Critical Loads of Atmospheric N Deposition for the Protection of Plant Biodiversity in the Western United States in the Context of Oil and Gas Development and a Changing Climate

T.J. Sullivan[1], T.C. McDonnell[1], S. Belyazid[2], H. Sverdrup[3], W. Bowman[4], E. Porter[5]

We integrate results from empirical critical load (CL) estimates for protecting vegetation diversity, vegetation maps, and estimates of nitrogen oxide (NO_x) emissions and deposition to evaluate the likelihood that reactive N CLs are exceeded in National Park Service Class I areas and to assess the relative importance of oil and gas (O&G) emissions to NOx emissions in counties near parks. Our focus is on selected national park units in the southwestern United States and the Northern Great Plains networks.

Based on lower limits of reported CL ranges, terrestrial resources in most study parks were either in exceedance of the CL or received ambient (year 2008) total wet plus dry N deposition within 1 or 2 kg N/ha/yr of the CL. Thus, nutrient sensitive terrestrial resources in some of these parks may be experiencing adverse impacts associated with CL exceedance.

Of the parks evaluated, estimated CL exceedances were most pronounced in Mesa Verde, Black Canyon of the Gunnison, and Saguaro national parks. Large portions of Grand Canyon, Arches, Badlands, Theodore Roosevelt, and Wind Cave national parks and Colorado and Dinosaur national monuments received N deposition in 2008 that was within 1 kg N/ha/yr of the CL.

Although O&G development appears to be a quantitatively important component of the oxidized N emissions in many areas, the data summarized here do not fully capture the extent of the O&G contribution to oxidized N emissions in these areas. This is because other sources are important in some areas and additional O&G development has occurred since 2008. It will be important to continue to track O&G NO_x emissions. In addition, analyses are needed to evaluate the relative contributions of both oxidized and reduced N emissions to deposition and CL exceedances in these, and perhaps other, national park units.

Potential effects of CL exceedance and climate change were evaluated for one highly sensitive vegetation community in the subalpine zone of Rocky Mountain National Park. The ForSAFE-Veg model was used for evaluating past and future terrestrial plant biodiversity at a subalpine site. Model results were generated from a matrix of climate and N deposition scenarios. Changes in climate and N deposition since 1900 resulted in pronounced changes in plant species cover. Simulated tree sapling coverage increased by more than 25%, graminoid response was mixed, and forbs generally decreased in abundance in the simulations. Results suggested that the ground vegetation at the study site has already undergone a change relative to estimated background N deposition. Future increases in temperature are forecasted to have further impact on plant community composition, exacerbating expected changes in response to N deposition alone.

[1] E&S Environmental Chemistry, Inc., P.O. Box 609, Corvallis, OR 97339; 541 758-5777; tim.sullivan@esenvironmental.com

[1] Belyazid Consulting & Communication AB, Stationsvägen 13, 517 34 Bollebygd, Sweden; salim@belyazid.com

[1] Biogeochemistry and Systems Analysis, Chemical Engineering, Lund University, SE-221 00 Lund, Sweden; Harald.Sverdrup@chemeng.lth.se

[1] Ecology and Evolutionary Biology, University of Colorado, Boulder, CO; Bill Bowman; William.Bowman@Colorado.edu; 303 492-2557

[1] National Park Service, Air Resources Division, PO Box 25287, Denver, Colorado 80225-0287; 303 969 2617; ellen_porter@nps.gov