Monitoring of Airborne Contaminants in the Southwest Alaska Network Using the Common Moss *Hylocomium splendens*

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Importance

Why is monitoring airborne contaminants important in the Southwest Alaska Network?

While parklands within southwest Alaska are still considered pristine, the transport and deposition of airborne contaminants have been recognized as a possible threat to aquatic and terrestrial ecosystems for several decades. Toxic compounds and metals are deposited through wet and dry deposition from sources as close as the local communities to as far away as Europe, Asia, and eastern North America. These airborne contaminants can pose serious biological consequences on Southwest Alaska Network (SWAN) resources, including degradation of highly sensitive nonvascular plant (i.e., mosses and lichens) communities, bioaccumulation in fauna, and increased contaminant levels in forage. Recognizing the potential ecological impacts of increasing contaminant concentrations, the SWAN has included contaminant monitoring in several of its Vital Signs programs.

Parks of the Southwest Alaska Network: Alagnak Wild River, Aniakchak National Monument & Preserve, Lake Clark National Park & Preserve, Katmai National Park & Preserve, and Kenai National Park.

***Hylocomium splendens* is a widespread and abundant moss in northern hemisphere boreal forest and arctic tundra habitats.**

Objectives

What do we want to know about terrestrial airborne contaminants in the Southwest Alaska Network?

A suite of contaminant monitoring protocols are being developed for both aquatic and terrestrial environments within the SWAN. For terrestrial monitoring there is a need to know how contaminants move through and accumulate, specifically:

What are the baseline levels and long-term trends in deposition and accumulation in the SWAN of the following elements or compounds: Al, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Zn, Total S, Total N, and NO_3^-?

To address this question, SWAN will use a well-established method for monitoring moss-derived contaminant concentrations currently in use in the Arctic Network (ARCN). For over a decade, ARCN has successfully used *Hylocomium splendens* as a passive sampler for monitoring airborne contaminants within Cape Krusenstern National Monument (CAKR). A specific concern for the ARCN has been fugitive dust deposition and accumulation from mining operations and ore transport along a haul road that passes through CAKR, linking the world's largest zinc mine, Red Dog Mine, with a shipping port on the Chukchi Sea. Changes in the chemistry of *Hylocomium splendens* with distance from the haul road has clearly demonstrated a strong road-related gradient of heavy metal deposition (Ford & Hasselbach 2001).

Literature Cited
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Typical Hylocomium splendens habitat, Kirshnup Lake, Lake Clark National Park and Preserve, 2010

Long-term Monitoring

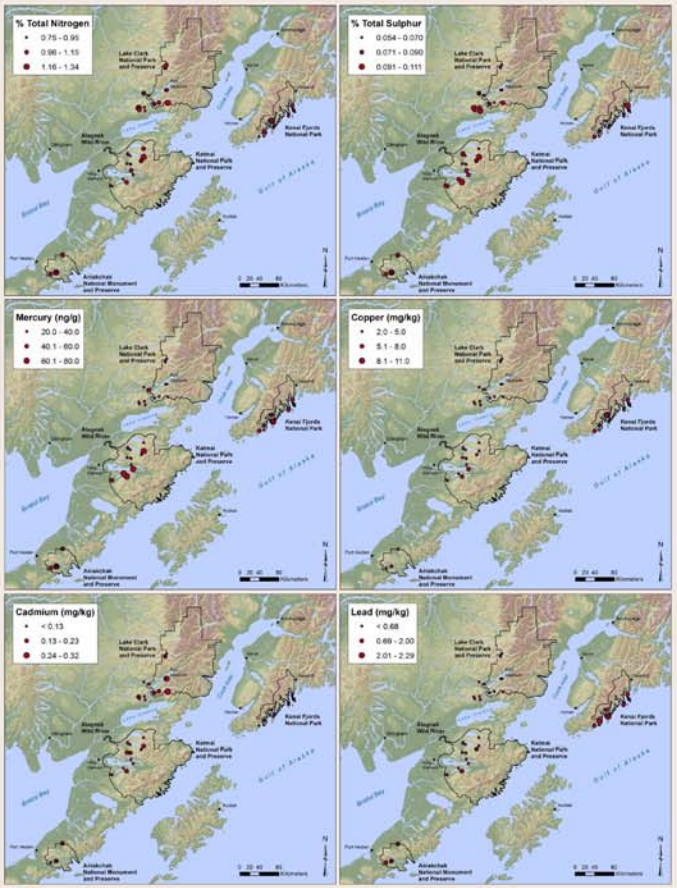
How will we monitor terrestrial airborne contaminants in the Southwest Alaska Network?

Use of moss as a biomonitor is a well established technique to estimate wet and dry trace element deposition on a geographical basis. Characteristics of moss that make them suitable for the study of airborne contaminants include: they obtain most of their nutrient supply directly from wet and dry atmospheric deposition, they lack the variability of morphology through the growing season that many other plants have, they lack cuticles, they have a high surface to volume ratio, and they have shown a great capacity to retain many elements. Across many northern European countries and Alaska, the moss *Hylocomium splendens* is routinely used for biomonitoring because it is widespread, the annual growth increments are easily identified, and it is easy to distinguish from other mosses.

Field Data Collection
Hylocomium splendens samples have been made both opportunistically and co-located with long-term vegetation monitoring plots in and around SWAN parks since 2008. Approximately 1-2 L are collected into plastic lined containers (i.e., Ziplock™ or KPAK™) using powderless latex gloves. For lab QA/QC, a small subset of duplicate collections are made at field sites, as well as divided into lab duplicates during the moss tissue cleaning process.

A researcher collects *Hylocomium splendens* (left) into 1 L collection bags (right).

Laboratory Analysis
Hylocomium splendens samples are currently analyzed at the University of Minnesota Research Analytical Laboratory. Unwashed, air-dried samples of the past three-year annual growth increments are used for all analyses. Total Sulfur (S), Total Nitrogen (N), and Nitrate (NO_3^-) are determined using standard combustion methods, while the elements Al, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, Zn are determined using emission spectrometry. A set of standardized QA samples are used throughout the analyses to ensure lab QA/QC.



Preliminary baseline concentrations (dry weight) of select trace elements in the moss *Hylocomium splendens* (Data shown are 2008-2009 samples only). Values generally fall within what are considered background levels in other studies across Alaska and parts of Europe. While subtle distribution patterns appear for several elements, further research is needed in understanding and controlling for sources of variability, including the influence of lithologic sources due to landscape setting and hydrological factors.

Management Applications

How can monitoring terrestrial airborne contaminants help protect parks in SWAN?

Emerging Mining District Near Lake Clark National Park and Preserve
At present, airborne contaminants deposited on SWAN parklands come primarily from global sources, though regional and local sources may increase with increasing industrial development and resource extraction. As outlined in a recent resource condition assessment, the greatest threat to the resources of Lake Clark National Park and Preserve is a potential mining district to the southwest, notably the proposed Pebble Mine site. Mining activity is currently limited due to state and federal permitting processes, but intensive exploration continues at what could potentially be the largest mining operation in Alaska and the largest open-pit mine in the world (NPCA 2009). Establishing baseline levels and long-term trends of local and regional airborne pollutants helps NPS set the stage for engagement with stakeholders to work on possible pollutant reduction strategies.

International Contribution
Monitoring global pollutants helps contribute scientific data to various international efforts (e.g. United Nations, Global Atmospheric Pollution Forum) to reduce inputs of airborne contaminants.

NPS Resource Condition Assessment
According to a recent multiagency airborne contaminants study, bioaccumulation of toxic compounds and metals is occurring in western and Alaskan parks and is of concern for both ecosystem and human health (Landers et al. 2008). Through its Vital Signs program, the SWAN is actively monitoring wet and dry deposition in both its aquatic and terrestrial ecosystems, in concordance with federal regulation that requires protection of natural parks in perpetuity.