Scientist Profile

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Collaborating with colleagues across the USDA Forest Service, across government agencies, and across the Atlantic, Bytnerowicz brings together forest researchers and managers on a national and international basis to evaluate the ecological effects of air pollutants on forests.

His recent achievements include hosting an international symposium on passive sampling in ecological research and coediting a volume on ozone air pollution in the Sierra Nevada. Promoting international teamwork for long-term research collaboration is an important element of Bytnerowicz' research program.

Bytnerowicz is known for his enthusiasm in sharing his knowledge about passive samplers, now being adopted by a number of scientists worldwide, and for welcoming others to participate jointly in his research. His in-depth background both in chemistry and ecology makes it possible for him to address research problems centered between these fields.

Close researcher-manager relationships are important, emphasizes Bytnerowicz, to help identify research problems and to effectively carry out forest air quality research, which often involves installing and maintaining research equipment and collecting data in remote areas.

Originally from Poland, Bytnerowicz received his Ph.D. in natural sciences from Silesian University in Katowice while heading the laboratory of Chemical Analysis of Plant Material for the Botanical Garden of the Polish Academy of Sciences in Warsaw. He was a Senior Fulbright Scholar at the Statewide Air Pollution Research Center, University of California, Riverside. Following postgraduate work, also at the Center, Bytnerowicz moved to the USDA Forest Service, Pacific Southwest Research Station in Riverside as an ecologist, becoming a Senior Scientist in 2002.

Bytnerowicz has served on a number of International Union of Forest Research Organizations (IUFRO) task forces and working parties. Since 2002, he has been Deputy Coordinator of the research group "Impacts of Air Pollution on Forest Ecosystems."

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car exhaust and agricultural operations are major sources. These pollutants are deposited both directly and as a result of precipitation. Acting as fertilizer, nitrogen compounds upset the ecological balance by encouraging the success of some plants over others. An increase in nitrogen levels also prompts algal and other growth in lakes and streams, which eventually dies and decomposes, robbing the water of oxygen needed to maintain animal life.

Until recently, scientists had only skeletal knowledge of air pollution in forests. "The technology required electricity and air-conditioned shelters, making it expensive and unsuitable for remote locations," explains Bytnerowicz. These limitations restricted the number of points that could be monitored. Scientists trying to understand the effects of ozone and nitrogen deposition on forests and other ecosystems lacked basic information.

But over the past few years, two major developments have led to vast improvements in mapping air quality on a landscape scale. These pave the way for better understanding of how air pollutants affect forests and other wildlands, and, potentially, will lead to better stewardship of these lands.

AIR POLLUTANT
Effects on Forests

Damages Vegetation Directly	
Ozone	O_3
Nitric Acid Vapor	HNO_3
Sulfur Dioxide	SO_2
Nitrogen Deposition	
Nitric Oxide	NO
Nitrogen Dioxide	NO_2
Nitric Acid Vapor	HNO_3
Particulate Nitrate	NO_3^-
Ammonia	NH_3
Particulate Ammonium	NH_4^+

Writer Anne M. Rosenthal holds B.S. and M.S. degrees in Biological Sciences from Stanford University and a Certificate in Technical Writing from San Jose State University. A science writer based in the San Francisco Bay Area, she served as editor of *Jasper Ridge Views*, a publication of the Stanford University Jasper Ridge Biological Preserve, for ten years. Her articles have been published in *Scientific American On-line*, *Astrobiology Magazine* (NASA), and *California Wild* (California Academy of Sciences).

Unless otherwise noted, all photos taken by Andrzej Bytnerowicz

What's Next

Passive samplers in Joshua Tree National Park

Continuing work on passive samplers and models for air pollutants is a priority. One focus is improving model estimates of pollution from forest fire smoke, with potential applications for prescribed fires and respiratory alerts. Bytnerowicz' group has tested passive samplers for a variety of gaseous smoke constituents and is currently evaluating various portable samplers for particulate matter.

Bytnerowicz is applying the methods he developed to air quality issues related to direct plant injury and human health hazards. With a passive sampler network installed in the Lake Tahoe region, he is determining whether high ozone and nitric acid vapor levels stem from local traffic or air pollution transported from other parts of California. His study will provide baseline data needed to address the high air pollution levels in the Tahoe basin.

In Joshua Tree National Park exotic grasses are invading in large numbers, affecting biodiversity and increasing fire danger. Bytnerowicz and PSW Research Station colleague Mark Fenn are evaluating concentrations of nitrogenous air pollutants transported to the Park and measuring the amount of nitrogen deposition. Bytnerowicz' colleague Edie Allen, University of California, Riverside, is evaluating how nitrogen deposition is affecting two plant communities common to the Park, creosote scrub and pinyon-juniper woodland.

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For Further Reading

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Air Pollution

Worldwide Effects on Mountain Forests

Widespread forest decline in remote areas of the Carpathian Mountains has been linked to air pollution from urban and industrial regions. Besides injuring plant tissues directly, pollutants may deposit to soils and water, drastically changing susceptible ecosystems. Researcher Andrzej Bytnerowicz has developed effective methods for assessing air quality over wildlands.

A mountain road winds steeply through a remote forest far from urban development. At the lookout, a driver pulls over and surveys the expansive view below—ridge after ridge of conifers eventually fading into the horizon.

On closer inspection, however, patches of brown trees stand out against blue-green hues on nearby hillsides. What has caused this uneven dieoff—insect damage, disease, a leapfrogging fire?

Perhaps—but a splotchy pattern of susceptible tree loss is often the signature of a more insidious threat—air pollution—a hazard created far away and difficult to curb. In many cases, the initial symptoms portend far greater future damage, as trees are exposed to continued pollution and secondary infections and infestations set in.

"Air pollution is rarely thought of in conjunction with forests," says Andrzej Bytnerowicz, an ecologist with the USDA Forest Service Pacific Southwest Research Station. "However it threatens vast areas of forests and other wildlands on a worldwide basis."

In California, smog from the San Francisco Bay Area travels hundreds of miles to the Sierra Nevada. Laden with pollutants, the smog contains tiny droplets called aerosols, minuscule particles known as particulates, and toxic gases. Additional toxins may form when smog constituents react with one another during transport. Agricultural processes in the Central Valley also produce potent pollutants that end up in the Sierra.

Similarly, smog from the Los Angeles Basin affects the San Bernardino and San Gabriel Mountains in southern California, as well as the Grand Canyon.

"We usually think of air pollution in relation to its detrimental effects on human health," says Bytnerowicz. "At the same time, air pollution is extremely toxic to forests, affecting not only plants but soils and water quality."

Two types of pollutants have major effects on forests in the western United States. The first, ozone, is a reactive triplet molecule of oxygen. (While ozone in the stratosphere protects earth from the sun's ultraviolet rays, at the earth's surface, ozone is a pollutant.) Ozone affects plants directly: it enters leaves through openings called stomata and damages plant tissues, leading conifers to drop needles and die back.

A second category of pollutants greatly affecting forests today is nitrogen-containing compounds;

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