

Upper Columbia Basin Network Air Resources Summary

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Introduction

Visitors to national parks expect clean, clear air. The health of park ecosystems and the integrity of cultural resources depend upon clean air. Air pollutants can impair visibility, harm human and wildlife health, injure trees and other vegetation, acidify streams and lakes, leach nutrients from soils, and erode buildings and monuments. The NPS Organic Act provides the basis for air resource protection in all units of the National Park System. In addition, the Clean Air Act amendments of 1977 designated 48 national parks and NPS wilderness areas—including Craters of the Moon National Monument (CRMO)—as Class I areas, affording them the highest degree of protection. The rest of the parks in the Upper Columbia Basin Network (UCBN)—Big Hole National Battlefield (BIHO), City of Rocks National Reserve (CIRO), Hagerman Fossil Beds National Monument (HAFO), John Day Fossil Beds National Monument (JODA), Lake Roosevelt National Recreation Area (LARO), Minidoka National Historic Site (MIIN), Nez Perce National Historical Park (NEPE), and Whitman Mission National Historic Site (HWMI)—are designated Class II areas under the Clean Air Act.

Park managers have an affirmative responsibility to protect air quality and sensitive resources, called air quality related values (AQRVs), from the adverse effects of air pollution. To fulfill these responsibilities, the NPS monitors air quality; assesses effects on AQRVs; communicates information about air quality issues; advises and consults with regulatory agencies; partners with stakeholders to develop air pollution management strategies; and promotes pollution prevention practices in parks.

Air Pollution Sources

Most human activities, including manufacturing and industrial processes, agricultural practices, land disturbance, and fossil fuel combustion, produce air pollution. Air pollutants of concern include sulfur (S) and nitrogen (N) compounds, ground-level ozone, and persistent bioaccumulative toxics (PBTs), including mercury (Hg). The main source of S pollution is coal combustion at power plants and industrial facilities. Oxidized N compounds (i.e., nitrogen oxides) result from fuel combustion by vehicles, power plants, and industry. Reduced N compounds (e.g., ammonia and ammonium) are the result of agricultural activities, fires, and other sources. Ozone is formed when nitrogen oxides and volatile organic compounds from vehicles, solvents, industry and vegetation react in the atmosphere in the presence of sunlight, usually during the warm summer months. Persistent bioaccumulative toxics include heavy metals and organic compounds, such as polychlorinated biphenyls and pesticides. Coal combustion, incinerators, mining processes, and other industries emit Hg.

Air Pollution Effects

Fine particles of S and N compounds, and other pollutants in the atmosphere, absorb or scatter light, causing haze and reducing visibility. Sulfur and N pollutants eventually fall out of the atmosphere and are transferred to the Earth's surface by either wet deposition (e.g., rain, snow, clouds, and fog) or dry deposition (gases and particles). These pollutants change water and soil chemistry, which in turn, affects algae, aquatic invertebrates, and soil microorganisms, and can

lead to impacts higher in the food chain. Because N is an essential plant nutrient, N compounds may cause unwanted fertilization or eutrophication, with subsequent changes in soil nutrient cycling and plant community structure and composition. Sulfur and N deposition can acidify lakes and streams that have low buffering capacity.

Ozone is a respiratory irritant and can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. Ozone also affects vegetation, causing significant harm to sensitive plant species. Ozone enters plants through leaf openings called stomata and oxidizes plant tissue, causing visible injury (e.g., stipple and chlorosis) and growth effects (e.g., premature leaf loss, reduced photosynthesis, and reduced leaf, root, and total size).

After Hg is deposited, it can be transformed by ecosystem processes into methylmercury, which biomagnifies in the food chain and can reach toxic levels in fish and wildlife. Biological effects of PBTs include negative impacts on reproductive success, growth, behavior, disease resistance, and survival.

Park Air Quality and AQRV Data

Air quality and AQRV data are two of the Inventory and Monitoring (I&M) Program's 12 basic inventories. An NPS air quality website (<http://www.nature.nps.gov/air/maps/airatlas/index.cfm>) includes a mapping tool and five year averages of visibility, ozone, and S and N deposition data. An AQRV website (<http://www.nature.nps.gov/air/permits/aris/networks/index.cfm>) identifies stressors to AQRVs and describes resources at risk from air pollution. There are few air quality monitors in parks and we have limited understanding of thresholds for pollutant effects on park resources. Given current information, the air quality and AQRV inventories provide our best estimates of pollution levels and effects in UCBN parks.

In *Air Quality in National Parks: 2009 Annual Performance and Progress Report* (NPS ARD, 2010), the NPS Air Resources Division (ARD) reported average values and 1999-2008 trends for visibility, ozone and wet S and N deposition (Table 1). The ARD used all available data from NPS, EPA, state, tribal, and local monitors to generate interpolations for the continental U.S. These interpolations allowed them to derive estimates of the air quality parameters at NPS units located within the continental U.S., including those without on-site monitoring. The report also included information to inform park Natural Resource Condition Assessments. Parks were assigned to one of three condition categories—good, moderate or significant concern—for each pollutant.

Table 1. Average air pollutant concentrations (2005-2009), trends* (1999-2008) and condition categories for UCBN parks (*trends are only available for parks with long-term data).

PARK	VISIBILITY (dv)	OZONE (ppb)	WET N DEPOSITION (kg/ha/yr)	WET S DEPOSITION (kg/ha/yr)
BIHO	3.0 ↔	64.7	0.43	0.24
CIRO	3.1	74.9	1.55	0.59
CRMO	3.6 ↑	66.8 ↔	0.94 ↔	0.39 ↔
HAFO	3.2	72.1	0.82	0.33
JODA	5.0	63.4	0.32	0.19
LARO	4.5	61.0	0.76	0.34
MIIN	-	-	-	-
NEPE	4.2 ↔	64.4	0.95	0.41
WHMI	4.9	63.2	0.47	0.24

dv = deciview

ppb = parts per billion

kg/ha/yr = kilograms/hectare/year

↑ = improving air quality trend

↓ = degrading air quality trend

↔ = no air quality trend



Air quality condition is good

Air quality condition is moderate

Air quality condition is of significant concern

Visibility is often reported using a haze index called the deciview (dv). To assess the visibility condition at a park, ARD determined the dv difference between measured (or estimated) visibility and calculated natural visibility (i.e., without human-caused impairment). For example, at BIHO, the average 2005-2009 visibility difference was 3.0 dv, indicating current visibility is 30% hazier than natural conditions. Parks with estimates ranging two to eight dv higher than natural visibility, which includes all UCBN parks, were considered by ARD to be of moderate concern.

The U.S. Environmental Protection Agency (EPA) has established a primary National Ambient Air Quality Standard (NAAQS) for ozone that is designed to protect public health. The NAAQS is based on the 3-yr average of the annual 4th-highest 8-hr ozone concentration and is currently set at 75 parts per billion (ppb). In January 2010, based on recommendations from their Clean Air Scientific Advisory Committee, EPA proposed to lower the ozone NAAQS to a value in the range of 60–70 ppb. At the same time, EPA proposed a new secondary ozone NAAQS to protect vegetation. The secondary standard would be based on a metric called W126, which is a cumulative sum of hourly ozone concentrations, with hourly values weighted according to their magnitude. The EPA proposed to set the secondary NAAQS in the range of 7–15 parts per million-hours (ppm-hr). Although EPA has not made a final decision regarding new ozone NAAQS, ARD used the values at the low end of the EPA-proposed ranges as the reference conditions for ozone (i.e., 60 ppb to protect human health, and 7 ppm-hr to protect vegetation). Parks with 4th-highest 8-hr ozone concentrations of 61–75 ppb, which includes all UCBN parks, were considered to be of moderate concern. The W126 values for BIHO (7.5 ppm-hr), CIRO (16.5 ppm-hr), CRMO (10.3 ppm-hr) and HAFO (11.6 ppm-hr) also exceed the reference condition for the secondary ozone NAAQS.

Because of the difficulties in measuring dry and total atmospheric S and N deposition, ARD used only wet deposition data to assess park condition. They considered wet deposition of S or N of significant concern if it exceeded 3 kilograms/hectare/year (kg/ha/yr), or if deposition was 1–3 kg/ha/yr and the park contains ecosystems with known sensitivity to N. All UCBN parks are in good condition for S deposition. City of Rocks National Reserve is in moderate condition for N deposition. Based on concern that N deposition may be increasing invasion of exotic species such as cheatgrass (*Bromus tectorum*) at CRMO, ARD concluded N deposition is a significant concern for that park. As discussed below, the influence of N deposition on exotic species abundance may also be an issue for other UCBN parks.

As part of the AQRV inventory, an ozone injury risk assessment was completed for UCBN parks in 2004 (Kohut, 2004). The assessment used sensitive species and 1995-1999 ozone concentration and soil moisture data to assess the risk of foliar injury. City of Rocks National Reserve was considered at moderate risk for ozone injury; all other UCBN parks were determined to be at low risk. Ozone sensitive species at CIRO include quaking aspen (*Populus tremuloides*), Saskatoon serviceberry (*Amelanchier alnifolia*) and Scouler's willow (*Salix scouleriana*). No ozone injury surveys have been conducted in UCBN parks.

Risk assessments for UCBN parks have also been completed for nutrient enrichment from N (Sullivan et al., 2011a) and for acidification from S and N deposition (Sullivan et al., 2011b). Both assessments considered pollutant exposure, occurrence of ecosystems known to be sensitive to N enrichment or acidification, and mandates for park protection (Class I parks and parks with wilderness areas were ranked high for park protection; all other parks were ranked moderate) (Tables 2 and 3). Compared to the other I&M Networks, UCBN was considered at low risk for both N enrichment and acidification (Figures 1 and 2). Sullivan et al. (2011a and 2011b) also evaluated relative risk for all NPS areas larger than 100 square miles, including CRMO and LARO. Craters of the Moon National Monument was considered at moderate risk for N enrichment, while LARO was ranked as low risk (Figure 3). Both parks were considered as low risk for acidification (Figure 4). A researcher from the University of California at Riverside is currently conducting a study at CIRO, CRMO, HAFO and MIIN to evaluate the effects of atmospheric N deposition on the extent of cheatgrass invasion of the parks' sagebrush steppe ecosystems. A final project report should be available in the spring of 2014.

Table 2. Rankings of UCBN parks for pollutant exposure, ecosystem sensitivity, park protection, and summary risk from atmospheric N enrichment (from Sullivan et al., 2011a).

I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
	Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Big Hole	Very Low	High	Moderate	Very Low
City of Rocks	Low	High	Moderate	Low
<i>Craters of the Moon</i>	Low	Moderate	High	Moderate
Hagerman Fossil Beds	Moderate	Very High	Moderate	Moderate
John Day Fossil Beds	Very Low	Very High	Moderate	Low
<i>Lake Roosevelt</i>	Very Low	Moderate	Moderate	Very Low
Nez Perce	Very Low	High	Moderate	Very Low
Whitman Mission	Moderate	Low	Moderate	Very Low
¹ Relative park rankings are designated according to quintile ranking, among all I&M Parks, from the lowest quintile (very low risk) to the highest quintile (very high risk).				
² Park name is printed in bold italic for parks larger than 100 square miles.				

Table 3. Rankings of UCBN parks for pollutant exposure, ecosystem sensitivity, park protection, and overall summary risk for acidification due to S and N deposition (from Sullivan et al, 2011b).

I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
	Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Big Hole	Very Low	Moderate	Moderate	Low
City of Rocks	Very Low	High	Moderate	Moderate
<i>Craters of the Moon</i>	Very Low	Very Low	High	Low
Hagerman Fossil Beds	Low	Moderate	Moderate	Moderate
John Day Fossil Beds	Very Low	Moderate	Moderate	Low
<i>Lake Roosevelt</i>	Very Low	Moderate	Moderate	Low
Nez Perce	Very Low	Moderate	Moderate	Low
Whitman Mission	Low	Very Low	Moderate	Low
¹ Relative park rankings are designated according to quintile ranking, among all I&M Parks, from the lowest quintile (very low risk) to the highest quintile (very high risk).				
² Park name is printed in bold italic for parks larger than 100 square miles.				

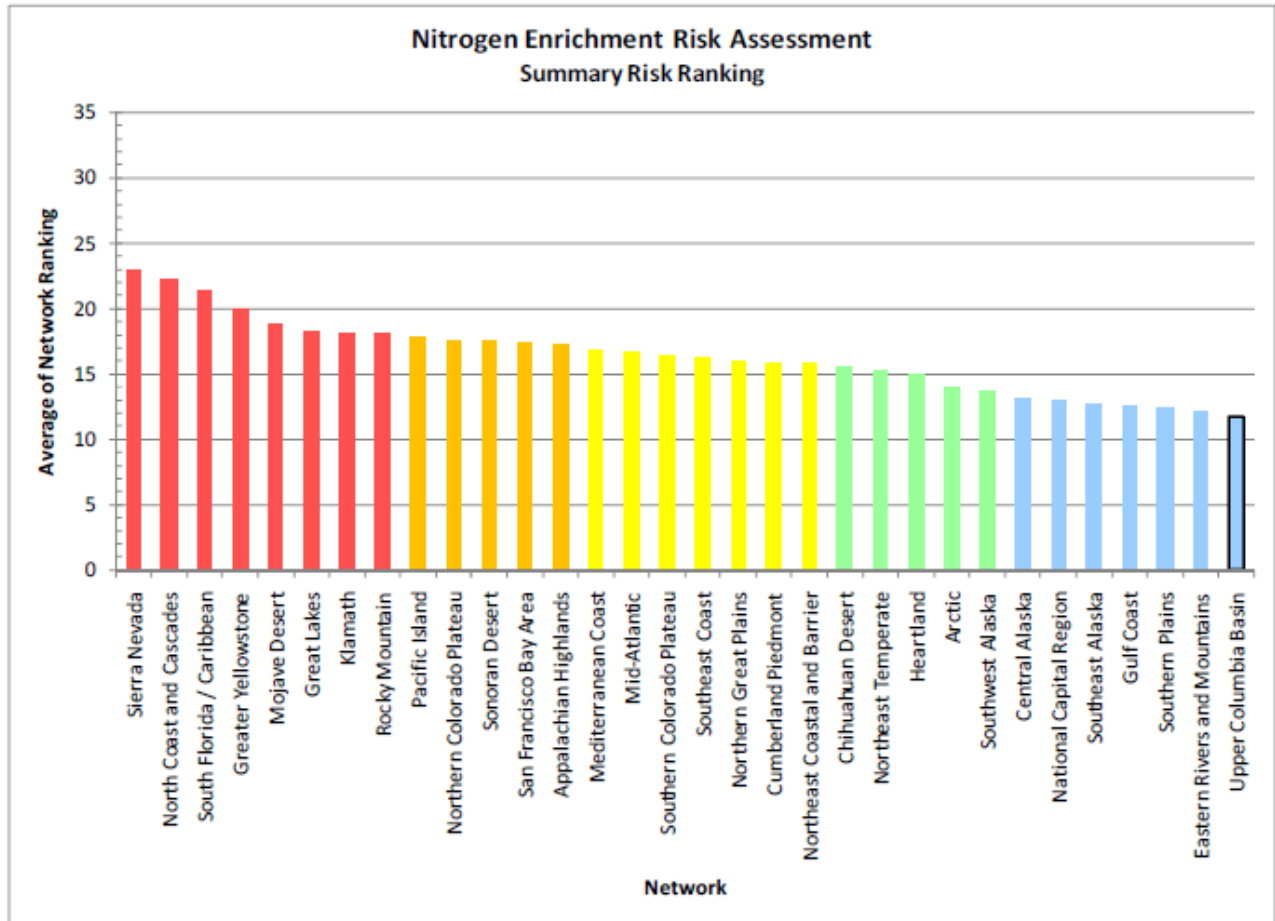


Figure 1. Summary risk ranking of atmospheric N enrichment for the 32 I&M Networks (from Sullivan et al., 2011a).

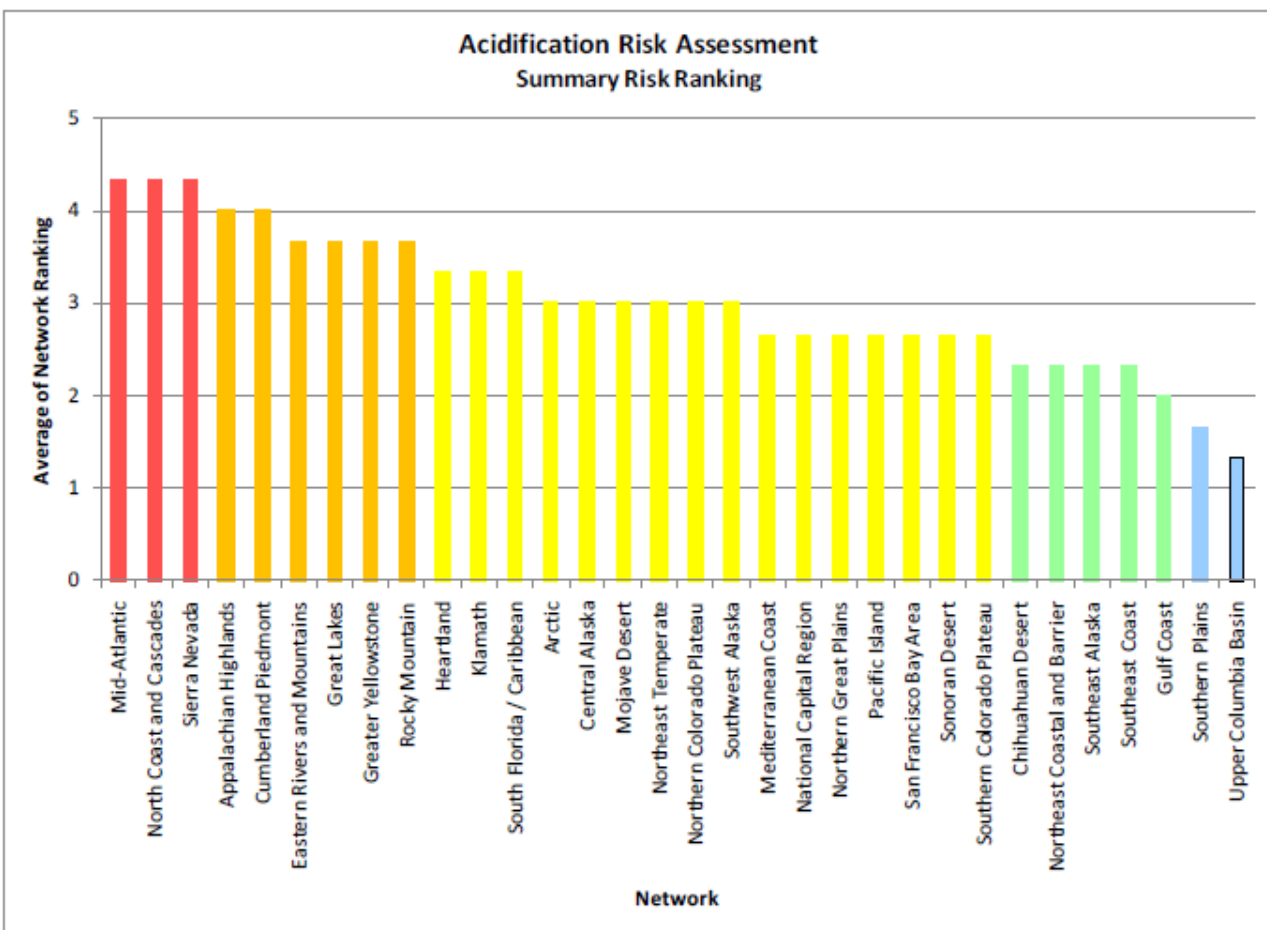


Figure 2. Summary risk ranking of acidification due to S and N deposition for the 32 I&M Networks (Sullivan et al., 2011b).

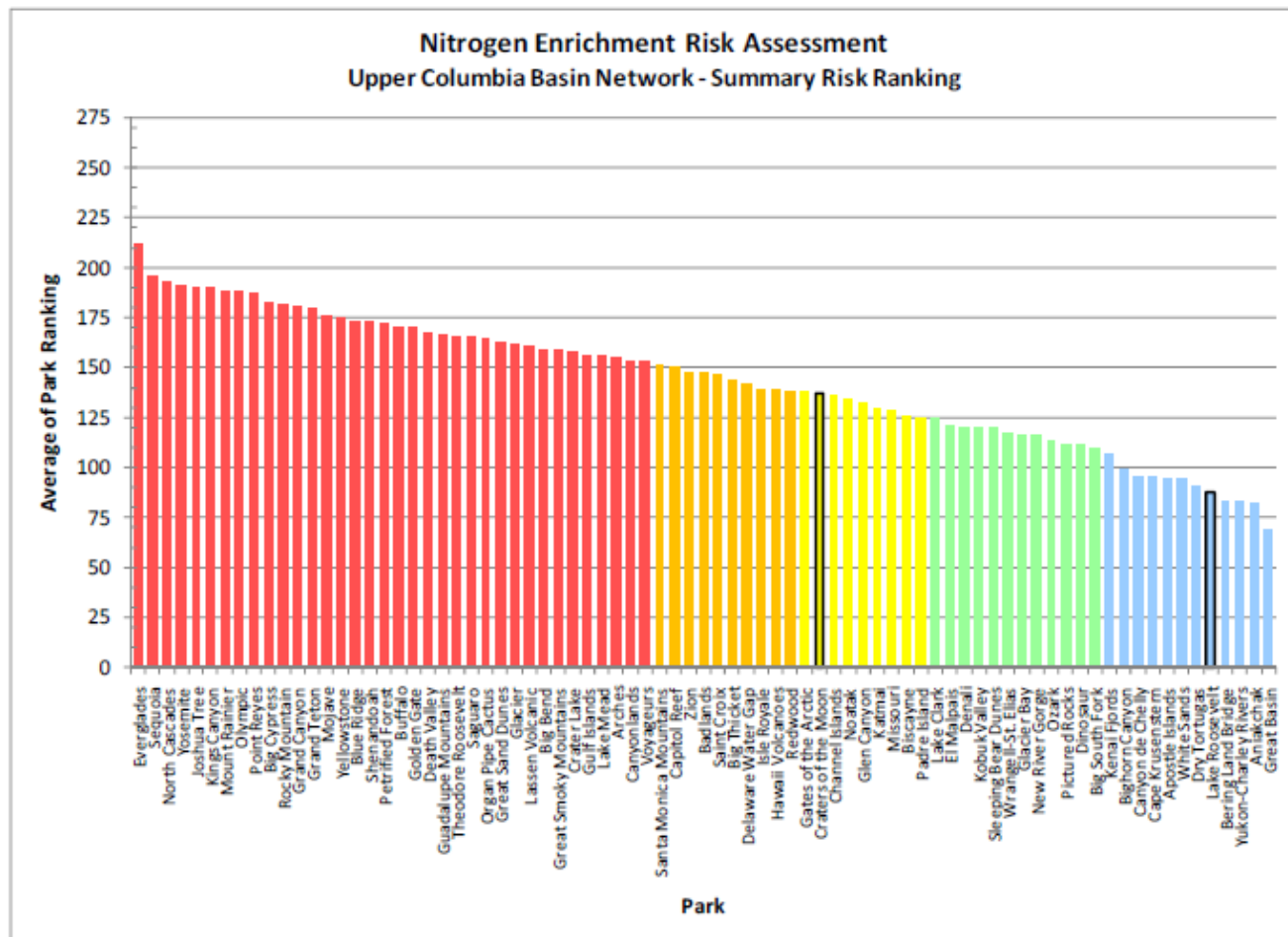


Figure 3. Summary risk ranking of atmospheric N enrichment for all NPS areas larger than 100 square miles (from Sullivan et al., 2011a).

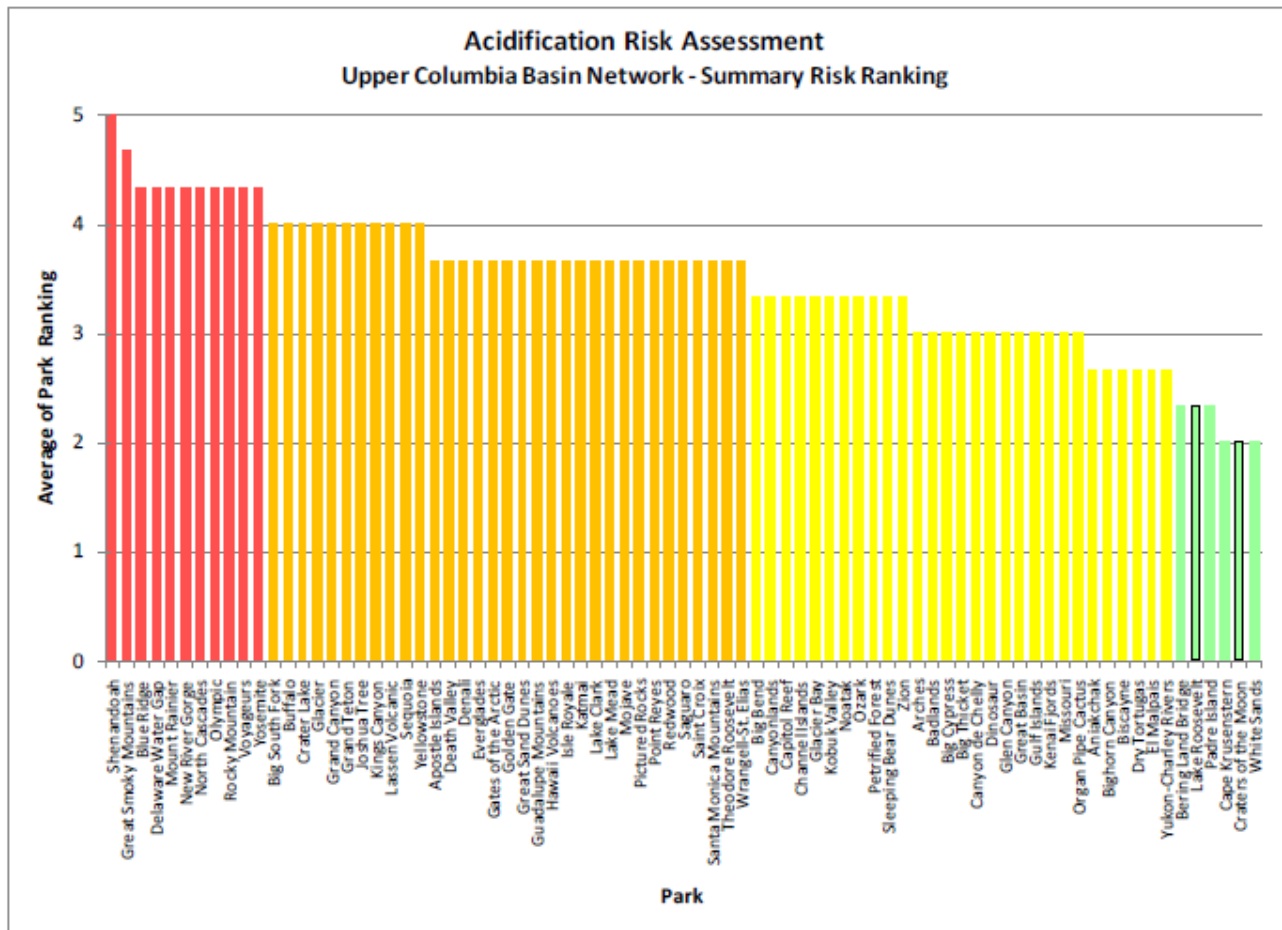


Figure 4. Summary risk ranking of acidification due to S and N deposition for all NPS areas larger than 100 square miles (from Sullivan et al., 2011b).

An Hg risk assessment is being completed for UCBN parks (Krabbenhof and Lutz, in preparation). The assessment evaluates water quality and landscape variables such as pH, sulfate, total organic carbon and percent wetlands to determine the likelihood that atmospherically-deposited Hg will be converted to toxic methylmercury. Preliminary results indicate watersheds in and near UCBN parks should have low to moderate concentrations of methylmercury (Figure 5).

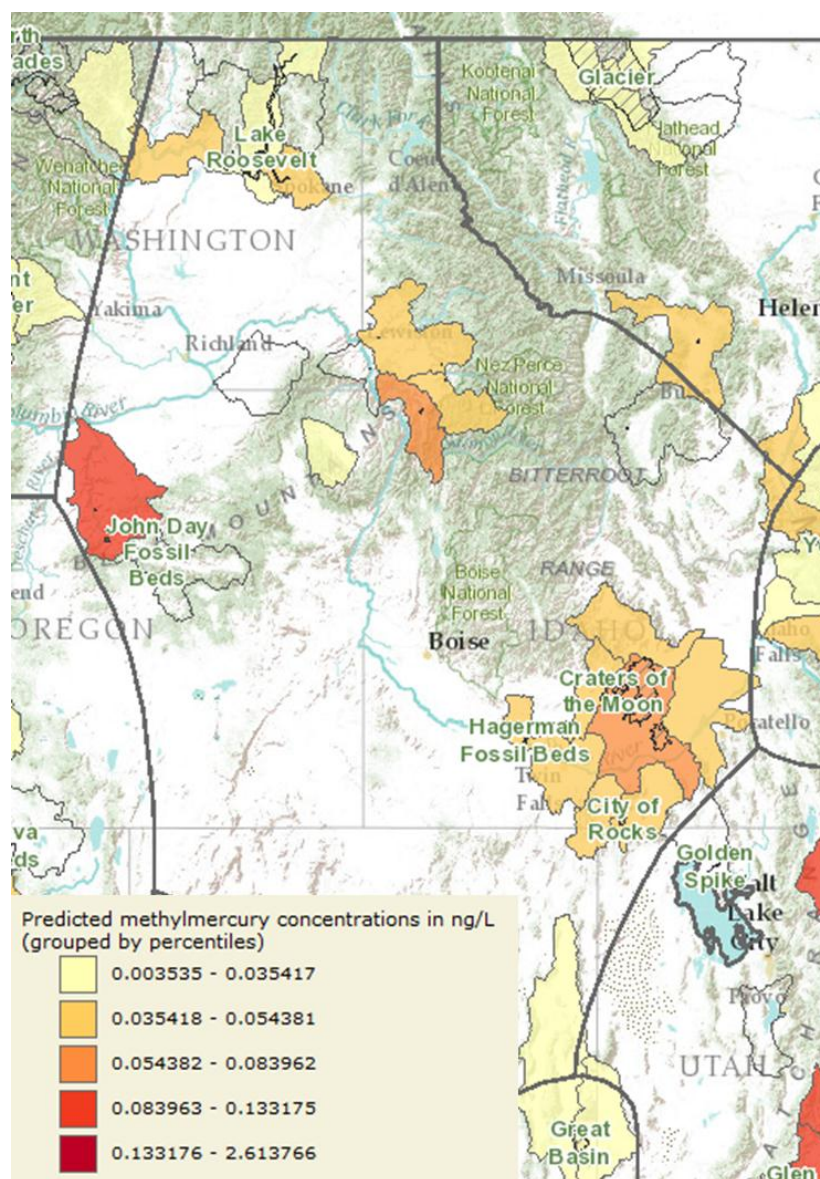


Figure 5. Predicted methylmercury concentrations in nanograms/liter (ng/L) in watersheds in the UCBN area (from Krabbenhoft and Lutz, in preparation).

Conclusions

Air quality of UCBN parks is relatively good compared to other parks in the U.S. Nevertheless, visibility is degraded in all UCBN parks, all the parks have ozone concentrations that would exceed a human health-based ozone NAAQS of 60 ppb, and N deposition may be affecting plant communities in some of the parks. Climate change-induced effects on temperature and precipitation could influence air pollution levels in the region.

Data showing the extent of air quality degradation in parks enable the NPS to make a strong case for EPA and states to develop management strategies that improve air quality in parks. Continued monitoring and research is essential to improve our understanding of air pollution effects and provide valuable information that can inform NPS management decisions and be shared with regulators and the public.

Literature Cited

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