



# Evaluation of the Sensitivity of Inventory and Monitoring National Parks to Nutrient Enrichment Effects from Atmospheric Nitrogen Deposition

*National Capital Region Network (NCRN)*

Natural Resource Report NPS/NRPC/ARD/NRR—2011/317



**ON THE COVER**

Some ecosystems, such as arid shrublands, subalpine meadows, remote high elevation lakes, and wetlands, are sensitive to the effects of nutrient enrichment from atmospheric nitrogen deposition.

Photograph by: National Park Service

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T. J. Sullivan  
T. C. McDonnell  
G. T. McPherson  
S. D. Mackey  
D. Moore

E&S Environmental Chemistry, Inc.  
P.O. Box 609  
Corvallis, OR 97339

February 2011

U.S. Department of the Interior  
National Park Service  
Natural Resource Program Center  
Denver, Colorado

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This report received peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Please cite this publication as:

Sullivan, T. J., T. C. McDonnell, G. T. McPherson, S. D. Mackey, and D. Moore. 2011. Evaluation of the sensitivity of inventory and monitoring national parks to nutrient enrichment effects from atmospheric nitrogen deposition: National Capital Region Network (NCRN). Natural Resource Report NPS/NRPC/ARD/NRR—2011/317. National Park Service, Denver, Colorado.

## National Capital Region Network (NCRN)

National maps of atmospheric N emissions and deposition are provided in Maps A and B as context for subsequent network data presentations. Map A shows county level emissions of total N for the year 2002. Map B shows total N deposition, again for the year 2002.

There are 11 parks in the National Capital Region Network. None are larger than 100 square miles. Some are in and around the Washington DC urban area; others are located further to the west.

Total annual N emissions, by county, are shown in Map C for lands in and surrounding the National Capital Region Network. County-level emissions within the network ranged from 1 to 5 tons per square mile in the west to more than 20 (and as high as more than 100) tons per square mile in the area surrounding Washington, DC. In general, annual county N emissions were more than 5 tons per square mile throughout most of the network. Point source emissions of oxidized (nitrogen oxides,  $\text{NO}_x$ ) and reduced (ammonia,  $\text{NH}_3$ ) N are shown in Map D. There are no large (larger than 2,000 tons per square mile) point sources of N within the network, but several outside the network, especially to the west. Most point sources in and around the network are sources of oxidized N. Urban centers within the network and within a 300 mile buffer around the network are shown in Map E. The eastern third of the network is densely populated; the western two-thirds is not.

Total N deposition in and around the network is shown in Map F. Included in this analysis are both wet and dry forms of N deposition and both the oxidized and reduced N species. Total N deposition within the network ranged from as low as 5 to 10 kg N/ha/yr in small sections of the western portion of the network to as high as 15 to 20 kg N/ha/yr in and around Washington, DC.

Land cover in and around the network is shown in Map G. The predominant cover types within this network are generally forest in the west, pasture/hay and row crops in the central portion, and developed land in the east.

Map H is not presented for this network because at the scale of the network it is not possible to see the distribution within these parks of the five vegetation types thought to be most responsive to nutrient N enrichment effects (arctic, alpine, grassland and meadow, wetland, and arid and semi-arid).

Map I, showing park lands requiring special protection against potential adverse impacts associated with nutrient N enrichment from atmospheric N deposition is not shown for this network. There are no Class I or designated wilderness areas in this network.

Network rankings are given in Figures A through C as the average ranking of the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection metrics, respectively. Figure D shows the overall network Summary Risk ranking. In each figure, the rank for this particular network is highlighted to show its relative position compared with the ranks of the other 31 networks.

The National Capital Region Network ranks in the highest quintile, among networks, in N Pollutant Exposure (Figure A). Along with the Northeast Coastal and Barrier Network, it had the highest N Pollutant Exposure ranking of all networks. Nitrogen emissions and N deposition within the network are both very high. However, the network Ecosystem Sensitivity ranking is very low, within the lowest quintile among networks (Figure B). This is because there is limited known N-nutrient sensitive vegetation and no high elevation lakes in the I&M parks in this network. This network also ranks in the lowest quintile in Park Protection, having no protected Class I or wilderness lands (Figure C).

In combination, the network rankings for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection yield an overall Network Risk ranking that is in the lowest quintile among all networks (Figure D). This is despite having the highest N Pollutant Exposure ranking of all 32 I&M networks. The overall level of concern for nutrient N enrichment effects on I&M parks within this network is considered Very Low.

Because there are no parks in this network that are larger than 100 square miles, Figures E through H, that compare rankings among individual parks, are not presented for parks in this network. Relative ranks for all parks, including the smaller parks, are given in Table A and Appendix B.

All parks in this network are ranked in the top quintile for Pollutant Exposure. However, none are ranked higher than the second lowest quintile for Ecosystem Sensitivity. All parks in the network are ranked in the middle quintile for Park Protection. The individual parks in this network were ranked in the Moderate to High Summary Risk categories.

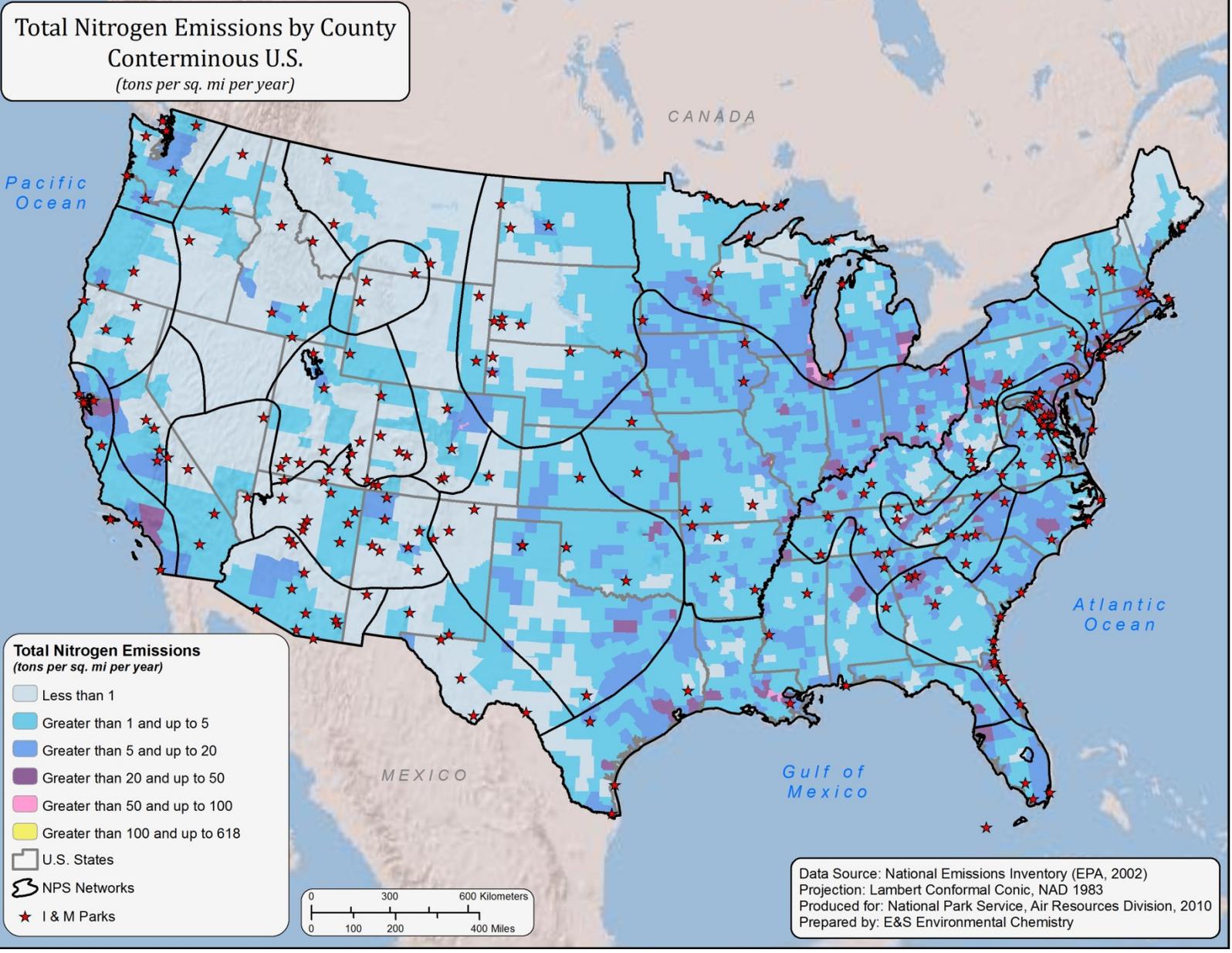
<b>Table A.</b> Relative rankings of individual I&M parks within the network for Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and Summary Risk from atmospheric nutrient N enrichment.				
<b>I&amp;M Parks<sup>2</sup> in Network</b>	<b>Relative Ranking of Individual Parks<sup>1</sup></b>			
	<b>Pollutant Exposure</b>	<b>Ecosystem Sensitivity</b>	<b>Park Protection</b>	<b>Summary Risk</b>
Antietam	Very High	Very Low	Moderate	Moderate
Catoctin Mountain	Very High	Very Low	Moderate	Moderate
Chesapeake and Ohio Canal	Very High	Very Low	Moderate	Moderate
George Washington	Very High	Low	Moderate	High
Harpers Ferry	Very High	Very Low	Moderate	Moderate
Manassas	Very High	Low	Moderate	High
Monocacy	Very High	Low	Moderate	High
National Capital Parks - East	Very High	Very Low	Moderate	High
Prince William Forest	Very High	Very Low	Moderate	Moderate
Rock Creek Park	Very High	Low	Moderate	High
Wolf Trap National Park for the Performing Arts	Very High	Low	Moderate	High

<sup>1</sup> 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).  
<sup>2</sup> Park name is printed in bold italic for parks larger than 100 square miles.

- Map A. National map of total N emissions by county for the year 2002. Both oxidized (nitrogen oxides, NO<sub>x</sub>) and reduced (ammonia, NH<sub>3</sub>) forms of N are included. The total is expressed in tons per square mile per year. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)
- Map B. Total N deposition for the conterminous United States for the year 2002, expressed in units of kilograms of N deposited from the atmosphere to the earth surface per hectare per year. Wet and dry forms of both oxidized (nitrogen oxides, NO<sub>x</sub>) and reduced (ammonia, NH<sub>3</sub>) N are included. For the eastern half of the country, wet deposition values were derived from interpolated measured values from NADP (three-year average centered on 2002) and dry deposition values were derived from 12-km CMAQ model projections for 2002. For the western half of the country, both wet and dry deposition values were derived from 36-km CMAQ model projections for 2002. NADP interpolations were performed using the approach of Grimm and Lynch (1997). CMAQ model projections were provided by Robin Dennis, U.S. EPA.
- Map C. Total N emissions by county for lands surrounding the network, expressed as tons of N emitted into the atmosphere per square mile per year. The total includes both oxidized (nitrogen oxides, NO<sub>x</sub>) and reduced (ammonia, NH<sub>3</sub>) N. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)
- Map D. Major point source emissions of oxidized (nitrogen oxides, NO<sub>x</sub>) and reduced (ammonia, NH<sub>3</sub>) N in and around the network. The base of each vertical bar is positioned in the map at the approximate location of the source. The height of the bar is proportional to the magnitude of the source. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)
- Map E. Urban centers having more than 10,000 people within the network and within a 300-mile buffer around the perimeter of the network. (Source of data: U.S. Census 2000)
- Map F. Total N deposition in and around the network. Included in the total are wet plus dry forms of both oxidized (nitrogen oxides, NO<sub>x</sub>) and reduced (ammonia, NH<sub>3</sub>) N. Values are expressed as kilograms of N deposited per hectare per year. (Source of data: Interpolated NADP wet and CMAQ Model dry deposition data for 2002; see information for Map B above for details)
- Map G. Land cover types in and around the network, based on the National Land Cover dataset. (Source of data: National Land Cover Dataset, [http://www.mrlc.gov/nlcd\\_multizone\\_map.php](http://www.mrlc.gov/nlcd_multizone_map.php))
- Figure A. Network rankings for Pollutant Exposure, calculated as the average of scores for all Pollutant Exposure variables.
- Figure B. Network rankings for Ecosystem Sensitivity, calculated as the average of scores for all Ecosystem Sensitivity variables.

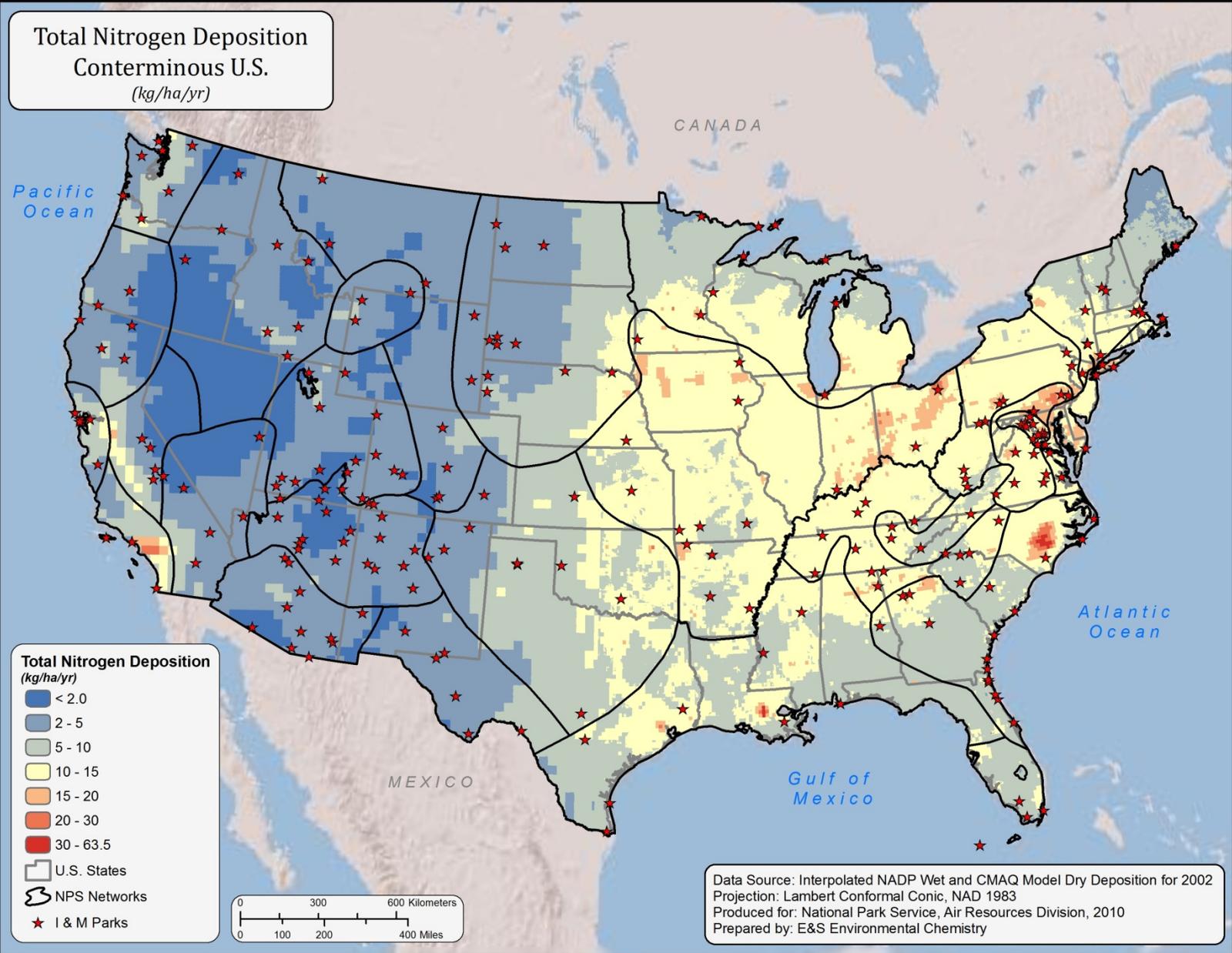
Figure C. Network rankings for Park Protection, calculated as the average of scores for all Park Protection variables.

Figure D. Network Summary Risk ranking, calculated as the sum of the averages of the scores for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection.



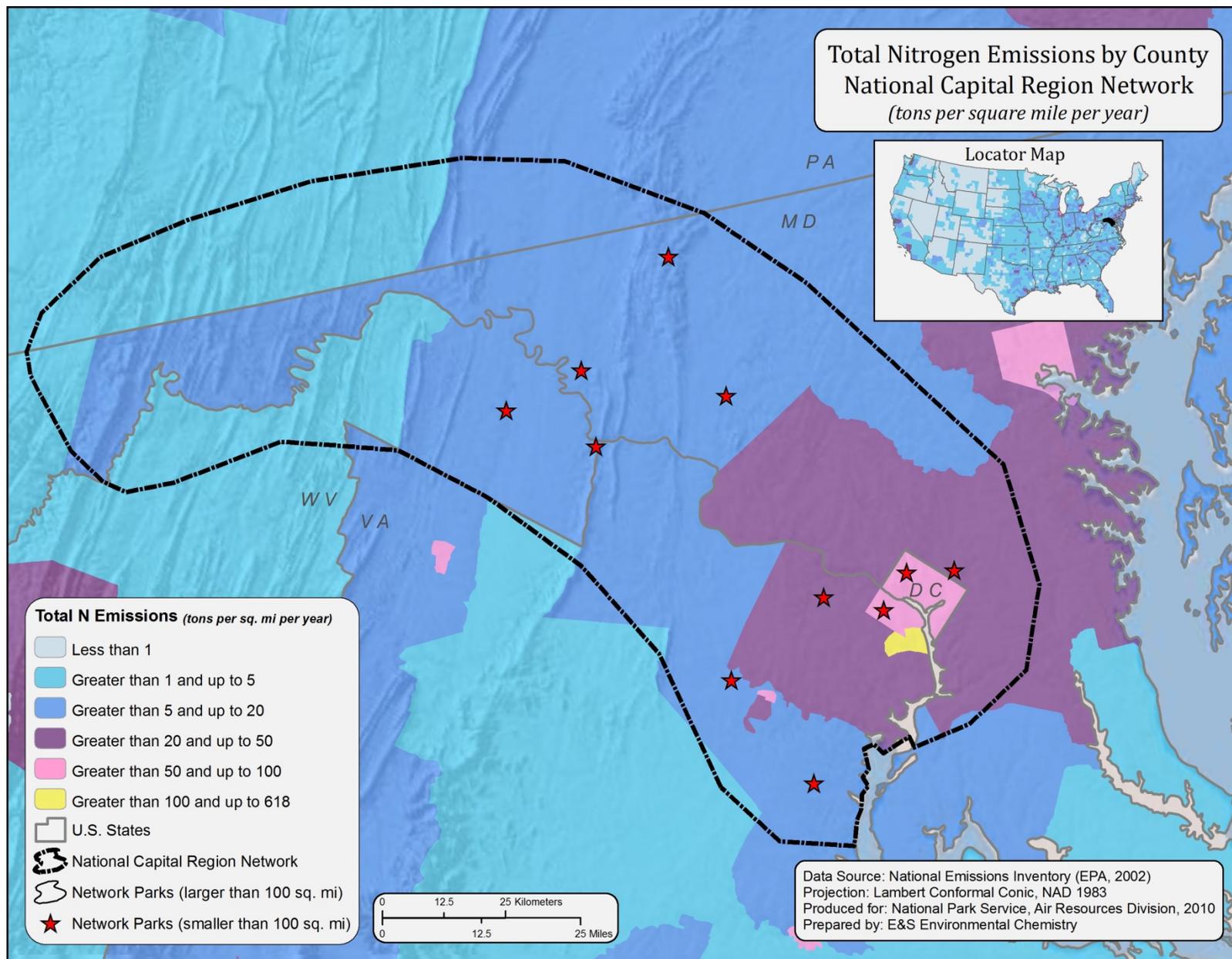
NCRN-5

Map A

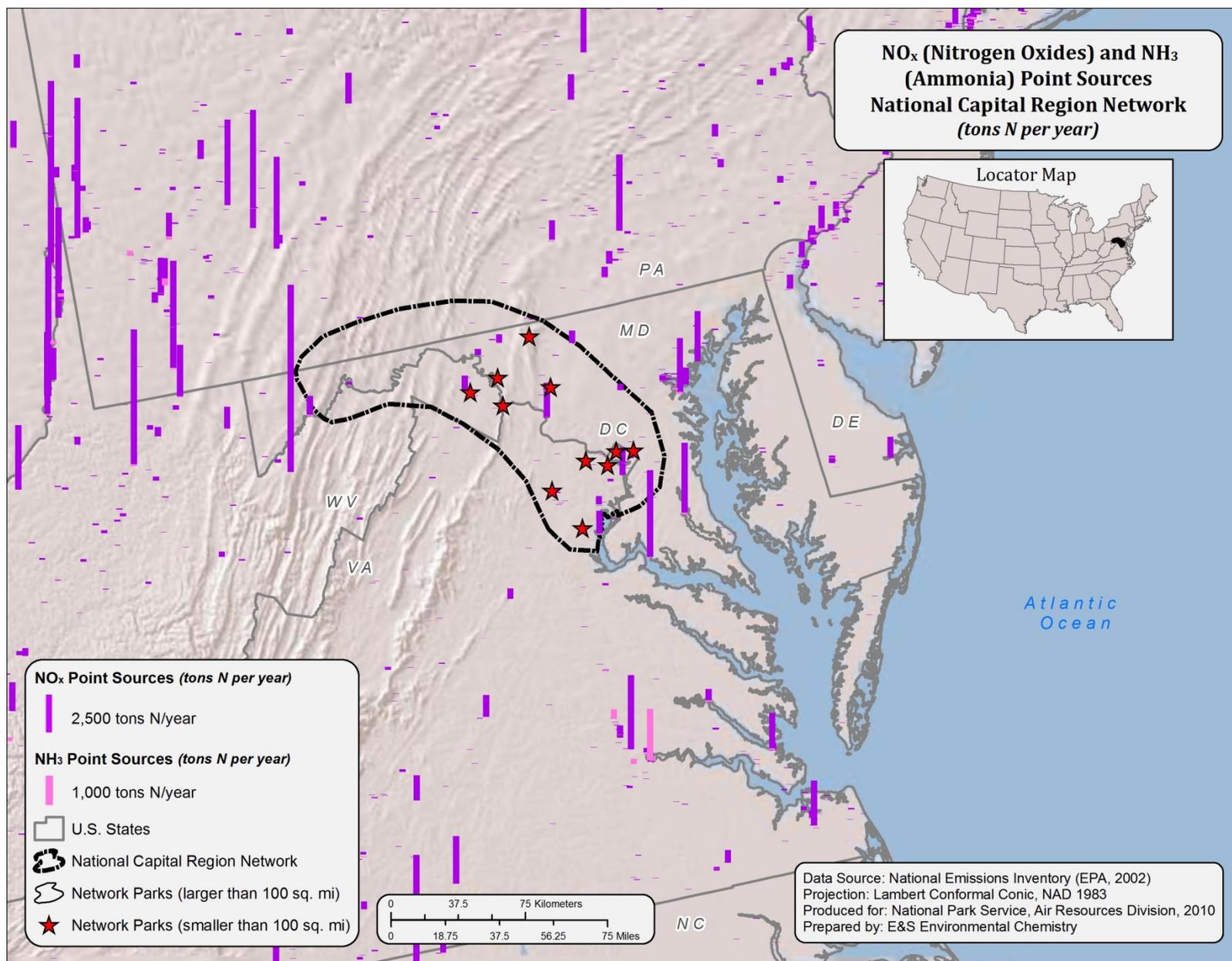


NCRN-6

Map B



Map C



Map D

**Park Locations and Urban Centers  
National Capital Region Network**  
(Population Centers Over 10,000)



**Major Cities**

- Over 1,000,000
- 500,000 - 1,000,000
- 100,000 - 500,000
- 50,000 - 100,000
- 25,000 - 50,000
- 10,000 - 25,000

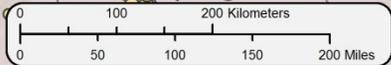
U.S. States

300 Mile Network Buffer

National Capital Region Network

Network Parks (larger than 100 sq. mi)

Network Parks (smaller than 100 sq. mi)

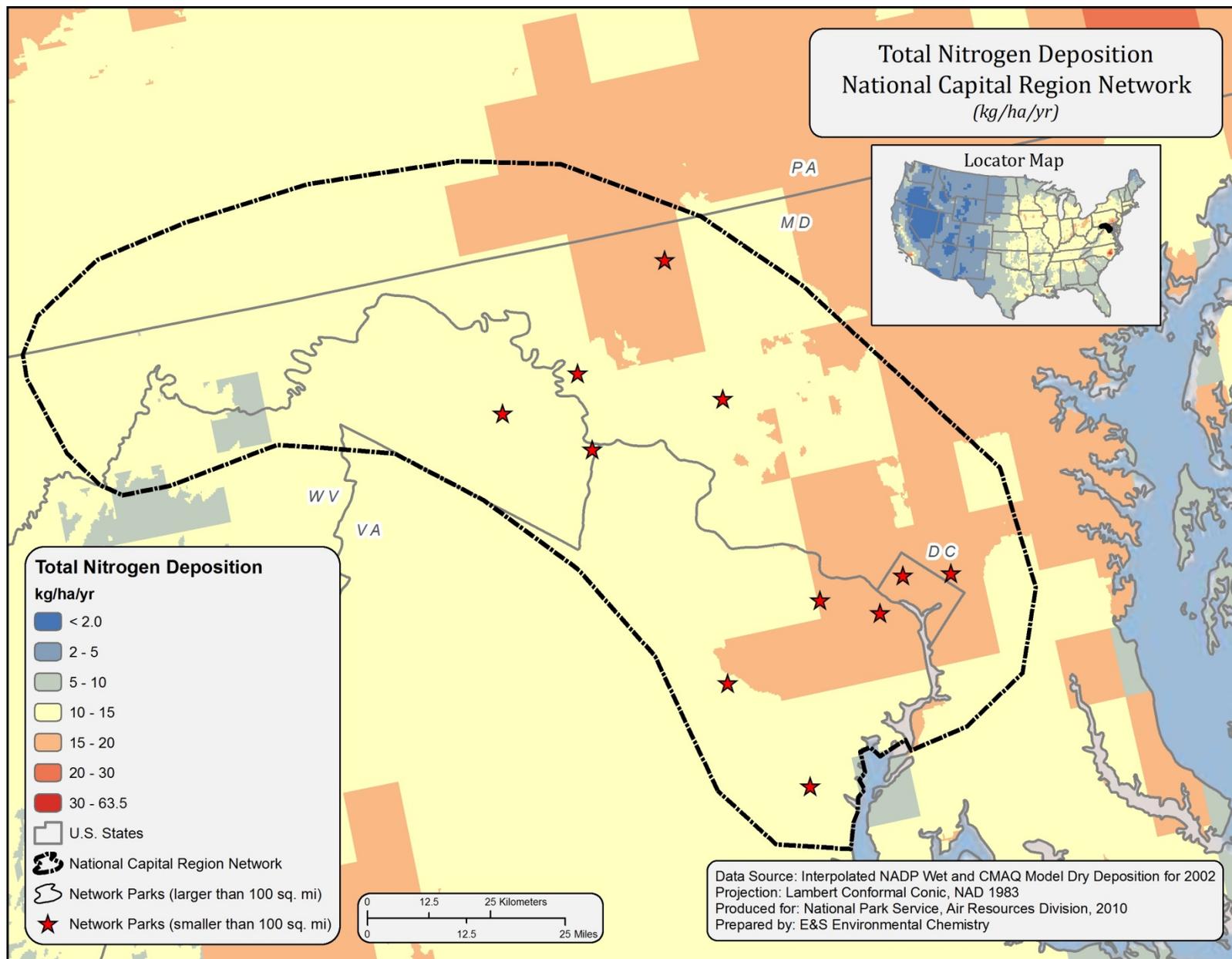


Data Source: U.S. Census Data, 2000  
 Projection: Lambert Conformal Conic, NAD 1983  
 Produced for: National Park Service, Air Resources Division, 2010  
 Prepared by: E&S Environmental Chemistry

NCRN-9

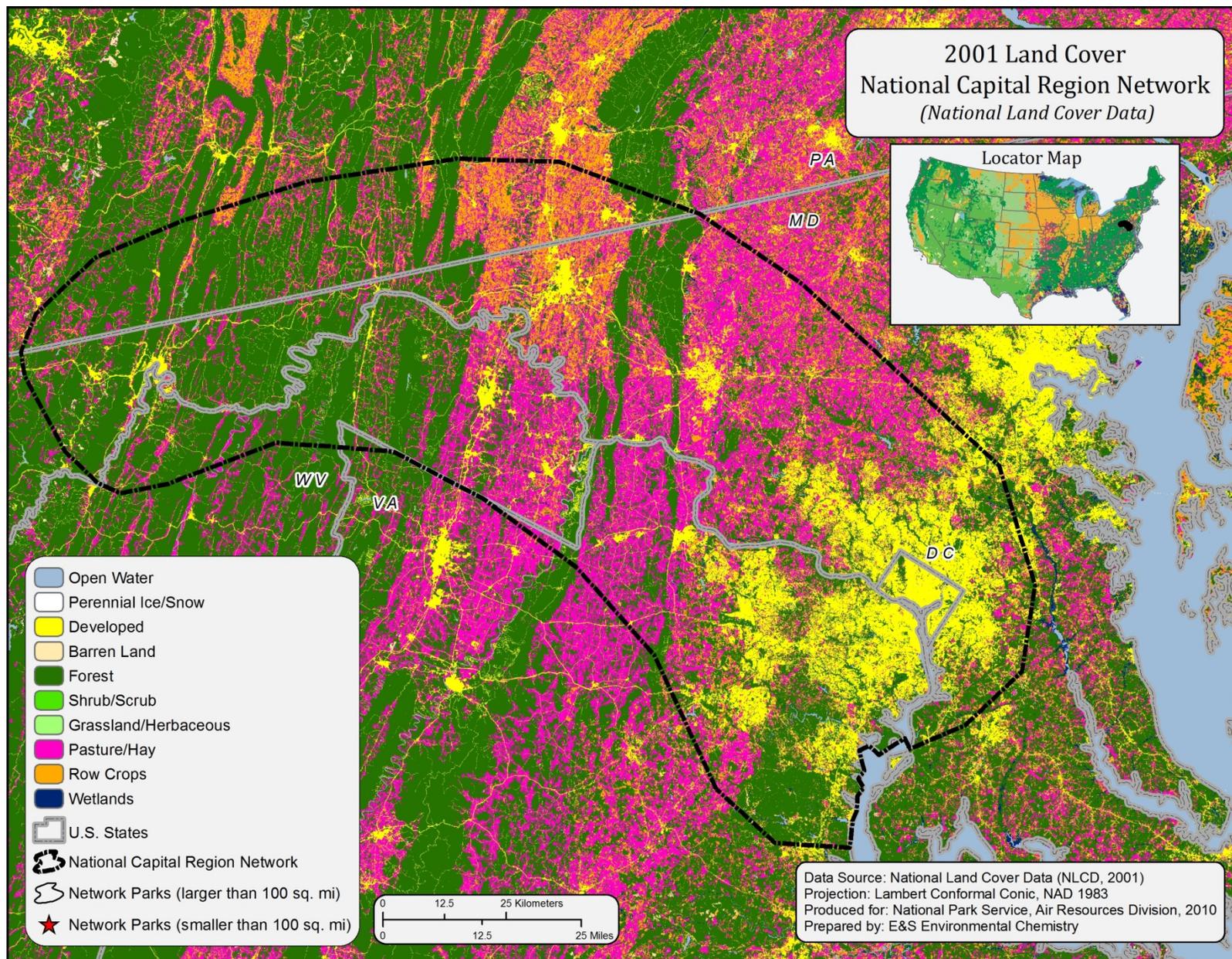
Map E

NCRN-10



Map F

NCRN-11



Map G

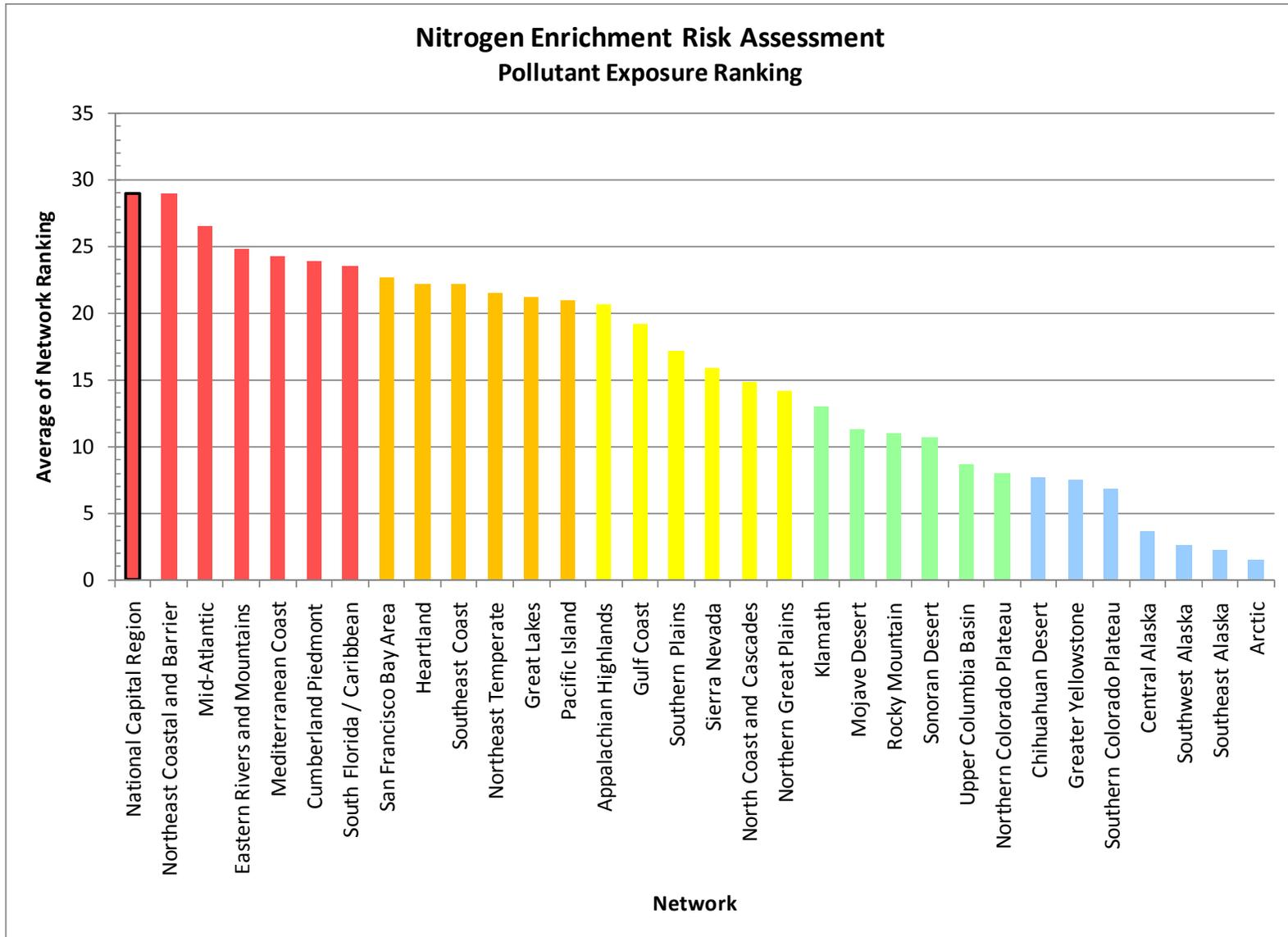


Figure A

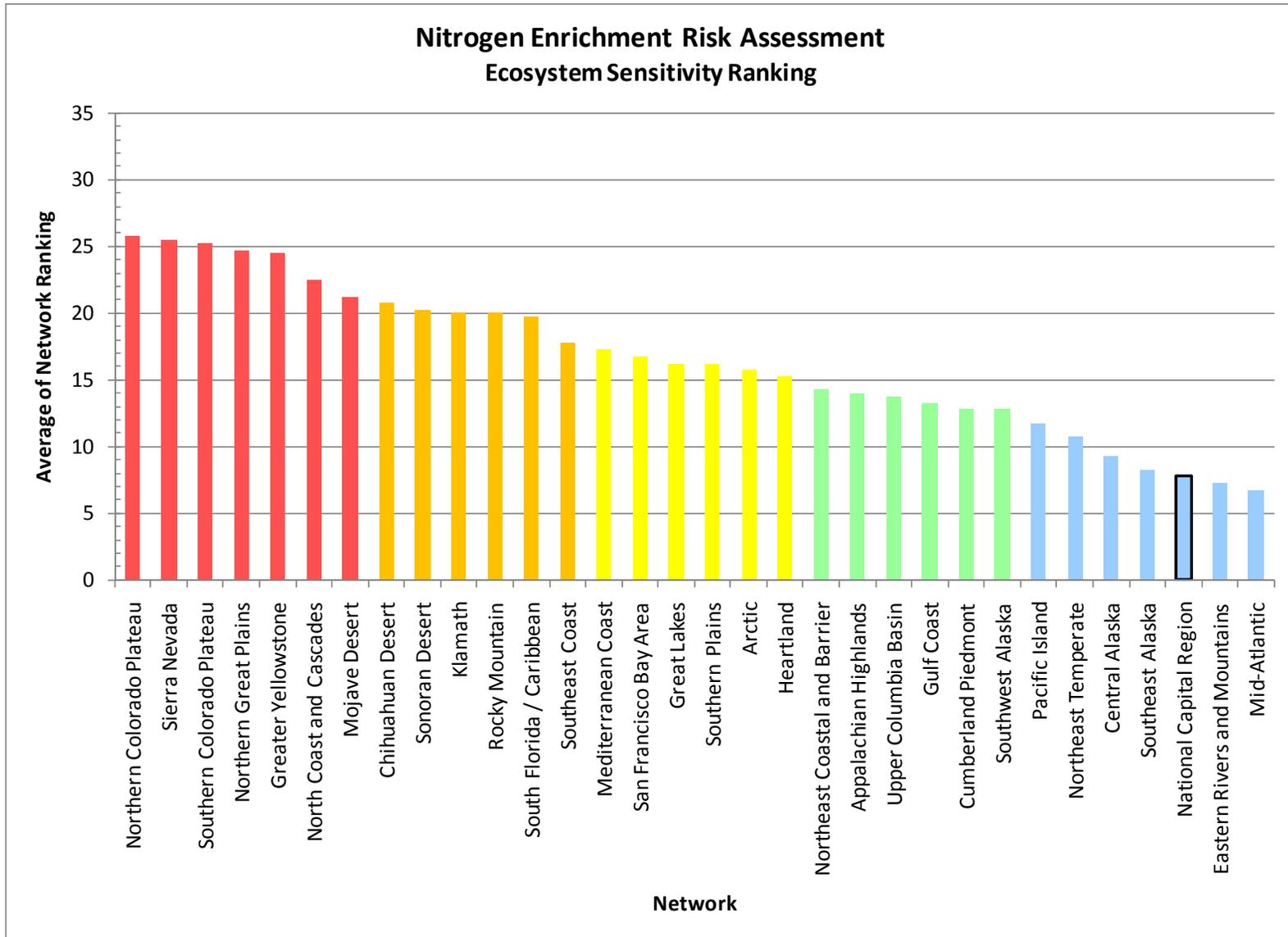


Figure B

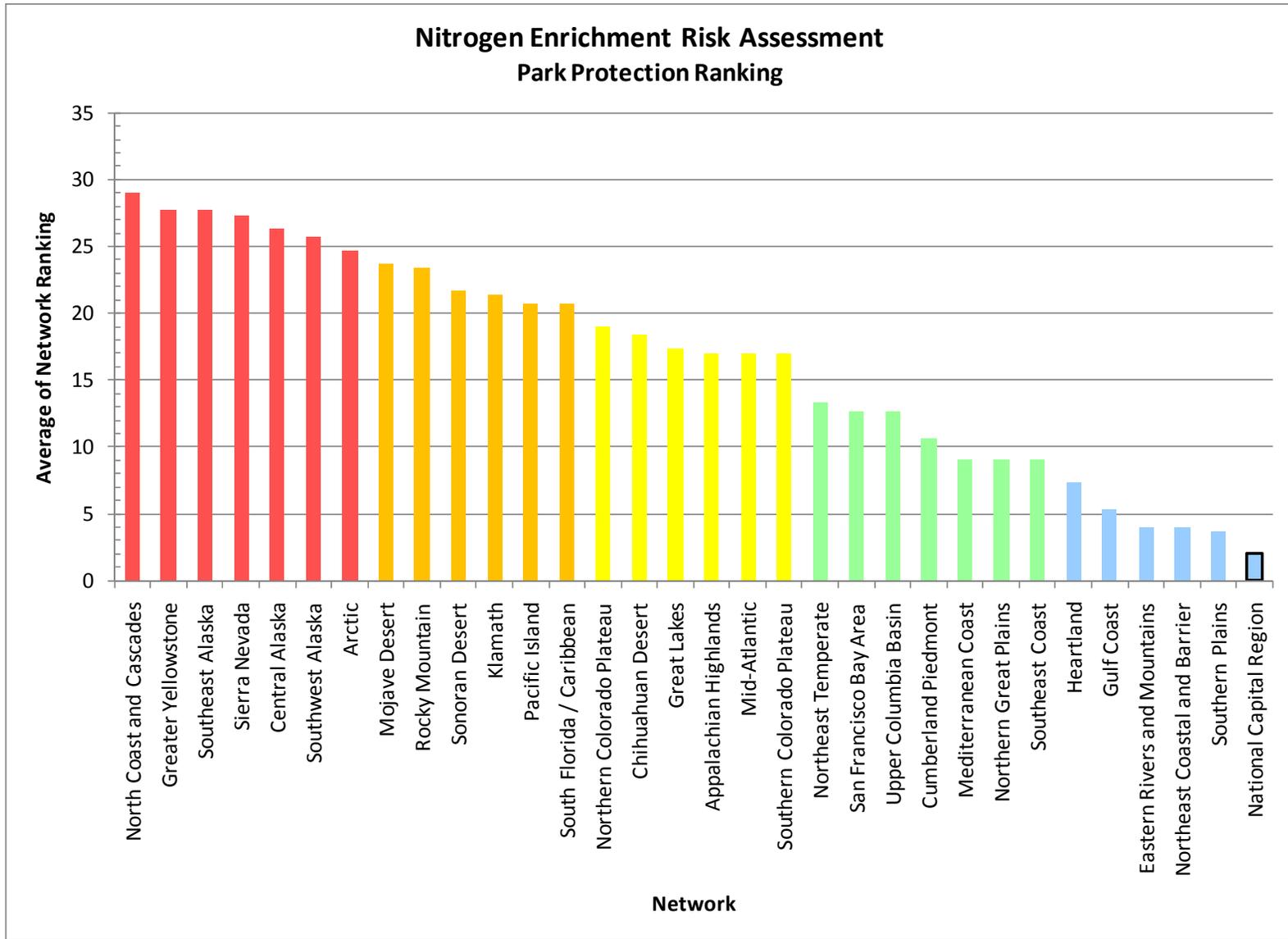


Figure C

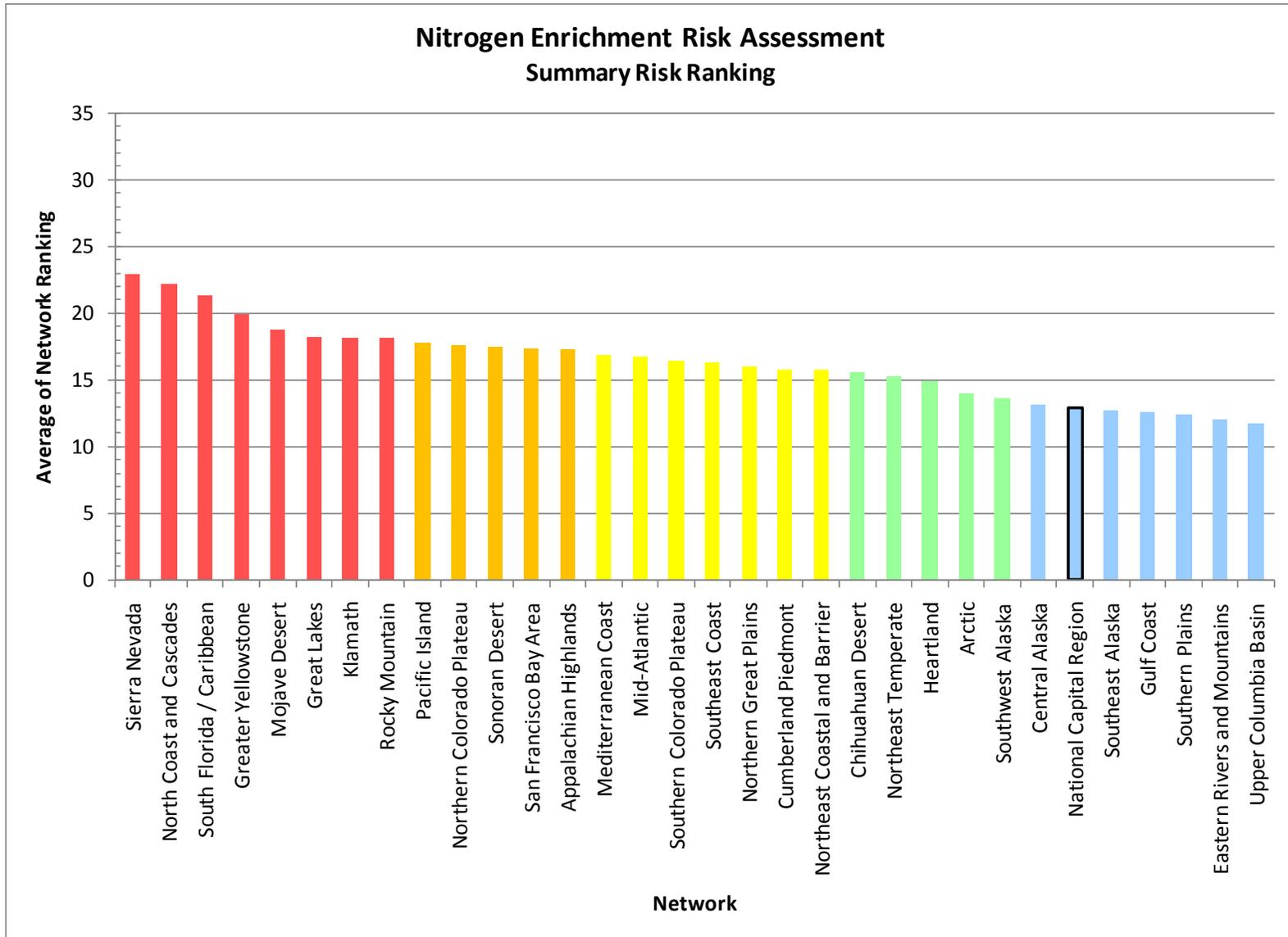


Figure D



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 800/106681, February 2011

**National Park Service**  
**U.S. Department of the Interior**



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**Natural Resource Program Center**

Air Resources Division

PO Box 25287

Denver, CO 80225

[www.nature.nps.gov/air](http://www.nature.nps.gov/air)