



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

## *Northeast Coastal and Barrier Network (NCBN)*

Natural Resource Report NPS/NRPC/ARD/NRR—2011/318



**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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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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## Northeast Coastal and Barrier Network (NCBN)

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 eight parks in the Northeast Coastal and Barrier Network. None are larger than 100 square miles. Most are located in or adjacent to the heavily developed coastal corridor between Washington, DC and Boston.

Total annual N emissions, by county, are shown in Map C for lands in and surrounding the Northeast Coastal and Barrier Network. County-level emissions within the network ranged from less than 1 ton per square mile to greater than 100 tons per square mile. In general, annual county N emissions were between 5 and 20 tons per square mile, but higher than 20 tons per square mile in many areas, including the New York City area, all of Long Island, and portions of the network near Washington, DC. Point source emissions of oxidized (nitrogen oxides, NO<sub>x</sub>) and reduced (ammonia, NH<sub>3</sub>) N are shown in Map D. There are several relatively large (larger than 2,000 tons per square mile) point sources of oxidized N, but no large sources of reduced N, within the network. Most of the largest point sources are in Maryland. Urban centers within the network and within a 300-mile buffer around the network are shown in Map E. There is a very high density of large human population centers within the network, including New York City and Philadelphia. In addition, Baltimore and Washington, DC are both located on the network boundary.

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 throughout most of the network ranged from 10 to 20 kg N/ha/yr.

Land cover in and around the network is shown in Map G. There is a wide mix of cover types, including developed land, row crops, pasture/hay, forest, and wetlands.

Map H, showing the distribution within the park lands that occur in this network 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), is not shown. The parks in this network are too small to see the vegetation distribution within the parks at the scale of the network.

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 wilderness designations 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 Northeast Coastal and Barrier Network ranks in the highest quintile, among networks, in N Pollutant Exposure (Figure A). Nitrogen emissions and N deposition within the network are both

very high. However, the network Ecosystem Sensitivity ranking is relatively low, at the top of the second lowest quintile among networks (Figure B). This is because there is only limited vegetation coverage in the I&M parks in this network that includes the vegetation types that are among those expected to be especially sensitive to nutrient enrichment effects from N deposition, and there are no high elevation lakes. This network ranks in the lowest quintile in Park Protection, having no wilderness or Class I lands (Figure C).

In combination, the network rankings for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection yield an overall Network Risk ranking that is at the bottom of the third quintile, below the median among all networks (Figure D). The overall level of concern for nutrient N enrichment effects on I&M parks within this network is considered below average.

Figures E through H are not presented for this network because there are no parks that are larger than 100 square miles. Relative rankings for all parks, including the smaller parks, are given in Table A and Appendix B. Pollutant Exposure for each of the individual parks is ranked in the highest or second highest quintile. Ecosystem Sensitivity rankings for the individual parks tend to be somewhat lower, in the middle and lower quintiles for all of the parks except George Washington Birthplace (GEWA), which is ranked High. Park Protection ranks are Moderate (middle quintile) for all parks except Fire Island (FIIS), which is ranked High.

The Summary Risk rankings for the individual parks in this network are High in five of the parks, and Very High in FIIS, Gateway (GATE), and GEWA.

<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>
Assateague Island	High	Moderate	Moderate	High
Cape Cod	High	Moderate	Moderate	High
Colonial	High	Moderate	Moderate	High
Fire Island	Very High	Low	High	Very High
Gateway	Very High	Moderate	Moderate	Very High
George Washington Birthplace	Very High	High	Moderate	Very High
Sagamore Hill	Very High	Low	Moderate	High
Thomas Stone	Very High	Very 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).

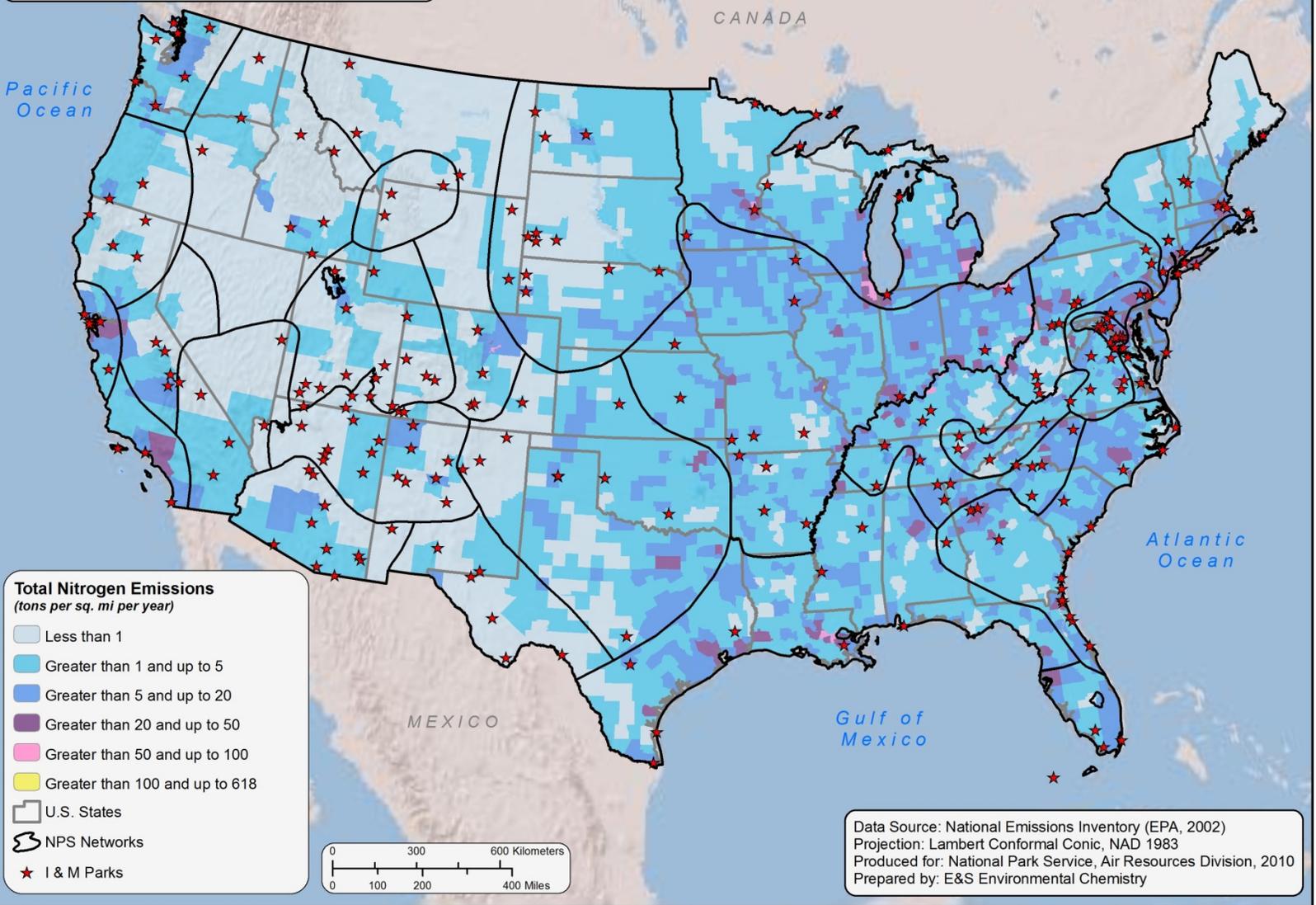
<sup>2</sup> Park name is printed in bold italic for parks larger than 100 square miles.

- 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.

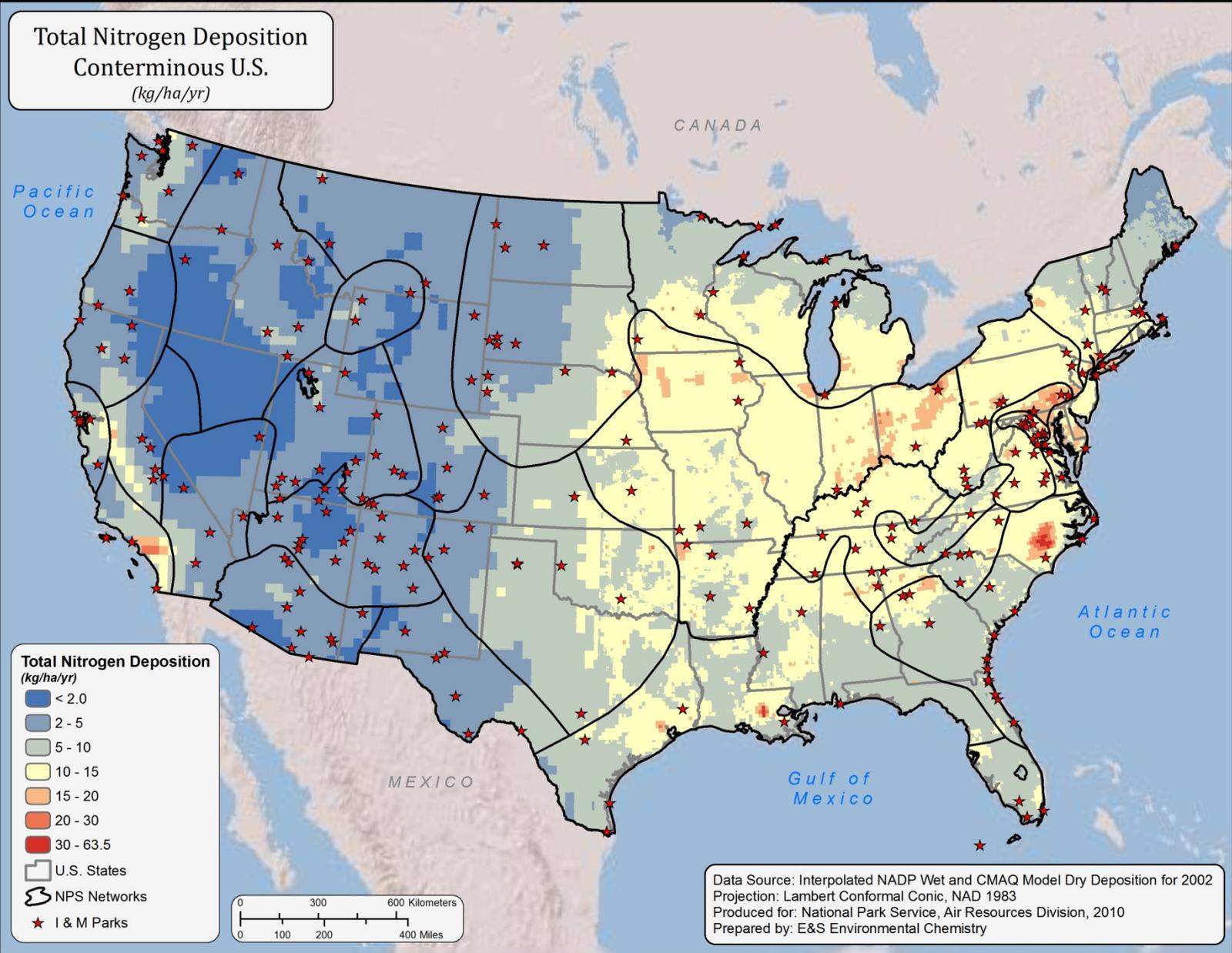
Figure D. Network Summary Risk ranking, calculated as the sum of the averages of the scores for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection.

**Total Nitrogen Emissions by County  
Conterminous U.S.**  
*(tons per sq. mi per year)*



NCBN-5

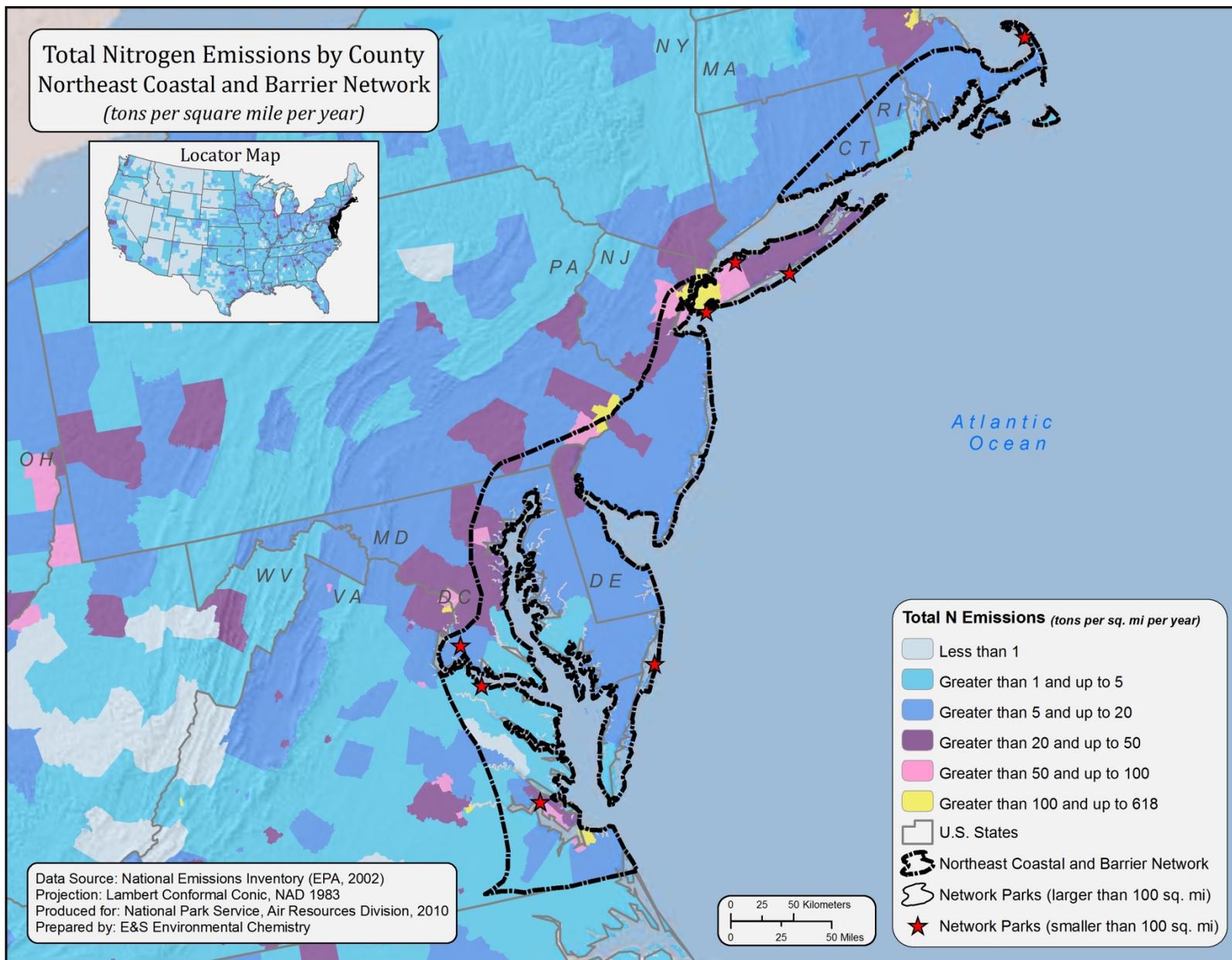
Map A



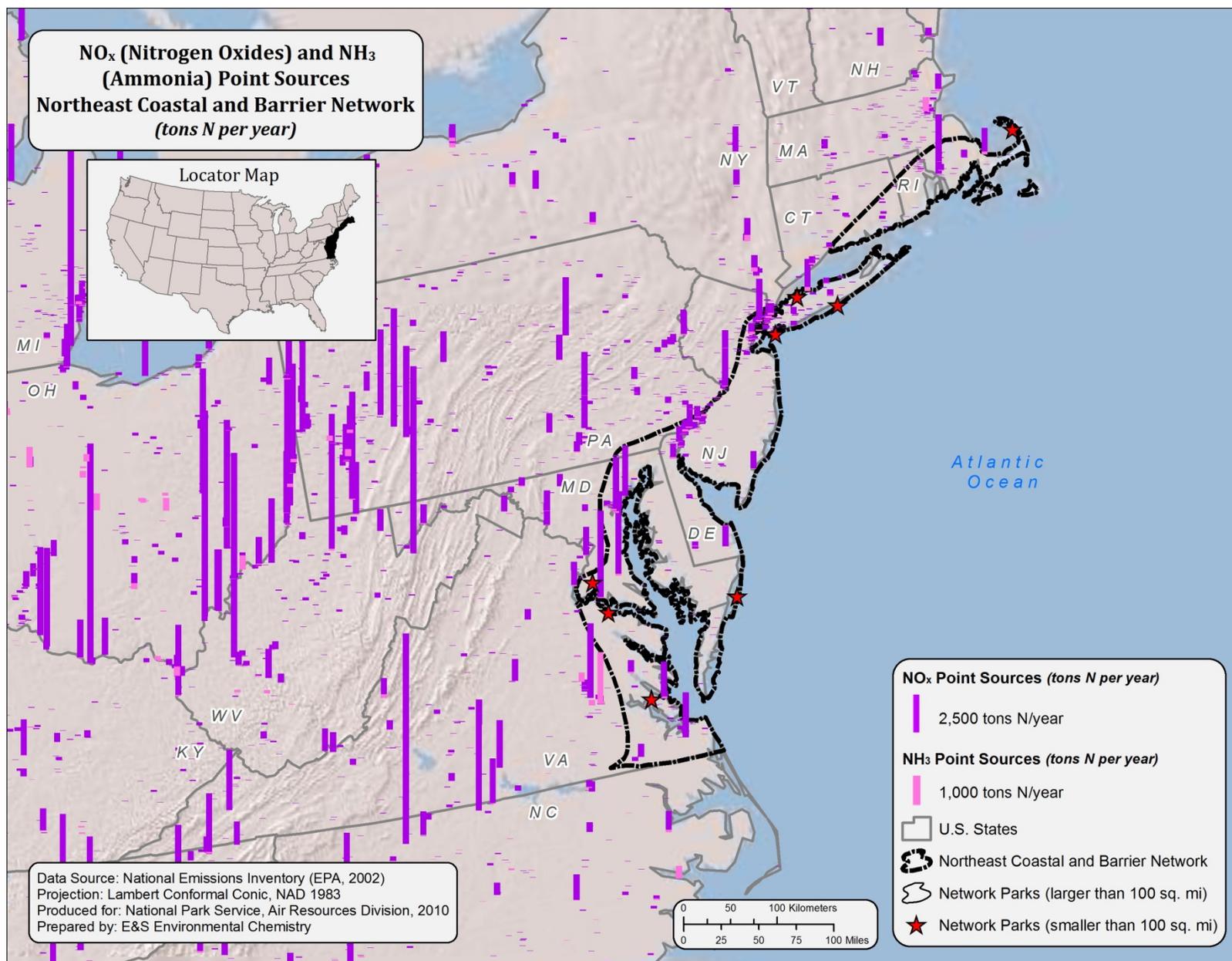
NCBN-6

Map B

NCBN-7

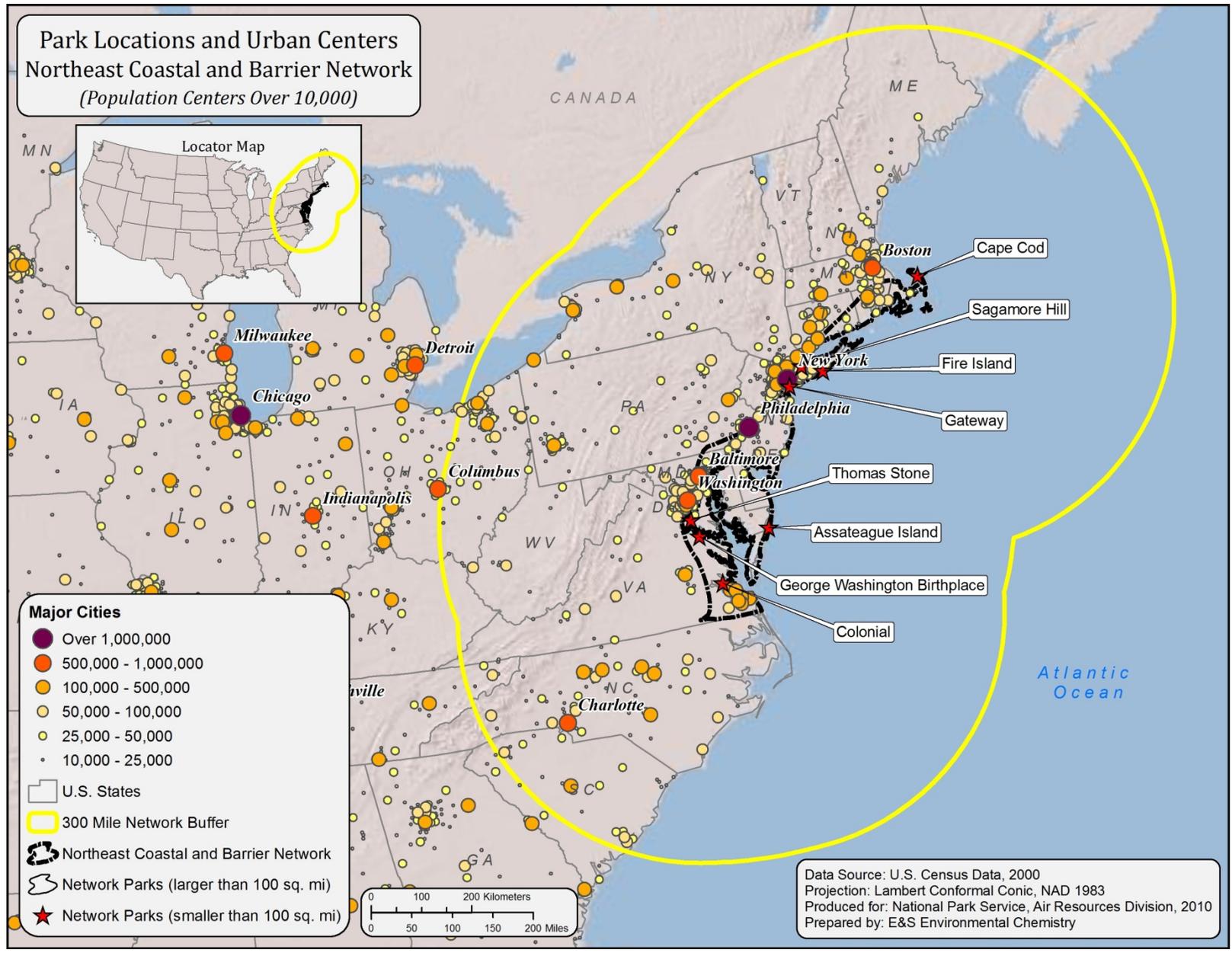


Map C



Map D

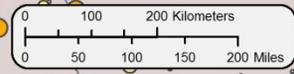
**Park Locations and Urban Centers**  
**Northeast Coastal and Barrier Network**  
*(Population Centers Over 10,000)*



**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  
 Northeast Coastal and Barrier Network  
 Network Parks (larger than 100 sq. mi)  
 Network Parks (smaller than 100 sq. mi)

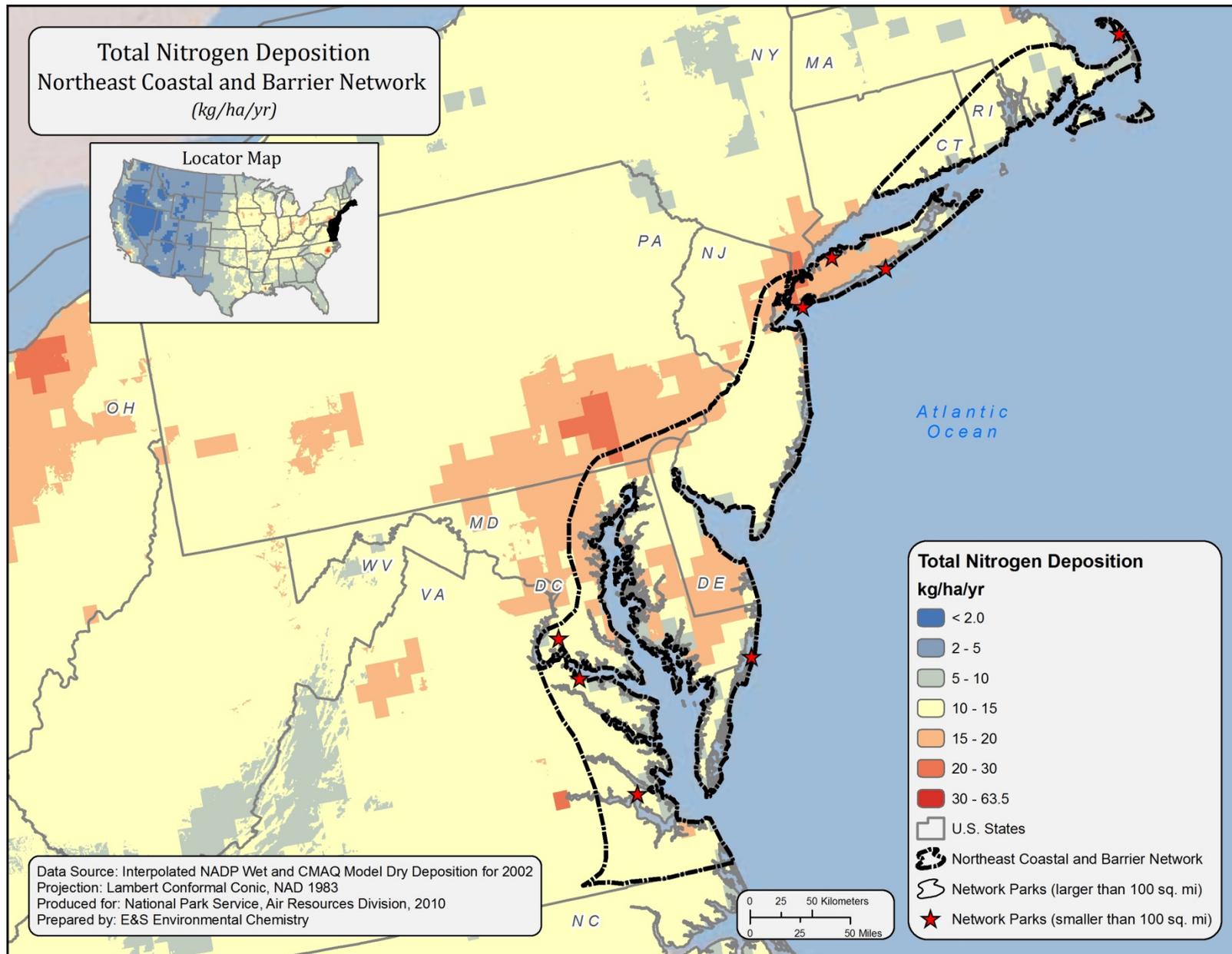


Data Source: U.S. Census Data, 2000  
 Projection: Lambert Conformal Conic, NAD 1983  
 Produced for: National Park Service, Air Resources Division, 2010  
 Prepared by: E&S Environmental Chemistry

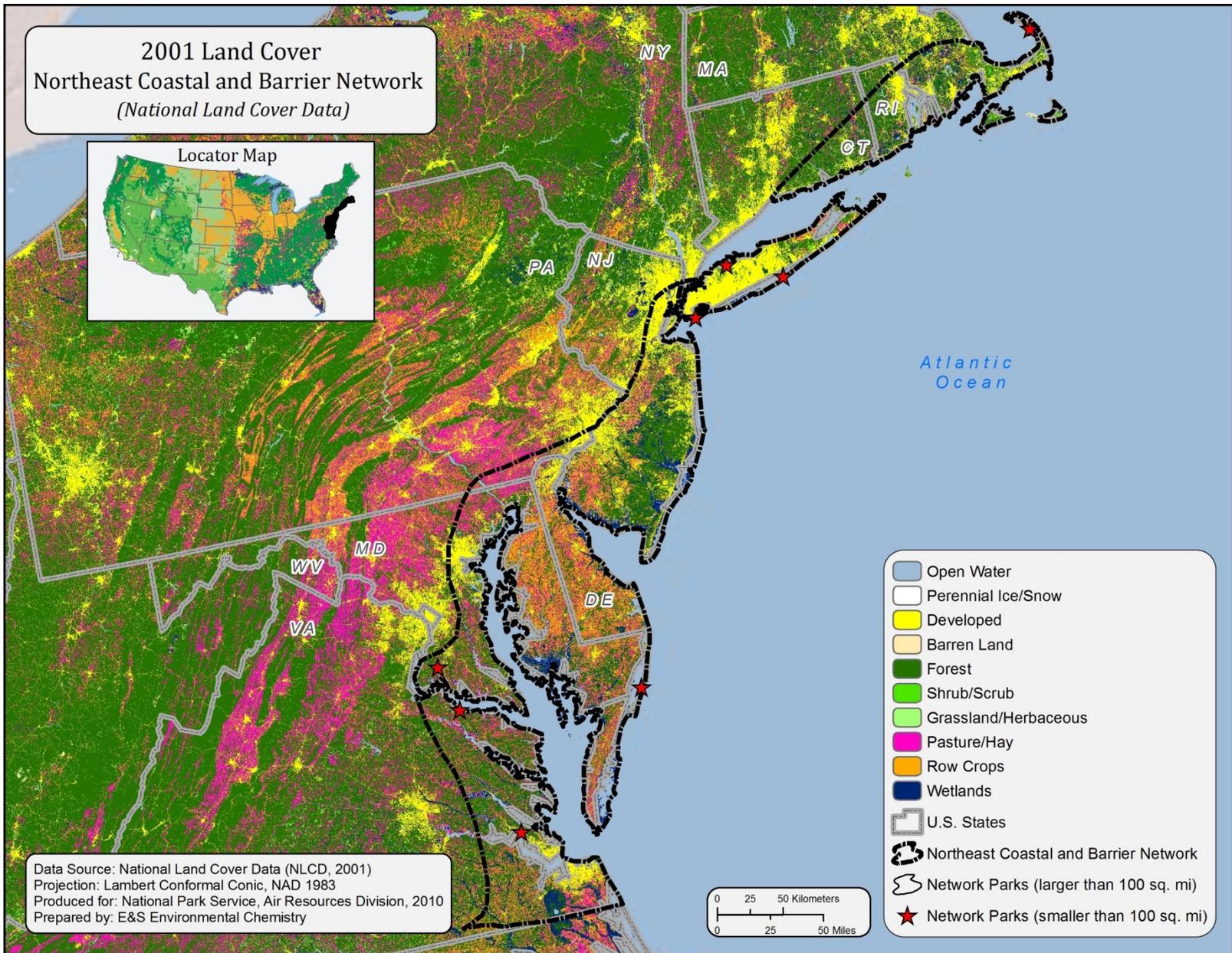
NCBN-9

Map E

NCBN-10



Map F



Map G

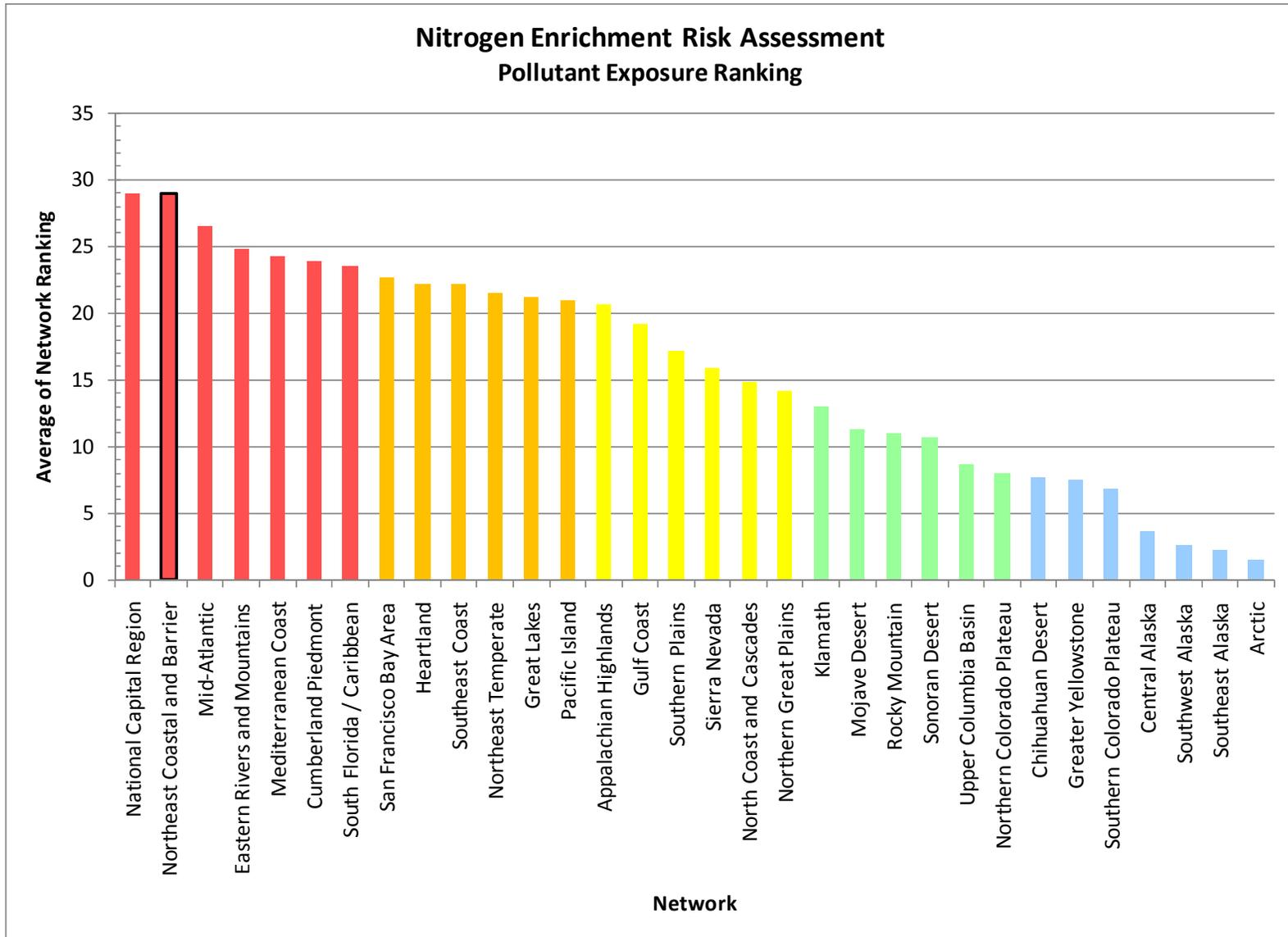


Figure A

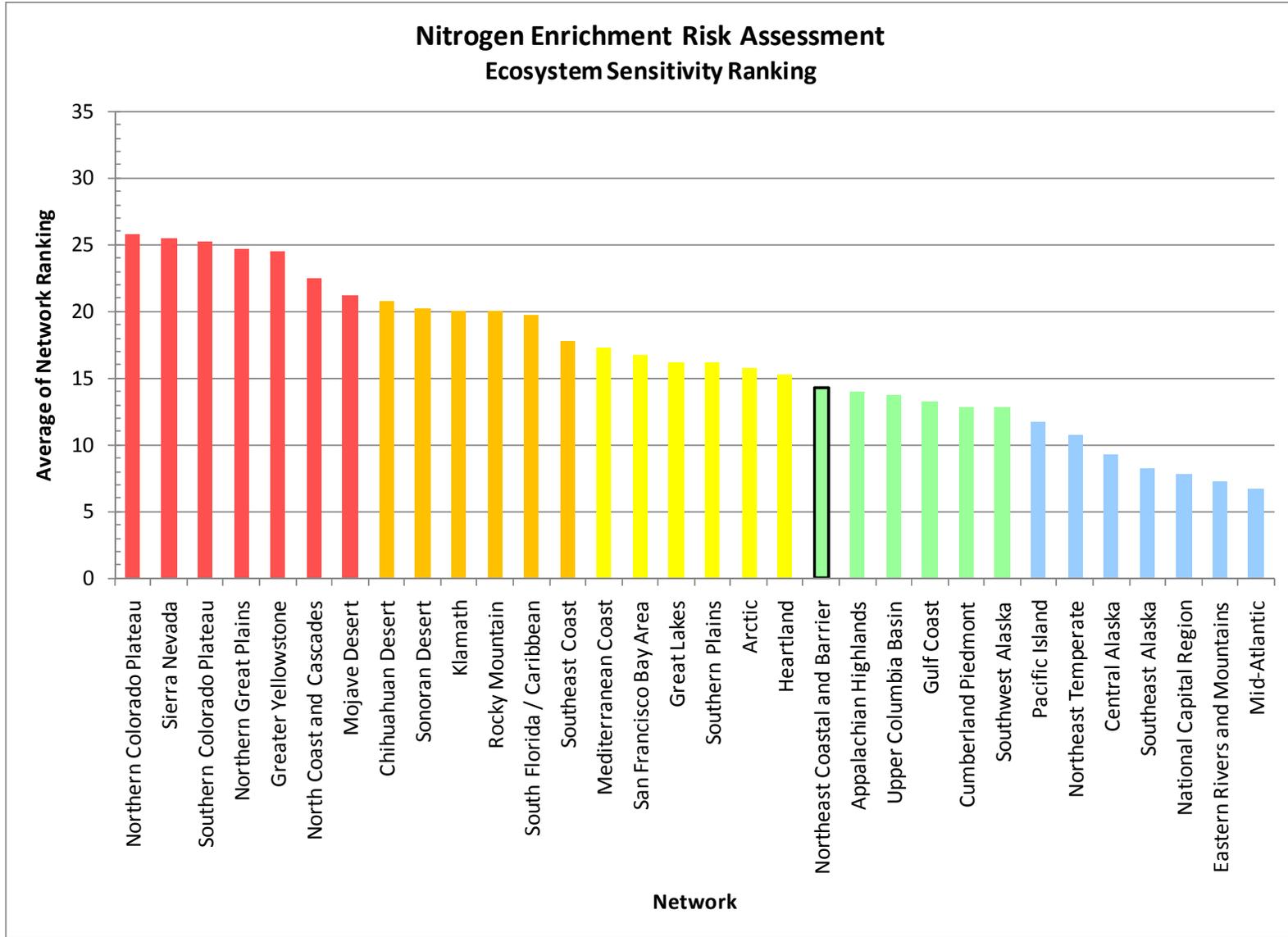


Figure B

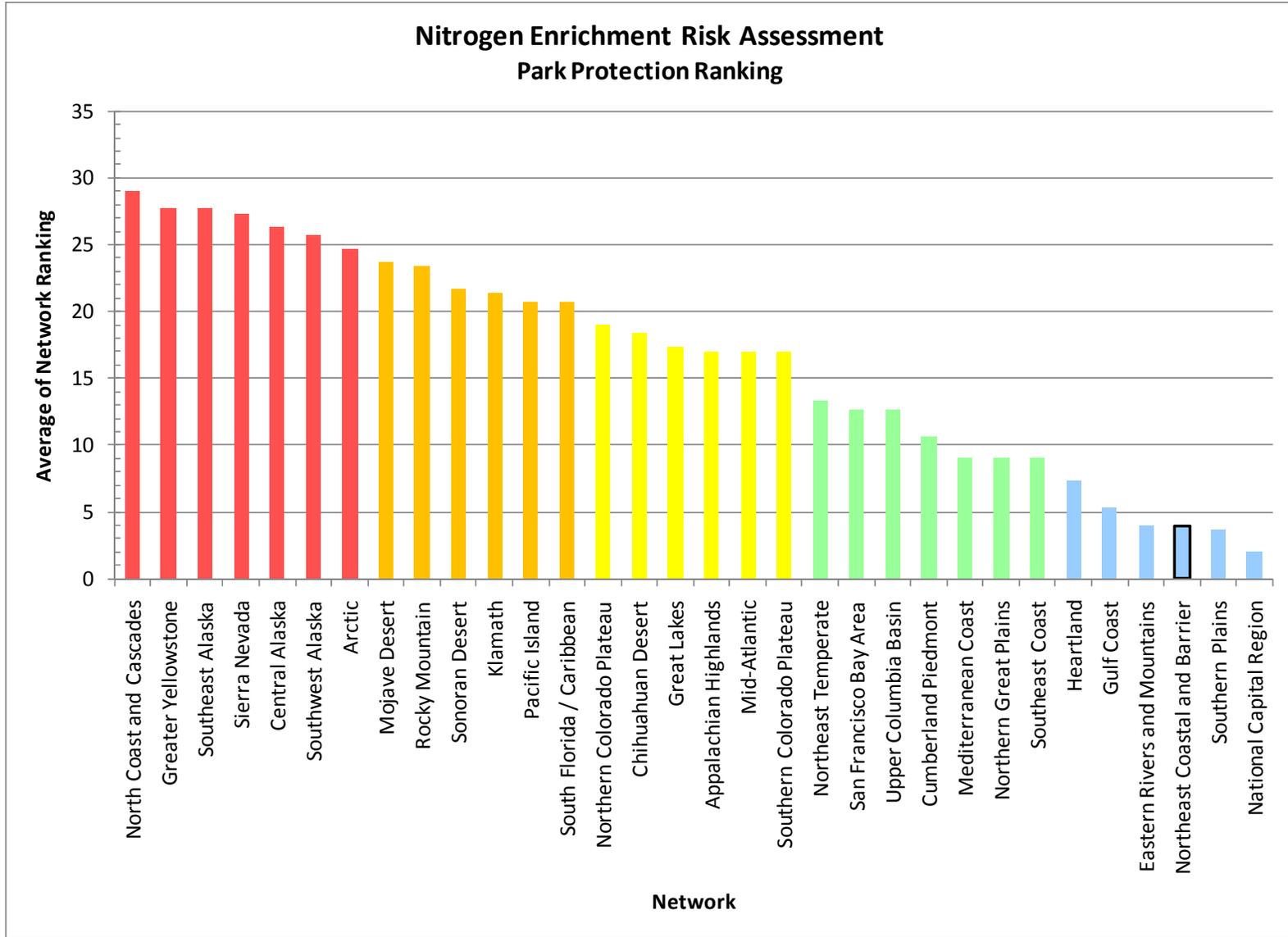


Figure C

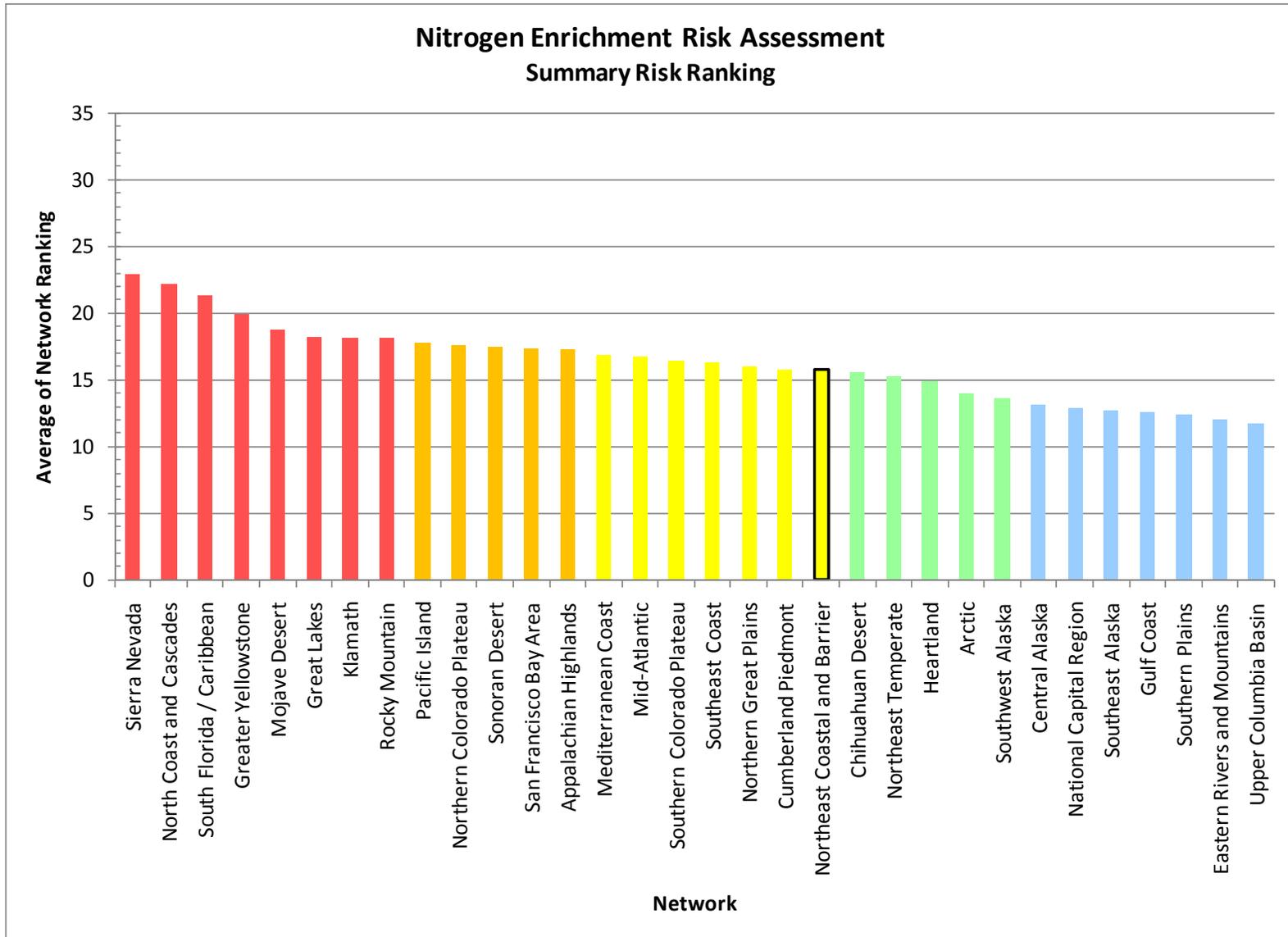


Figure D



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.

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



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