

Protocol Development Summary

Protocol: Wet and Dry Deposition

Parks Where Protocol will be Implemented: BELA, CAKR, GAAR, KOVA, NOAT

Justification/Issues being addressed:

Despite the pristine appearance of the arctic parklands, the steady input of contaminants from both local and global sources make pollution a primary concern in ARCN. Sources of contaminants in ARCN's parklands include point sources, regional sources, trans-pacific and trans-polar global pollution sources. Point sources include heavy metals, sulfur and nitrogen from the Red Dog Mine, the largest zinc and lead mine in the world. Regional sources include those associated with northwest Alaskan community and industrial development. The furthest-range pollutants are semi-volatile organic compounds (SOC's) including persistent organic pollutants (POP's), mercury, sulfur and nitrogen from Asian (and even eastern North American) sources.

There are myriad potential biological consequences from these various pollutants on ARCN resources. ARCN ecologists have recently focused studies on the effects of heavy metals on ecosystem components in CAKR (e.g., impairment of lichen and bryophyte communities, bioaccumulation in fauna, contaminant levels in forage, increasing bioavailability with weathering). Bioaccumulation of mercury in piscivorous freshwater fish has begun to receive some attention from the perspective of human health, though food-chain effects for wildlife are relatively unknown. The effects of sulfur and nitrogen on vegetation are well known generally, but are relatively unknown in Alaska.

Wet and dry deposition is of concern to park management for a number of reasons. First, increasing loads of sulfur and nitrogen from Asian coal-burning has the potential to seriously degrade tundra and alpine vegetation and boreal forest epiphytes. These vegetation communities are dominated by nonvascular plant species (i.e., lichens and mosses) that are highly sensitive to these pollutants. Bioaccumulation of heavy metals including mercury and organic toxins is another key concern from the perspectives of food chain health and subsistence hunting. A recent study that included two lakes within the ARCN found that mercury levels in older, piscivorous fish already exceeds EPA guidelines for human health in some cases (Western Airborne Contaminant Assessment Program: WACAP 2008). Thus far, semi-volatile organic compounds (SOC's) including pesticides, do not appear to be concentrating in arctic Alaska's foodchain (WACAP 2008). However, increasing use of toxic SOC's in Asia is likely to increase deposition levels in Alaska in the future. Re-measurement of baseline values would therefore be of keen interest.

Specific Monitoring Questions and Monitoring Objectives to be Addressed by the Protocol:

Some of the specific monitoring questions that will be addressed by this protocol include:

1. What is the current baseline level of heavy metals, sulfur, nitrogen, and SOC's in the Arctic Network.

2. In what ecosystem compartment (biotic or abiotic/terrestrial or aquatic) are airborne heavy metals, sulfur, nitrogen and SOC's occurring?
3. Are levels of airborne metals, sulfur, nitrogen, and SOC's in terrestrial and aquatic ecosystems of the Arctic Network changing?

Objectives are as follows:

1. Establish baseline and long-term framework for airborne metals, sulfur and nitrogen using the moss *Hylocomium splendens* as a passive sampler.
2. Determine current levels of mercury in piscivorous freshwater fish (e.g., Lake Trout, Sheefish).
3. Link *Hylocomium splendens* tissue sampling with surveys of lichen community structure via the Forest Inventory and Analysis (FIA) Lichen Indicator protocols currently conducted by Vegetation vital sign. This permits a linkage between observed pollutant levels and changes in community structure.
4. Compare historic and current levels of deposition using sediment cores.
5. Monitor changes in heavy metals and persistent organic pollutants in small mammals near active industrial sites.
6. Monitor changes in heavy metals, sulfur and nitrogen in streams, lakes and lagoons.

Basic Approach:

A baseline level of heavy metals, sulfur, nitrogen, and SOC's will be established in ARCN using the common moss *Hylocomium splendens*, fish, and small mammals. Collocating sample sites with the aquatic vital signs, and the Terrestrial Vegetation and Soils vital sign will allow for determination of baseline values in abiotic components. It is expected that these measures will occur on a decadal basis. The air quality station currently being established by ARCN in Bettles, Alaska will provide a weekly measure for air pollutants.

ARCEN will use a well-established method for monitoring moss-derived contaminant concentrations for point source contamination (i.e., Red Dog Mine mine) that was used previously in ARCN (Hasselbach et al. 2004). These methods will be documented in formal protocols and expanded to other sampling locations in the ARCN parks. Methods for measuring mercury in fish are well established. Methods utilized and reported on in the Western Airborne Contaminant Assessment Program (2008) will be utilized and adapted to ARCN needs. Small mammals will be ...

Principal Investigators and NPS Lead:

The Principal Investigators are Linda Geiser (USDA/Forest Service), Staci Simonich (Oregon State University), Dixon Landers (EPA-Corvallis, OR), Todd Gouin (UAF), Jesse Ford (OSU). The NPS Principal Investigators will be Greta Burkhart (NPS-ARCEN), Amy Larsen (NPS-WRD) and Peter Neitlich (NPS-WEAR). The NPS lead is Peter Neitlich (509-996-8031).

Development Schedule, Budget, and Expected Interim Products:

The protocol will be developed on the following schedule:

- FY 2009: PIs meet to coordinate protocol development. Field testing of methods (\$15,000)
- FY 2010: Draft protocol completed by December 1, 2009
- FY 2011: Protocol reviewed and finalized. Implement (recurring decadal) (\$125,000).

