

Letter

Understanding the role of air pollution in species invasions

The Fall 2004 issue of *Park Science* (volume 22, number 2) provided an excellent overview of the invasive species crisis now facing the National Park Service (NPS). The cover article and the accompanying features and short articles combined to tell a compelling story about this “biological wildfire” and its implications for native biodiversity and natural ecosystems. As many of the authors pointed out, biological invasions constitute one of the most significant threats to terrestrial, aquatic, and marine systems, with the potential for changing the very character of the parks we treasure. The articles discussed the many factors that encourage invasives, including habitat disturbance, breakdown of natural barriers, and intentional or accidental introductions. As biologists with the NPS Air Resources Division, we would also like to highlight the role of air pollution in biological invasions, particularly plant invasions.

Evidence is mounting that air pollution, in the form of atmospheric nitrogen deposition, is encouraging the proliferation of alien annual plants, and possibly promoting the invasion of new species in certain regions. Nitrogen compounds, emitted from automobiles, power plants, and agricultural activities, can be transported by air currents and deposited far from their sources. Current rates of nitrogen deposition across many areas of the United States are from one to two orders of magnitude higher than in preindustrial times, and in some areas nitrogen deposition is increasing. Nitrogen deposition has been implicated in the decline of coastal sage scrub vegetation of southern California and its subsequent replacement by Mediterranean annual grasses (Allen et al. 1998). Increased nitrogen has been shown to increase the dominance of alien annual plants in the Mojave Desert (Brooks 2003) and decrease species richness in alpine tundra in the Rocky Mountains (Bowman 2000). An analysis of more than 900 plant species responses from 34 fertilization experiments across nine terrestrial ecosystems in North America showed that nitrogen additions reduced species diversity, with rare species often being lost. The researchers concluded that as nitrogen availability increases, management that focuses on locally susceptible functional groups and generally susceptible rare species will be essential to maintain biodiversity (Suding et al. 2005).

These results indicate that air pollution, in the form of nitrogen deposition, may have a profound effect on native vegetation communities and their responses to invasions and future restoration efforts. We would like to suggest, therefore, that nitrogen deposition be considered when developing strategies for monitoring and restoring sites impacted by invasive plants. In the *Park Science* article

“Assessing the invasive plant issue,” Benjamin and Hiebert outlined the requirements of an effective weed inventory, mapping, and monitoring program, and proposed a strategy for prioritizing disturbed sites for restoration. We recommend that this strategy also include an assessment of long-term, cumulative nitrogen deposition at impacted sites, as well as research on the effects of nitrogen on plant communities.

The Air Resources Division of the National Park Service is funding projects at Joshua Tree, Rocky Mountain, and Big Bend National Parks, and other areas to evaluate nitrogen impacts on natural vegetation communities, and is developing strategies to estimate “critical loads” for atmospheric deposition (Porter et al. 2005), that is, “how much is too much.” Critical loads for site-specific changes in species composition may eventually help us assess an area’s vulnerability to invasion or its potential for restoration.

Addressing biological invasions must be done on many fronts. In addition to working with partners on our park borders to control local plant invasions, we must continue to work with state and local air regulatory agencies, and industries, to reduce nitrogen deposition to parks. As Lloyd Loope pointed out in the cover article, “Major breakthroughs in science, policy, and management will likely be needed to address the complex and important issue of biological invasions if substantial impairment of the parks is to be averted.” Some of the complexities of the challenge, including the role of air pollution, are just being recognized. Consideration of all factors contributing to invasions will be necessary if the National Park Service is to meet this challenge and keep our parks “unimpaired for the enjoyment of future generations.”

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References

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