

Monitoring Air Quality in Southeast Alaska National Parks:

Linking air quality to ecological effects



Airborne contaminants are deposited into ecosystems by rain, snow, and dust. Samples collected by these funnels are analyzed for nitrogen and sulfur compounds. Concentrations of contaminants in the samples are then analyzed and compared to the concentrations of contaminants found in lichen tissue.

The presence or absence of certain lichen species can indicate adverse effects of air pollution to the ecosystem.

National park managers are challenged to protect park resources and to evaluate and, when possible, mitigate factors that may contribute to the degradation of park resources. Low population densities, lack of large-scale industrial development, proximity to the Pacific Ocean, and vast stretches of wild-lands lead many people to believe the environmental quality of Alaska is among the most pristine in the world. However, a pilot airborne contaminants study completed in 1999 demonstrated that sulfur, nitrogen, and heavy metal concentrations in lichens in Klondike Gold Rush National Historical Park (KLG0) and the Skagway area exceeded thresholds established by the USDA Forest Service for lichens in southeast Alaska.

In order to assess changes over time, lichen tissue will be collected and analyzed in KLG0 and nearby areas for airborne contaminants following the same methods

established in 1999. Additional air chemistry data will be collected by deploying passive air and deposition samplers, which were not part of the 1998-99 study in KLG0. The study is also being expanded to include sites in Glacier Bay National Park and Preserve and Sitka National Historical Park.

The Klondike-Skagway area is exposed to a number of local and regional air pollution sources. Homes and businesses expel exhausts into the air from heating, cooking, cleaning and business operations. Road transportation includes cars, buses, shuttles and large trucks. Ferries, barges and small boats operate year-round. Air traffic consists of small planes and helicopters. All of these sources increase dramatically during the summer season when Skagway becomes the 16th busiest cruise ship port in the world. Up to five large cruise ships dock at Skagway daily from May to September. Diesel-powered trains also operate several times a day. Regional air pollutants include soot, fine particulates, metals, and nitrogen oxides associated with forest fires, wind-blown dust, and industrial emissions transported from Eurasia. Local and regional air pollutants are a concern because of the potential adverse impacts on human health and sensitive park resources like soils, water, vegetation, and wildlife. Visibility, an important park resource, may also be compromised by haze from local and global air pollution.

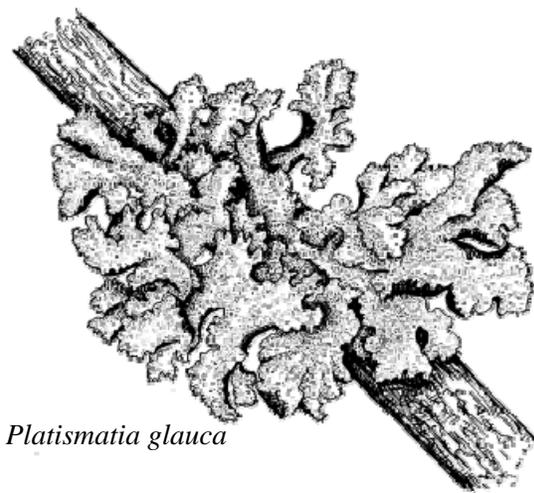
Lichens are ideal useful long-term integrators of atmospheric deposition due to their longevity and lack of inter-seasonal morphological variation. Lichens lack roots, get their mineral nutrients directly from the air, and their tissue structure traps airborne particulates and soluble metal ions. Because of this, they are more susceptible to the harmful effects of airborne nitrogen, sulfur, and heavy metal compared to plants and animals that have better protective coverings and selectively obtain their nutrients from the soil or from eating other organisms. Some lichens are particularly sensitive to certain air pollutants, and they decline or die when exposed to low levels



The concentrations of contaminants in the air are measured by passive samplers deployed at the lichen collections sites. The filters are changed every week throughout the summer.

of those pollutants. The presence or absence of these lichens in an area can be used to indicate adverse effects of air pollution to the ecosystem. Lichen community studies can be used to compare areas exposed to different levels of air pollution.

Lichens that grow on trees get their nutrients primarily from the atmosphere. As a result, many chemical elements in air and water are absorbed and accumulated by lichens. Mobile elements like nitrogen, sulfur, and potassium are easily absorbed and also easily leached, maintaining a dynamic equilibrium with seasonal changes in the availability of these nutrients. Chemical properties of other elements, (e.g., lead and cadmium), may cause them to bond more strongly to lichen surfaces and these elements may take years to decrease in concentration after the source has been removed. Accumulated pollutants may adversely affect lichens by interfering with important physiological processes like photosynthesis. Airborne pollutants also affect morphology and cause decline or death, or they may simply bioaccumulate without harming the lichen depending on the species. Studies that examine the concentrations of chemicals in lichens may reveal signs of air pollution before more overt signs, such as lichen death and changes in the species composition of lichens in an area, become apparent.



Platismatia glauca

Lichens are a combination of a fungus and an algae. The fungus provides a substrate for the algae while the photosynthetic algae provides nutrition of the fungus. The fungus component does not exist in nature without its algal partner. Over 20,000 species of lichen exist worldwide.

identifying areas of maximum impact from local emission sources and quantifying individual source contributions to total deposition. Modeling can also be used to evaluate the effects of various emission reduction strategies.

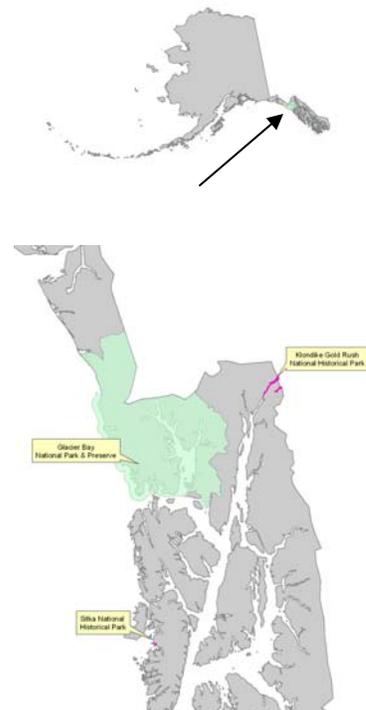
The goals of this investigation are to further the science of using lichens to assess the ecological health of wild-lands at broad spatial scales and to initiate a long-term (100 years or more) lichen-based air quality monitoring program for the National Park Service's Vital Signs Program.

Objectives include:

- Track trends in air quality over time
- Contribute to the development of models linking ambient air quality to concentrations of pollutants in lichen tissue by deploying passive air samplers at lichen collection sites
- Assess the effects of air pollution on lichen community composition by comparing lichen communities at sites with different levels of air contaminants
- Collect reference data on lichen community composition for future trends analysis
- Create a spatially explicit model of the Skagway airshed
- Develop long-term monitoring protocols for air quality

Accumulated pollutants may adversely affect lichens by interfering with important physiological processes like photosynthesis

In order to understand how emissions travel through the Skagway Valley where KLGO is situated, an airshed model will be created to assist with estimating the concentration and deposition impact of nitrogen and sulfur from cruise ships, busses, ferries, harbor vessels, the railroad, and the municipal incinerator. The modeling will complement the larger ecological indicator study by



The southeast Alaska Network includes Glacier Bay National Park & Preserve, Klondike Gold Rush National Historical Park, and Sitka National Historical Park



This research is conducted in partnership with the USDA Forest Service and the Municipality of Skagway