National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Federal Land Managers' Interagency Guidance for Nitrogen and Sulfur Deposition Analyses

November 2011

Natural Resource Report NPS/NRSS/ARD/NRR—2011/ 465

ED_005364I_00054975-00001

ON THE COVER

Atmospheric nitrogen deposition causes enrichment effects that may lead to simplified plant communities dominated by weedy species at the expense of native wildflowers, which are a source of food and shelter for some wildlife, including the Bay Checkerspot butterfly in California.
Credit: U.S. Fish and Wildlife Service.

ON THIS PAGE

Some plant species are very sensitive to the acidifying effects of atmospheric nitrogen and sulfur deposition. The decline of native sugar maple trees in some areas of the eastern U.S. has been linked to high levels of acid deposition.
Credit: National Park Service

Federal Land Managers' Interagency Guidance for Nitrogen and Sulfur Deposition Analyses

November 2011

Natural Resource Report NPS/NRSS/ARD/NRR—2011/ 465

U.S. Forest Service
Air Quality Program
1400 Independence Ave, SW
Washington, DC 20250

National Park Service
Natural Resource Stewardship & Science
Air Resources Division
PO Box 25287
Denver, Colorado 80225

U.S. Fish and Wildlife Service
National Wildlife Refuge System
Air Quality Branch
7333 W. Jefferson Ave., Suite 375
Lakewood, CO 80235

November 2011

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Denver, Colorado

ED_005364I_00054975-00003

The National Park Service, Natural Resource Stewardship and Science office in Denver, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received formal, high-level peer review based on the importance of its content, or its potentially controversial or precedent-setting nature. Peer review was conducted by highly qualified individuals with subject area technical expertise and was overseen by a peer review manager.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Air Resources Division of the NPS (http://www.nature.nps.gov/air/Permits/flag/index.cfm) and the Natural Resource Publications Management Web site (http://www.nature.nps.gov/publications/nrpm/) on the Internet.

Please cite this publication as:

U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. 2011. Federal land managers' interagency guidance for nitrogen and sulfur deposition analyses: November 2011. Natural Resource Report NPS/NRSS/ARD/NRR—2011/465. National Park Service, Denver, Colorado.

NPS 909/111538, November 2011

ED_005364I_00054975-00004

Contents

Page

1. Background **1**

2. Deposition Analysis Thresholds (DATs) **3**

3. Refined Analysis **5**

3.1. Are AQRVs in the affected area sensitive to deposition? **5**

3.2. Are AQRVs in the affected area currently impacted by deposition? **5**

3.3. Have critical loads or target loads been developed for the affected area? **5**

3.4. Does current deposition exceed the critical load(s) or target load(s) in the area? If so, by how much? Is current deposition approaching the critical load or target load? **6**

4. Adverse Impact Determination **7**

References **9**

Figures

Page

Figure 1. FLM Assessment of Potential Deposition Effects from New Emissions Sources.. ..... **2**

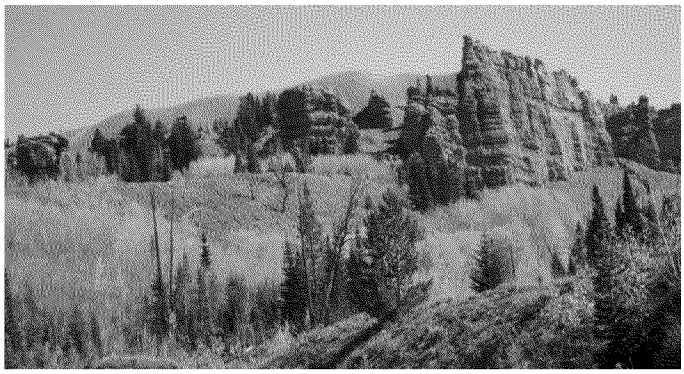
ED_005364I_00054975-00005

1. Background

Increased nitrogen (N) or sulfur (S) deposition may result from emissions from new or modified facilities subject to New Source Review (NSR), activities subject to requirements under the National Environmental Policy Act (NEPA), and other actions. This increased deposition may have a negative impact on air quality related values (AQRVs) sensitive to N or S deposition, including lakes, streams, estuaries, coastal waters, soils, vegetation, and wildlife. The Federal Land Managers (FLMs), including the National Park Service (NPS), the U.S. Forest Service (USFS), and the U.S. Fish and Wildlife Service (FWS), have developed guidance for evaluating the impact of additional nitrogen (N) or sulfur (S) deposition on lands under their management for NSR permit applicants and NEPA action lead agencies and project proponents. This guidance is provided in the Federal Land Managers' Air Quality Related Values Workgroup Report (FLAG 2010),[1] which also includes guidance for evaluating visibility and ozone impacts from new or modified emissions sources. In FLAG, the FLMs anticipated that over time, more information would become available on ecosystem responses to N and S deposition and that further guidance would be needed to use this information in evaluating impacts of new emission sources. This current document summarizes existing and emerging deposition analysis tools and explains when and how these tools should be applied. It reflects the FLMs' commitment to continue to develop consistent, predictable review processes for NSR permits and Environmental Assessments and/or Environmental Impact Statements under NEPA. The information and procedures outlined in this document are generally applicable to both Class I and Class II areas for evaluating the effect of increased N or S deposition.

This current guidance describes a minor change in the FLM assessment process given in Figure 1. Previously, in step 2 the FLM evaluated whether the source's contribution to deposition in the FLM area was predicted to be less than the Deposition Analysis Thresholds (DATs) or Concern Thresholds established by the FLM. The DATs were used by the NPS and FWS; one DAT value was established for the eastern U.S., while another value was established for the western U.S. Concern Thresholds were used by the USFS and these values varied across USFS areas. Step 2 has been simplified; all FLMs have now adopted the DATs, eliminating the need to consider Concern Thresholds in this step. In addition to describing this change, the current guidance provides more detail on incorporating critical loads for deposition into the refined analysis (step 3).

Figure 1 illustrates the recommended decision process that the FLM will use to determine whether a deposition impact analysis is warranted and, if so, to determine if predicted



Federal lands such as Bridger-Teton National Forest have resources sensitive to nitrogen and sulfur deposition.
Credit: U.S. Forest Service.

impacts are potentially adverse. As part of the process, the applicant[2] provides the FLM with information on the types and amounts of emissions and modeled deposition levels from the proposed source. The FLM asks the following questions:

1. Are a source's impacts negligible? Agencies will consider a source locating greater than 50 km from an FLM area to have negligible impacts with respect to AQRVs if its total SO_2, NO_x, PM_{10}, and H_2SO_4 annual emissions (in tons per year, based on 24-hour maximum allowable emissions), divided by the distance (in km) from the FLM area (Q/D) is 10 or less ($Q/D \leq 10$).[3] If so, the Agencies would not request any further AQRV analyses. If $Q/D > 10$, the FLM proceeds to the next step.
2. Is the source's predicted contribution to deposition (in kilograms per hectare per year - kg/ha/yr) in the FLM area less than the Deposition Analysis Threshold (DATs) established by the FLM? If the answer is yes, the source's impacts are presumed to be negligible. If the answer is no, the FLM proceeds to the next step.
3. Does the refined/contextual analysis alleviate concerns, e.g., indicate that the source's impacts would not cause or contribute to harm to an AQRV, or that the source would provide some ancillary environmental benefit, as described in FLAG 2010?[4] If the answer is yes, the impacts are presumed to be not adverse. If the answer is no, the impact is potentially adverse and the FLM proceeds to the next step.
4. Are there mitigation strategies that could alleviate the potential adverse impact? FLAG 2010 should be consulted for a more detailed discussion of the adverse impact determination process.[5]

The following sections describe in more detail the DATs and the refined analysis.

[1] U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. 2010. Federal land managers' air quality related values work group (FLAG): phase I report—revised (2010). Natural Resource Report NPS/NRPC/NRR—2010/232. National Park Service, Denver, Colorado.

[2] The terms "permit applicant" or "applicant" refer to any proponent of a project that will result in new emissions, including NSR, NEPA, and other projects.

[3] The Q/D procedure is explained in more detail in Section 3.2 of the FLAG 2010 guidance: http://www.nature.nps.gov/air/permits/flag/index.cfm.

[4] Ibid., Section 4.3.

[5] Ibid., Section 2.2.4; Section 4.3.

ED_005364I_00054975-00007

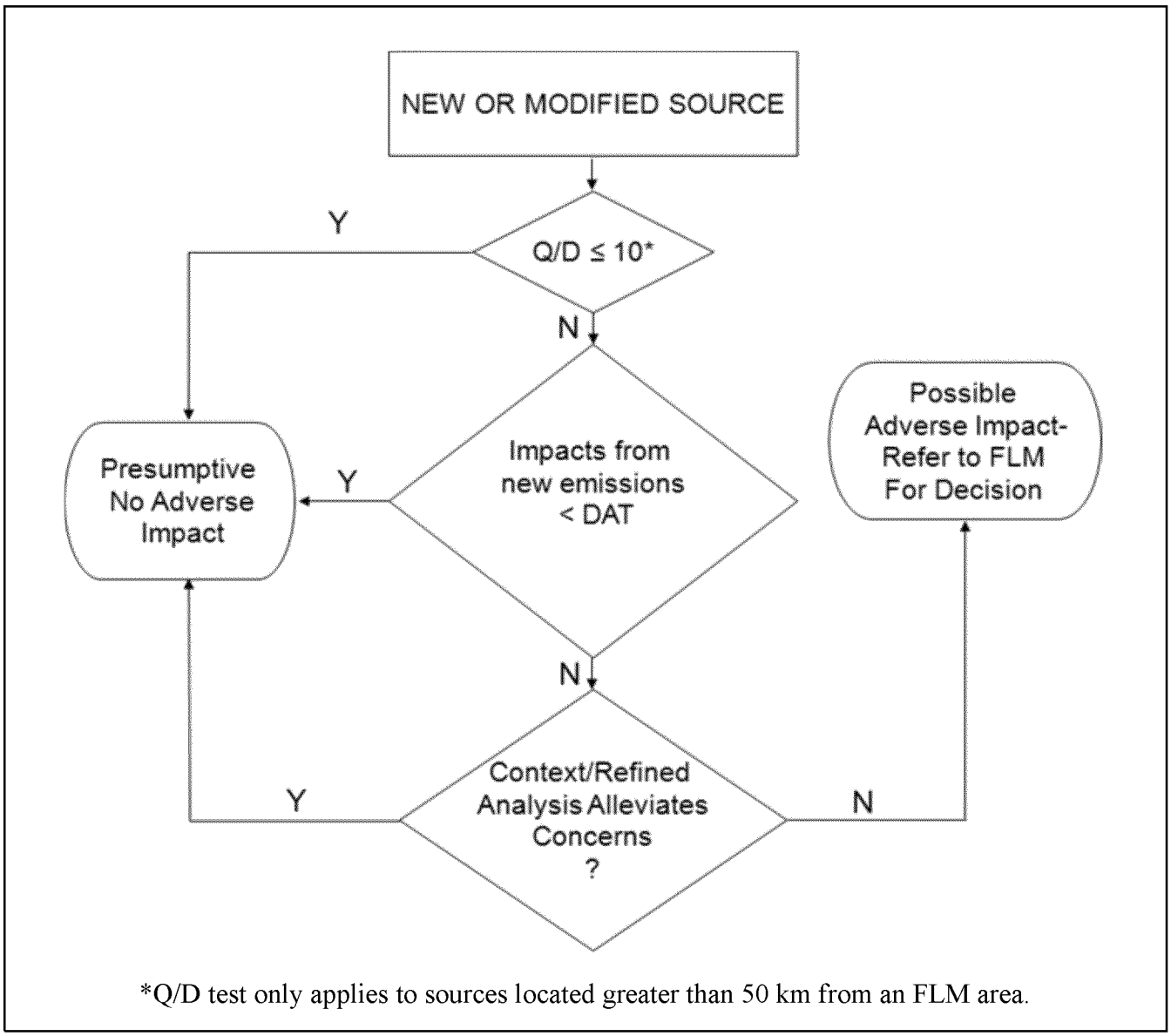


Figure 1. FLM Assessment of Potential Deposition Effects from New Emissions Sources (Revised from FLAG 2010).

ED_005364I_00054975-00008

2. Deposition Analysis Thresholds (DATs)

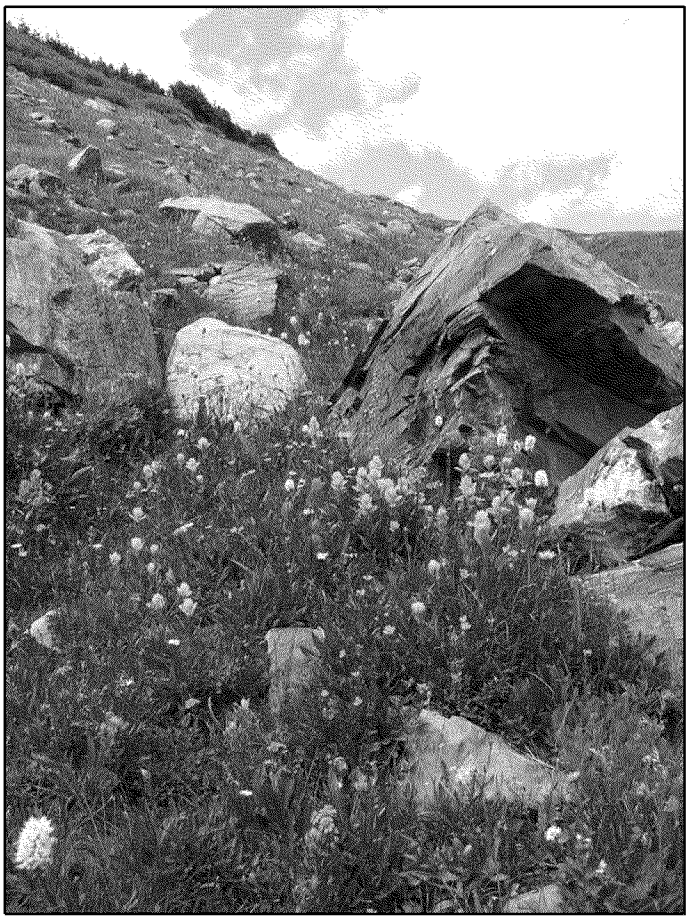
A DAT is defined as the additional amount of N or S deposition within an FLM area, below which estimated impacts from a proposed new or modified source are considered negligible. In other words, if the new or modified source has a predicted N or S deposition impact below the respective DAT, the FLM will consider that impact to be negligible, and no further analysis would be required for that pollutant. In cases where a source's impact equals or exceeds the DAT, the FLM will make a project specific assessment of whether the projected increase in deposition would likely result in an "adverse impact" on resources considering existing AQRV conditions, the magnitude of the expected increase, and other factors.

The DATs are based on "naturally occurring deposition" that park and wilderness ecosystems may have experienced prior to anthropogenic influences and are scaled to enable assessment of the impacts of individual sources of air pollution. Scaling is done by use of a variability factor and a cumulative factor applied to natural background deposition. The variability factor of 0.5 is based on the FLM's decision that all combined anthropogenic sources could contribute up to 50% of natural background deposition without triggering concerns regarding resource impacts. The FLMs believe this is appropriate because the natural background estimates selected are very conservative (0.50 kilograms/hectare/year (kg/ha/yr) for the eastern U.S. and 0.25 kg/ha/yr for the western U.S. for both N and S) and the range of natural variability in deposition could be plus or minus 50%. The cumulative factor of 0.04 (1/25) is based on the assumption that, over time, one might expect 25 or fewer new sources to increase deposition in an FLM area. These assumptions ensure that cumulative deposition from all new sources would not exceed 50% of natural background. The DAT is then calculated as:

DAT = Natural Background Deposition * Variability Factor * Cumulative Factor

Using this equation, the DATs for both N and S in eastern and western FLM areas are 0.010 and 0.005 kg/ha/yr, respectively. Guidance on DATs can be found at: http://www.nature.nps.gov/air/Permits/flag/index.cfm. The DATs are used by the NPS, FWS, and USFS.

The FLMs reserve the right to modify the DAT based upon new scientific information or in situations in which the assumptions are violated. For example, as noted above, the cumulative factor inherent in the DAT is based upon the assumption that 25 or fewer new sources will add to deposition in an FLM area over time. However, situations may occur in which that assumption is not valid, because the number of existing and proposed new projects near an FLM area exceeds 25. In such situations, the FLM reserves the right to modify the DAT according to new information.



Alpine meadow plant communities are very sensitive to the enrichment effects of nitrogen deposition.
Credit: U.S. Forest Service.

If predicted deposition impacts from new or modified sources or projects are below the DATs, the impacts are considered negligible. If the predicted impacts are equal to or exceed the DATs, the source or project proponent should consult with the FLM regarding the need for a refined analysis to determine the severity of the impacts, described below. The refined analysis is based on all available information, including information from the FLMs' websites:

FWS: http://www.fws.gov/refuges/airquality/

NPS: http://www.nature.nps.gov/air/Permits/aris/index.cfm

USDA FS: http://www.fs.fed.us/air/index.htm

ED_005364I_00054975-00009

3. Refined Analysis

If the source's contribution to deposition in an FLM area is predicted to equal or exceed the DAT, a refined analysis may be conducted. In the refined analysis, the FLM evaluates several questions:

- Are AQRVs in the affected area sensitive to deposition?
- Are AQRVs in the affected area currently impacted by deposition?
- Have critical loads or target loads been developed for AQRVs in the area?
- Does current deposition exceed the critical load(s) or target load(s) in the area? If so, by how much? Is current deposition approaching the critical load or target load?

3.1. Are AQRVs in the affected area sensitive to deposition?

AQRV information is available for many parts of the country and for various ecosystems, ranging from alpine environments to coastal estuaries. In general, poorly buffered soils, lakes, and streams, as well as certain vegetation types, are sensitive to acidification from N and S deposition. Acid-sensitive areas are often located at relatively high elevation, on steep slopes having shallow, base-poor soils. Some types of vegetation are more sensitive to acidification effects than others. Some lichens are especially sensitive, with documented effects occurring in the deposition range of only a few kilograms of S or N per hectare per year. Among the vascular plants, red spruce and sugar maple trees are known to be very sensitive. In aquatic ecosystems, acidification can alter water chemistry, causing harm to certain species of fish, aquatic invertebrates, and other biota, allowing more tolerant species to thrive, changing the diversity of these ecosystems.

In addition to contributing to acidification, N deposition causes enrichment effects that may allow fast-growing, weedy plant species to thrive at the expense of native species that generally are adapted to low N conditions. As a consequence, diversity changes and the ecosystem may become simplified, dominated by species like annual grasses that can take advantage of added N.

Existing research, monitoring and other inventory data in various ecosystems can give important information regarding a particular AQRV's sensitivity to deposition. FLMs will reference research on the AQRV in question based on the most current and representative data. If sensitive AQRVs are located in the area, the FLM will carefully evaluate potential impacts from significant increases in deposition. Not all FLM areas will have site-specific data and so the FLM may use data from another, similar area to evaluate sensitivity.

3.2. Are AQRVs in the affected area currently impacted by deposition?

Research and monitoring data may be available for the affected area, providing information on whether AQRVs are currently impacted by acidification or N enrichment. For example, lake and stream monitoring data showing decreased pH or acid-neutralizing capacity (ANC) may indicate effects from N and S acidic deposition. Absence of oligotrophic lichens in a forest may indicate effects from N enrichment. If available information indicates that AQRVs are currently impacted by deposition, the FLM is more likely to consider significant increases in deposition to constitute a potential adverse impact.

3.3. Have critical loads or target loads been developed for the affected area?

The term critical load is used to describe the threshold of air pollution deposition that causes harm to sensitive resources in an ecosystem. A critical load is technically defined as "the quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur according to present knowledge." Critical loads are typically expressed in terms of kilograms per hectare per year (kg/ha/yr) of wet or total (wet + dry) deposition. Critical loads can be developed for a variety of AQRV and ecosystem responses, including shifts in microscopic aquatic species, increases in invasive grass species, changes in soil chemistry affecting tree growth, and lake and stream acidification. When critical loads are exceeded, the environmental effects can extend over significant distances. For example, excess nitrogen can change soil and surface water chemistry, which in turn can cause eutrophication of downstream estuaries.

Critical loads are calculated using data from ecosystem modeling, observations, or experiments. Observations and dose-response experiments can identify the loading at which a specific response occurs, but information is often limited to a specific area. Modeled critical loads are also based on site-specific data but can, in some cases, be extrapolated over larger areas with more limited data. Critical load models typically are steady-state models, that is, they are used to calculate the deposition loading that could be sustained by a specific AQRV or ecosystem over the long-term without harm. Dynamic models, on the other hand, incorporate a time element to determine the loading that would result in a given AQRV or ecosystem condition at a particular point in time. For example, a dynamic model could be used to estimate the deposition reductions needed for recovery of an acidified stream in 20 years versus 100 years. Loadings determined by dynamic modeling are termed "target loads," and may consider policy or management goals.

ED_005364I_00054975-00011

U.S. scientists, air regulators, and natural resource managers are currently developing critical loads and target loads for areas across the United States and collaborating with scientists developing critical loads and target loads in Europe and Canada.[6] Critical and target loads are not yet widely available. However, if an AQRV is experiencing harm such as decreased pH or ANC, by definition the critical load for that AQRV is exceeded, even if it has not yet been quantified. The FLM would evaluate additional deposition to the area as a potential adverse impact, as described for the previous question.

3.4. Does current deposition exceed the critical load(s) or target load(s) in the area? If so, by how much? Is current deposition approaching the critical load or target load?

Critical loads and target loads provide valuable tools for quantifying effects to AQRVs. As noted above, critical loads define the amount of loading of N or S that an AQRV can tolerate over time without harm, while a target load might be used as an interim management goal during recovery of an impacted ecosystem. If critical loads are available for AQRVs in an area, the FLM would determine whether current deposition exceeds those loads. By definition, an exceedance of a critical load would indicate that AQRVs are experiencing deposition in excess of what can be sustained without harm, and additional deposition would be evaluated as a potential adverse impact. The FLM would evaluate the magnitude of the exceedance; a larger exceedance constitutes a greater threat to resources. For example, in acid-sensitive areas of the Southeast, including Shenandoah NP and several USFS wildernesses, current deposition is about twice the critical load estimated to sustain healthy stream biota (Sullivan et al. 2010). If a critical load is not exceeded, but current deposition is approaching the critical load, the FLM would evaluate the likelihood that an exceedance will occur in the future, either as a result of increased deposition from a specific source or project, or other growth in the region that would increase deposition.

Similarly, if a target load has been established for AQRVs in an area, the FLM would determine whether current deposition exceeds that target. An exceedance of a target load would indicate that management goals for recovery and protection of AQRVs would not be achieved. For example, target loads to achieve recovery of acid-neutralizing capacity by the year 2100 in the most sensitive streams in Shenandoah NP are estimated to be in the range of less than 0 to 6 kg/ha/yr (Sullivan et al. 2008). Current deposition exceeds these target loads, slowing or preventing recovery of streams and associated fish communities. Any significant increase in deposition would be evaluated as a potential adverse impact.

High elevation ecosystems are at a particular risk from nitrogen and sulfur deposition due to greater amounts of snow and rain, short growing seasons, steep slopes, and shallow base-poor soils that have limited capacity to buffer or absorb sulfur and nitrogen.
Credit: National Park Service.

[6] Links to critical loads information are available at http://nadp.sws.uiuc.edu/clad/links.aspx.

ED_005364I_00054975-00012

4. Adverse Impact Determination

An exceedance of the DAT in conjunction with documented deposition-caused impacts to an AQRV or an exceedance of a critical or target load does not automatically trigger an adverse impact determination. Rather, each proposed source or project is evaluated on a case-by-case basis. The FLM would consider all information on critical or target loads, current deposition, and exceedances, in conjunction with information on the condition and sensitivity of AQRVs in the affected area when evaluating a proposed new source or project. The FLM will review this information from the refined analysis and consider additional factors as described in Chapter 4 of FLAG 2010. These factors include air quality trends in the area, the expected useful life of the source, the stringency of the emissions limits, and any ancillary environmental benefits to AQRVs proposed by the source (e.g., from reductions in toxic contaminants). A source or project may choose to alleviate potential adverse impact concerns by obtaining emission offsets or reducing emission rates (FLAG 2010). All these things will be taken into consideration when the FLM determines whether deposition from the source or project constitutes a potential adverse impact to the affected FLM area.

Rare plant species found in some wetlands are at risk from nitrogen enrichment that may increase the establishment of non-native species, leading to the loss of rare species.
Credit: U.S. Fish and Wildlife Service.

ED_005364I_00054975-00013

References

[FLAG 2010] U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. 2010. Federal land managers' air quality related values work group (FLAG): phase I report—revised (2010). Natural Resource Report NPS/NRPC/NRR—2010/232. National Park Service, Denver, Colorado. Available for download at http://www.nature.nps.gov/air/permits/flag/index.cfm.

Guidance on nitrogen and sulfur deposition analysis thresholds deposition analysis thresholds guidance (2002). Available for download at http://www.nature.nps.gov/air/Pubs/pdf/flag/nsDATGuidance.pdf.

Sullivan, T.J., Cosby, B.J., McDonnell, T.C. 2010. Aquatic critical loads and exceedances in acid-sensitive portions of Virginia and West Virginia. Report to National Park Service, US EPA, USDA Forest Service, and USGS. April 2010.

Sullivan, T.J., Cosby, B.J., Webb, J.R., Dennis, R.L., Bulger, A.J., Deviney Jr., F.A. 2008. Streamwater acid-base chemistry and critical loads of atmospheric sulfur deposition in Shenandoah National Park, Virginia. Environmental Monitoring & Assessment 137:85–99.

ED_005364I_00054975-00015

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 909/111538, November 2011

National Park Service
U.S. Department of the Interior

U.S. Forest Service
Air Quality Program
www.fs.fed.us/air

National Park Service
Natural Resource Stewardship and Science
www.nature.nps.gov/air

U.S. Fish and Wildlife Service
National Wildlife Refuge System
www.fws.gov/refuges/airquality

EXPERIENCE YOUR AMERICA™