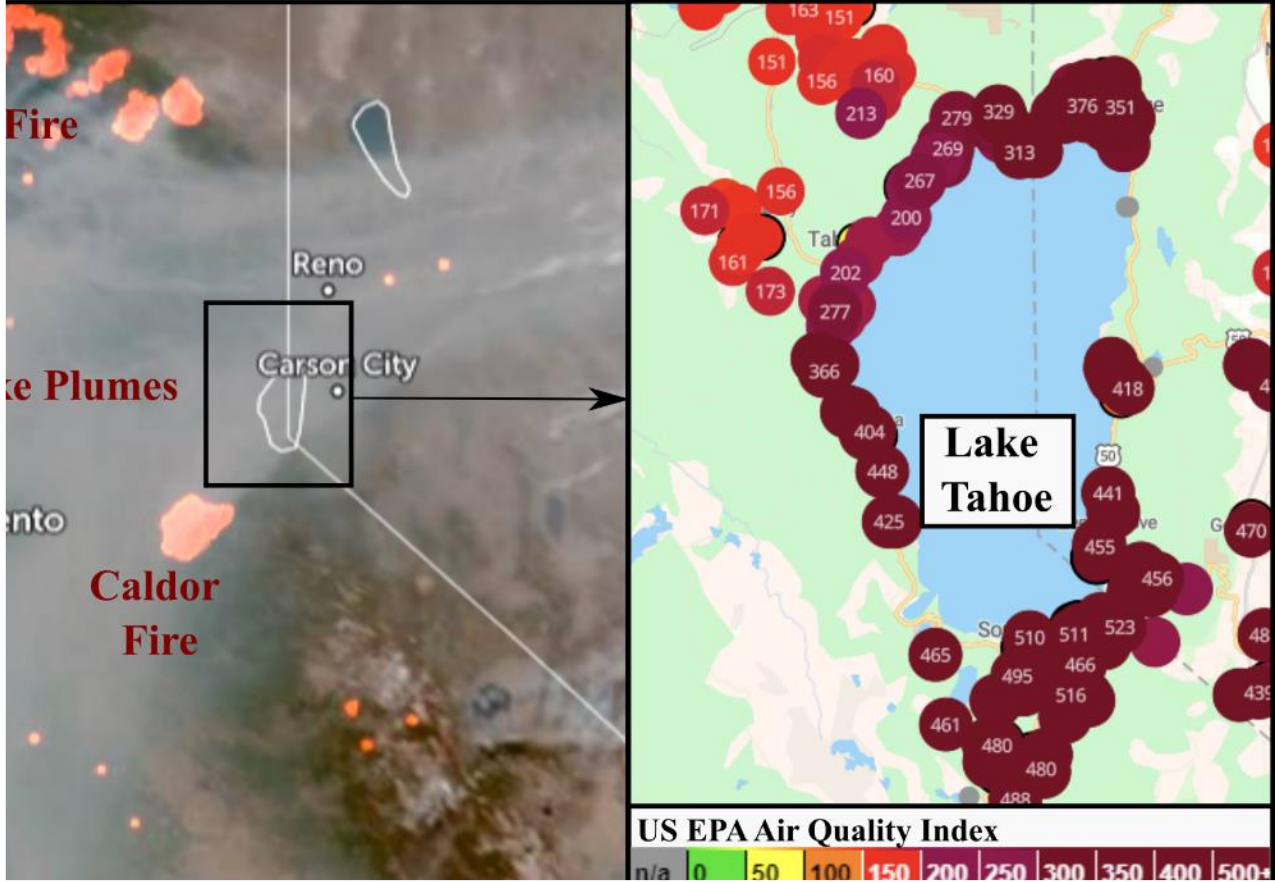
Tahoe fire related research (1985 to present) -> we are intimately connected to burns from far away and with the direct burning of our watershed.

Caldor and other wildfires -> initial responses from the Tahoe Science Advisory Council and member institutions

TSAC
Tahoe Science Advisory Council

Caldor and other wildfire responses, coordinated through the Tahoe Science Advisory Council & its members institutions

- Initiated meetings and a developed a process for gathering short-term immediate, scientific studies to assist in the management of Lake Tahoe
- Evaluation of direct watershed and indirect atmospheric impacts (smoke) to the basin and watershed.
  - **Enhancing Tributary Monitoring-** Enhancements to the Tahoe Interagency Monitoring Program -> increase the extent of current monitoring to the primary streams impacted by the fire – Trout Creek, Saxon Creek, Cold Creek, and the Upper Truckee River.
  - **Assessing Effectiveness of Forest Treatments-** Lake Tahoe's forests have benefited from extensive fuels management work. Understand how treatment projects helped firefighters battle the Caldor Fire and assess how the vegetation management impacted fire behavior and post fire recovery. The work will help managers better design of future forest health treatments to create safer communities and a healthier watershed.
  - **Wildfires smoke impacts to 2021 clarity-** The Caldor, Dixie, Tamarack, and other fires sent ash and charred leaves falling from the sky and elevated the Tahoe basin's Air Quality Index to hazardous levels. The Council and partners (League to Save Lake Tahoe, Tahoe Fund, TRPA and State Agencies) supported a rapid response investigation to address how wildfire smoke may impact water quality parameters including algal growth and clarity.



Wildfire smoke driven air quality can be intense on some days while on other days much less on the West and Northern shores of the lake

Examination of wildfire smoke particles and nutrients depositing around the lake -> network of local landowners and businesses

Measuring particles and enhancing lake clarity monitoring during the Caldor fire’s smoke emissions

Next steps by the Tahoe Science Advisory Council

- Revisit our request to partnering institutions to suggest additional projects to understand wildfire impacts to Lake Tahoe. This issue will not go away so we need to plan to the future.
- Our Watershed Science to Action plan developed completed in 2020 recommended actions to understand forest and lake resilience under a new climate and wildfire regime. Revisit this science to action planning in 2022 to integrate lake and watershed plans.
- Engage the Environment Improvement Program in future efforts to integrate best available contemporary science to guide future management of the basin with changes in climate and large disturbances like wildfire, drought, atmospheric rivers.
- Enhance our communication and discourse with the public and partnering agency institutions on subjects from wildfire, invasive species, biodiversity and forest management.