National Park Service Air Toxics Workshop: Western U.S. and Alaska

Proceedings

Final

June 26 and 27, 2001
NOAA Sand Point Center
Seattle, Washington

NPS Air Toxics Seattle Workshop Proceedings

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I. Introduction

A. Workshop Background

The Air Resources Division of the National Park Service sponsored an air toxics workshop in Seattle on June 26 and 27th, 2001, in response to a technical assistance request from several western U.S. and Alaska parks. The workshop was designed to be a first step to address air toxics (persistent organic pollutants and metals including mercury) in National Parks in the western U.S. The workshop brought together scientists with expertise in specific areas of interest to assist NPS managers in meeting two immediate goals:

(1) Discuss potential risks of bioaccumulation of toxics to NPS areas in the western US and Alaska.
(2) Obtain sufficient background information such that NPS can begin initial planning for a future POPs monitoring strategy and network in the west, including Alaska.

Staff of the ARD and the Rocky Mountains Cooperative Ecosystem Studies Unit selected agency and university experts who had experience with different aspects of air toxics monitoring. NPS staff from parks and regional offices attended the workshop to provide the management perspective. A list of the workshop participants is included in Appendix A; the agenda for the workshop is found in Appendix B.

The geographic focus of western U.S. and Alaska for the workshop was based on concerns over trans-Pacific, trans-Arctic, and regional transport of toxics and accumulation of these toxics in Arctic, near-Arctic, and mid-latitude mountain snowpacks. This accumulation has been linked with the phenomena of "cold condensation" of atmospheric pollutants at high elevations and high latitudes. Therefore, the initial focus of NPS efforts to study and address air toxics on a landscape scale will be to establish an air toxics network among NPS areas of high elevations and high latitudes in the Pacific Northwest, Sierra Nevada Mountains, Northern Rockies, and Alaska.

This workshop was envisioned as a very small, focused, technical forum, designed to elicit monitoring recommendations from the scientific community and to assist the NPS in fine-tuning the toxics questions that we should be asking, based on the current state of the science and NPS management goals. Specific questions addressed at the meeting were:

(1) Why should we care about air toxics deposition and accumulation in park ecosystems?
(2) Where have we seen effects of air toxics and at what concentrations?
(3) What do we know about air toxics distribution and effects in the western U.S. and Alaska?
(4) What recommendations can be made about monitoring of air toxics in specific media in parks?
(5) What "advance work" needs to be done in parks before an air toxics monitoring plan can be devised?
(6) What trends can we predict in toxic emissions, deposition, and impacts?
(7) What do we need to know (research gaps and knowledge gaps with special emphasis on effects on primary productivity)?
(8) What should the goals of the NPS be for monitoring air toxics in parks?
(9) What specific chemicals or compounds would it be best to focus on?
(10) Are there priority geographic areas to focus on based on 'hot spots'?
(11) What ecosystem indicators and endpoints would be best to focus on?
(12) What other national/international toxics or deposition monitoring networks (and other opportunities for collaboration) currently exist?
(13) What media for future monitoring would best meet NPS goals (air, water, sediments, snow, lichen, fish/animal tissue)?
(14) How would we prioritize NPS monitoring in Alaska and the western U.S. if only limited amounts of funding were available?

B. Why Should We Care?

At the beginning of the workshop, participants were asked "why should we care about air toxics impacts to National Park lands?" The following is a summary of their comments:

Because of the National Park Mission/Goals of "no impairment":

- The NPS goal is to allow National Parks to function without impairment.
- The "no impairment" mandate of National Parks requires an adequate information base – we lack this with regard to POPS.
- We need to manage natural systems "unimpaired" but have concern for the effects of toxics on ecosystem processes and food chains.
- Many Parks (e.g.: PNW) are headwater areas – and may be more sensitive and be receiving more deposition of airborne toxics.

Because knowledge of air toxics distribution and accumulation will help NPS managers take appropriate policy actions:

- Understanding what monitoring is underway now will inform what we need to do from here—better coordination and planning
- Toxics thresholds of the food web and biogeochemical systems are needed – National Parks provide a place to tease apart thresholds.
- Can use toxics effects information in policy/regulatory arena to manage/protect resources.

Because of linkages of toxics to high food chain (human, fish, wildlife) impacts:

- Human health concerns because many air toxics bio-magnify up the food chain
- Rocky Mountain NP is the water supply source for 4-5 million people in the Colorado Front Range. Concern for human health.
- These substances: bioconcentrate, are toxic at low levels, and are persistent.
- Need more information on air toxics to understand risks to wildlife species.
- Concern for threshold levels for human health – what's happening in circumpolar regions?
- Food web dynamics -- cumulative impacts of toxics may cause problems.
- Lack of US/Alaska data on POPs distribution – fill in data gaps; Concern about persistent nature of existing toxic chemicals in the environment and the new chemicals that have replaced some of the banned substances.

Because toxics may affect ecosystem processes within parks:

- Parks are natural laboratories and can provide an understanding of the role/effects of toxics in the ecosystem.
- Air toxics can affect biological diversity in parks.
- Don't know what levels constitute impairment of ecosystem processes (biogeochemical) (how high can we go and still be "safe")
- Air toxics have great variability in pathways and interactions with complex systems.
- Establish a baseline, especially in Alaska.

Because Parks serve as microcosms for global scale environmental impacts:

- This is a global problem: production in temperate areas – effect in remote areas.
- Detectable levels of POPS measured in remote areas such as DENA
- Global issues: Parks provide a measuring stick for outside areas.
- Global problem that will require a global solution – we do not have the sole power to effect a solution. Parks have a special role in that people care and listen to what is happening in parks – that special role may help precipitate a solution.
- Parks offer a good set of sites to compare with areas outside the Parks – good sites to study transport, deposition and effects – parks are "nuclei"

- Parks represent defined study areas with controlled development inside boundaries, where monitoring can be standardized, and coordinated between geographic areas.
- Some atmospheric and resource monitoring already exists within Parks.
- The majority of manufacture and use of POPs and other air toxics occurs distant from Parks, but some emission may occur within park boundaries.
- Toxics can be local as well as global problem– don't forget to look in our own backyards.
- National Park information serves as a sentinel for global trends.

Because public has limited awareness about potential risks of toxics to human & ecosystem health:

- Public use of parks in Rockies is high. Exposure of ecosystems to pollutants occurs and ecosystem recovery time is long.
- Air (and associated toxics) are not key "features" of public consciousness and concern (such as charismatic species) not high in public awareness.
- Nationwide education needs can benefit from information gathered in this program – public misconception that these places are clean.
- Insufficient resources are going to studying POPs/toxics; lack of public education. Documentation of problems in national parks can help the public education efforts.
- Subsistence users in Alaska Parks rely heavily on food sources from within parks that may be bio-magnifying air toxics.

C. Workshop Overview – Kathy Tonnessen (NPS)

(Note: NPS air toxics web site (http://www2.nature.nps.gov/ard/aqmon/air_toxics) will include links to this power point presentation)
Workshop History
Monitoring vs. Research
Agenda Overview

II. **Goals**

A. Introduction:
While developed specifically for this workshop, which focused on POPs/air toxics effects in western U.S. and Alaska parks, these goals may have relevance for air toxics effects issues on NPS areas servicewide. The goals listed here should be considered “draft” goals, as the National Park Service has not formally approved them. Workshop steering committee members developed the goals prior to the air toxics workshop, workshop participants revised and made comments on these goals, and steering committee members incorporated those comments to develop the general programmatic goals listed below. Their purpose is to guide development of the NPS toxics monitoring program, which is currently in its infancy. As such, the goals are currently very broad in scope. Additional, specific, and quantitative objectives will need to be added to the broader goals as implementation planning of the air toxics program proceeds.

B. Draft Air Toxics Goals:

1. ***Presence, Distribution, and Trends***: Document exposure to and accumulation of air toxics that may cause ecosystem impairment across national parks. Focus on long-lived POPs and heavy metals that are persistent and are known to bioaccumulate.

   1.1 Presence and Distribution: Identify distribution patterns, including “hotspots” of toxic deposition within National Parks across a broad geographic area, to determine concentrations of toxics in ecosystems and identify where further site specific targeted monitoring or effects research should be conducted.

   1.2 Trends: Implement toxics monitoring that is repeatable over time, allowing a long-term assessment of trends in air toxics distribution and accumulation in specific targeted media (e.g.: lake sediments, snow, lichens, and air).

2. ***Effects:*** Based on exposure, spatial distribution, and trends of air toxics accumulation in national parks, assess effects to fundamental ecosystem processes (e.g. primary productivity, nutrient cycling) and components (e.g. species and populations).

   2.1. Determine concentrations of air toxics that accumulate in biological tissue of organisms including fish or wildlife and assess toxicity of these concentrations.

   2.2. Determine the concentrations and effects of air toxics in species that serve as food for subsistence uses.

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   2.3. Assess impacts of air toxics to ecosystem processes such as primary productivity and nutrient cycling in key ecosystems.

3. ***Study Design, Data Collection, and Integration***: use consistent methods, quality assurance procedures, and reporting so that data sets can: (a) integrate with other national and international monitoring programs (b) inform human health or ecosystem-level risk assessments (b) guide research and additional monitoring of air toxics transport and fate, and (c) communicate results to appropriate audiences.

4. ***Communication*:** Communicate, consult, and cooperate with stakeholders to inform and educate them about air toxics and specific effects on national park ecosystems. *Stakeholders include: research community, park visitors, general public, park subsistence users, regulators, park managers, policy makers, etc.*

5. ***Management***: Use information from air toxics assessment and monitoring to affect local, regional, national, and international policy and regulation, resulting in actions that prevent or mitigate impairment of NPS resources.

5.1 Use air toxics data to determine fate, transport, and source attribution of chemicals that affect national parks.
5.2 As warranted, use fate, transport, and source attribution information in local, state, national and international regulatory arenas to reduce toxics production that affects national parks.

C. Implementation of Goals:

These goals, as with the overall air toxics workshop, are part of a first step in the agency's efforts to address air toxics issues, concerns, and monitoring strategies. Many additional NPS servicewide decisions and actions are necessary to build on the results of this workshop prior to implementation of an NPS air toxics program. Therefore, additional, specific, and quantitative objectives and actions will need to be added to the broader goals listed above to implement the air toxics program.

III. Summaries of Presentations

(Note: NPS air toxics web site (http://www2.nature.nps.gov/ard/aqmon/air_toxics) will include links to power point presentations for each speaker)

A. Atmospheric Processes (transport of air toxics; source-receptor relationships) – Mark Cohen (NOAA)

Vapor particle partitioning - dry conditions
Vapor droplet partitioning - in clouds
Chemical transformations - producing new compounds
Wet deposition - complicated but easy to measure
Dry deposition - complicated and difficult to measure
Re-emission - grasshopper effect

Dry deposition is common for many POPs, which can be re-emitted. PCB and DDT are deposited by wet and dry methods. Many particles are extremely small, less than 1 micron, which makes it difficult to understand the deposition type. Classify compounds by atmospheric half-life (average amount of time spent in the atmosphere). Those compounds that are not water-soluble last longest in the atmosphere. Compounds travel about 400 km/day on average.

What do you want to know? Is a pollutant causing a problem? Is it showing up at levels that are a concern? If so, is the atmosphere an important pathway and where is it coming from? Is it local, regional, national, global? What are the most significant source categories contributing to atmospheric loading? Answers depend on the pollutant, the location, and the time that you are considering it.

Methods:
Wet deposition
Dry deposition - measure concentration and velocity to determine flux.

Ecosystem processes are complex so it is difficult to know what will have effects on an organismal level.

Ambient monitoring -- take measurements and estimate deposition.
Back trajectory -- when level was high, where was wind coming from? When levels were low, where was it coming from? You do not want a long, integrated sample (i.e. monthly vs. daily).
Comprehensive fate and transport modeling -- (forward model) -- measure contaminants at sources, model transport. You must have ambient data for validation of flow model (i.e. emissions inventories, model where the pollutant will likely go).

Fog water is a very good integrator/concentrator of toxics. May be very important at high elevations.

For a lot of compounds, modelers have no data. If you had one station that measures everything this could be very valuable. Mark suggested the Sierra Nevada to measure Bay Area/Central Valley emissions.

B. Air toxics in ambient air and deposition (gases, particles, wet and dry deposition) - Matt Simcik (Univ. of Minnesota)

Atmospheric deposition is the only source to remote areas such as National parks

Sources
Combustion - produces both gas and particle phase toxics (dioxins and furans)

Volatilization - produces only gas phase toxics (PCBs)
Transport
Transformation
Gas particle partitioning - controls fate of contaminant….physical-chemical
adsorption….absorption into a liquid-like matrix.
cloud scavenging- partitioning to snow….as snowflake forms, the expanding water pushes all internal particles (including toxins) towards the surface.
reaction/loss reaction with the OH radical is predominant loss mechanism for most air toxics;
most reactions occur fastest in gas phase; reaction products can be more toxic than parents.
Deposition
dry particle deposition - deposition velocity is a function of particle size distribution……typical value of .2 cm/sec.
dry gas deposition - lots of surface area on plants…waxy organic surface which compounds like….what you see in a plant is an integration of the deposition over a long period of time.
wet deposition - best done as total deposition (dissolved and particle).
Air sampling
Hi-Vol air sampling provides an operationally defined gas and particle phase….remote areas especially need high volume sampling because toxics concentrations are low
Alternatives to Hi Vol samplers
semi-permeable membrane devices (SPMD)
lichens or other plant material
surrogate surface
Historical deposition
look at lake sediments (used in Great Lakes and Adirondacks) to look at toxic contaminants…..take a core, date it and analyze contaminants. This method wouldn't work well with glacier cores because lipophilic compounds don't partition to ice surfaces as much as sediments (detection limit problems)…some glaciers have percolation problems.
melting snow or ice can lose volatile compound; keep as cold as possible.

C. Overview of monitoring of air toxics in sediment, snow and aquatic bioaccumulators - general design considerations - Dixon Landers (Environmental Protection Agency)

Why care?
- toxic deposition from Asia
- degree of risk undetermined
- elevational re-distribution likely
- snow as pathway for deposition
- snow as primary alpine deposition source
- bioaccumulation
- multiple stressors at multiple scales
- high elevations could be sinks for toxics
- early warning (in west) for rest of continent

Where have we seen effects?
- go to http://www.amap.no/
- mainly effects seen in arctic food webs, fish, waterfowl, piscivorous fish
- cause/effect relationships are poorly studied…. non-lethal effects on immune and reproduction systems probable

Toxics distribution and effects in Western US
- trans-pacific toxics are poorly characterized

- distribution of toxics poorly understood spatially, vertically, and temporally
- some investigations are beginning: amphibians in Southern Sierra, Denali NP, others
-

Recommendations to NPS:
- develop clear objectives
- create a robust spatial design (see EMAP)
- sediments, snow, biota….examine flux, variability and important indicators

Advance work to do:
- develop objectives, and spatial design
- integrate effort with atmospheric monitoring efforts
- combine exposure and effects monitoring
- create research plan
- get high quality analytical support
- create Scientific advisory board to guide effort
- provide for adequate peer review
- Collaborate internationally (Canada, Mexico?)
- Get more money

What trends are predicted for POPs
- regulations appear to have reduced POPs….declines in emission, deposition, and impacts have been observed (DDT, PB, HCH)
- Arctic/high altitudes may serve as environmental sinks
- mercury is one to look for even though regulation is beginning
- monitor new generation pesticides
- impacts need much greater study to link contaminants with effects

Research Gaps
- primary production is difficult to see effects due to low concentrations, need to look further up trophic levels
- determine effects on development, and eggs
- investigate cumulative effects and non-lethal effects

Asian sources: mercury not unique to Asia, but maybe we can develop isomers or ratios as source "fingerprints"

Reasons long-term monitoring programs fail:

no longer relevant to decision-makers as time goes on
science/methods gets stale
money can't be justified
poor productivity

D. Monitoring air toxics in snow, glacial ice, aquatic bioaccumulators (including salmon) - Jules Blais (Univ. of Ottawa)

POPs are:
- toxic at low concentrations
- persistent in the environment
- biomagnify in the food chain
- increase in concentrations with age (in animals)
- semi-volatile (have capacity to move around)

Effects:
- PCBs in human breast milk….Inuit N. Quebec women had higher concentrations of PCBs than Caucasian S. Quebec women (111.3 g/l vs. 28.4 g/l) despite lower density of population….dispels myth that toxic concentrations occur in high density areas….these chemicals are not produced by

natural processes….very remote areas can be contaminated….infants are taking in 47 times adult amounts of toxins through human breast milk
- some studies show effect on pre-natal development
- measurable consequence of higher PCB concentrations in cord serum (mothers eating PCB-contaminated fish in Great Lakes)
- Lake LeBarge….1990 fish warning due to high levels of contaminants….high degree of picivery (zooplankton up to predator fish)….combination of long-range transport and bio-accumulation prompted health officials to issue warning

Global distillation model (Waria and Mackay) - toxics tend to migrate towards northern environments as they tend to distill progressively and move from warm emission areas to arctic areas and alpine areas (especially most volatile compounds)

Long range transport of atmospheric pollutants: tendency to concentrate in alpine areas via cold-condensation…especially areas that have high precipitation amounts.

Deposition of organic compounds in snow in relation to altitude: -compounds most volatile, most susceptible to distillation, these are the ones that concentrate at high altitudes, which is also where delivery via snow is much higher (precipitation amounts increase with elevation)

Biological endpoints: lipid content of *Gammarus* (fish eat *Gammarus*) increased as a function of elevation….growth rates for *Gammarus* decreased with lake elevation; they are older, fatter, stunted populations at high elevation…more susceptible to bioaccumulation…they have the physical environment AND their own biology working against them.

HCH: fluxes during the three month sampling period: colder environments, higher altitudes, especially those that are glacier-fed, are places these accumulate.

Recommendations for monitoring:
-Grasshopper effect study - study interface between air, land and water
-Mass balance work to determine where chemicals are coming from….significant input from glaciated environments, dominant source gas absorption and volatilization (wet deposition to a lessor degree)….gas exchange important, temperature dependent….colder environments would be expected to accumulate more chemicals
-What about biological sources – e.g. anadromous fish not only carry valuable nutrients, but also release all the toxic chemicals they have accumulated over their lifetime….fluxes of PCBs to a salmon nursery lake in British Columbia: salmon may be by far the largest contributor of PCBs. 1.6 kg of PCBs via 12,000 salmon…this compares to a large industrial source.

HCH: fluxes during the three month sampling period: colder environments, higher altitudes, especially those that are glacier-fed, are places these accumulate.

E. Case Study: monitoring snow for air toxics in the U.S. Rocky Mountains – George Ingersoll (USGS-WRD)

Snowpack monitoring….sampled snowpack along transects north to south along the Rocky Mountains in Montana, Wyoming, Colorado, and New Mexico. Sites were at high elevation with no early seasonal melting.

Purpose of study:
- identify regional background levels of constituents
- locate elevated levels and determine sources
- address concerns…

General methodology:

- constituents bonded to snow remain for season
- bulk deposition (wet + dry)
- single annual snowpack sample
- represent large regional areas
- analyze major inorganics (nitrogen, ammonium, etc), metals, S-isotopes, limited organics
- collocated snowpit sampling sites with NADP/NTN sites to compare snowpit results
- seasonal snowpack: all strata are observed and sampled before snowmelt

Hydrocarbon sampling in snow, 1998, YELL…effects of snowmobiles:

Ammonium and sulfate elevated close to road. Benzene detected in snowpack readily, but disappears readily in streams in snowmelt, even in smaller streams….benzene signal lost and is substantially below any water quality standards for drinking water.

<u>Pesticide sampling, 2001</u>:

- developing methods to sample snow for POPs
- full 2001 snowpack sampled at 3 ROMO sites
- analytical work in progress

Not sure if they'll be able to detect things like PCBs, even though the ROMO sites fit the high elevation, cold distillation parameters.

<u>Problems:</u>

- trace amounts of metals
- contamination and noise levels near detection levels
- volatility of organic compounds in liquid phase: snowmelt and surface water
- interaction with air masses during transport: local to region sources pathways are variable

<u>Advantages of snowpack sampling:</u>

- one sample represents large fraction of year
- scavenging of transported gases, discrete periods
- lower volatilization, reactivity
- no site construction
- flexible locations, large areas and/or densities
- time-efficient, one-time site visits
- geographic patterns emerge in network sampling

<u>Field methods:</u> stainless steel shovels, teflon bags.
Analytical methods (ca. $500 per sample):

- filtration of 5 liters snowmelt for 1 liter method
- USGS National Water Quality Lab schedules
- solid-phase extraction, gas chromatography

<u>Future sampling recommendations:</u>

- analyze snow chemistry for initial detection of selected set of POPs in a study area
- determine scale desired (local, regional, global)
- design network to show desired gradient(s) (elevational, spatial, temporal)
- justify locations for more intensive studies combining ppt., SW, GW, sediment, tissue, etc.

F. Monitoring of air toxics in fresh waters (using semi-permeable membrane devices) David Alvarez (USGS-BRD)

Specifically designed to separate lipophilic from lipophobic chemicals from water and air. It is an abiotic mimic of the bioconcentration process occurring in organisms exposed to chemicals.

SPMDs are passive samplers…typical exposure 30 days.
A non-porous membrane that allows the chemicals to pass through into the lipid layer; the holes in the membrane mimic the "porosity" of a fish gill. Passively samples chemical residues from the vapor or dissolved phase under nearly all environmental conditions.
No maintenance, no power requirements,
Just need adequate protection (from vandalism, etc.)

Dependent on temperature, time, and chemical properties
Start off in linear range with integrated sampling – can detect any kind event (runoff, spill, etc.)
Time waited average (TWA) concentrations can be calculated (public health levels)

Can correct for variability using compound not found in environment….corrects for a wide range of environmental conditions (temp, facial velocity of air/water, etc.) using PRC (permeability reference compound).

SPMD samples vapors readily….should ship cold and cannot expose to atmosphere.
Chemical analysis through dialytic recovery to enrichment and fractionation to instrumental chemical analysis (chromatographic analysis)

Bioassays and toxicity testing—dialytic recovery to dialysate to in-vitro toxicity testing to acute toxicity and genotoxicity.

Compared to other ways to test toxicity – can only expose fish to one chemical at a time….with SPMD can sample many chemicals at one time.

Good reproducibility between replicate SPMDs. Variation <20%

PAH and PCB sampling in Antarctica used SPMD samplers so extreme temperatures and snow/ice conditions not a barrier to use (but did have to cut through 3-4 ft water).

Comparisons to biomonitoring organisms: (membrane is 10 angstrom size) SPMDs sample only the bioavailable dissolved phase uptake by organisms occurs via respiration (dissolved phase) and feeding (dissolved and suspended)….reproducible with very low background. Not affected by most water quality parameters or contamination. Best if used side by side with bio sampling.

Passive sampling of water and coastal air using SPMDs. Results showed similar for air and water sampling. Can use SPMDs where you would use the standard sampling techniques and results were comparable (compared with HiVol sampler).

Time weighted average (TWA) concentrations for lipophilic compounds in water and air. Developed uptake models to estimate ambient concentrations of selected chemicals based on lab testing.

SPMD gives complex mixing of chemicals which allows the actual affects on organisms to be measured.
Can use in many environments – polluted or clean.

Alaska has plans to put them across the state including a site at DENA….have been used heavily at Scandinavian sites.

USFWS doing work in Kenai (Alaska) to look at deformed frogs….putting SPMDs out to collect in situ samples and dosing frogs with integrated samples.

G. Case Study: Distribution of selected organic contaminants in the Sierra Nevada - Jim Seiber (USDA-ARS)

Study area Sierra Nevada –interested in movement of chemicals from Central Valley and SF Bay area \and S. Coast basin into Sierra Nevada. Wind currents off Pacific carry to Sierra Nevada – to rain and snow with both wet and dry deposition. Amphibian decline was focus of study.

Selected organic contaminants – chlorpyrifos, PCB, TFA (breakdown of freon)
Gradient from Central Valley floor up to higher elevation in Sequioa-Kings Canyon….also sampled Lake Tahoe and Mariette Lake (above Tahoe, protected lake, no nearby roads)…PCBs found in Tahoe….took trout samples and water….analyzed PCBs in Mariette lake and found to be identical to Tahoe for both fish and water. This means it came from atmospheric deposition.

Looked at source of PCBs – snow is a good accumulator for persistent organics….best accumulator was fish. No matter where you catch fish in the Sierra Nevada you find fish with contaminants….granitic catchment basins, not much sediment or microbial activity….contaminants will end up in streams, ponds and lakes….globally persistent materials (PCBs) are in upper air and lower air but upper air is better place to sample these….current use pesticides are better sampled at lower elevations.

Pesticides come from Central Valley – sprayed in winter and summer….use data available so they know when, where chemicals were used. 10% of all pesticides applied in the U.S. are applied in Central Valley, CA.
High Vol air sampler used in SEKI and other sites to detect concentrations of organophosphates (chlorpyrifos, diazinon, parathion, paraoxon)….data collected showed lower trends as they moved away from spray sites to higher elevations.
Another study looked at wet deposition and found different results that showed pesticides are deposited in mountains at high concentrations.
Much depleted air mass due to degradation, dilution and deposition…to confirm they experimented with chlorpyrifos and its oxon in pine needles….concentrations low but significant. Breakdown product (oxon) was more toxic form of OP and was found in higher concentrations.

Looked at streams in SEKI….found highest amounts in valley floor but fell off at about 3000 meters….concentrations of chloropyifos and others are about one tenth of what you would find in San Joaquin River which is heavily polluted.
Frog sampling pesticide concentrations – found chlorpyrifos , endosulfan, chlorothalonil in frog tissues.

Potential ecosystem issues

- direct vs indirect (food chain) effects
- acute vs chronic effects
- reproductive effects
- bioavailability and persistence
- acute vs chronic exposure
- breakdown products
- mixtures - need to look at cumulative effects of all – can't just focus on one.

Looked at rain and fog water sampling in Santa Rosa, CA and on coast - found trifluoracetate (TFA) in rain and fog water…did transect from Bodega Bay to Sierra Nevada to Reno, Nevada to see where TFA is coming from…large amounts of TFA in streams near urban areas in California (20-30 nanograms/L in water is background).

Summary: What would be a useful improvement in monitoring

- focus in depth on a few high impact areas and sites chosen based upon available chemistry and biology and the use of predictive models….need a bio-toxicology lab to back up your analytical lab….need good dose response data
- focus on a few, representative analytes (organophosphates pesticides and metals)
- concentrate on in-depth, multiseason studies of exposure and ecological effects at a relatively few sites
- include temporal and spatial trend analyses in order to better pinpoint sources and characterize exposure
- build in an external assessment component from the beginning.

Spent nearly 1 million for a 10 year study that barely scratched the surface. Money from NSF, State, EPA and contributed services.

H. Use of lichens and mosses as biomonitors of air toxics - Linda Geiser (USDA-FS)
Biomonitoring air toxics using lichens: (Linda Geiser)

Lichens are dual organisms consisting of a fungus and an alga or a cyanobacterium.

What properties make them good indicators

- Large surface area and no roots…epiphytic lichens obtain nutrients from air, precipitation, and substrate runoff….tissue levels of many pollutants are correlated with ambient atmospheric levels
- Pollutants accumulated in lichen tissues often correlate to levels in, or deposition from, the air
- The photosynthetic partner in lichen can be affected by sulfur dioxide, ammonia, fluorine, and acidic particles
- Changes in the most sensitive lichen species provide early warning of pollution effects on ecosystems
- Readily absorb water and lack specialized barriers to prevent vapor loss…daily cycles of wetting and drying produce a dynamic equilibrium between concentrations and leaching of pollutants…as pollution concentrations change so do concentrations in lichens
- Mobile elements (S, N, Ca, Mg, Na) can change significantly over a few months….less mobile elements (Pb, Cd, Ni) change more slowly
- Range of air pollution sensitivities across species….lichens exhibit a range of sensitivities to S and N

USFS uses tissue analysis and community analysis….this presentation focuses on tissue analysis because lichens are good accumulators of metals, organochlorines and radioisotopes. Alternatively, lichen community composition is more sensitive to sulfur, nitrogen, and fluorine-containing pollutants. Tissue analysis of lichens can yield valuable information about distribution patterns of toxics and organochlorines because these compounds are unlikely to directly affect lichen health.

Important characteristics for tissue analysis

- best target species are pollution tolerant, abundant, large and broadly distributed over study area.
- good to establish baseline over a number of years 3-4 yrs or more to assess natural variation.
- to reduce within site variation and obtain a precise estimate of contaminant means for a site, samples must contain many individuals (e.g.: 20 g dw from 6 plus combined sub-samples) check within-site variation by collecting two to four replicate samples/site.
- random selection of sites important to make generalizations to larger study area.
- analysis of multiple pollutants detects unsuspected pollutants and is useful for source apportionment.
- QC is important. Keep training, field and lab methods constant. Use consistent system of standards and duplicates to track lab precision/accuracy within batches and between batches from different years.

USFS wanted to know what range of chemistry in lichen tissue is typical of clean sites…used FIA grid in OR and WA to sample two moss or lichens species from each site….removed problem sites (roads, Mount St. Helen's ash site, campgrounds)….clean data site above the 97.75 percentile was a threshold for clean vs. dirty sites.
Looked at S, N, and Pb….highest Pb values on crest of Cascades, Columbia River Gorge (CRG) and near Tacoma….it is deposited a lot along edges due to dry deposition scavenging….highest chromium and nickel values in CRG and near urban areas, and Mt. St. Helens ash deposition area

Uses of pollutant distribution data from lichen tissue analysis:
-Map relative intensity of air pollution and identify geographic areas of concern
-Provide a rapid assessment of air quality at specific sites within an area for which clean site ranges or a pollution gradient model have been defined
-Document deposition of pollutants in a park and help to ascertain their source
-Economically estimate deposition where modeling or instrumented monitoring is impractical
-Determine whether more expensive instrument monitoring is warranted
-Corroborate findings from visibility, deposition, camera, surface water or other measurements or "fill-in" spaces in existing networks

I. Toxics monitoring in fish and wildlife - Phil Johnson (USFWS)

Why care?

Biological effects
- survival
- reproductive success
- growth
- development
- immunology/disease
- behavior

What to measure
Chemical residues
- whole body, eggs
- feathers, fur, scat
- select tissues (liver, kidney, fat)

Biomarkers of exposure
- cytochrome P450 (PCBs, PAHs)
- HII4E (dioxins, furans, coplanar PCBs)
- reproductive hormones
- vitamins

Biomagnification - higher on food web, higher concentrations; uptake, metabolism, and selective retention of specific compounds results in contamination residues differing among taxa, air samples differing greatly from water samples, which differ from biological tissue samples (since chemical partitioning is influenced by physical, chemical and biological processes)
Marine and terrestrial food webs are very different, even within a species, feeding strategies and trophic position can change as the animal matures.
Factors affecting bioaccumulation
- metabolism and selective retention of chemicals
- marine vs. terrestrial food webs
- age/stage classes
- trophic position e.g.: determined using stable isotope analysis

Subsistence

- important issue in Alaska
- concern about contaminants in food
- some people abandoning traditional foods
- unhealthy alternatives in other foods and added expenses getting food to villages
- if NPS monitors biota in Alaska, issue will likely come up

What to monitor?
depends upon availability, and the traditions of local people and their diets (marine mammals, salmon, berries, etc.)

Characteristics of a good indicator to monitor
- widespread, found in all parks
- sessile or limited range (non-migratory)
- likely to accumulate contaminants
- sensitive to contaminant effects
- easy to sample, won't impact population
- ecologically important
- used for subsistence

Potential sentinel species

Need to find species common to all parks but is difficult

Zooplankton – ubiquitous….marine and freshwater…. important food items…. contaminants not well studied….low trophic level….trace level contaminants work

Benthic insects – ubiquitous….contaminants not well studied…. food items…. different trophic groups….stream drift… trace level contaminants work

Mussels - sessile….filter feeder….important food items….also useful for PAHs….extensive data base around the world.

Char and trout – most freshwater….some anadromous….at least one species found in all parks but no single species ubiquitous….trophic position varies with size, species, habitat….top predator in many freshwater systems….Canadian data variable (food web, lake size)- studies showed some biogeographic patterns but lot of noise in data….circumpolar data for Arctic char (AMAP species) ….lake trout data also abundant

Northern Pike - freshwater predators -highly contaminated species in Canadian studies (particularly mercury) occur in some parts of Alaska

Anadromous fish - Salmon (also some trout and whitefish): important ecologically and for subsistence, valuable sport and commercial fisheries, source of marine nutrients and contaminants (biological transport), not found in all parks, contaminant accumulation and sources outside park boundaries….whole fish, fillets, liver, kidney

Marine fish - marine bottom-dwelling and/or predatory fish, baseline data exist, particularly from highly contaminated areas

Seabirds - wide geographic distribution (gulls, cormorants): eggs, feathers easy to collect, wide range of trophic/feeding guilds, subsistence food for some communities, extensive database (gulls, cormorants, some others) biological effects have been studied), migratory

Loons - wide geographic distribution found in many parks: eat fish, accumulate contaminants, extensive database for metals (lead, mercury) …eggs, blood (metals), feathers (mercury) …migratory

Raptors - feed high in food web….bald eagle, osprey, falcons….known effects (eggshell thinning) ….wide geographic distribution, but rare in many areas….often migratory, peregrine falcons highly migratory….eggs easy to collect, feathers (mercury), blood

Riverine/Semi-aquatic mammals - river otters, mink (among most sensitive mammals to PCBs) ….toxicological benchmarks for mink….wide distribution but not abundant in many parks…. organs (liver, kidney)….mercury sampling – fur….Canadians – otter scat….blood sampling?

Large terrestrial mammals - caribou, moose, elk found in many parks….important for subsistence….charismatic mega-fauna….no single species found in all parks….herbivores (lower trophic position) ….caribou often highly migratory….metals (e.g. cadmium) elevated in some organs (i.e.; kidneys)

Polar bear- top arctic predator…extensive circumpolar database… known biological effects, limited distribution in parks

Seals - ringed seals are a primary food source for polar bears and some subsistence hunters (circumpolar database) but limited range in Parks, biological effects studied in harbor seals and more extensive range

Orcas - long-lived, resident populations feed on salmon vs. transient populations which feed on marine mammals (influences contaminant burden)… one of most highly contaminated marine mammals known… ecologically important… blubber samples minimally invasive

Trends from the Arctic:
Peregrine falcon study (79-95) - studied eggs of two sub species….Most organochlorines including DDE decreased with time….PCBs declined less rapidly than other organochlorines….most metals decreased or did not change except mercury….mercury concentrations in some cases approached levels which may impair reproduction. European otters, Canadian ringed seals and pike in Sweden showed same general pattern of decline in POPs like DDT and PCBs.

Summary and Research Needs:
-Contaminant monitoring in biota can be done for many reasons (evaluate ecosystem integrity, species health, subsistence implications, track temporal change), so goals need to be clearly articulated… various biota have different strengths and weaknesses, no single species ideal for all purposes or in all locations
-Need toxicological thresholds for many species (and various chemicals)… implications of chronic non-lethal exposure not well understood… chemical mixtures always present but not well studied… “new” chemicals of concern such as brominated flame retardants and perfluorinated compounds (e.g.: Scotchgard) need to be studied
-Results need to be communicated to NPS managers and to the public in a way that is easy to understand, informative, and accurate

J. Status of toxics monitoring in human populations and exposure studies - Susan Metcalf (ATSDR)

ATSDR - a federal public health agency that investigates and strives to prevent human health problems caused by exposure to toxic chemicals in the environment.

Why monitor?
From the public health perspective, we need to answer the question "What does this mean to my health?" Need to collect exposure data early on. A monitoring program with sequential samples over time would be best versus waiting until the disease is upon us.

The Arctic dilemma: risk from chemicals in subsistence foods versus nutritional and cultural benefits of subsistence lifestyle. There are benefits and downsides of both subsistence diets and lower 48 grocery store diets

There is no comprehensive human monitoring in Alaska - studies are convenience samples only.

Sources of contaminants
- military sties
- industry and mining
- air deposition

There is no comprehensive human monitoring in Alaska….studies are fragmented, isolated, and focused on one region.

Studies

- Maternal cord blood study - North Slope, Aleutians….enrolled pregnant women ….collected fetal and maternal blood….plan to follow the children through life to look at environmental contaminants and essential vitamins/elements
- Evaluating mercury levels in mummies
- Human monitoring in Aleutian and Pribilof Island - multi agency, 4-year research project
- NCEH breast cancer pilot study - NA serum banked since 1980s….analyzed for PCBs, DDT, etc….soon to be published….test serum for contaminants as women come in for biopsies.

What the future holds

- Alaska Traditional Diet Project - dietary surveys to identify important exposures (identify and characterize the regional traditional diets which vary throughout Alaska).
- Alaska Wild and Traditional Food Safety Program - (has not begun yet….Alaska asking for federal funding)….educate people about safety, track human exposure

Continuum for relating environmental contamination with clinical disease….need to look at blood, urine, or hair in humans.

There are a limited number of biomarkers in humans
- heavy metals - better documented/developed….good estimate of recent exposure….reference ranges generally available….standardized analytic methods
- organic compounds
    - volatile organic compounds - very short-lived
    - persistent organic compounds - very long half-lives

Analytic studies have changed over the years (PCB studies of the 1980s are very hard to compare to today)….dioxins are very expensive to analyze ($1000 to $2000 to sample) so little reference range information is available….having banked serum is key because analytic methods change over time

Biomarkers measure aggregate exposure: all routes, all sources

Reference ranges are population-based and they do not relate to health effects. Lead is the only contaminant that we have good reference points on.

Network with other studies beginning in Alaska and consider GIS when you design sample plans so that you can interface with health studies

IV. Recommendations on monitoring priorities

A. Overview

An important part of the workshop was to solicit recommendations from the participants on air toxics monitoring priorities for NPS lands. With the extensive and diverse amount of monitoring and research conducted internationally on toxics, narrowing the scope of all possible monitoring to a smaller range of possibilities that would best meet NPS goals and mandates was desirable. Participants discussed the pros and cons of monitoring several types of toxics "media"; the potential for integration for each "media" across organizations, and agencies in terms of leveraging funds, people, and existing monitoring networks; which air toxics were of highest concern or priority; and which geographic and ecosystem areas were at greatest risk or highest priority to monitor. Presenters were also asked to develop a "conceptual diagram" illustrating how air toxics move through the ecosystem, and at which ecosystem indicators and endpoints monitoring should occur. These conceptual diagrams were scanned and are included in Appendix C.

B. Criteria for making choices in monitoring by media (pros, cons and integration)

PROs, CONs

Media	Pros	Cons
Gas and/or particles	True measure of air concentration	May spend a lot of $$ measuring, but may turn out to be relatively unimportant biologically
	Can relate back to the source via meteorology	Power (electricity) requirements
	A defined system so we know where strengths are	A defined system so we don't know where all the weaknesses are
	Universally comparable	Variability: missed episodes if you sample only at e.g. 10 day intervals
	Data is good for model evaluation; model can give you more information on source-receptor	Not sure what portion of the air mass that you are measuring actually ends up in the ecosystem (since your methodology is sucking air)…have to infer deposition: exposure is measured but deposition of chemicals on landscape is unknown. No direct measure of deposition.
	Will fill a data gap; there are few monitoring stations for this on the west coast	Temporal issue; detection limits. How long to sample for high enough concentrations to approach detection limits
	Can calculate exposure to humans and animals from air concentration data	There are no regulatory limits so unsure utility of the data
		Limited spatial representation because the sites are expensive and require manpower
		Miss some of Class II parks if solely based on locations of current sampling equipment

Media	Pros	Cons
Wet & Dry Deposition	Wet deposition relatively easy.	Dry deposition is hard to measure directly. Very complicated and subject to debate. Only locally representative. But in arid southwest, there may be more possibilities. *More research is needed here*. Supersite (?) program via EPA will conduct research on this topic.
	Integrated long term samples; does not miss episodes.	Artifacts when you are collecting via snow – bucket collection method. Two samplers side by side will get different answers
	Directly related to where the critters live.	Will miss some pollutants that don't show up in the rain
	Occurs during summer when ecosystem components are active	Special methodological care required
		Wind events are problematic; influences accuracy
		Light, dry snowfall isn't always sampled
		High maintenance required
		Power (electricity) required
		Need to measure precipitation alongside; need really good rain gauge
		Archived wet deposition cannot generally be analyzed for POPs.
Fog Water	Easy to analyze.	Fog difficult to measure
	Fog water is a good integrator	Doesn't occur everywhere
	Accumulates many elements	Episodic
		Huge variance
		Hard to see your sampler
		Hard to interpret results
		Archived samples generally not useful

Media	Pros	Cons
Snow	Common, widespread; many parks get snow.	Snow gives only a part of the picture.
	Integrates the whole winter deposition. If you only have $$ to get one sample, monitoring snow is a benefit…cheap	Can also be a disadvantage to integrate the whole winter because episodes and source sites may be difficult to ascertain
	Major contribution to water balance, esp. high elevation	Tough to interpret; you'll get a number but not sure where it all came from
	Effective scavenger of the compounds of concern	Snow may not sample the worst time of year for AK, since the Asian pollutants deposit when snowmelt is occurring
	Sample handling and collection is straightforward (doesn't contaminate easily)	Large volume required for archiving
	Doesn't need power source	Early and mid-season melting events, rain on snow events result in loss of snow (and some contaminants)
	Because is cheap, can get good spatial, temporal, elevational sampling	
	Actual media; not a surrogate	
	May be the only viable alternative for many remote sites where there is no power and you can't keep a sample frozen (Dixon advises that you can bring the extractor to the site to get around this problem)	
	Can archive extracts easily and cheaply	

Media	Pros	Cons
Sediment Cores	Allows long-term, multi year study; provides historic records of deposition if dated properly	Access may be a problem; may require a helicopter or fixed wing airplane– difficult in wilderness (except Alaska)
	Lots of source material available	Highly variable with native geologic material; organic matter, metals, etc.
	Plenty of archives	May be labor intensive to get sediment samples clean enough (of organic matter) to prepare for analysis
	A good starting point for sampling where you think there may be hot spots; then use to design complementary sampling approaches	Some pollutants of interest don't accumulate in sediment. May need large volume to detect POPs
	Easy to sample through the ice	Have to know geologic processes of the area; are you sampling in an accumulation zone or an erosion zone?
		Sediments can be deeply mixed, so may be integrating, and prevent you from getting more precise distinction than, e.g. decades. Sometimes you have to pay for several cores to get one that has good chronology
		$1K to $2K just to get the cores dated
		The sediment processes change some chemicals (e.g. mercury to methyl mercury)
		Not all areas (e.g. high elevation granitic basins) have good sediment records

Media	Pros	Cons
Freshwater	For very water soluble compounds (e.g. endocrine disrupters, some current use pesticides and pharmaceuticals), this is best place to monitor	Difficult to get to and sample (Rivers in Alaska are something the most accessible sites)
	Realistic exposure medium for aquatic organisms	Temporal issue: timing of the sample re. High flow vs. low flow, seasonal differences
	Can compare water concentrations to lab toxicity testing	Many bioaccumulating compounds require large volumes of water to detect; difficult to detect (except with SPMDs)
	SPMD technology is a reasonable way to overcome some of the Cons	Some compounds unstable in the water either before and/or after sampling
	Parks represent source water in many areas	
	Freshwater tends to harbor the most contaminated food chains for mercury	
	There are many good aquatic fate models with which to integrate	
	Methylation of mercury is best obtained through freshwater sampling; may be the only place found	
	There are many standard protocols for monitoring water	Although difficult if the compounds adhere to sediment, small sediment traps can be deployed

Media	Pros	Cons
Lichens & Mosses	What's in the freezer…archived samples may be used to monitor for some pollutants, depending on storage conditions	Temporal resolution is not good; you may find compounds but not know when it happened…however, resolution may be obtained in some months
	Archived samples can be used to analyze for metals, sulfur, and nitrogen	Uneven capturing efficiency (but consistent within a species)…and if you select a species to compare across the landscape, you can avoid the problem
	Good indicators of deposition, esp. for metals (lead, cadmium, zinc etc)…accumulate sulfur, nitrogen, metals to a greater extent than other plants. Can detect hot spots spatially.	The public may not be particularly interested (however, recent media stories have captured some interest (i.e.: Caribou diets) but more charismatic than invertebrates
	Have been widely used in the PNW and AK and Rockies -so large database of measurements	Not effective for low concentrations and for POPs
	EMAP has an existing program of lichen communities; is being implemented in national parks but not in AK	Can't equate concentration of pollutants to exposure
	Many vital signs programs will be looking at lichens so sampling can piggyback on other programs	
	Important component of vegetation in PNW and AK	
	Mosses good for mapping areas; can usually find a few species that are region wide	

Media	Pros	Cons
Lichens, (cont.)	Sessile species; not mobile so represents that particular location	
	But there are methods developed now for OC and a database for reference in AK	OC analysis is complex; they have alkaloids in the thallus
	Can get spatial representation in a screening mode more easily; can look at variability across the landscape in terms of exposure	
	Cheap to sample	
	Can pick up air-soluble compounds that are not water-soluble can pick up compounds that water sampling won't pick up	
	Base of the terrestrial food web in some areas	
	Widespread; occur throughout the continent and worldwide	
	Easy to find	May be hard to find in dry areas
	Not much veg some AK locations, so exposure pathways more open	
	Literature body is extensive	
	Good in places where can't get power and in rugged areas where modeling is difficult	
	Metals in lichens can be calibrated to deposition correlated with substrates of known age	

Media	Pros	Cons
Invertebrates	They're everywhere; ubiquitous	Not charismatic
	Can use them to detect presence	Will not be able to show adverse impact
	Fast generation times; so may be able to see population impacts	Not long lived; so don't bioaccumulate as much as some longer-lived species (however mussels are good at accumulating contaminants)
	Important link in food chain	Detection limit problems
	Huge literature body available regarding using these for indicators of aquatic health	May be difficult to link to a specific pollutant; compounding factors of other environmental stressors or natural variability
	Gives you the first measure to indicate that a pollutant is now bio-available	

Media	Pros	Cons
Fish and wildlife	Top of the food chain; this is where effects will occur if they are occurring; if there's going to be a problem, this is where it will be	Harder to catch than lichens. Some species and/or tissues more difficult to sample than others. Some tissue sampling requires sacrificing animals
	Many are charismatic	Destructive sampling may not be desirable or even legal (e.g.: protected species)
	Many used for subsistence	Difficult to know the source of the contaminant; except landlocked fish will tell you about that watershed
	Economic attention (consumption advisories)	Analysis of samples can be difficult and labor intensive
	Many opportunities for free sampling; hunters	Endocrine disrupters may affect early development yet not be measurable in adult
	There are archived samples available in Charlotte NC	Can be difficult or expensive to determine effects, e.g. behavioral effects
	Good base of toxicological data (for some species or classes or organisms) to compare your findings	
	May be able to use widespread species; e.g. ungulates across a large area	
	Effects may mimic what is happening with humans	
	If there is an effect on fish, wildlife (esp. endangered species) and humans, this is most likely to cause a policy change	
	For site specific pollution sources, can do NRDA actions to restore; i.e. funds would be available – also 16 USC 19jj; Natural Resource Protection Act if can link to cause and effect	

INTEGRATION

Gas and/or particles	Wet & Dry Dep.	Fog Water
Because of power requirements, good potential to collocate with other existing air/met monitoring equipment (e.g. IMPROVE)	Integrated long-term samples with other programs: MDN, NDAMN, IMPROVE	Can/should collocate with met data.
Integrate with IADN, NADP network; will provide longitudinal data and east to west comparisons	Can/should collocate with met data	Integrate long-term samples with other programs
Can estimate the flux to the ecosystem		
Can use the information with models to contribute integrative information		
Can you use old, “archived” filters? Depends on the pollutant and how the filter was stored. Cadmium and dioxin are still there; benzene, no.		

Snow	Sediment Cores	Freshwater
Lots of other snow monitoring going on, so can integrate with other areas	There are sediment cores available from studies throughout the world	Much water chemistry work being done by other agencies; EMAP, NAWQA, NASQAN, etc. can be integrated with other surface water sampling
Can integrate with existing glacier monitoring	Can use for model evaluation	SPMD technology can be used for both water and air
Need to integrate annual wet deposition with snow deposition monitoring	Can use for other types of analysis you might want in an ecosystem monitoring program: lake trophic status change, vegetation monitoring, climate change, diatoms	SPMDs can be deployed in conjunction with other studies
West-wide SNOTEL system is a tremendous near real-time network to describe what is happening with snowpack	Can sometimes get source-receptor information; integrate emission source trends with sediment core trends	

Lichens and Mosses	Invertebrates	Fish and Wildlife
Many vital signs programs will be looking at lichens so sampling can piggyback on other programs	Consider overlapping sampling within a watershed to compare loadings e.g. Sample snow and invertebrates in the SAME watershed	Integrate with other programs; free samples via hunters, and other sampling programs, but requires training and ongoing coordination
FHM plots, other USFS studies		Archived marine mammal samples in NIST in Charlotte SC (Seabird eggs, bird tissue at University of AK
Could do at same time as sampling air/water.		Can get samples from individuals with known life histories, e.g. orcas
Industry does a fair amount of sampling of lichens and mosses	There are federal, state, international programs using invertebrates for indicators (NAWQA, EMAP, State bioassessment programs etc)	AMAP report provides a good start with effects
EMAP program looking at lichens		Need to define what niche NPS can fill that isn't already being done via another agency; however, may be able to capitalize on the public interest in national parks (compared to USFWS areas)
		Partner with USFWS which at least has recurring chunks of short term (2-3 year) funds
		For NRDA sites may be able to leverage funds

C. Priority Chemicals/Compounds to Monitor

We presented the list of air toxics that are considered to be part of the "dirty dozen" covered by the POPs treaty. These include: DDT, chlordane, toxaphene, mirex, aldrin, dieldrin, endrin and heptachlor, and the industrial chemicals PCBs and hexachlorobenzene, in addition to dioxins and furans. Toxic metals considered in the discussion include: mercury, lead, zinc and cadmium.

The Great Lakes Regional Air Toxic Emission Inventory targets 82 compounds. These are listed on the Great Lakes Commission web site at http://www.glc.org/air/82tox.html.

There was considerable discussion about the need to monitor the air toxics listed in the POPs treaty and Great Lakes priority lists. There is concern among the experts that we need information about the "new chemicals", including the brominated compounds, flame retardant coatings and the substitutes for CFCs.

D. Priority Geographic and Ecosystem "Hot Spots" to Monitor

1) high elevation and high latitudes, affected by "cold condensation
2) areas that are not affected by local sources of emissions
3) areas that are influenced by trans-Pacific and circumpolar air masses
4) locations that have obvious regional source of toxic emissions, for instance the western slope of the Sierra Nevada is influenced by pesticide applications in the Central Valley
5) northern Arctic parks have both the potential for deposition because of the "cold condensation" and "grasshopper effect" and have the pathway to humans via subsistence fish and wildlife resources

V. Existing Networks List:

1) Mercury deposition network (MDN): There are about 55 sites in this network, organized as part of the National Atmospheric Deposition Program (NADP). Cost is about $20K in capital costs, with $12K for routine measurements. Extra costs for methyl mercury analysis. Sites currently located in ACAD, EVER. Website is http://nadp.sws.uiuc.edu/mdn.
2) National Dioxin Monitoring Network (NDAMN): EPA established this network in 1998 to measure air concentrations of dioxin and dioxin-like substances. The 29 existing sites are co-located with NADP. Cost for a number of "sampling moments" per year is $10-20K. Website is http//www.epa.gov/.
3) California Air Resources Board - Air toxics monitoring: The state runs several dozen sites that include both ambient air and particulate samples. Most of these are in urban areas, the Central Valley and one in Lake Tahoe.
4) Integrated Atmospheric Deposition Network (IADN): This is an EPA-funded network that includes a "master station" on each of the Great Lakes. Both ambient air and precipitation samples are collected at different sampling intervals. Cost of the program at five sites is about $400K/year. In place since 1991. Web site is www.epa.gov/glmpo/.
5) New Jersey air deposition network: This state network includes about 6 sites similar to IADN, at about the same cost.
6) National Water Quality Assessment Program (NAWQA): The USGS has plans to begin sampling 18 sites for agricultural chemicals in wet deposition. Each watershed basin site will be monitored for a year. Website is http://water.usgs.gov/nawqa.
7) Synoptic surveys of lake sediments and fish tissues: There are various research projects looking at a geographic distribution of trace elements and mercury in geologic and biological media. USGS program (Peter van Meter) is looking at lakes throughout the US (including the Yukon) for metal accumulation in sediments. Part of NAWQA is a study of 80 lakes (beginning in 2002) for analysis of sediments and fish tissue for mercury.
8) Arctic Monitoring and Assessment Programme (AMAP): Established in 1991, this program integrates arctic pollution research and monitoring in the 8 arctic nations and produces periodic assessments. These assessments are not risk assessments, but evaluation of information on environmental quality and prevailing conditions in arctic regions. The assessments are prepared in a systematic way to provide for regional environmental comparisons and to assess human influences over broad scales. Website is http://www.amap.no/

VI. Strawman Monitoring Plans

A. Intent of Strawman Monitoring Activity

The intent of this part of the workshop was to develop strategies and recommend priorities for network monitoring in parks. Workshop participants were divided into three groups and each group was instructed to come up with "strawman" monitoring strategies and priorities for three funding scenarios ($200K, $400K and $600K). The groups were instructed to outline monitoring strategies consistent with the science and policy information and the group priority setting (goals and recommendations about monitoring priorities) that occurred earlier in the workshop. The funding scenarios were not based on committed funding, but they were intended to direct the group toward making hard trade-offs about which types of monitoring could provide the greatest value to the NPS for the least amount of money.

B. NPS Management Remarks – Chris Shaver

- Network monitoring must be "results-oriented" because of NPS obligations under GPRA (government performance results act)
- 3 ways of defining the level of effects from toxics:
  - Any change from natural condition is bad: (err on the side of ecosystem protection)
  - If change occurs in any component of an ecosystem it might be an adverse effect
  - Maintain the "ecological integrity" of the ecosystem and determine how toxics might affect this integrity.
- To determine what effects occur, NPS must define "natural" condition of resources
- NPS must define departure from "natural" condition to know how much toxics related change is detrimental
- Determine current conditions…increasing or decreasing toxics/POPs?
- Monitoring emphasis should consider the need to capture people's attention
- Global POPs treaty means some toxics (dirty dozen or "old toxics") may decrease:
  - Effects work may be more appropriate on "new generation" of toxics/POPs?
  - For "old toxics/POPs", focus more on status, current conditions
- Define what the NPS program can do to create a research magnet, to encourage others to build on work in parks.
- NPS needs two types of information: "representative data" and "answers to management questions"

C. Sample Strategic Toxics Network Programs Developed by 3 Working Groups:

1. Group 1

a. Group 1 Participants:

Tamara Blett/Bill Baccus (facilitator/recorder), Dave Alvarez, Jules Blais, Steve Fradkin, Dave Mills, Bud Rice, Matt Simcik, Kathy Tonnessen

b. Group 1 Proposal:

200 K Proposal
Phase I (Year 1 & 2)

Monitor Fish and Sediments

- Sediments provide spatial coverage and history of deposition (historical trends)
- Fish are a bioaccumulator and a charismatic megafauna (Good Looking & Tasty)

Monitoring will take place in 5 Regions (in priority order)

- Arctic Alaska

- Sierra Nevada
- Pacific Northwest
- Rocky Mountains
- Coastal Alaska

Spatial design of sampling will attempt to "pin point" areas throughout all regions which may be "hot spots" of contamination from non-point sources.

Sample design based on elevational gradient to create predictive tool for toxic concentrations based on park location.

Fish Monitoring:

- 50 sample sites (10 per region per year) Each sample consists of 5-6 homogenized fish.
- Fish should be non-migratory, predatory, old and preferably from oligotrophic systems. This maximizes the potential for bioaccumulation, measurement and usefulness of fish as an indicator of non-point source contamination.

Sediments:

- 1 core sample per region/park per year
- Avoid sampling lakes that may have point source or local (current or historic) contamination, in order to represent long distance deposition applicable to multiple sites.

Analysis:

- Traditional toxics (including dirty dozen + Hg) and emerging contaminants except for new generation contaminants (because these will not be found in fish or sediment).
- Portion of homogenized sample and analyte will be archived and frozen for later analysis.

Phase II (Year 3 & 4)

Once spatial coverage has been established from Phase I sampling, use widespread snow surveys to:

- Increase spatial coverage & look at inputs to hot spots indicated by sediments & fish
- To determine spatial design of long term input monitoring.

Phase III (Year 5)

Develop and deploy long term monitoring with spatial design established from Phase I and Phase II monitoring. This will be a combination of inputs from the atmosphere and other important media.

400K and 600 K options

These options would follow the same plan with more sites monitored in the first year, providing better coverage and a final spatial design earlier. These options would also incorporate an important, arctic "charismatic megafauna", such as Caribou or Bear.

c. Group 1 Notes and Discussion:

Members of the group were asked to present their highest priority for what and where monitored.

Bud Rice:

- Add sampling train for gas & particles ($1000) to measure POPs & Hg ($10 K – Tekran) to existing IMPROVE sites in Class I areas. Add an Arctic IMPROVE to the system.

David Alvarez:

- Same as Bud Rice – add sampling for pesticides and metals to existing IMPROVE
- Add water samples – either grab or SPMDs. USGS should archive 20% of samples

Jules Blais:

- Use a fish focus. Fish are bioaccumulator and are therefore most likely to find Hg, POPs and toxaphene. This will get immediate results. It is relatively inexpensive and is likely identify contaminant hot spots. Identify vulnerable regions, oligotrophic systems, altitude and latitude gradients, and areas in proximity to Asian Air masses. Possibly leverage fisherman to supplement sampling. Use input from fisheries/limnologists to determine best sampling sites.

Dave Mills:

- Look at some of the New Generation Contaminants
- If we use fish, tie fish to bears – i.e. Charismatic Megafauna
- Possibly consider edible fish (mostly anadromous fish). In Alaska less than 1% of salmon are consumed as subsistence. The remainder is harvested and sold elsewhere. Possibly gain support from tie in with commercial fisheries interest.

Steve Fradkin:

- Focus on new chemical
- Mix the basics (air & snow?) with some biomagnifiers (to ensure results)
- Use lake cores to provide trend/historic information

Matt Simcik:

- Fish that are migratory may not be good indicators. Suggest using non-migratory fish, 40 sites, 10 per region. 4 Regions – Alaska, PNW, Sierra Nevada, Rockies.

- Snow is good because it is actual deposition. Collect near NADP if possible.

- Sediment would be great to use because it provides history of deposition.. Catarafts are a good way to collect.

- Precipitation: Passive – only POPs only in summer (same as IADN)

Kathy Tonnessen:

- Where: 5 Regions – Arctic Alaska, Sierra Nevada, PNW, Rockies, Coastal SE Alaska
- Yr: 1 Sediment Cores
- Yr: 2 Additional Sediments plus snow and air measurement (to capture inputs)

- Develop the spatial extent of contaminants based on snow sampling and sediment results.

Group Thought on Linkages:

- Store fish tissue and homogenate archives
- Link with other sediment studies (park specific or study specific)

2. <u>Group 2</u>

a. Group 2 Participants:
Ellen Porter/Barbara Samora (facilitator/recorder), Mark Cohen, George Ingersoll, Bob Black, John Vimont, Phil Johnson, Lois Dalle-Molle, Ken Czarnowski, John Reber

b. Group 2 Proposal:
IMPROVE, NADP, CastNet at Class I parks:
(MORA, NOCA, OLYM, DENA, ROMO, GLAC, CRLA, LAVO)
Western Arctic parks may get sites within next two years (see NPS Air Quality Action Plan)

Media	200K	400K	600K	Comments
Snow Current use pesticides and emerging compounds	10 to 15 sites 50K	20 to 30 sites 100K	50 to 80 sites 150K	See discussion notes
Water			SPMD 20 sites @$500 20K	Cost estimates do not include staff costs for collection
Air Mercury NDAMN plus other compounds MDN is a precipitation sample NDAMN is an air sample	2 limited sites 70K	3 sites 120 K	4-5 sites 200K	Cost estimates do not include staff costs for collection Consider existing air station operators to collect samples
Plants Lichens which are a food chain issue (e.g., caribou)				All sites $50/sample 20K
Animals Mercury Dirty dozen POPs Look at Trout (occurs in all parks) Look at subsistence foods in Alaska	Trout: 8 parks (2 sites within each park) 40K do subsistence species analysis in alternate years	Trout: Add more parks and sites within parks Add more species/samples 100K	Trout: Add more parks and sites within parks Add more species/samples 110K	Consider sample design frequency on a 5 yr. or so interval
Sediments POPs, mercury and emerging contaminants	8 parks (2 locations within each park) analyze surficial sediments only first year, then other layers in subsequent years. 40K	Add additional sites Date other layers of sediment cores 80K	Add sites Date other layers of sediment cores 100K	

c. Group 2 Notes and Discussion:

Need to design monitoring network to address elevational and precipitational gradients, wind direction, east and west side of major mountain ranges (e.g., Cascades, Sierra Nevada).
Need to look at snow deposition and characterize it from the least likely impacts to highest expected impacts and identify the apex of where impacts are located.

Mark Cohen felt that for the $200,000 level we should focus on snowpack samples in the Sierra Nevada (SEKI, YOSE) because it can address current use pesticides and emerging compounds as well as Trans-Pacific.
$1000 to $2000/sample to analyze for suite of contaminants. He recommended 20-30 samples @$150,000.
John Vimont mentioned that there were some problems with rain on snow at higher elevations in Sierra Nevada.

Rest of the group felt that there should be a network of snowpack sampling (not just focusing on Sierra Nevada) and including emerging compounds.
Justification for this was that the protocols are well developed.
Cost is $500-$600/sample.
Organochlorines low levels and current use pesticides (60 or so compounds).

At a lower level 10-20 sites @ $1000/site.
Newer chemicals are increasing significantly and are unknown threat
Flame retardant may be expensive to analyze
John Vimont said that there are differences in the way snow is formed and this affects scavenging. (Arctic is dry and may bypass the water stage).

Biota

Subsistence food is an extremely important issue in Alaska.
Phil said this could be addressed in the higher level of funding, not the 200K.
Lois said sample collection could take advantage of ongoing activities such as hunting and fishing to obtain samples (Phil said this is already in place in other areas in Alaska). Should also consider local or volunteer labor for collecting samples since park staffs are small.

Select a range of sites focusing on similar species (top-level piscivores)
$1000/fish (does not include cost for collection -- assumes someone will collect at no cost to project)
Suggest two sites within each park for comparison within parks as well as between parks
Site selection: one site high in the Arctic, DENA, Katmai/Aleutian area, MORA (because it's high elevation), maybe OLYM (for non-US emissions), GLAC or ROMO, SEKI, CRLA or LAVO (SEKI and LAVO are important for differentiating between Trans Pacific and Central Valley sources).
Different schedule for different media: sediment cores (one time depth profile)
Add snow sampling

Sediment Cores

Consider surficial sediment analysis or past 5 yrs but collect entire core to have for future analyses when additional funding is available.
$2000 for sample analyses (rough quote for small suite of analytes)
Cost of collection may vary on coring technique. Suggest using smaller coring devices designed for remote, high mountain lakes.

George suggests looking at precipitation, snow, water, sediments, plants, and animals at various funding levels. He suggests a multi-year, multi-media approach and revise future monitoring based on results of early monitoring.

John Vimont added quantitative air monitoring at 3 sites in Alaska, one or two PNW, one Sierra and one ROMO site.

Mark Cohen suggested adding some MDN sites (Alaska, SEKI or YOSE) and add NDAMN sites (@$20,000/yr cost) and add other analysis.
OLYM is an NDAMN site already – should add additional analysis of samples

George suggested that we consider adding additional NADP sites.

John Vimont said that there are different air masses in geographic regions so we need to consider site selection.

3. <u>Group 3</u>

a. Group 3 Participants:
Cat Hoffman /Jon Riedel (facilitator/recorder) Jim Seiber, Dixon Landers, Richard Heffern, Dave Vana-Miller, Annie Esperanza, Linda Geiser, Andrea Blakesley

b. Group 3 Proposal:

<u>LOCATIONS</u>: Latitudinal gradient of parks plus an east-west gradient of parks.

From south to north these would be: Sequoia, Olympic, Glacier Bay, Denali, Noatak.
Process: An initial list of parks was suggested by Dixon Landers, and then modified by group discussion. For instance, Dixon first listed Gates. Andrea recommended that Gates not be included since they do not have staff to tend the project. Jon Riedel suggested NOCA and MORA for additional buy-in from Supts. Dixon noted that information on trans-Pacific pollutants indicates that a hose is aimed at the NW coast of WA. Etc.)

From west to east, the parks would be: Olympic, others listed above, plus Glacier and Rocky Mountain.

Total number of parks is 7.

<u>AT EACH LOCATION (PARK)</u>:

Establish 2 transects per park to get some idea of variability, and also select 2 lakes per park.

<u>ALONG EACH TRANSECT WITHIN EACH PARK</u>:

(1) Select 4 elevations. Collect snow and lichens from the same sites.
(2) In snow: analyze for POPs and metals (as broad a suite as can be included), and include QA costs. Rationale for collecting snow: (see pro/con list, and in addition…) snow is a good integrator and good scavenger. Cost for snow analysis: $1000 per sample.
(3) In lichens: analyze suite of metals, nutrients, S, and N. Collect snow and lichens once annually. Collect snow post-highest-accumulation but before snowmelt. Cost for lichen analysis: $ 50.00 per sample.
(4) At 2 of the 4 elevations above. Collect sediment cores. Date the cores. Analyze for OC's, metals, etc. Cost for analysis: $2,000 per core.
(5) Budget-fitting strategy: Depending on the total budget, one to two parks would be done per year until all 7 were done. (Note: Bob Black's upcoming study that includes NOCA, MORA, OLYM may be able to cover the costs for this at OLYM, although Bob hasn't completed study design so not sure what will be included).

WITHIN EACH OF THE 2 LAKES PER PARK:

(1) Collect 3 fish per lake (because fish are good integrators/accumulators).
(2) Install 2 SPMDs per lake.
(3) Costs: we didn't know the cost of SPMD's but are hoping the SPMD plus bassomatic composite analysis would be no more than $1000 per sample.
(4) Total cost for fish plus SPMD analysis for all parks: $75K. We spread this over 3 years at $25K per year.
(5) Budget-fitting strategy: Depending on the budget, split the 7-park list into 3 groups. Sample one set of the parks each year over 3 years until all parks are done. Lakes sampled in each park on a 3-year cycle. $25K cost to the total network program per year.

SUBSISTENCE TIE-IN

(1) Develop a subsistence-sampling program in conjunction with subsistence users.
(2) Focus on sampling fatty, non-marine, higher trophic species (this was a point of discussion, as many subsistence folks on west coast in Lower 48 within and outside parks are marine subsistence users…i.e. salmon and shellfish along the WA coast)
(3) Budget-fitting strategy: Andrea recommended to rotate this sampling program among the AK parks, at 1site per year, $10-$15K total expenditure per year.

OPPORTUNISTIC: SAMPLE TOP CARNIVORES, CARRION EATERS, ETC.

(1) Recommendation from Andrea to sample predators opportunistically. Link with researchers who may be working on top carnivores and request to take samples. Also, samples from road kill, hunters, etc. Early in the program and as extensively as possible. $10K per year.

OTHER COSTS

(1) Science Advisory Board: $20K
(2) QA: $60K
(3) Data Management: $70K
(4) Labor & travel/helicopters (park folks not entirely free, plus include standardized training) $100K
(5) Design: consult atmospheric experts $20K
(6) Analysis, publication, interpretation: $50K

SUMMARY (we didn't have time to finish Year 2 and Year 3 columns, e.g. no doubt database management costs need to be covered in all years etc.).
" * " indicates the group suggested these parameters as priorities. To meet standards of good science, QA, Analysis, and Database Management should probably also be starred.

	Year 1	Year 2	Year 3
* Snow	56,000	56,000	56,000
* Fish/SPMDs	25,000	25,000	25,000
* Lichens	10,000	10,000	10,000
* Sediment Cores	50,000	50,000	50,000
* Labor	100,000	100,000	100,000
QA	60,000	60,000	60,000
Analysis/Publication	50,000	50,000	50,000
Science Advisory Board	20,000	20,000	20,000
Travel	100,000	100,000	100,000
Design	20,000		
Database Management	70,000		
Subtotal	$ 561,000		
Subsistence Studies	15,000		
Charismatic Predators	10,000		
Total	586,000		

c. Group 3 Notes and Discussion:
Initial discussion in our group (brainstorming ideas):

- Start with – for example – 5 sites (Andrea suggested this number which she said was arbitrary)
- Focus on area that has an elevational gradient and also has subsistence people at upper elevations (Andrea)
- Dixon: suggested a lat/long plus elevational gradient
- General comments: Consider redundant measures since SPMD is relatively new; co-locate SPMDs with Hi Vol sampler. And/or: Hi-Vol co-located with IMPROVE sites, run all year, and also co-locate with "test" SPMD sampler and sampling lichens same location.
- Get modelers on board early to be part of the planning and design
- Cost-saving, budget-fitting strategies: Consider staging tasks so can collect samples in one year, and analyze the next year.

VII Conclusions and Actions

Next Steps – (Next 3 months):

- Prepare meeting proceedings and draft recommendations (Tamara Blett & Kathy Tonnessen)
- Review proceedings (Meeting Participants)
- Develop list of relevant (to the workshop) literature citations (Meeting Participants)
- Develop list of web linkages to other relevant toxics sites (Tamara Blett and Meeting Participants)
- Post all products above to a newly created "toxics" section on the NPS web site (Tamara Blett and Laurie Lindner)
- NPS subgroup (Barbara Samora leads) prepares and makes presentations at the three western regions of the NPS to summarize and communicate toxics issues and concerns.

Next Steps – (3 mo – 2 yrs)

- Develop Technical Study Proposal for NPS toxics monitoring network in western U.S. and Alaska:
  NPS Air Resources Division, Kathy Tonnessen, Dixon Landers
  (Note: following the workshop Dixon Landers entered into an interagency personnel agreement with the NPS to lead the effort to develop and implement a technical study proposal for NPS air toxics monitoring network in the western U.S. and Alaska)
- Workshop Participants Subset Review Technical Study Proposal:
  Phil Johnson, Ken Czarnowski, Jim Seiber, Dave Bradford (EPA), NPS I&M Coordinators, Resource Staffs of Western and Alaska Parks, Park Science Advisors

- Form Science Advisory Board for NPS air toxics monitoring network

Appendix A

Workshop Participants List

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Appendix B

NPS Air Toxics Workshop Agenda

Seattle, WA – NOAA, Sand Point, WA
June 26 and 27, 2001

Objective: This is a Technical Workshop Session intended to identify issues associated with deposition and effects of air toxics (persistent organics and metals, including mercury) in national parks of the western U.S., with emphasis on high elevation areas and Alaska. This discussion will lay the foundation for developing an air toxics monitoring strategy for the national parks in this region. This workshop is considered "step one" in the process of addressing airborne toxics in the NPS. Air toxics of interest to workshop participants include: (1) those that can be transported long distances, (2) those that are volatile and persistent, and may be concentrated at high elevations or high latitudes, and (3) those that can be concentrated in biological tissue with adverse effects to higher levels in the food chain.

Workshop Goal: At the end of two days, we will all have a general understanding of the state of the science in the Western United States and Alaska as it pertains to toxics research. We will have a list of prioritized goals for future study and an understanding of how and why toxics research fits with current management issues for Parks. NPS participants will have a general understanding that toxics are something to care about and that we will work to develop a cohesive monitoring plan for its study.

Info Sharing and Feedback: Other mechanisms for sharing air toxics monitoring information (in addition to this workshop) are being developed. They may include conference calls, workshop reports, web site summaries, etc. Contact one of the steering committee members (Tamara Blett, Kathy Tonnessen, Cat Hoffman, Barbara Samora, Bud Rice) if interested in these other information sharing for.

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Tuesday June 26, 2001

8:00-8:15 Introductions/ Workshop Overview – *Kathy Tonnessen & Facilitator, Katharine Coffin*
8:15- 8:30 Welcome and Setting the Stage -- *Chris Shaver*

8:30-9:00 Why should we care about air toxics deposition and accumulation in park ecosystems? What do you want to get out of the next two days? – *All participants*

Speakers Should Address the following questions:

(1) Why should we care about air toxics deposition and accumulation in park ecosystems?
(2) Where have we seen effects of air toxics and at what concentrations?
(3) What do we know about air toxics distribution and effects in the western US?
(4) What are your recommendations to NPS for monitoring of air toxics in specific media in parks?
(5) What "advance work" needs to be done in parks before an air toxics monitoring plan can be devised?
(6) What trends can we predict in toxic emissions, deposition and impacts?
(7) What do we need to know (research gaps and knowledge gaps with special emphasis on effects on primary productivity)?

Presentations should be 20 minutes; 10 minutes for clarifying questions

9:00 Atmospheric Processes (transport of air toxics; source-receptor relationships) – **Mark Cohen (NOAA)**

9:30 Air toxics in ambient air and deposition (gases, particles, wet and dry deposition)
- Matt Simcik (Univ. of Minnesota)

10:00 Break

10:30 Overview of monitoring of air toxics in sediment, snow and aquatic bioaccumulators - general design considerations
- **Dixon Landers (Environmental Protection Agency)**

11:00 Monitoring air toxics in snow, glacial ice, aquatic bioaccumulators (including salmon)
- **Jules Blais (Univ. of Ottawa)**

11:30 Case Study: monitoring snow for air toxics in the U.S. Rocky Mountains
– **George Ingersoll (USGS-WRD)**

12:00 Discussion: (1) Discuss pros and cons of using different media for monitoring, (2) Discuss how to integrate with other types of monitoring for currently archived samples (looking backwards) and future network linkages (looking forward)—*all participants*

12:30 Lunch

1:30 Monitoring of air toxics in fresh waters (using semi-permeable membrane devices)
– **David Alvaraz (USGS-BRD)**

2:00 Case Study: monitoring of air toxics transport and deposition in the Sierra Nevada
- **Jim Seiber (USDA-ARS)**

2:30 Use of lichens and mosses as biomonitors of air toxics
- **Linda Geiser (USDA-FS)**

3:00 Toxics monitoring in fish and wildlife
- **Phil Johnson (USFWS)**

3:30 Break

3:45 Discussion: (1) Discuss pros and cons of using different media for monitoring; (2) Discuss how to integrate with other types of monitoring for currently archived samples (looking backwards) and future network linkages (looking forward) – *all participants*

4:15 Status of toxics monitoring in human populations
- Susan Metcalf (ATSDR)

4:30 Exposure pathways studies - where to target air toxics monitoring
- **Susan Metcalf (ATSDR)**
-

4:45-5:00 What's one thing that stood out to you today? – *all participants*
Tomorrow's Plan, Administrative Details -- *facilitator*

"Towards an Air Toxics Monitoring Strategy and Network for the NPS"
Wednesday June 27, 2001

8:00-8:15	Agenda update and questions – *Kathy Tonnessen and Facilitator, Katharine Coffin*
8:15-8:45	**Discussion:** Review prior day discussions. Add anything new, brief cumulative review of (1) pros and cons of using different media for monitoring; and (2) how to integrate with other types of monitoring for currently archived samples (looking backwards) and future network linkages (looking forward) – *All participants w/ facilitator*
8:45-9:45	NPS goals for monitoring air toxics? – Strawman goals for comment and review – *Tamara Blett*
9:45-10:15	Break
10:15-11:00	Recommendations from presenters on priorities for the most appropriate air toxics to monitor and which receptors/ecosystems to monitor. (What, Where and Why in priority based on pros and cons: what can group agree are of highest priority for each of the 3 items listed below?) --*Presenters w/ facilitator* -What are the chemicals we should focus on and why? -Identify known geographic "hot spots" or specific NPS regions that are impacted. -Discuss ecosystem indicators and endpoints (using conceptual diagrams).
11:00-12:00	Based on monitoring goals and priorities determined above, list the monitoring protocols currently available for air toxics in different media. Then develop an outline of other types of monitoring protocols that NPS could use for monitoring. --*Kathy Tonnessen* -fill out a data sheet template for each protocol -note existing networks -costs of monitoring, if known -if don't have appropriate protocols for monitoring a certain media -- describe research that needs to be done before protocols can be used
12:00-1:00	Lunch
1:00-1:15	Power Point Presentation – An overview of POPs in Alaska (available disks) – *Bud Rice*
1:15-2:45	Small Groups –*All participants* -Develop "strawman" air toxics monitoring program in NPS units, using priorities developed above, at three funding levels ($200K, $400K, $600K per year). -Describe what, where, how often, and linkages with other programs -Over what area should the program be implemented? -How should the program be implemented - contractor? Another agency? In-house? Compile Recommendations on flip charts and be ready to report at 3:15
2:45-3:15	Break
3:15-4:15	Reports and synthesis of Small Group Reports – *Small Group leaders w/ facilitator*

Next steps in developing a monitoring plan --*Tamara Blett*

4:15-5:00 Wrap up and Close – *All participants w/ facilitator*
(1)What did you get out of these two days ? (2) How do you think NPS should use this information? (3) How would you like to be involved?
Science Integration Comments – *Kathy Tonnessen*
Policy Integration Comments – *Chris Shaver*

Close – *Kathy Tonnessen*

Appendix C
Conceptual Ecosystem Diagrams

Note: NPS air toxics web site (http://www2.nature.nps.gov/ard/aqmon/air_toxics) will have links to these scanned diagrams

Appendix D

Bibliography

Note: NPS air toxics web site (http://www2.nature.nps.gov/ard/aqmon/air_toxics) will have links to literature suggested by participants