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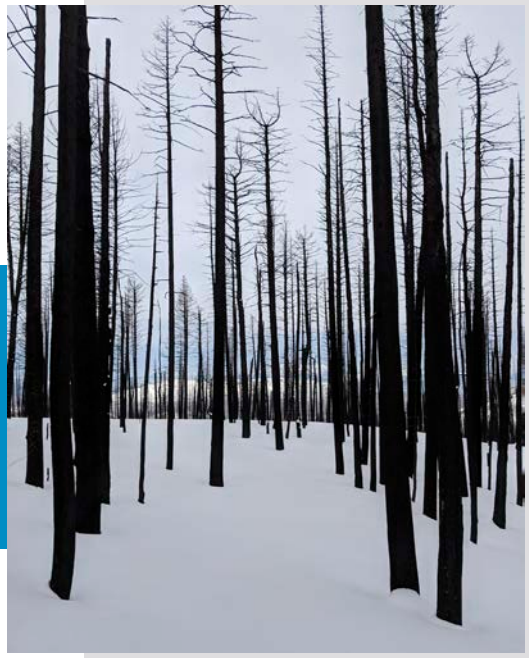
Wildfires Impact Snowpack



A forest impacted by wildfire in winter.

Credit: Derrell Williams, public domain via Wikimedia Commons.

Snowpack provides our water, especially in the American West. And new research shows wildfires may be affecting it.

Snow accumulates in the mountains in winter, then melts in spring to fill rivers. As we've discussed in prior *EarthDates*, that runoff is critical to water supplies, for irrigation, fisheries and cities.

Earlier melting, due to more winter rain, has brought spring floods. This can mean lower water supplies in summer and fall. Now wildfires have been shown to also promote earlier melting.

For the past century, U.S. forestry policy has been to put out all wildfires, which has led to an accumulation of deadwood that could burn as fuel.

Combine this with hot, dry "fire weather," and more people now living in fire zones, who set more fires, and the result is more acres of Western forests burned each year.

Scientists analyzing snowpack across Western mountains found that an evergreen forest canopy reduces the amount of snow that can accumulate on the ground. But it reflects more sunlight from snow-covered branches. This keeps the ground cooler and slows melting.

By contrast, where a forest has burned, *more* snow accumulates on the ground. But it reflects less sunlight, warms faster and melts as much as 10 days earlier in the season.

More research is needed to understand how earlier melting in burned areas may affect runoff. But it could be another important tool for scientists analyzing water supplies in a parched American West.

Bureau of Economic Geology

Background: Wildfires Impact Snowpack

Synopsis: Wildfires are a serious concern for humans and wildlife, along with the impacts on soil erosion and water quality. Multiple studies have investigated how wildfires impact snowpack dynamics (phenology) in the western U.S. using data from advanced remote sensing and satellite sources. The research finds that wildfires generally lead to reduced snowpack and earlier snowmelt, with significant variations depending on the region and environmental factors like burn severity and tree types. This could have major implications for water resources in areas dependent on snowmelt.

- Snowpack is the seasonal accumulation of snow that stays frozen on the ground during the winter and slowly thaws during the spring. In a previous *EarthDate*, (ED-206 The Value of Snowpack) we learned how vital this resource is to the regions in the western United States.
  - Snowpack is crucial for water supply in the western U.S., accounting for up to 75% of runoff.
  - The slowly melting snow protects the soil from erosion and reduces runoff.
  - The snow keeps areas cool by reflecting sunlight and allowing more snow to accumulate.
  - Snowmelt replenishes man-made reservoirs and natural aquifers.
  - Accumulated snow is the lifeblood of ski resorts and foundation of winter sports.
  - The slow release of water provides a steady source of water needed for irrigation throughout the growing season.
  - Changes in snowpack can have significant economic and environmental impacts.

A ranger stands next to a snow wall lining the path to the Kohm Yah-mah-nee Visitor Center at Lassen National Park in Northern California in 2010.

Credit: LassenNPS - 2010 Snowpack, public domain, via Wikimedia Commons

References: Wildfires Impact Snowpack

Wildfire Impacts on Snowpack Phenology | Water Resources Research
How Wildfires Affect Snow in the American West | Source?
Wildfire Impacts on Western United States Snowpack | Source?
Advances in Modeling of Forest-Snow Processes | Frontiers in Water

Contributors: Lynn Kistler, Juli Hennings, Harry Lynch

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Background: Wildfires Impact Snowpack

- This delicate balance between snow accumulation and snow melt can be disrupted by wildfires.
  - Understanding the impacts of wildfires on snowpack is essential, as these fires can significantly alter snow accumulation, melt rates, and ultimately affect water availability for downstream users.
  - Research on the effect of fire on snowpack is challenging due to the many variables involved.
- One group of researchers used data from the Snow Telemetry Network (SNOTEL) which are automated data collection sites and part of a system that creates water supply forecasts. Each SNOTEL location collects data to monitor snowpack, precipitation, temperature, and other climatic conditions.
  - Forty-five burned SNOTEL locations were identified, and each was compared to at least two similar non-burned SNOTEL locations. Factors that researchers had to consider in comparing sites included location and elevation.
  - Data was compared for all sites over the recording period, with most locations having 20-40 years of data collection and at least 10 years of pre- and post-fire data.
  - Other factors considered at each site included the types of trees (most sites consisted of pine, fir, and spruce) along with the tree canopy density, burn severity, and forest management practices.
  - They found that wildfires typically advance snowmelt by about 9 days and reduce the maximum snow water equivalent (SWE) by 10%. SWE is a measure of the depth of water that would cover the ground if the snow cover was in liquid state.
  - Burn severity, leaf-area index (LAI), tree genus, and elevation influence the extent of these impacts.
  - The study also identified regional differences, with some northern ecoregions showing increases in SWE due to wildfire.

Scale diagram comparing a human to two of the largest *Stegosaurus* species. These dinosaurs were similar in size to an African bull elephant.
Credit: KoprX, CC BY-SA 4.0, via Wikimedia Commons

A snow telemetry station (SNOTEL) located near Blazed Alder Creek in northwest Oregon. This station is in the Bull River watershed at an elevation of 3,650 feet (1,100 meters).

Credit: Unknown author - Blazed Alder SNOTEL, Natural Resources Conservation Service of the U.S. Department of Agriculture, public domain, via Wikimedia Commons

- Another group of scientists conducted literature review with the goal to further the understand the complex interaction of wildfires and snowmelt.
  - They first noted that burned areas have increased by 1,150% from 1984 to 2020.
  - The wildfires appear to have had a 9% increase in the geographic overlap of burned areas and seasonal snow zones.

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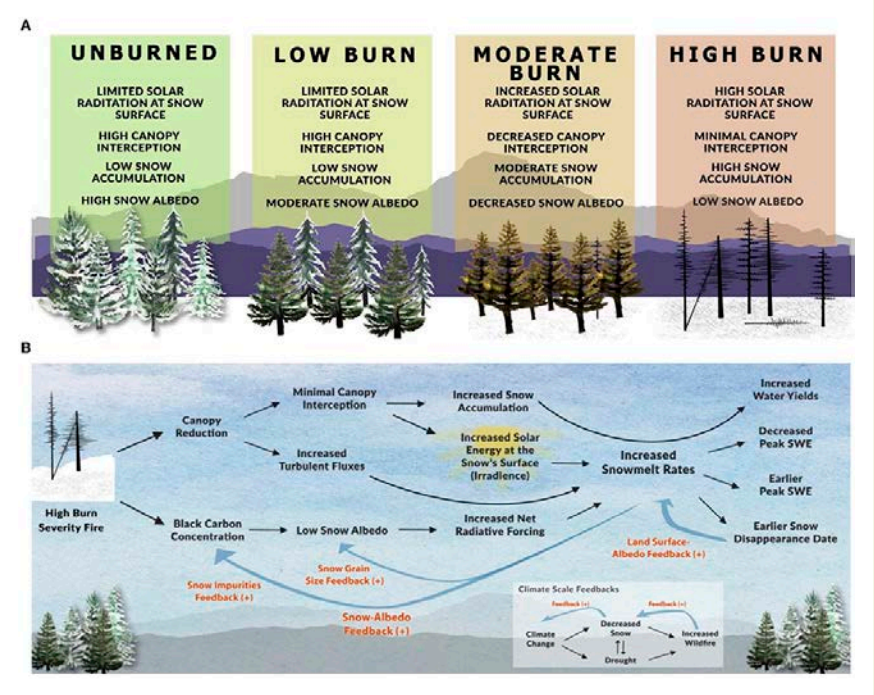
- Burn severity also plays a major role as the effect on the forest canopy and snow albedo have a complex relationship. A dense, unburned forest canopy intercepts the snow and prevents it from accumulating at the surface. A severely burned area with little canopy will allow more snow accumulation, however the decreased albedo or reflectivity, increases the rate at which the snow melts.
- To better understand this complicated relationship, the researchers recommend further study on the effects of albedo and forest canopy and the role both of these play in water availability.
- While research on wildfire impacts on snowpack shows varying results, it is widely accepted that wildfires significantly alter snow accumulation and melt patterns, affecting water availability.
  - Further studies are needed to fully understand the mechanisms involved.
  - Water managers in the western U.S. must consider these impacts when planning for the future, making proactive, long-term adjustments to reservoir and forest management strategies.



Diagrams showing the complex relationship between (A) fire severity and snow accumulation and (B) the multiple positive and negative feedback loops present in high-burn areas.

Credit: Author unknown

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