

BLOWING IN THE WIND



When the wind blows across your face, are you aware of what is in the wind? The wind blowing in our cities carries air pollution which can harm our health and affect the plants around us. Are air pollutants transported only in the winds blowing in our cities? NO! Today air pollutants are carried in the wind hundreds of miles to remote locations like Shenandoah National Park. Here at Shenandoah these air pollutants can affect vegetation directly through the leaves and/or indirectly by changing soil acidity around the plants. The air pollutants of concern are sulfur dioxide, nitrates, and ozone.

When you are in a national park you expect blue skies, beautiful vistas, clean clear water, and green foliage. Indeed, national parks are national treasures, and as visitors to these areas you should expect pristine natural resources. However, in recent years, the resources in the national parks have been affected by air pollution and contaminated by acidic precipitation.

The legislation establishing the National Park Service mandates the NPS to "...conserve the scenery..." and to manage parks "...in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." One of Shenandoah's resource protection concerns is that native, rare, endangered, and relict plant species, habitats, and communities will be protected and perpetuated.

HOW DOES AIR POLLUTION AFFECT PLANTS?

Rainfall in the Park is ten times more acidic than uncontaminated rainfall. Most of the acidity is caused by sulfur dioxide and nitrogen oxide emissions from fossil fuel burning sources. The formation of ozone at the earth's surface may cause health related problems and/or injury to vegetation.

SULFUR DIOXIDE

Sulfur dioxide is released into the atmosphere naturally from biological decay and volcanic activity, but the majority of the sulfur dioxide comes from man-made sources including fossil-fueled power generation facilities, coal and oil fired furnaces, and smelter operations. Sulfur dioxide ultimately transforms in the atmosphere into sulfates which are very fine particles. Sulfates can be transported very long distances and can cause reduced visibility. Sulfates are also precursors to acid deposition.

Sulfur deposits on the ground and filters down through the soil, causing aluminum and other metals to be released in the soil becoming biologically available to plants and soil microbes. The aluminum toxicity can kill the fine roots of a tree causing the

tree to reduce its uptake of nutrients and making it susceptible to disease and/or insect injury.

The soils at Shenandoah have two important characteristics. First, the soil has a tendency to retain acidic deposits. Second, when soils become acidic they can not hold any more acid and will then begin to leach acidity. Once the soil has lost its ability to absorb sulfur acidity it may not ever recover. The more sensitive soil types in the Park have already reached their limit for absorbing sulfur.

Normal background levels of sulfur concentrations have been estimated at 1000 parts per million. Current sulfur concentrations here in Shenandoah are two and a half times higher than normal background levels. These levels are high enough to cause morphological change in some species of lichens.

NITROGEN OXIDES

Nitrogen oxides are emitted from automobiles, as well as fossil-fueled power generation facilities. Nitrogen oxides can be transported in the wind for hundreds of miles. Nitrogen oxides are also deposited on the ground and can convert to nitric acids which acidify the soils and streams. A

nitrogen-limited system exists here at least at high elevations. Nitrogen deposition initially acts as a fertilizer, promoting growth. In nitrogen-limited areas, added nitrogen can cause a shift in species composition and may encourage pathogens. Research has found that nitrogen fertilization of hemlock seemed to enhance the buildup of populations of the hemlock woolly adelgid. At the same time the acid deposition causes nutrients to be released out of reservoirs and into the soils by the process of ion exchange, out of the soil's "bank account." This temporarily raises the availability of base cations and matches the increased availability of nitrogen. The result is increased tree growth until the "account" is empty. Then comes bankruptcy and collapse. The end result is acidified soil. Only then do deficiency symptoms such as susceptibility to disease and stress appear in vegetation.

Too much nitrogen in a system also leads to a decreased diversity in the forest herb layer, and eventually to nitrification of the soil. When this happens, microbes in the soil form nitrate and nitrite and begin to leach out the nitrate and associated cations. All this leads to high nitrate leaching into aquatic systems. Nitrate levels in the streams continue to be elevated after episodic peaks of leaching due to high rainfall events. Not only does this contribute to aquatic acidification, but it is a sign that soils in the Park are becoming nitrogen saturated.

OZONE

When released into the atmosphere, nitrogen oxides and hydrocarbons interact in the presence of sunlight to form ozone. In the upper atmosphere, a natural ozone layer screens us from harmful ultra-violet radiation, while near the surface of the earth, ozone can impair our health and cause injury to plants. Ozone can be absorbed through the leaves on some plants causing black spots---flecking, and loss of chlorophyll, and accelerated aging and death of leaves. At the same time, ozone can cause plants to become more susceptible to insects and disease, water stress, winter injury, and a loss of genotypes that are ozone-sensitive. Both Great Smoky Mountains and Shenandoah are documenting injury to plants due to ozone. Many of the species that occur in the

Smokies are the same ones that occur in Shenandoah. Ozone fumigation research in the Smokies is showing that early leaf-drop on some plants, previously thought to be normal aging, is actually caused by ozone injury.

WHAT CAN WE DO?

Aldo Leopold eloquently wrote that conservation is a state of harmony between men and land. By "land" is meant all of the things on, over, and in the earth. "Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left...the land is one organism." We must all support efforts to restrict the production of additional pollutants and to improve the quality of the environment. The air quality problem here is also found in many other remote areas of the United States and throughout the world.

There are several activities we can all be involved with to help limit the emission air pollution. Automobiles are a major source of pollution. By purchasing fuel efficient automobiles and maintaining the pollution control devices in good working condition and driving less and car pooling more we can all help to reduce pollution.

Energy production is another major contributor of air pollution. We all need to use energy wisely and conserve energy when possible. Choose an energy source that has minimal impacts on the environment. Heating with electricity or natural gas produces less pollution than does wood-burning stoves and fuel oil heating systems. Electric motors are also cleaner than gasoline or diesel engines.

We can also actively participate in recycling programs. Recycling conserves energy and our natural resources. Purchase products with packaging made of recycled and recyclable material.

Involvement also means awareness of air quality issues affecting our communities. Each of us needs to understand local, national, and world issues related to air pollution. We need to become more involved with the decisions concerning the air we live in and breathe. Let the local, state, and national decision-makers know about your concerns.

If we all participate, we may again have a clean fresh wind and clear vistas, and the trees and flowers will all be here for future generations to enjoy.

