How Fire Recycles Plants

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Photo source: Methow Valley News

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"Wretched." And "miserable."That's how I've described conditions here in the Methow Valley for the last month.

Lightning ignited the Crescent fire on July 29th. For a few days the fire dirtied the skyline. Then on August 1st it blew up, filling the whole valley with smoke. It's been unusually windy this month, and the wind carries a load of fine ash.

That ash—the remains of burning plants—made me curious. How is blowing ash affecting the ecosystem as it is dispersed across the landscape?Here's some of what I've learned.

According to fire managers, the Crescent fire is burning in an area of subalpine fir, spruce, Douglas-fir, and Ponderosa pine. Within that area, there are at least 40-50 tons of vegetation per acre. About half of that is water, which is being released as steam and water vapor—the main constituent of wildfire smoke.

Photo source: USFS

The fire is also releasing nutrients that have been stored in living and dead plant material. Although some nutrients will remain in unburned plant material and detritus on and in the soil, others are volatilizing or forming ash.

Nitrogen and sulfur are released at relatively low temperatures (<200˚ C. in the case of nitrogen) and are most likely to volatilize and be released to the atmosphere as gases. Phosphorus, potassium, calcium, magnesium, and other minerals are more likely to be incorporated in ash. Combustion temperature determines how much phosphorus, potassium, and magnesium remains in the ash and how much volatilizes. Calcium requires such high temperatures to volatilize that any calcium released by fire is assumed to be incorporated in ash.

Combustion temperature also determines how likely ash is to become airborne. A 2015 paper on wildfire ash reports that ash produced at combustion temperatures below 300˚ C is black and "retains many of the structural characteristics of the parent material. At higher temperatures, the residue ash is greyish, [consisting] of very fine particles that preserve almost none of the original structural characteristics of the fuel." Most of the ash I've been seeing—and, I would speculate, most ash light enough to become airborne—is fine and light-colored—the product of high-temperature combustion. (We did have a heavy rain of low-combustion ash last week, including what looked like perfectly-formed Douglas-fir needles that disintegrated into black smudges when touched.)

The softwoods that are burning in north-central Washington are relatively low in nutrients. Still, each acre burned is likely to release several hundred kilograms of nutrients. A 1975 study found that a fire in north-central Washington released over 1,700 pounds of nitrogen, calcium, magnesium, potassium, and sodium per acre. The Crescent fire now covers more than 40,000 acres—an area large enough to release thousands of tons of nutrient-rich gases and ash.

Most of the ash will remain on the burn site, at least initially, but a small percentage of it is becoming airborne and is moved away by the wind. Ash that lands in the burn area may later be moved by wind, as well. One researcher has reported that almost all of the ash was removed from a grassland study site after a single day of heavy wind. Although ash light enough to become airborne probably contains fairly low concentrations of most nutrients, the quantity being produced represents considerable potential to affect soil fertility over a large area.

Photo source: USFS

East of the Cascade crest, biomass is concentrated in mountains and along rivers. The hauntingly beautiful shrub-steppe ekes a living from dry mineral soils. Uncomfortable and even menacing though it is, fire unlocks the nutrient wealth that has been stored in the forest, and the wind carries that wealth out to nourish other places.

The windborne ash is generally deposited thinly over a wide area. It can reportedly travel hundreds of kilometers. I live 21 miles from the Crescent fire's ignition point—and, as of today, about 11 miles from its eastern front—and even at this distance I notice the accumulation of ash. It's on doormats, the leaves of plants, the tops of the gaskets that frame my car windows. The ash acts as a light dusting of fertilizer over the area on which it falls.

In addition to carrying nutrients that affect soil fertility, the windborne ash can affect soil pH. It's very alkaline. Like most soils in low-rainfall areas, eastern Washington soils tend to be alkaline already. Windblown ash is probably part of the evolution of soils, including soil pH, in this fire-evolved landscape.

One author has speculated that windborne ash may "have a micro effect on soil hydrologic properties." Various researchers have found that ash produced at high combustion temperatures—the ash most likely to become airborne—has a hydrophilic effect. Thus, it could increase water retention in the soils on which it falls—at a micro scale, of course—helping to combat the aridity of the shrub steppe and dry forests.

Finally, airborne ash may affect water quality. Due to its high phosphorus content, it can contribute to algal blooms, as well as clogging the gills of fish, if enough of it falls on a given water body.

Although I mourn the loss of thousands of acres of forest—and the dramatic changes to some of my favorite botanical rambling grounds—I recognize wildfire as part of a natural cycle. A growing understanding of how native plants are recycled in the ecosystem makes the loss a little easier to bear.

Did you know?

Burning trees and exporting the mineral-rich ash was an early industry in the United States. U.S. Patent No. 1 was issued in 1790 for an improved method of processing wood ash.

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