



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

Cumberland Piedmont Network (CUPN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/306



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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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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Cumberland Piedmont Network (CUPN)

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.

The Cumberland Piedmont Network contains 14 parks; none are larger than 100 square miles. Mammoth Cave (MACA) stands out as being at somewhat higher risk from nutrient N addition as compared with other parks in this network. The region occupied by this network receives relatively high levels of atmospheric N deposition.

Total N emissions, by county, are shown in Map C for lands in and surrounding the Cumberland Piedmont Network. County-level emissions within the network ranged from less than 1 ton per square mile to in the range of 50 to 100 tons per square mile. In general, county emissions were between 1 and 20 tons per square mile per year through most of the network. Point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH_3) N are shown in Map D. The larger point emissions sources were consistently sources of oxidized, rather than reduced, N. There were many very large point sources of NO_x emissions (> 5,000 tons per year) in and in close proximity to the network boundaries. Urban centers within the network and within a 300-mile buffer around the network are shown in Map E. There are many large populations centers (> 500,000 people) in and near the network, including Charlotte, Nashville, Memphis, Indianapolis, and Columbus.

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 to as high as 15 to 20 kg N/ha/yr. Throughout most of the network, total N deposition was relatively high, in the range of 10 to 15 kg N/ha/yr.

Land cover in and around the network is shown in Map G. The predominant cover types within this network are generally pasture/hay, forest, and row crop. There are also many smaller developed areas.

There are many I&M parks within this network, but none of them are larger than 100 square miles. Therefore, a network map (Map H) of potentially sensitive vegetation types is not provided.

Park lands requiring special protection against potential adverse impacts associated with nutrient N enrichment from atmospheric N deposition are shown in Map I. Also shown on Map I are all federal lands designated as wilderness, both lands managed by NPS and also lands managed by other federal agencies. The land designations used to identify this heightened protection included Class I designation under the CAAA and wilderness designation. There are only limited areas within this network that are classified as wilderness or Class I.

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 Cumberland Piedmont Network ranks in the top quintile, among networks, in N Pollutant Exposure (Figure A). Nitrogen emissions within the network and N deposition within the network are both Very High. However, the network Ecosystem Sensitivity ranking is Low, within the second lowest quintile among networks (Figure B). This is because there are no high-elevation lakes, and there is limited coverage within this network of vegetation types that are among those expected to be especially sensitive to nutrient enrichment effects from N deposition. This network ranks in the second lowest quintile in Park Protection (Figure C), having limited amounts of protected lands.

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

Because there are no parks in this network that are larger than 100 square miles, Figures E through H, which show individual park rankings for the larger parks, are not presented for this network. Relative rankings for all parks, including the smaller parks, are given in Table A.

Table A. 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.				
I&M Parks² in Network	Relative Ranking of Individual Parks¹			
	Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Abraham Lincoln Birthplace	Very High	Low	Moderate	Moderate
Carl Sandburg Home	High	Moderate	Moderate	Moderate
Chickamauga and Chattanooga	Very High	Very Low	Moderate	Moderate
Cowpens	High	Very Low	Moderate	Low
Cumberland Gap	High	Very Low	Moderate	Low
Fort Donelson	High	Very Low	Moderate	Moderate
Guilford Courthouse	Very High	Very Low	Moderate	Low
Kings Mountain	High	Very Low	Moderate	Low
Little River Canyon	Very High	Very Low	Moderate	Moderate
Mammoth Cave	Very High	Very Low	Very High	Very High
Ninety Six	High	Low	Moderate	Low
Russell Cave	High	Very Low	Moderate	Low
Shiloh	High	Low	Moderate	Moderate
Stones River	High	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).

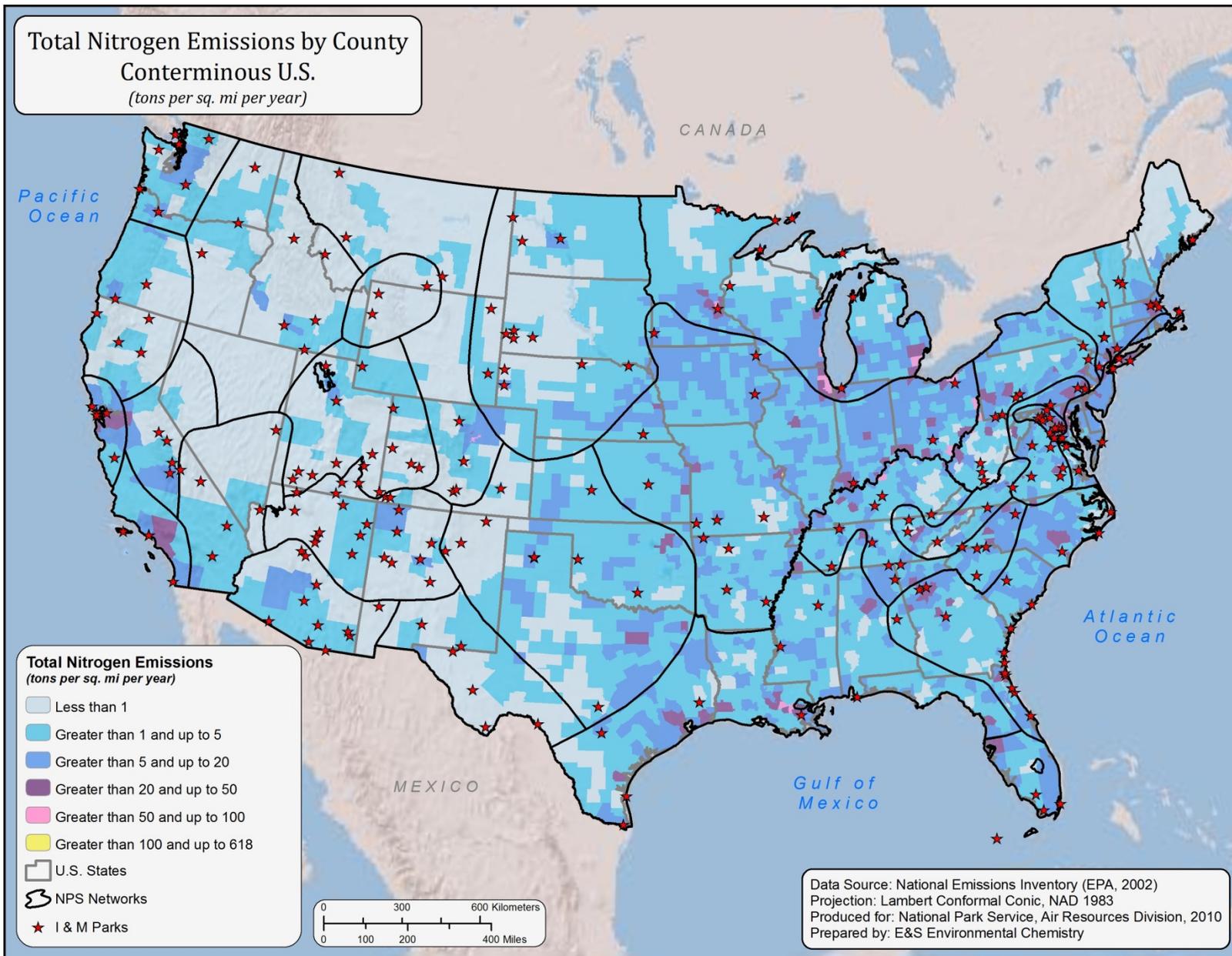
² Park name is printed in bold italic for parks larger than 100 square miles.

All parks in the network rank High or Very High in Pollutant Exposure. Emissions upwind of this network and atmospheric N deposition within the network are both relatively high. MACA, in particular, is known to have experienced significant visibility degradation in response to emissions of air pollutants. In general, Ecosystem Sensitivity for the various parks is ranked Low (for 3 of the parks) to Very Low (for 10 parks, including MACA). Only Carl Sandberg Home (CARL) was ranked Moderate for Ecosystem Sensitivity. All parks except MACA are ranked Moderate for Park Protection; MACA is ranked Very High. The summary risk from nutrient N contribution from atmospheric deposition ranges among parks in this network from Low to Moderate for all parks except MACA. In contrast, MACA was ranked as having Very High summary risk.

- Map A. National map of total N emissions by county for the year 2002. Both oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH₃) 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_x) and reduced (ammonia, NH₃) 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_x) and reduced (ammonia, NH₃) 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_x) and reduced (ammonia, NH₃) 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_x) and reduced (ammonia, NH₃) 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)

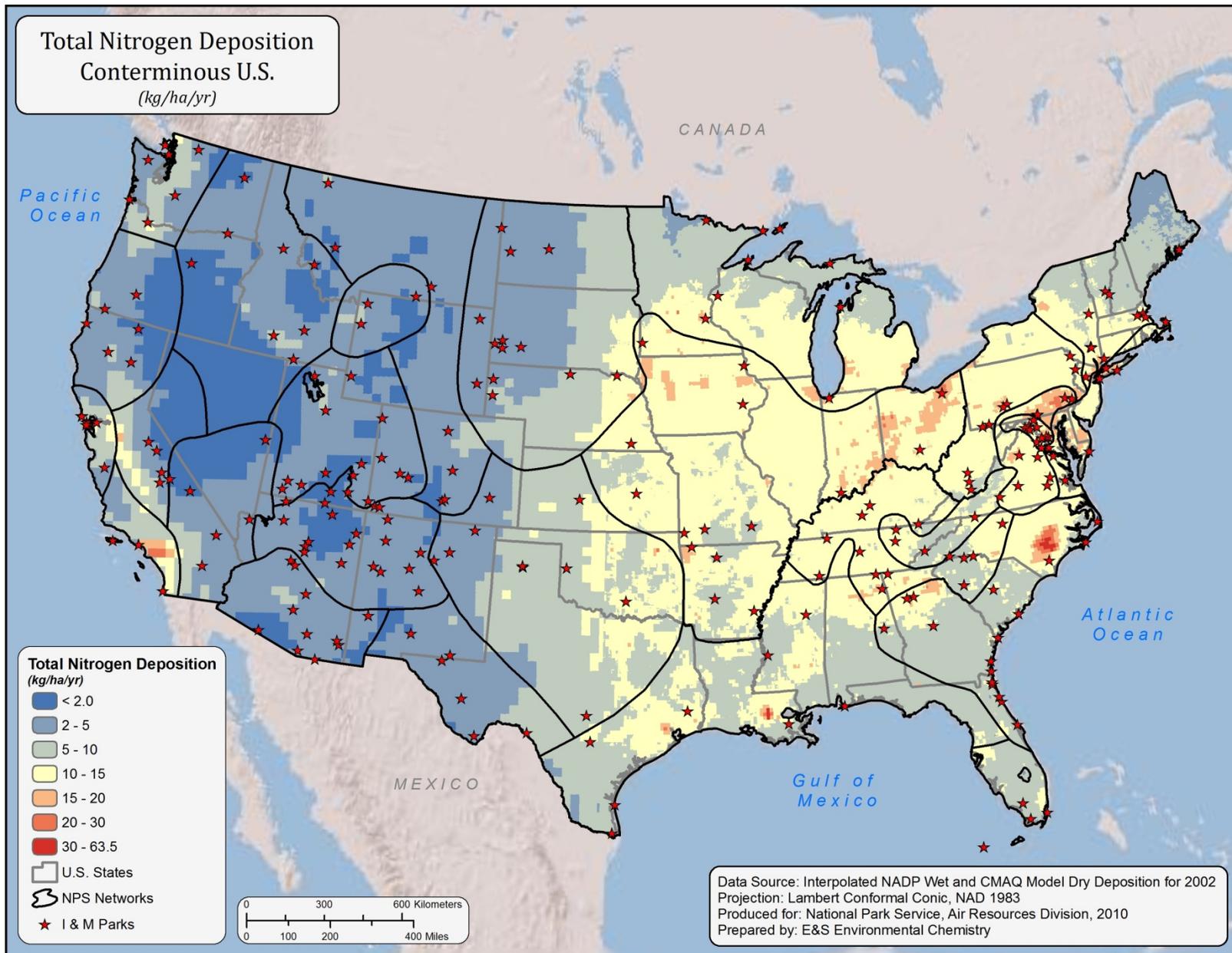
- Map G. Land cover types in and around the network, based on the National Land Cover dataset. (Source of data: National Land Cover Dataset, http://www.mrlc.gov/nlcd_multizone_map.php)
- Map I. Lands within the network that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; <http://nationalatlas.gov>] and NPS)
- 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.
- Figure G. Park rankings for Park Protection for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Park Protection variables.
- Figure H. Park rankings for Summary Risk for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Summary Risk variables.

CUPN-5

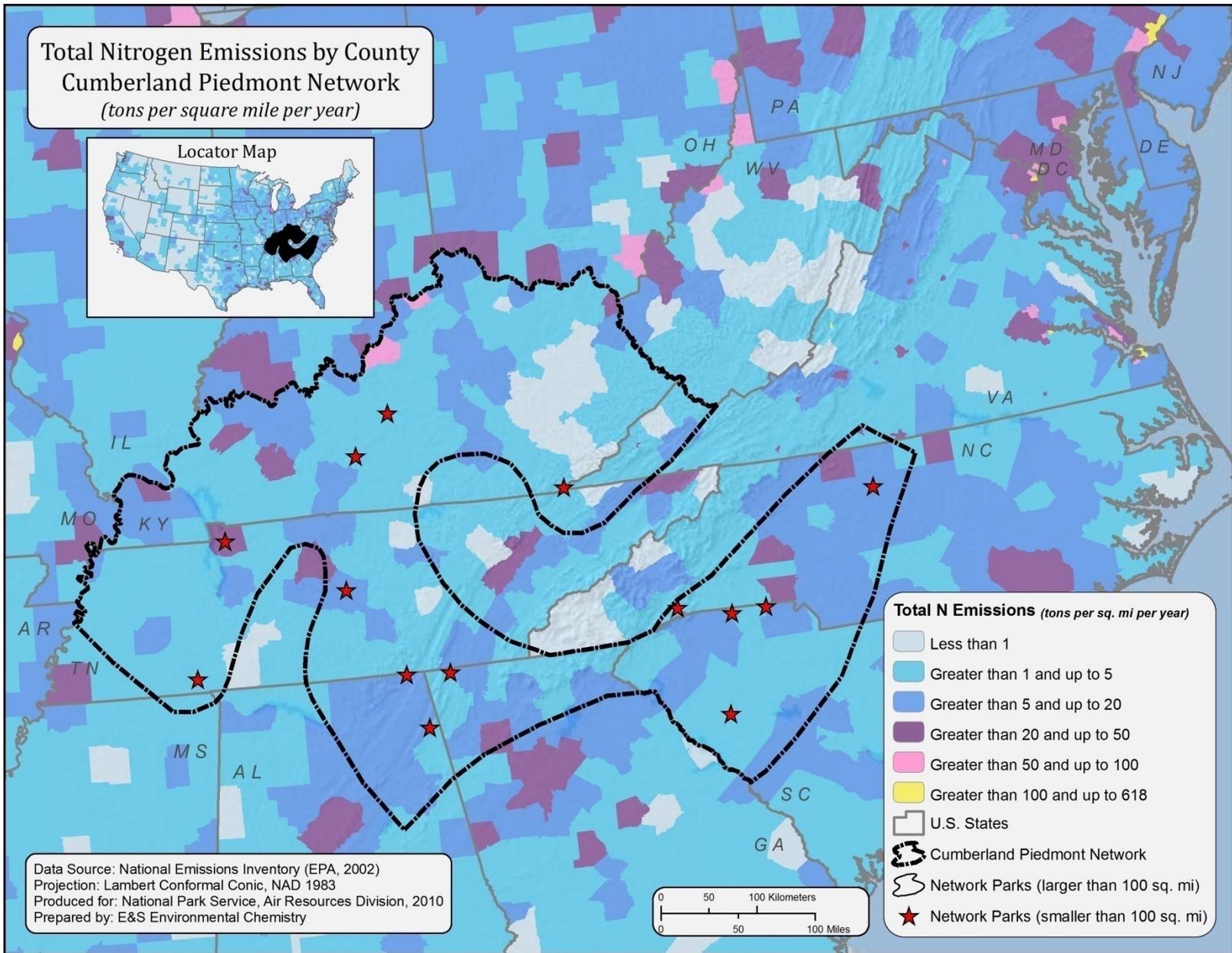


Map A

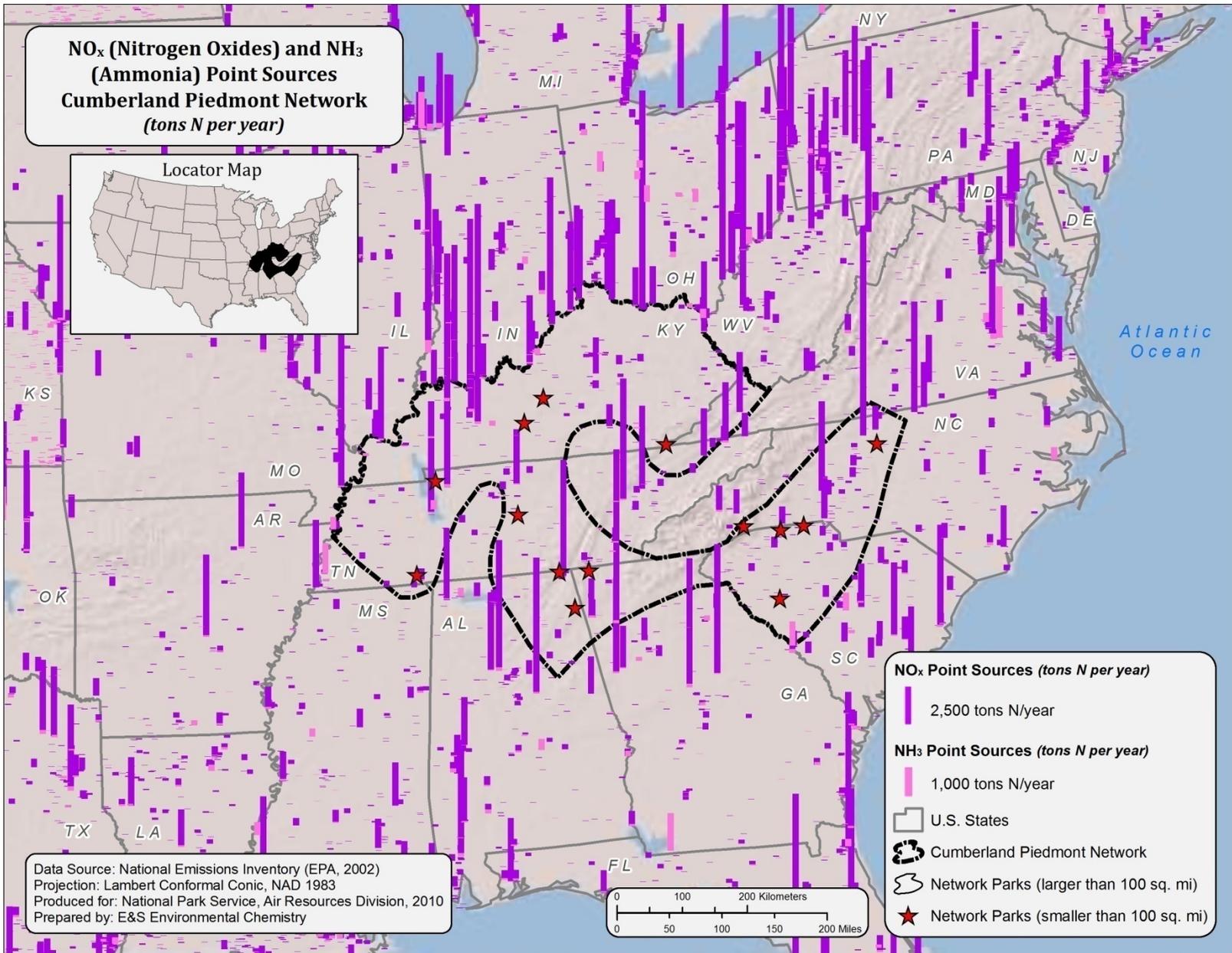
CUPN-6



Map B

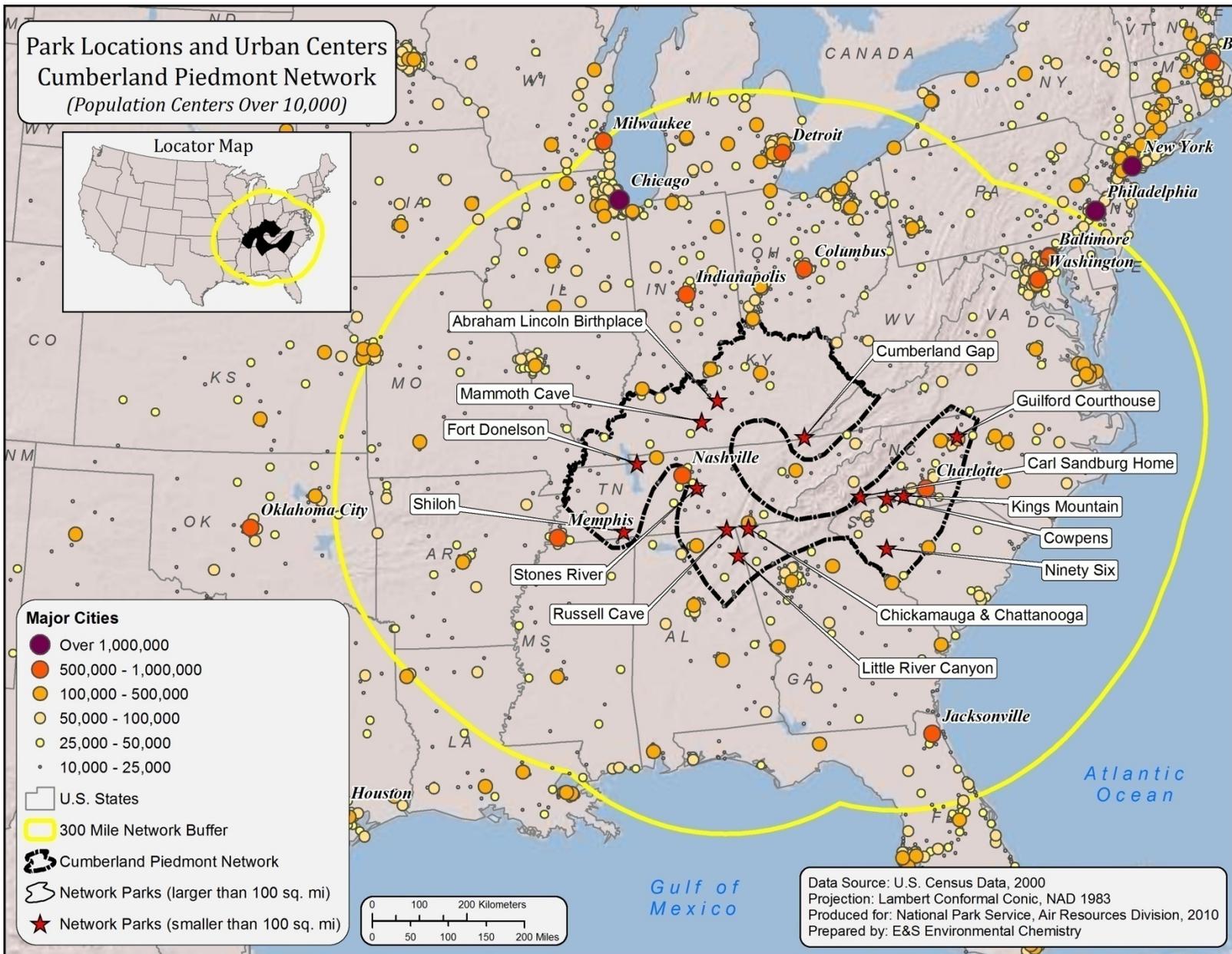


Map C



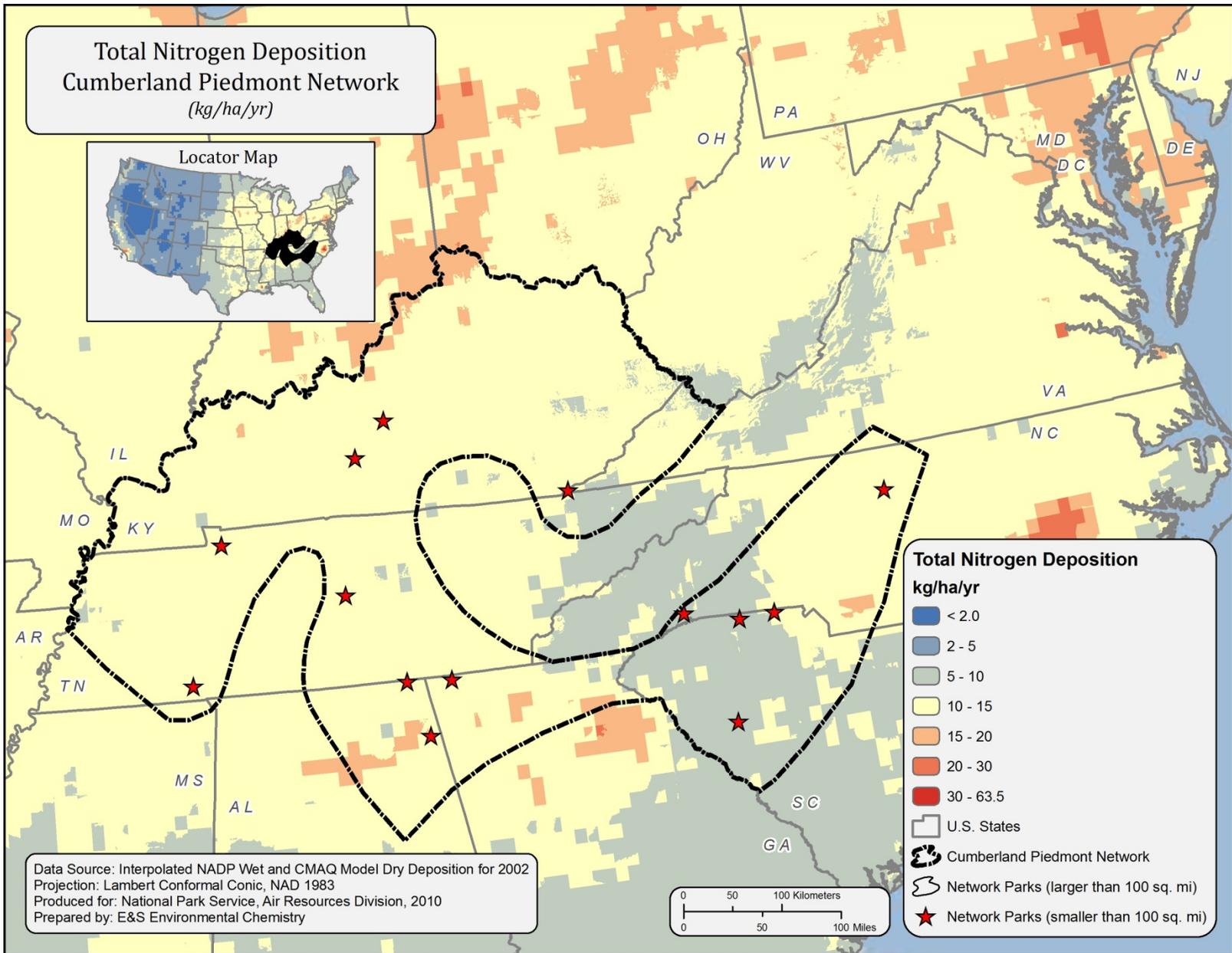
Map D

CUPN-9



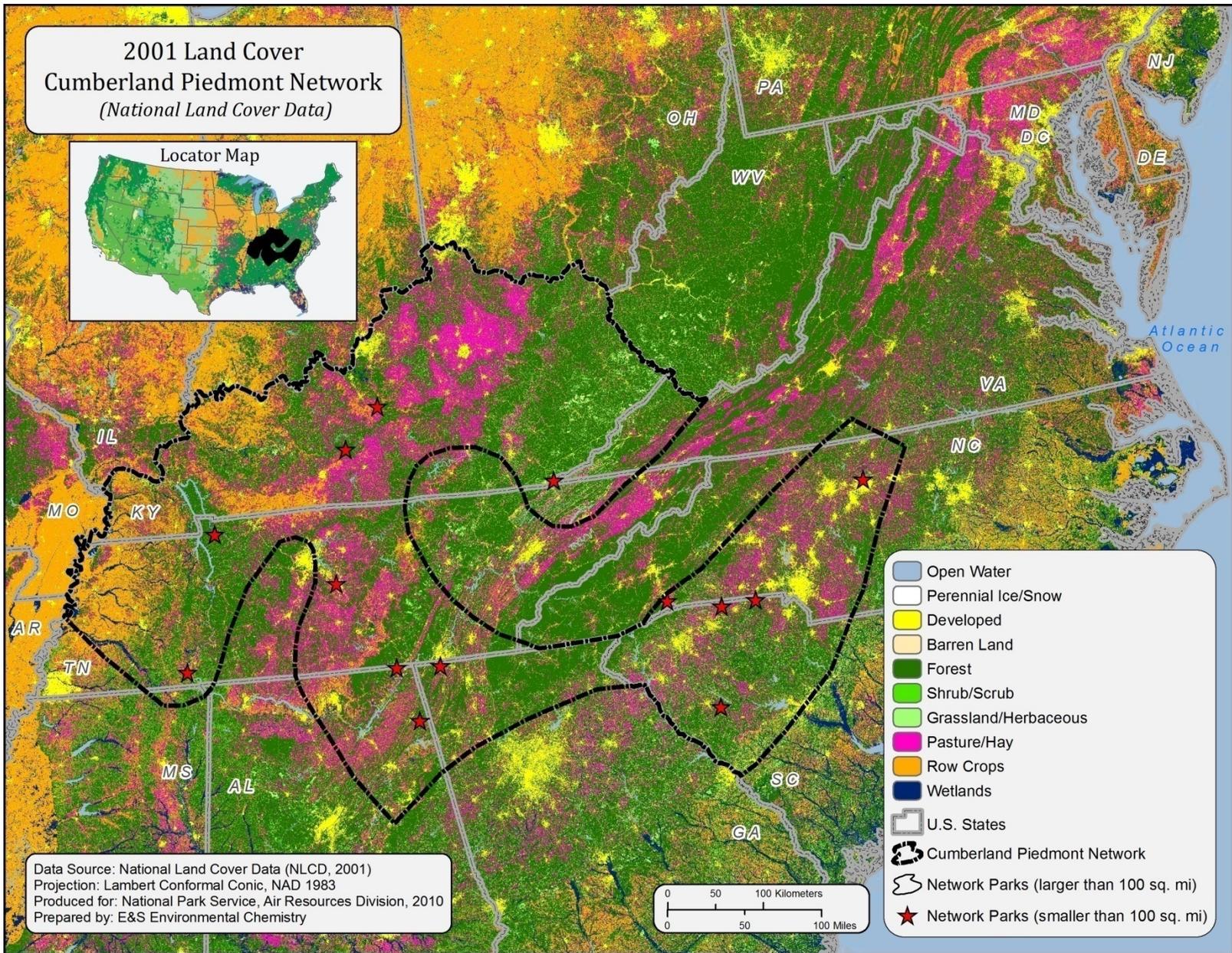
Map E

CUPN-10



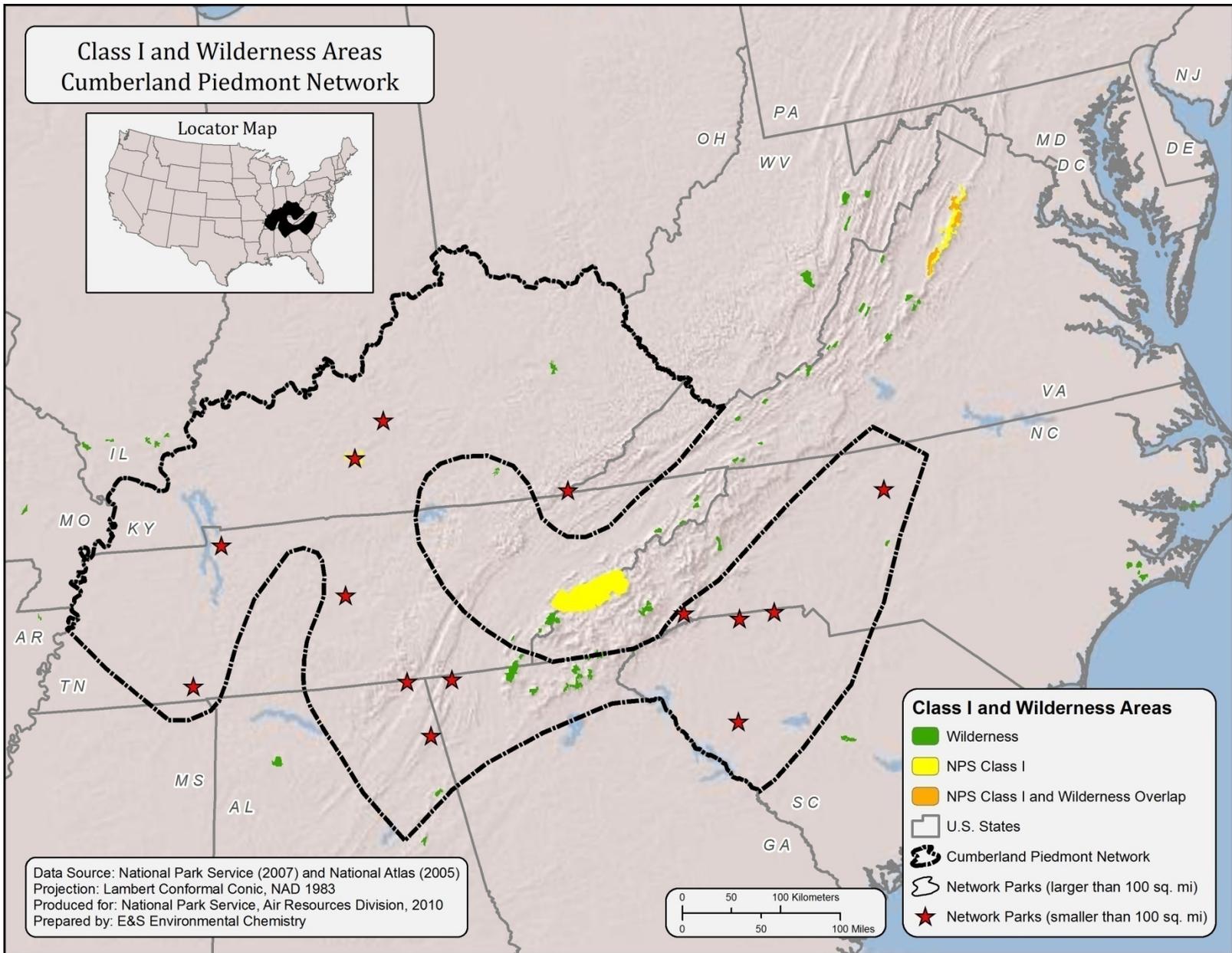
Map F

CUPN-11



Map G

CUPN-12



Map I

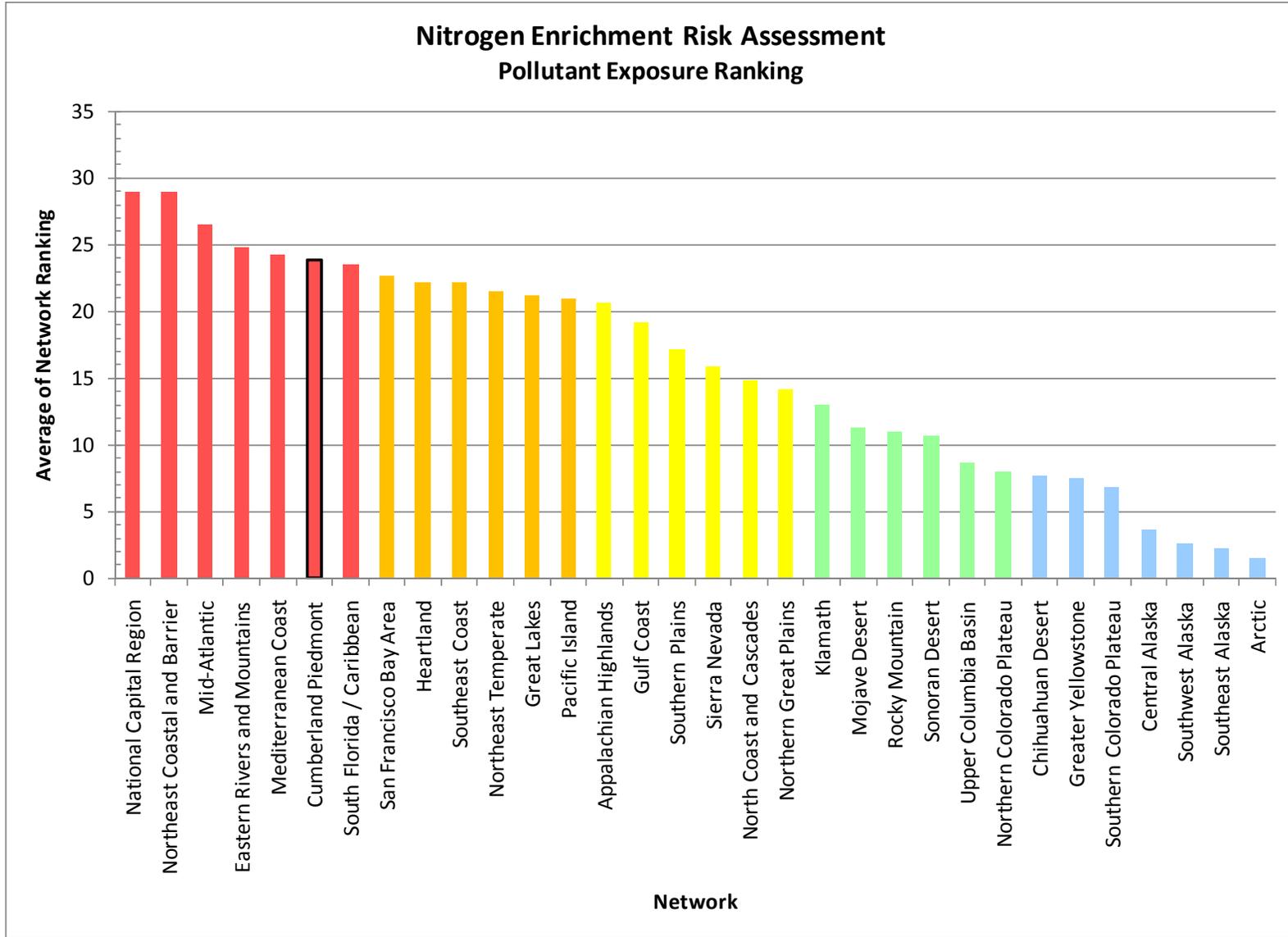


Figure A

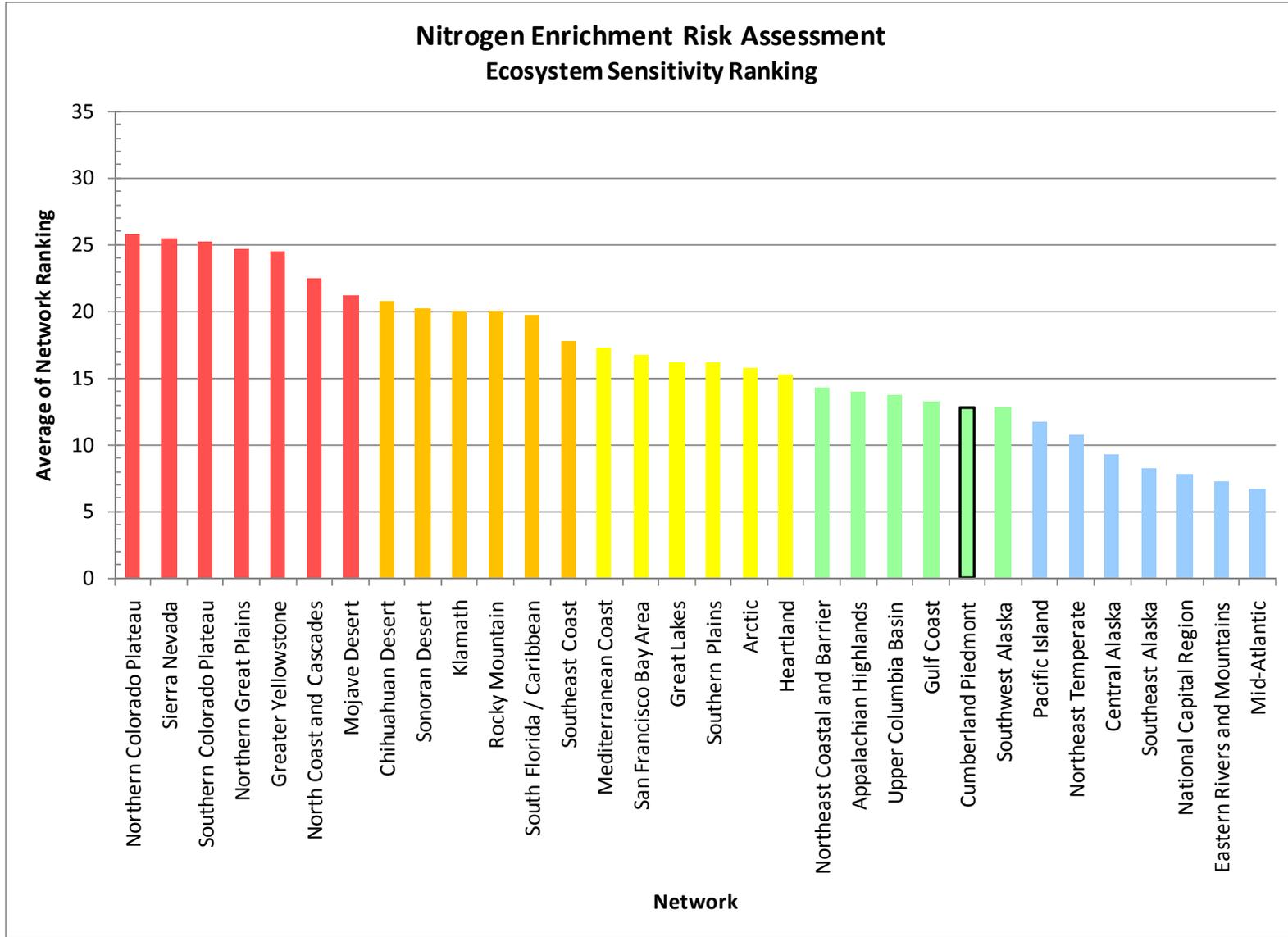


Figure B

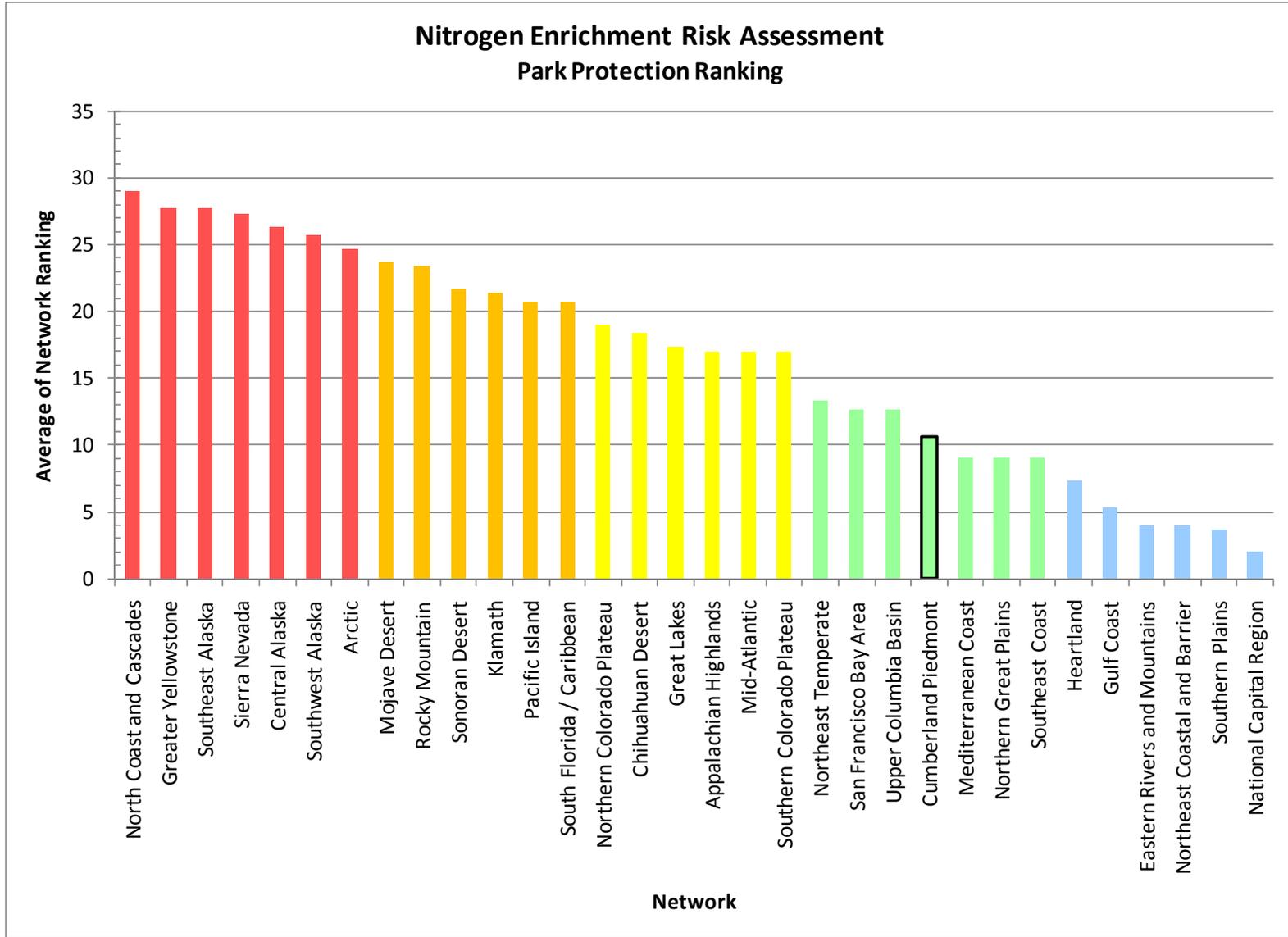


Figure C

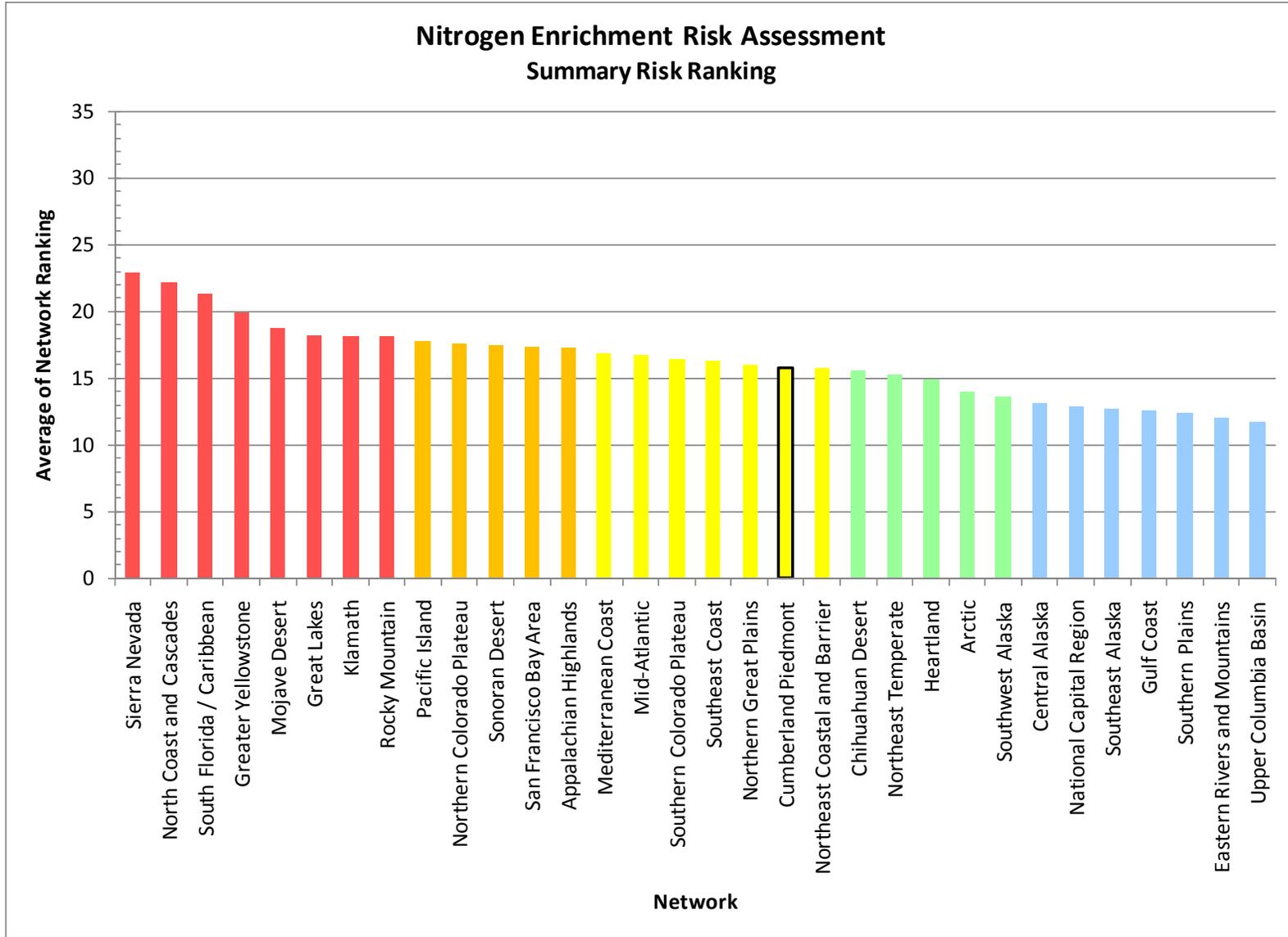


Figure D

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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