



Evaluation of the Sensitivity of Inventory and Monitoring National Parks to Acidification Effects from Atmospheric Sulfur and Nitrogen Deposition

Gulf Coast Network (GULN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/358



ON THE COVER

Some ecosystems and vegetation types, such as remote high-elevation lakes, sugar maple trees, headwater streams, and red spruce trees, are sensitive to the effects of acidification from atmospheric nitrogen and sulfur deposition.

Photograph by: National Park Service

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April 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.

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 Air Resources Division of the NPS (<http://www.nature.nps.gov/air/Permits/ARIS/networks/acidification-eval.cfm>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

Please cite this publication as:

Sullivan, T. J., G. T. McPherson, T. C. McDonnell, S. D. Mackey, and D. Moore. 2011. Evaluation of the sensitivity of inventory and monitoring national parks to acidification effects from atmospheric sulfur and nitrogen deposition: Gulf Coast Network (GULN). Natural Resource Report NPS/NRPC/ARD/NRR—2011/358. National Park Service, Denver, Colorado.

Gulf Coast Network (GULN)

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

There are three parks in the Gulf Coast Network that are larger than 100 square miles: Big Thicket (BITH), Gulf Islands (GUIS), and Padre Island (PAIS). In addition, there are five smaller parks.

Total annual S and N emissions, by county, are shown in Maps E and F, respectively, for lands in and surrounding the Gulf Coast Network. In general, county S emissions ranged from less than 1 to between 5 and 20 tons per square mile per year (Map E). However, several counties throughout the network produced S emissions greater than 20 tons per square mile per year, and two counties were in the range of 50 to 100 tons per square mile per year. County-level N emissions within the network ranged from less than 1 ton per square mile per year to greater than 50 tons per square mile per year (Map F). In general, county N annual emissions within the network were in the range of 1 to 20 tons per square mile. Two counties had emissions in the 50 to 100 tons of N per square mile per year and several in the range of 20 to 50 tons of N per square mile per year. Individual point source emissions of S are shown in Map G. There were many SO₂ point sources of substantial magnitude within this network. Several were larger than 20,000 tons per year, and two were larger than 40,000 tons per year. Many other large SO₂ point sources exist outside of the network boundary to the north and northeast. Point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH₃) N are shown in Map H. There were numerous N point sources throughout this network. Most of the larger sources (greater than 1,000 tons per year) emitted oxidized N, but there were also some relatively large point sources of reduced N.

Urban centers within the network and within a 300-mile buffer around the network are shown in Map I. Many large population centers occur in, or within the buffer around, the network, including San Antonio, Houston, Austin, Dallas, Fort Worth, Memphis, Nashville, Oklahoma City, Indianapolis, and Jacksonville (Map I).

Total S and N deposition levels in and around the network are shown in Maps J and K, respectively. Included in this analysis are both wet and dry forms of S and N deposition and both the oxidized and reduced N species. Total S deposition throughout the network ranged from less than 2 kg S/ha/yr to above 30 kg S/ha/yr (Map K). Sulfur deposition throughout most of the network was in the range of 5 to 15 kg S/ha/yr, with small pockets of deposition exceeding 30 kg S/ha/yr around large urban centers, such as San Antonio and Houston. The far western portion of the network, in southern Texas, had the lowest S deposition values, ranging from less than 2 to 5 kg S/ha/yr. Total N deposition within the network ranged from as low as 2 to 5 kg N/ha/yr near the border with Mexico to more than 15 kg N/ha/yr at some locations (Map K). Throughout most of the network, total N deposition was estimated to range from 5 to 15 kg N/ha/yr.

Land cover in and around the network is shown in Map L. There are a wide variety of cover types within this network, including forest, pasture/hay, row crops, wetlands, shrublands, and grassland/herbaceous, with scattered areas of developed land around the population centers.

The slope of lands within the parks, shown in Map M, is relatively flat across all park lands in the network. All parks in this network have average slope less than 10°.

Map N shows park lands requiring special protection against potential adverse impacts associated with acidification from atmospheric S and N deposition. There are no Class I areas and only small areas of wilderness scattered throughout the 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 Gulf Coast Network ranked near the median among networks in Pollutant Exposure (Figure A). Sulfur and N emissions and deposition levels within the network were near average among networks. The network Ecosystem Sensitivity ranking was low, at the bottom of the second lowest quintile among networks (Figure B). This was because there are limited low-order and high-elevation streams, no high-elevation lakes, low relief, and no areas identified as having acid-sensitive waters or geology. This network ranked in the lowest quintile in Park Protection (Figure C), having few protected lands.

In combination, the network rankings for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection yielded an overall Network Risk ranking that is relatively low among networks (Figure D).

Similarly, park rankings are given in Figures E through H for the same metrics. In the case of the park rankings, we only show in the figures the parks that are larger than 100 square miles. Relative ranks for all parks, including the smaller parks, are given in Table A and Appendix A. As for the network ranking figures, the park ranking figures highlight those parks that occur in this network to show their relative position compared with parks in the other 31 networks. Note that the rankings shown in Figures E through H reflect the rank of a given park compared with all other parks, irrespective of size.

Two of the three I&M parks in the Gulf Coast Network that are larger than 100 square miles (BITH and GUIS) ranked High among parks in Pollutant Exposure; PAIS was ranked Moderate (Figure E). Natchez Trace Parkway and National Scenic Trail (NATR) was ranked High for Ecosystem Sensitivity (Figure F, Table A). Other parks in this network were ranked Low (BITH; San Antonio Mountains, SAAN; and Vicksburg, VICK) or Very Low (GUIS; Jean Lafitte, JELA; PAIS, and Palo Alto Battlefield PAAL) for this theme. All parks in the network except GUIS were ranked Moderate in Park Protection; GUIS was ranked High (Figure G, Table A). The overall Summary Risk was Moderate for BITH and GUIS, and Low for PAIS (Figure H). For the smaller parks, the overall Summary Risk ranking was variable: Low in PAAL, High in NATR, and Moderate in the other three parks (Table A).

Table A. Relative rankings of individual I&M parks within the network for Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and overall Summary Risk from acidic deposition.

I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
	Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
<i>Big Thicket</i>	High	Low	Moderate	Moderate
<i>Gulf Islands</i>	High	Very Low	High	Moderate
Jean Lafitte	High	Very Low	Moderate	Moderate
Natchez Trace Parkway and National Scenic Trail	High	High	Moderate	High
<i>Padre Island</i>	Moderate	Very Low	Moderate	Low
Palo Alto Battlefield	Moderate	Very Low	Moderate	Low
San Antonio Missions	Moderate	Low	Moderate	Moderate
Vicksburg	Moderate	Low	Moderate	Moderate

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).

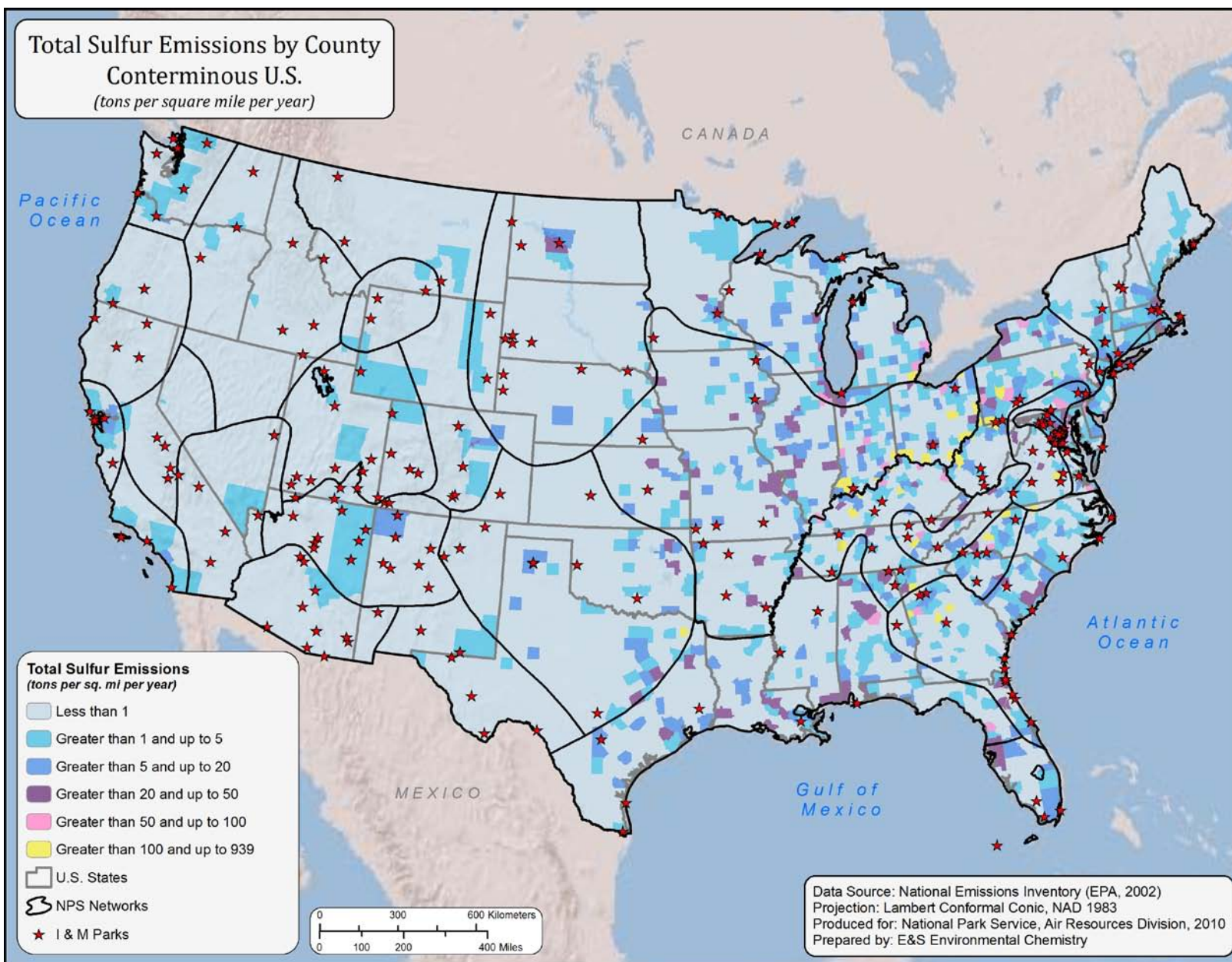
² Park name is printed in bold italic for parks larger than 100 square miles.

- Map A. National map of total S emissions by county for the year 2002, in units of tons of S per square mile per year. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)
- Map B. 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 C. Total S deposition for the conterminous United States for the year 2002, expressed in units of kilograms of S deposited from the atmosphere to the Earth surface per hectare per year. 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 D. 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

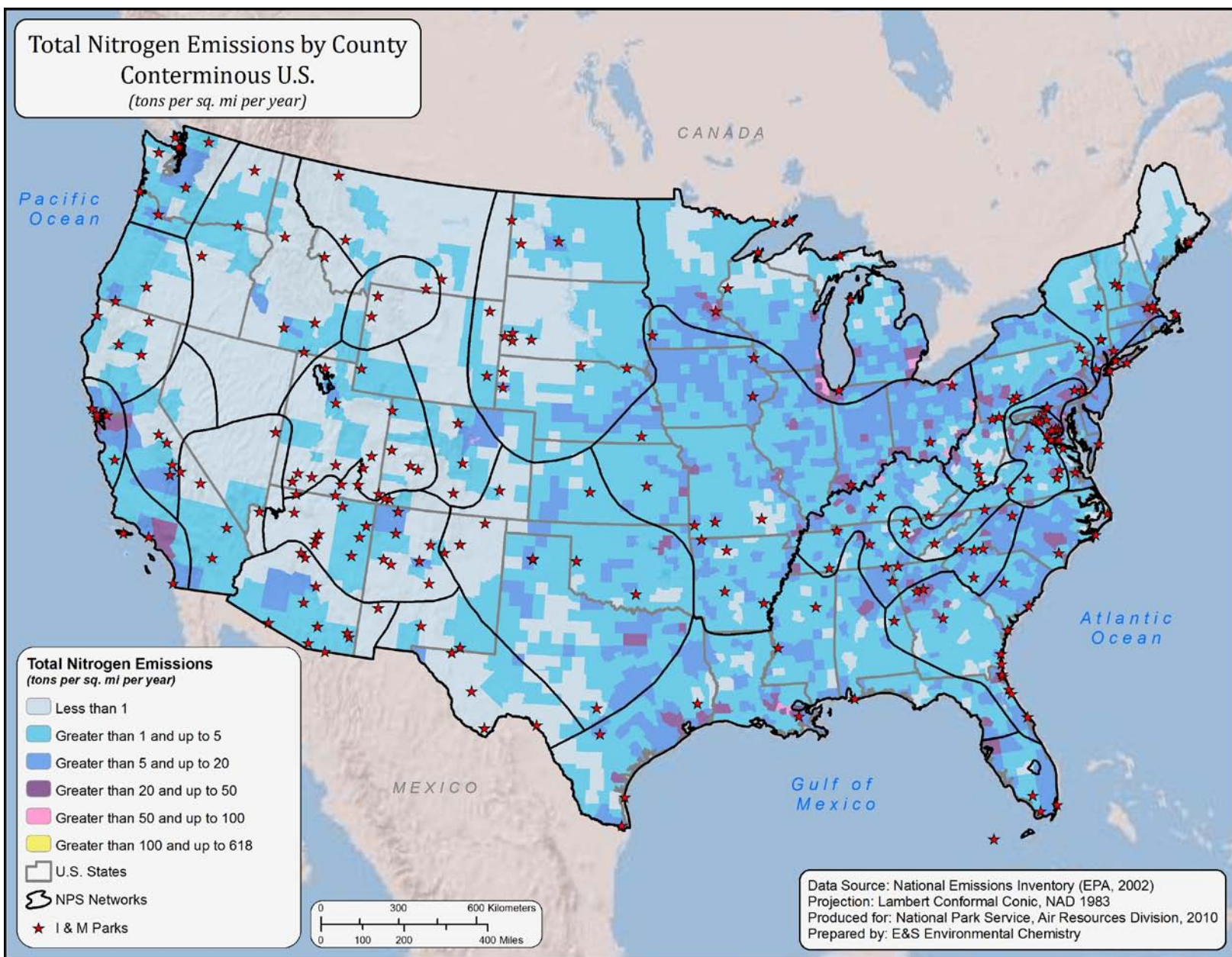
for 2002. NADP interpolations were performed using the approach of Grimm and Lynch (1997). CMAQ model projections were provided by Robin Dennis, U.S. EPA.

- Map E. Total S emissions by county for lands surrounding the network, expressed as tons of S emitted into the atmosphere per square mile per year. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)
- Map F. 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 G. Major point source emissions of SO₂ for lands surrounding the network. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)
- Map H. 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 I. 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 J. Total S deposition in and around the network. Values are expressed as kilograms of S deposited per hectare per year. (Source of data: Interpolated NADP wet and CMAQ Model dry deposition data for 2002; see information for Map C above for details)
- Map K. 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 D above for details)
- Map L. 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 M. Average land slope within park units that occur within the network, by 10-digit HUC. Some parks in this network are slightly larger than 100 mi², but yet too small to readily see the color within the park outline. These parks are represented on the map with a colored circle and a line from the circle indicating the park location. (Source of data: U.S. EPA National Elevation Dataset [<http://ned.usgs.gov/>])

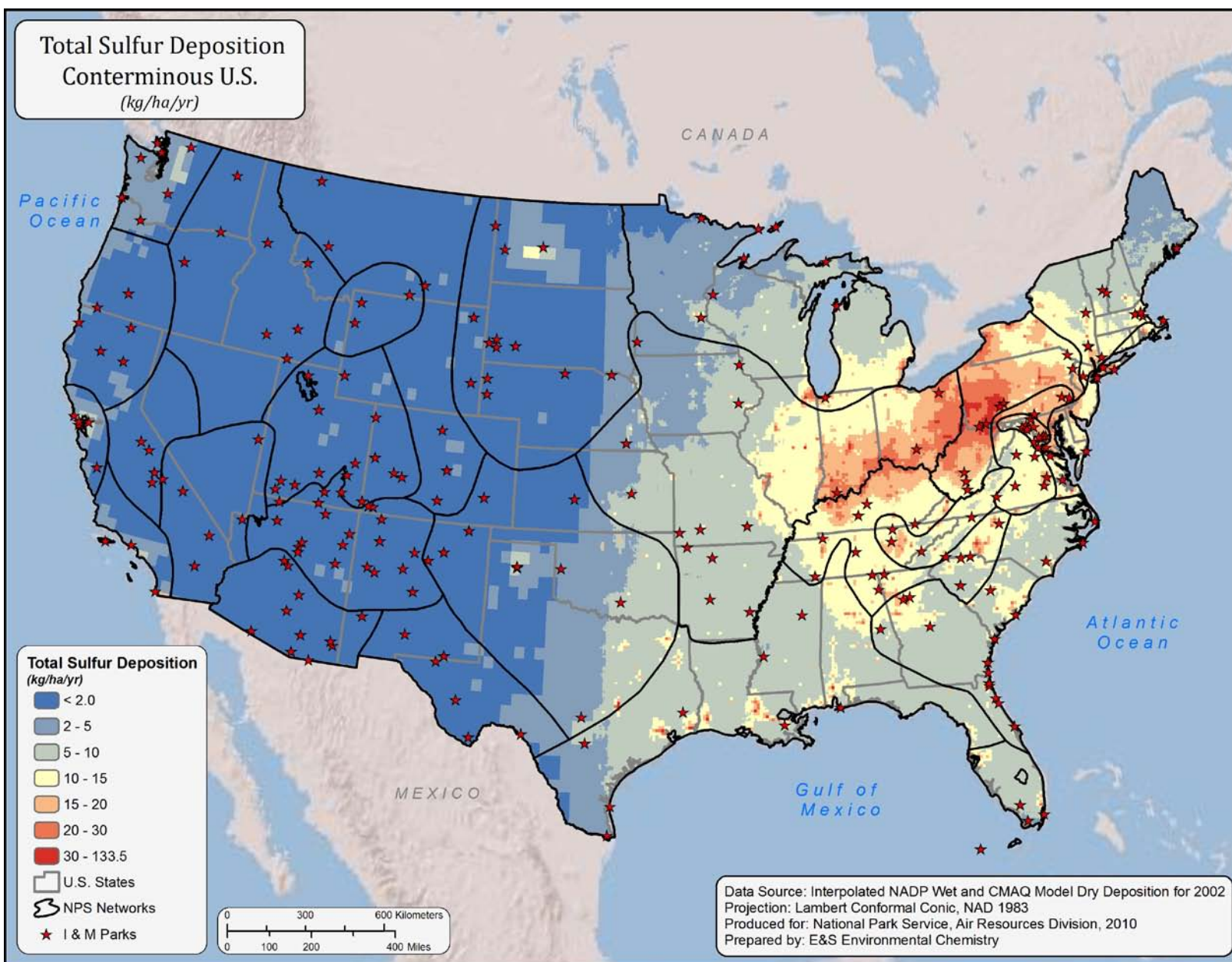
- Map N. Lands within the network that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; <http://nationalatlas.gov>] and NPS)
- Figure A. Network rankings for Pollutant Exposure, calculated as the average of scores for all Pollutant Exposure variables.
- Figure 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 rankings, calculated as the average of the quintile ranks for the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection themes.
- Figure E. Park rankings for Pollutant Exposure 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 Pollutant Exposure variables.
- Figure F. Park rankings for Ecosystem Sensitivity 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 Ecosystem Sensitivity variables.
- 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 the quintile ranks for the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection themes.



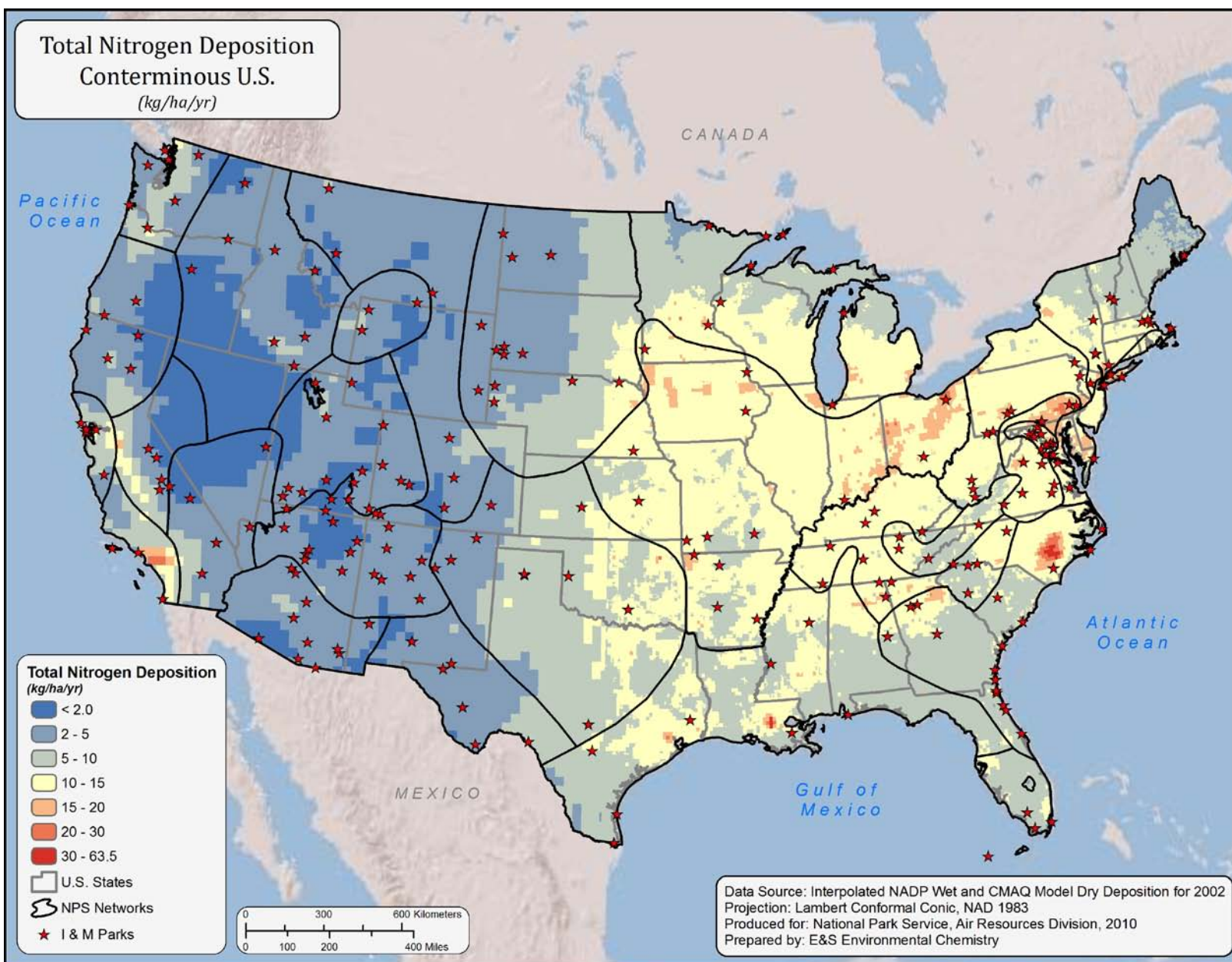
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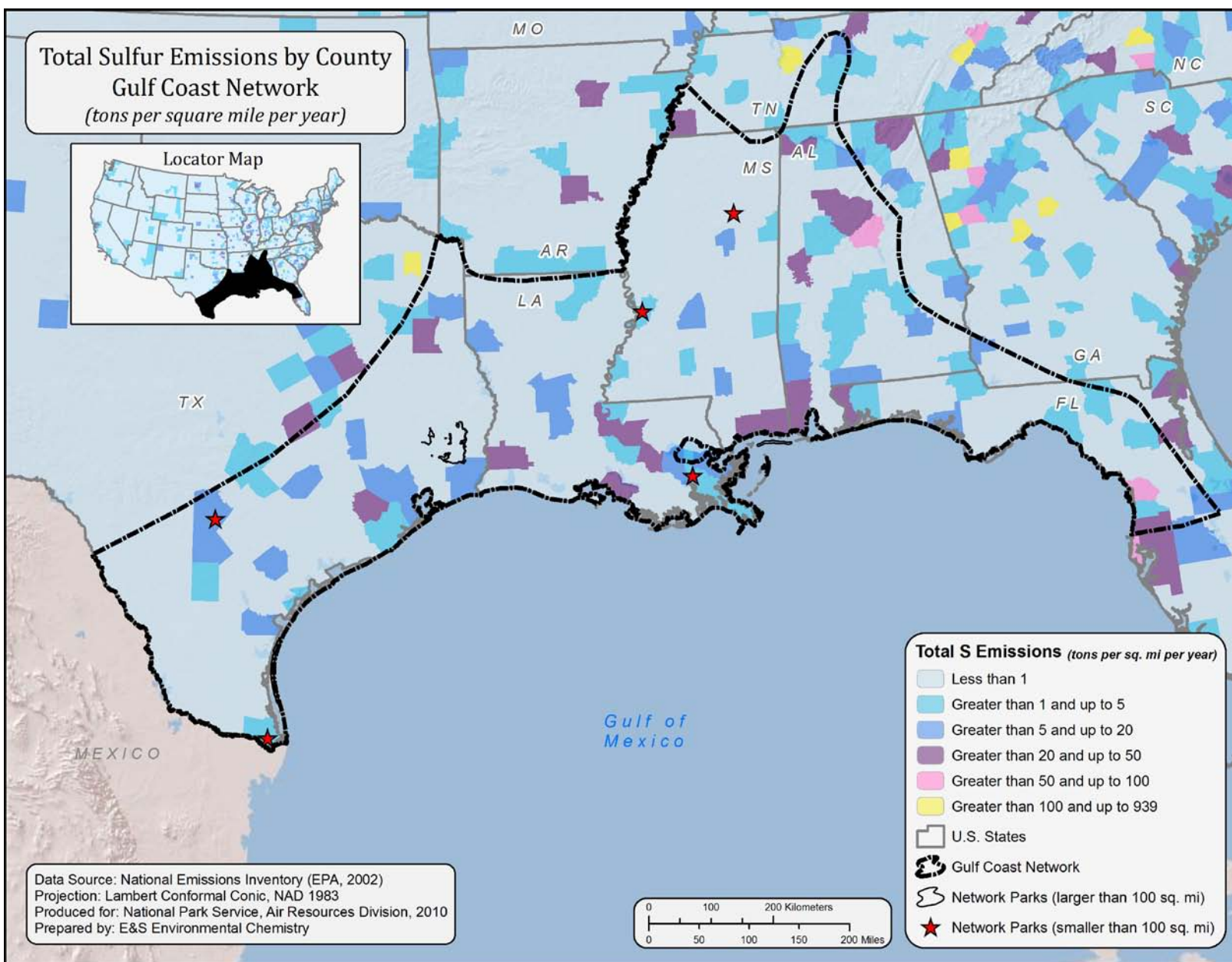
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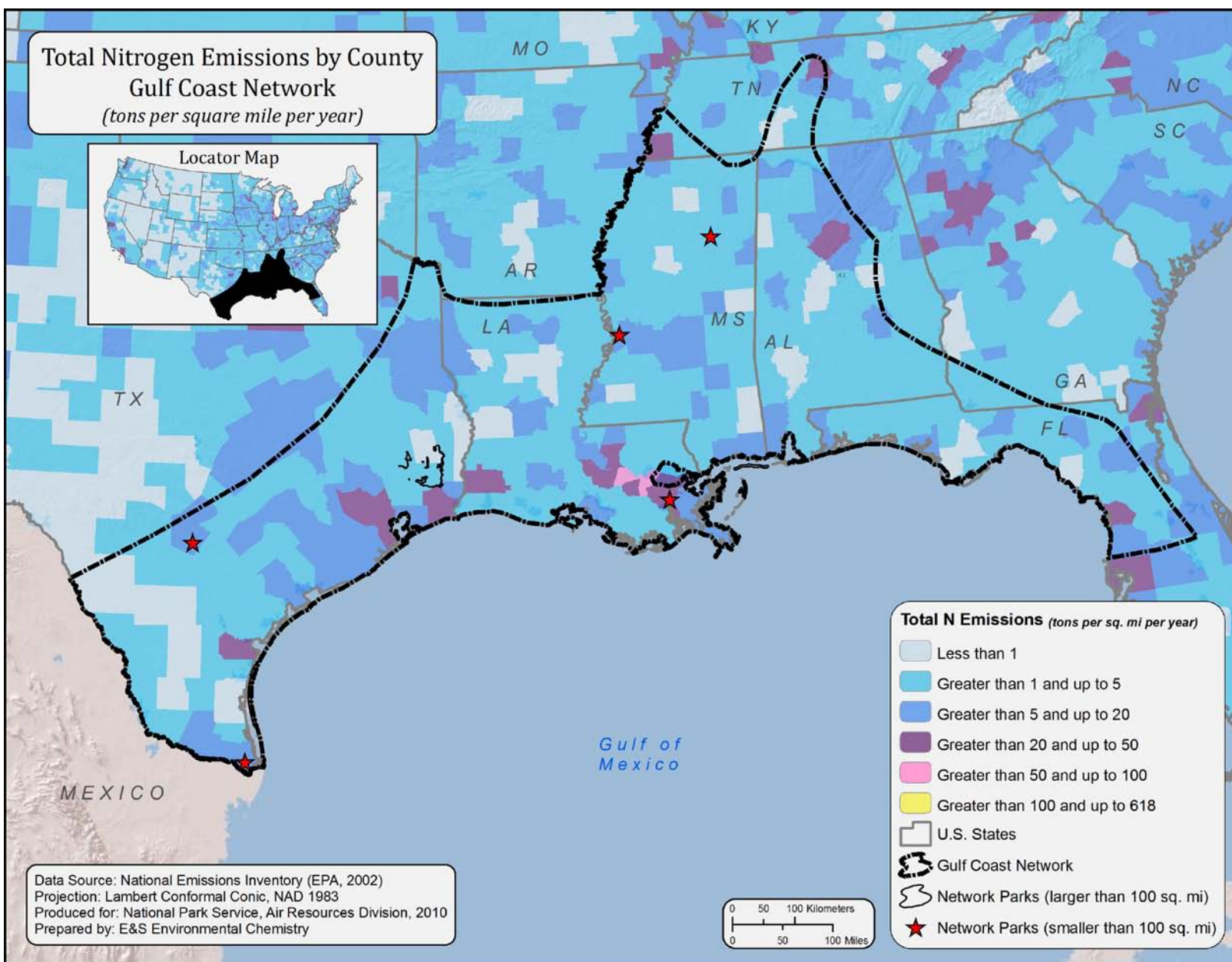
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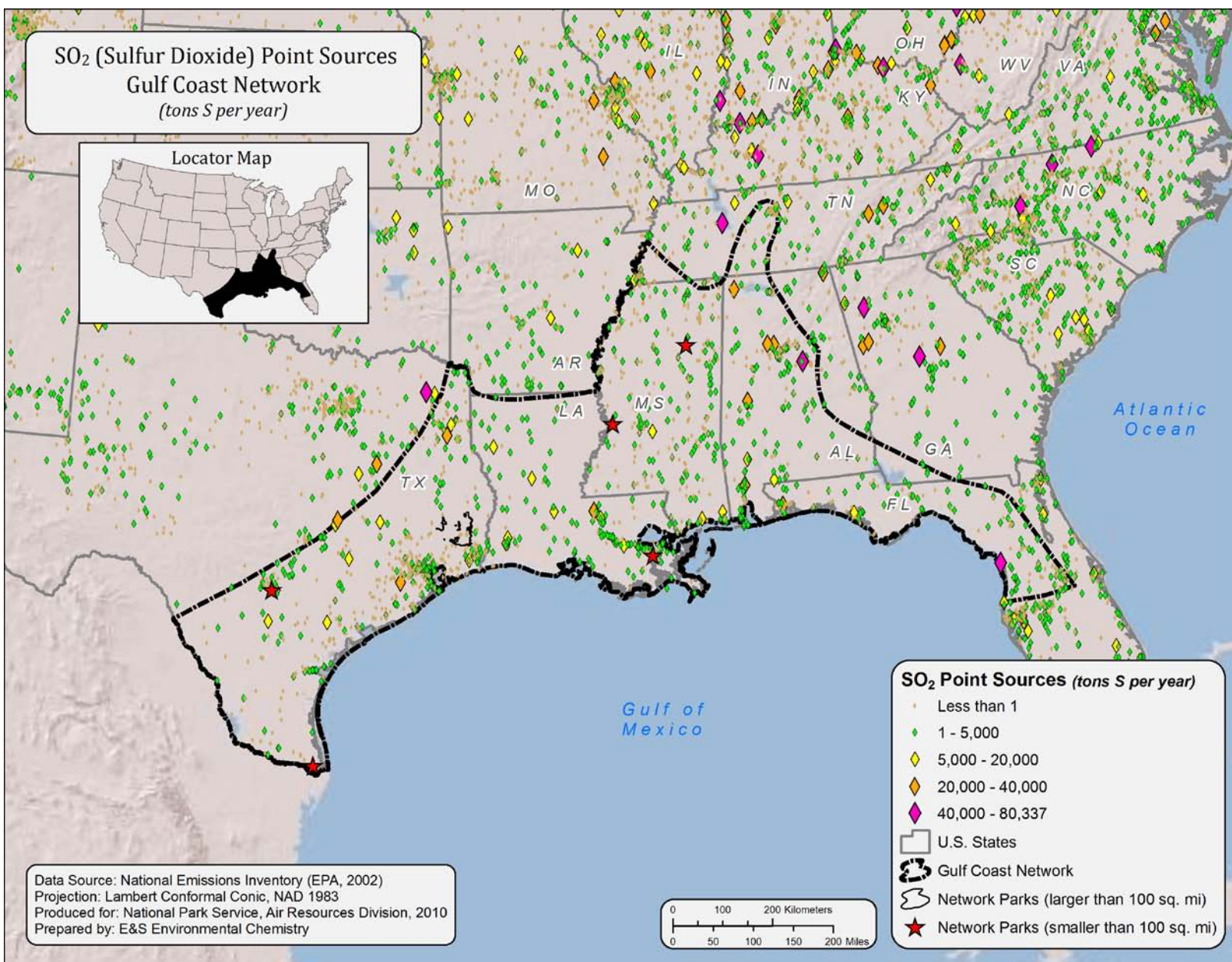
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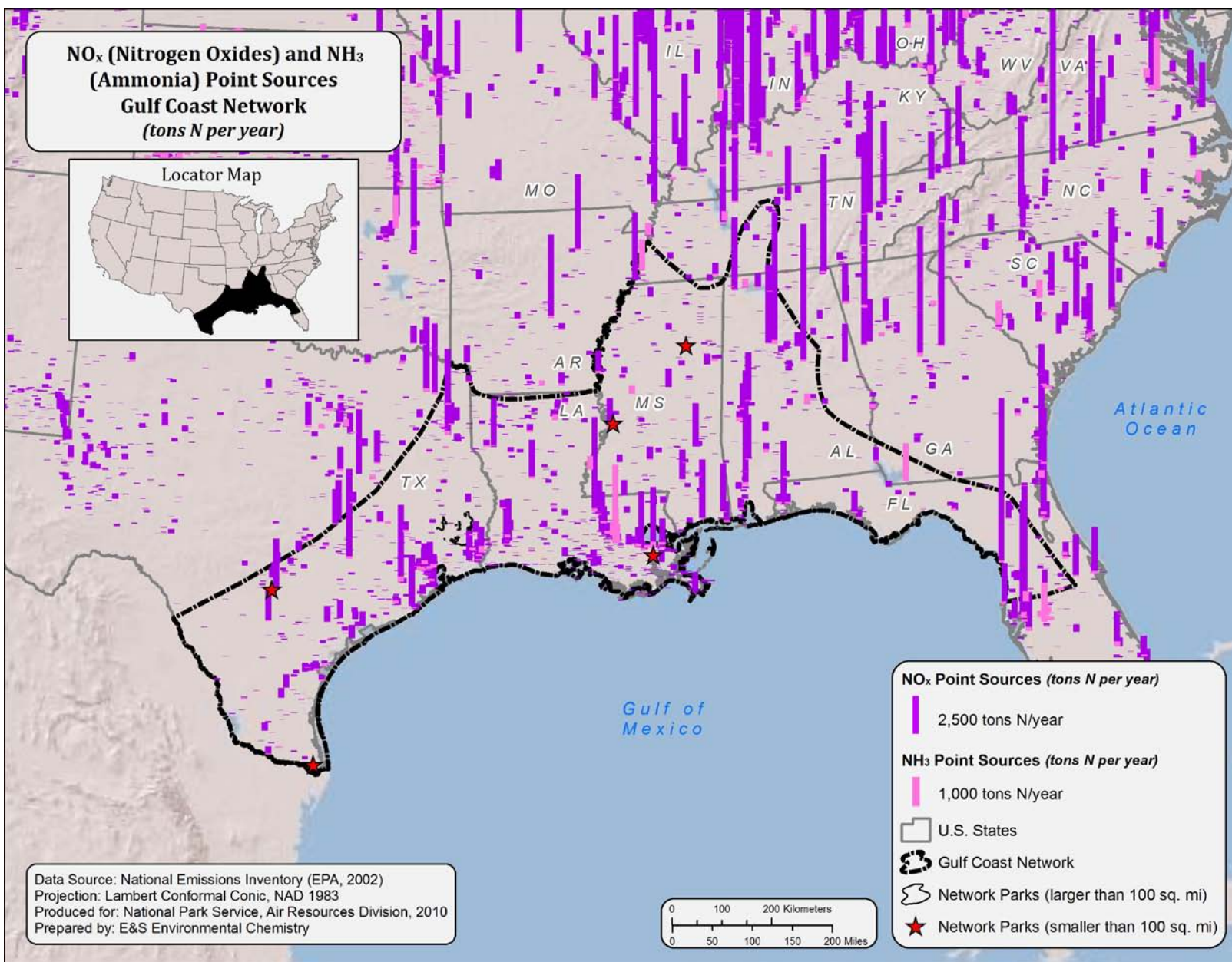
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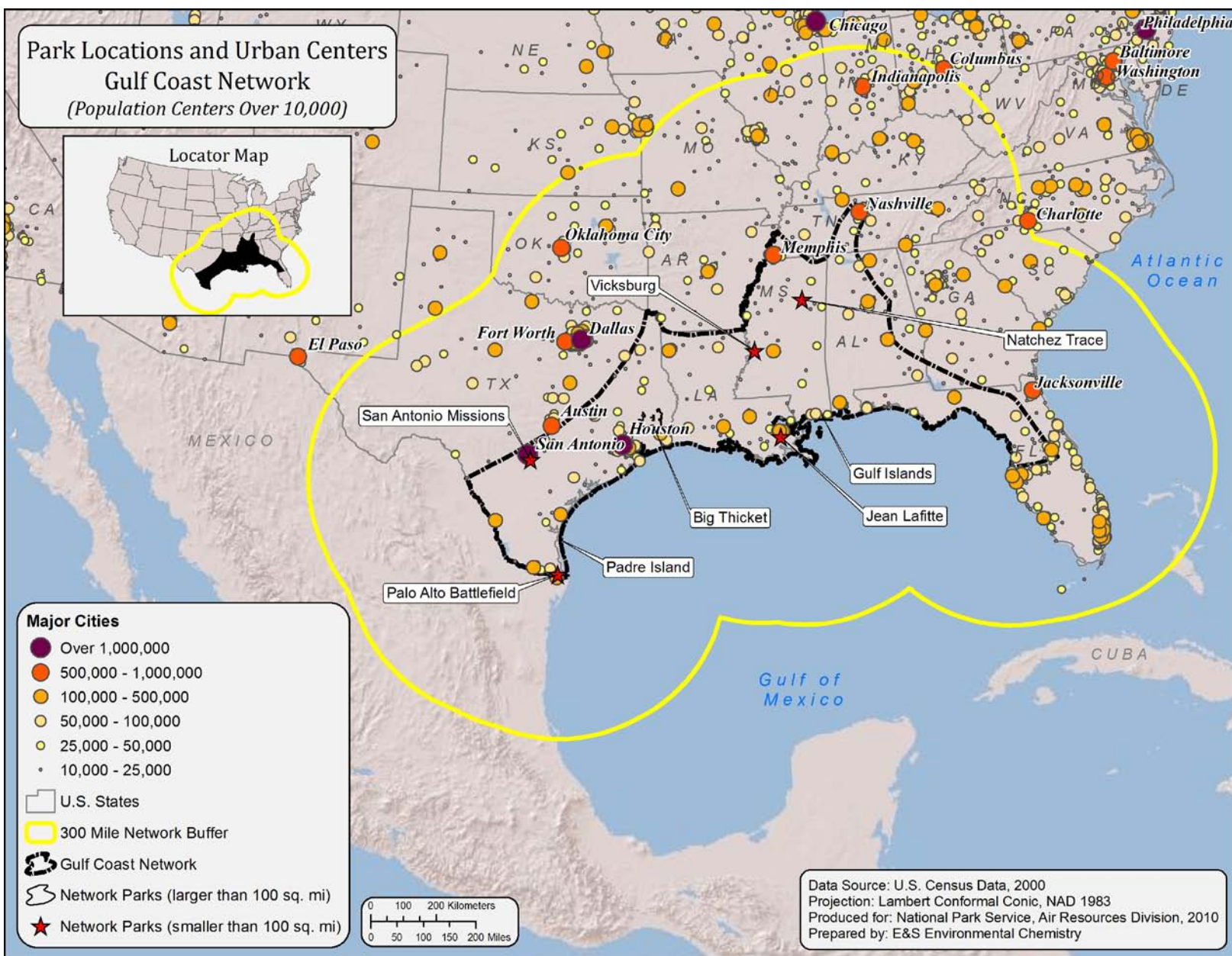
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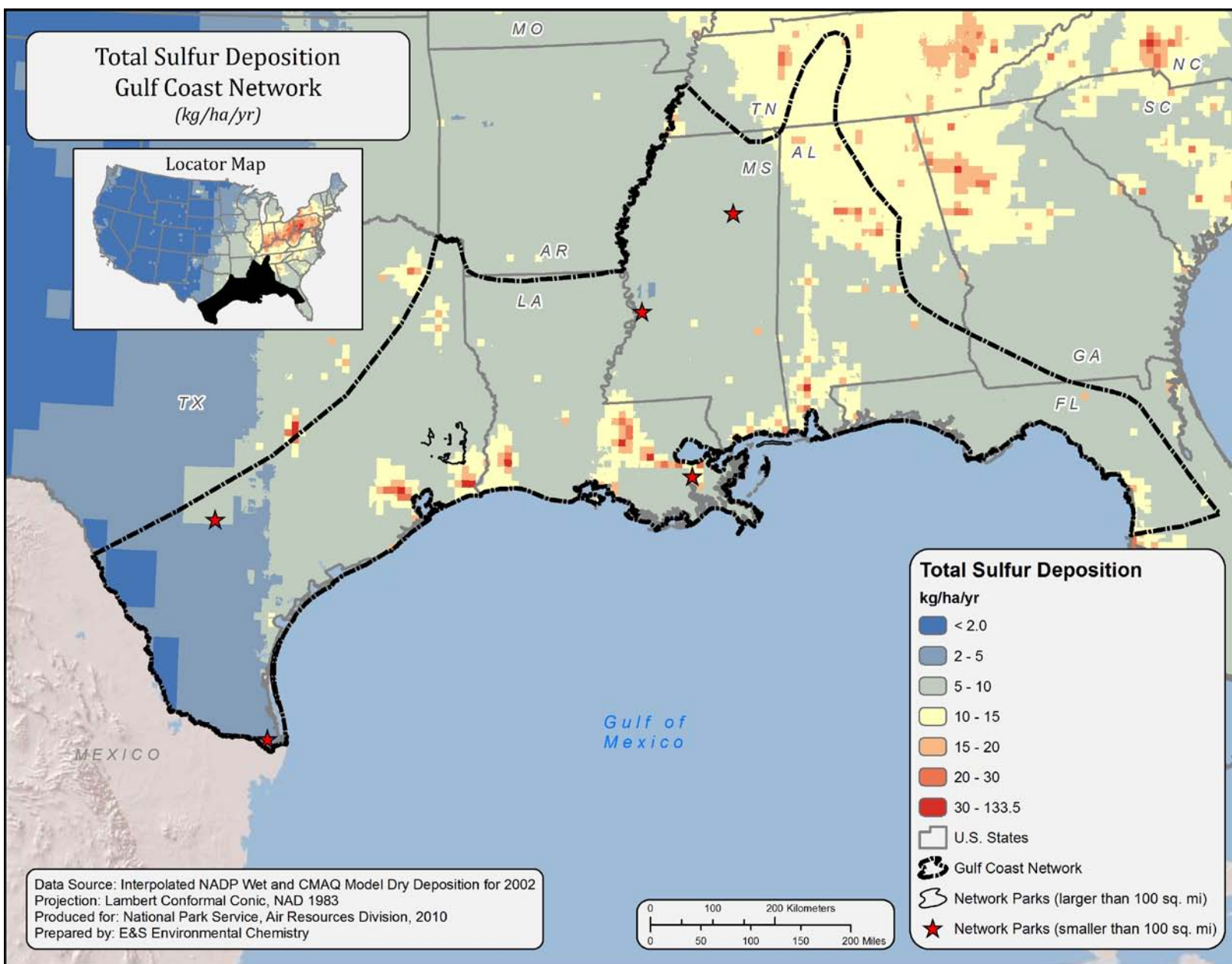
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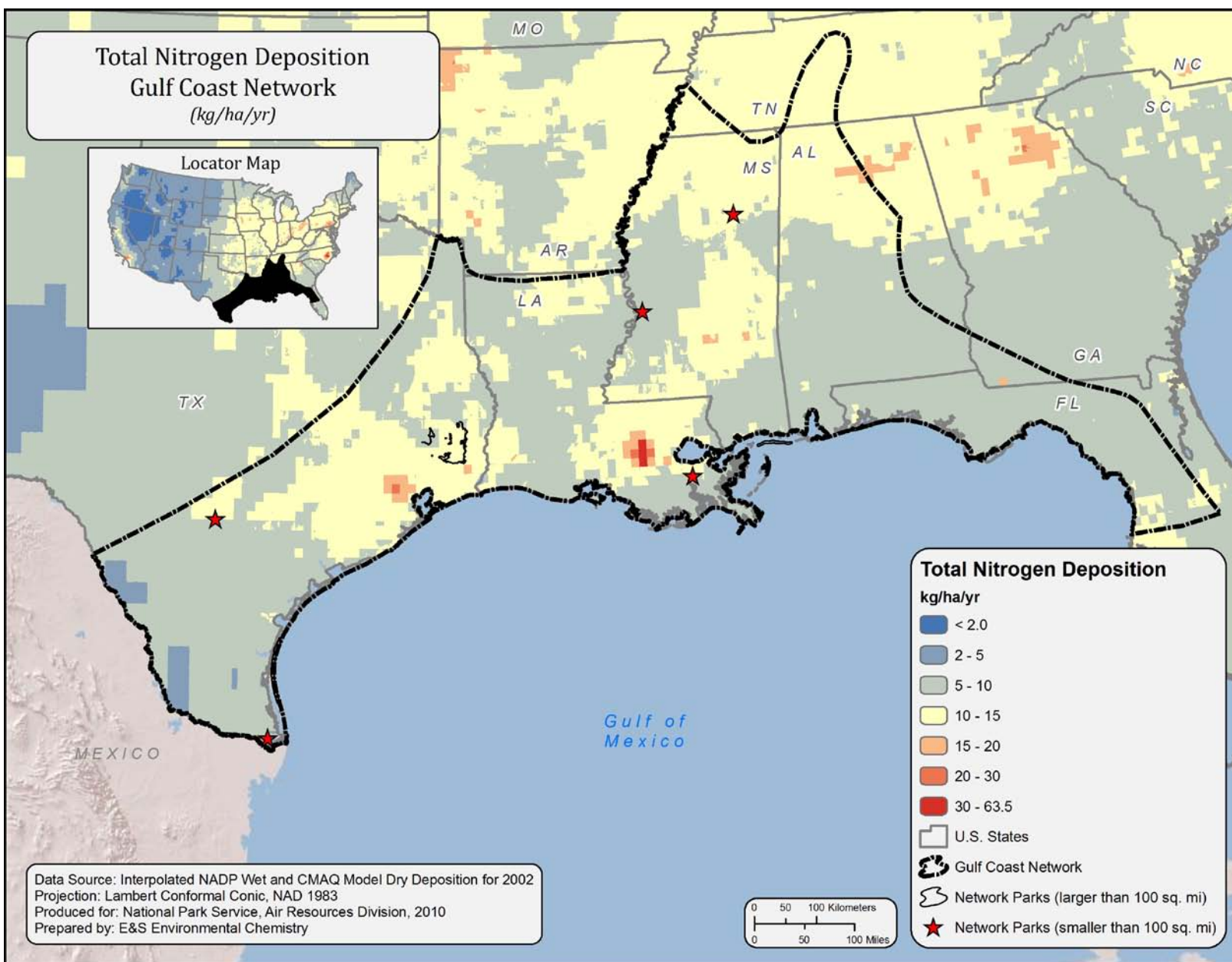
Map H



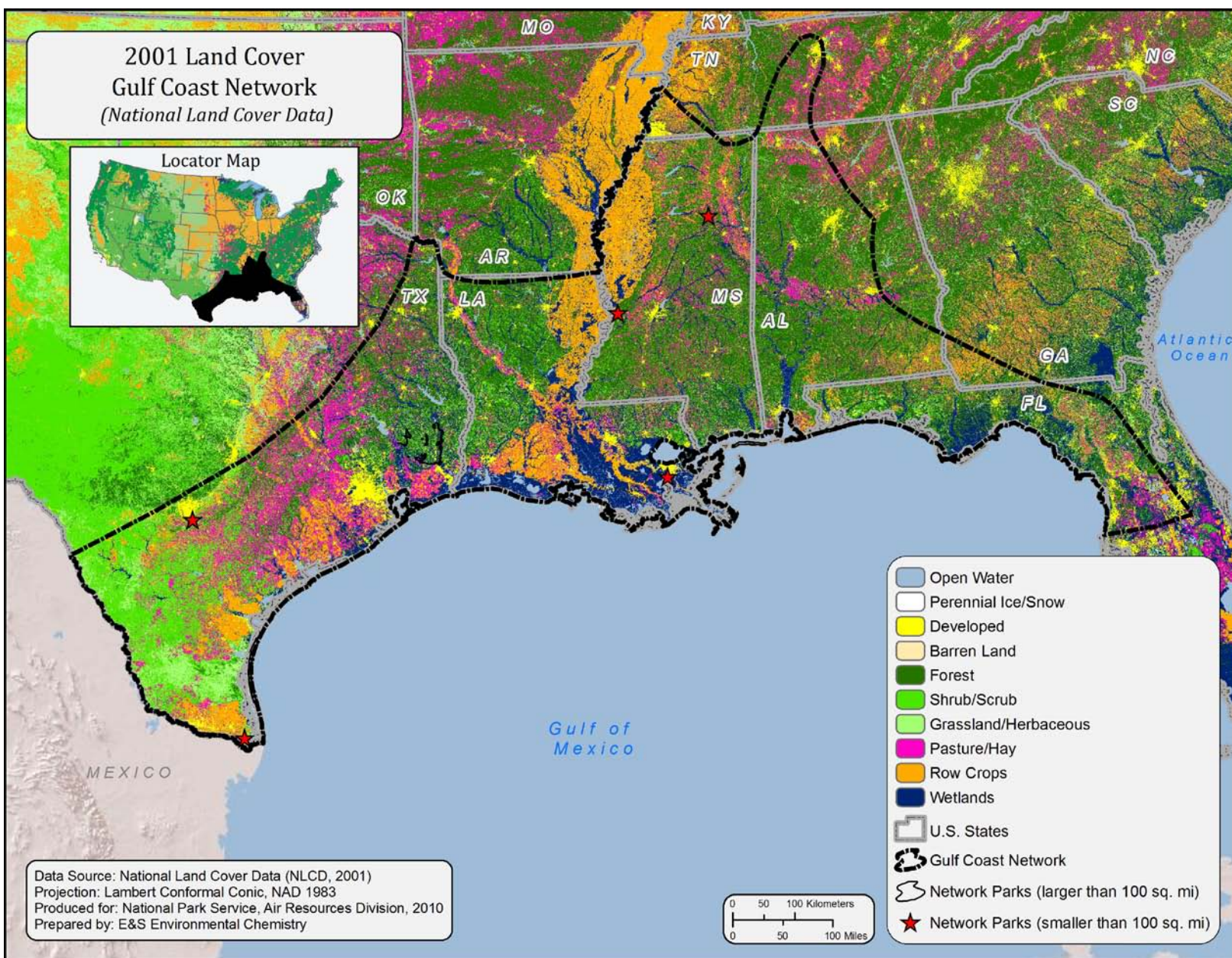
Map I



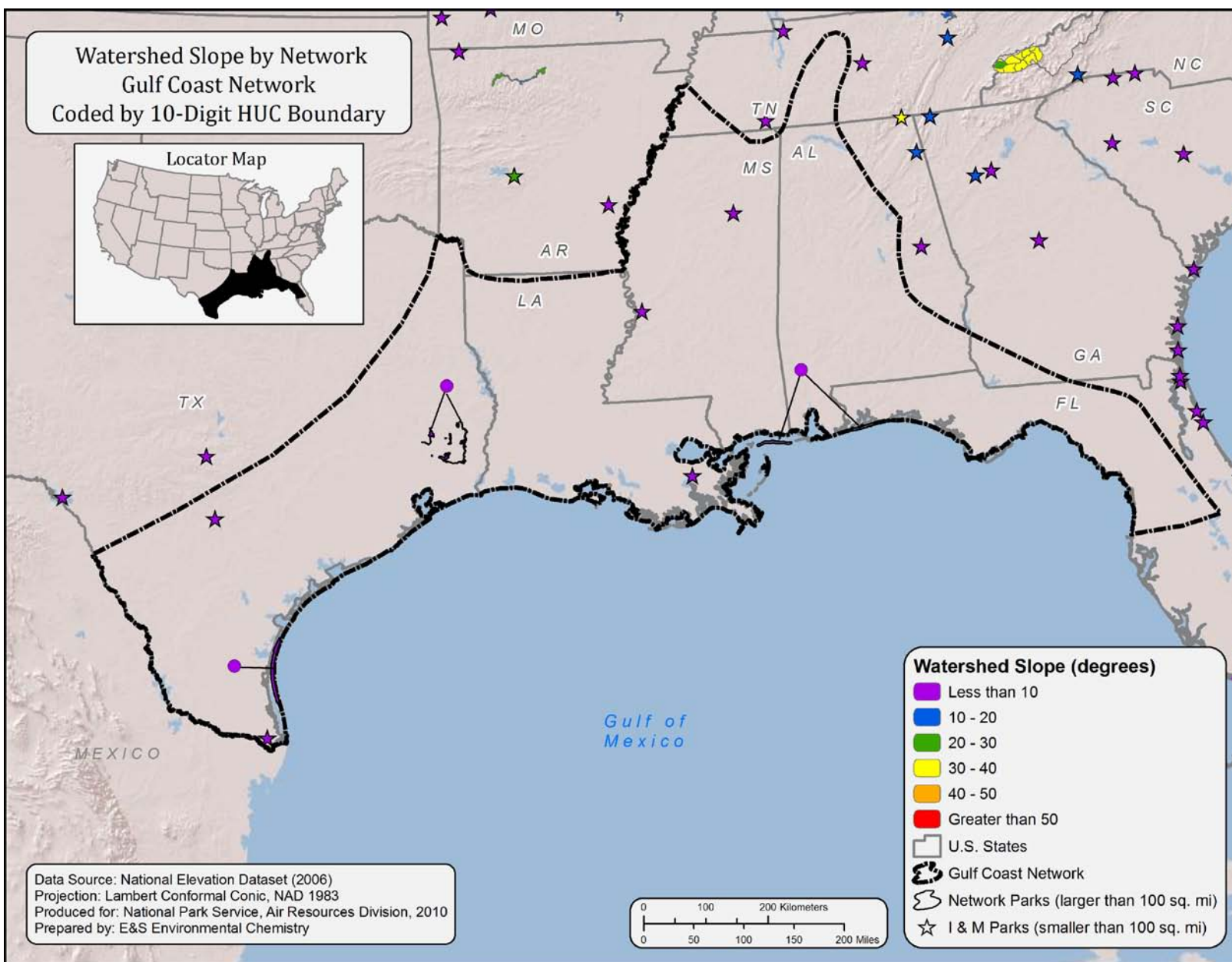
Map J



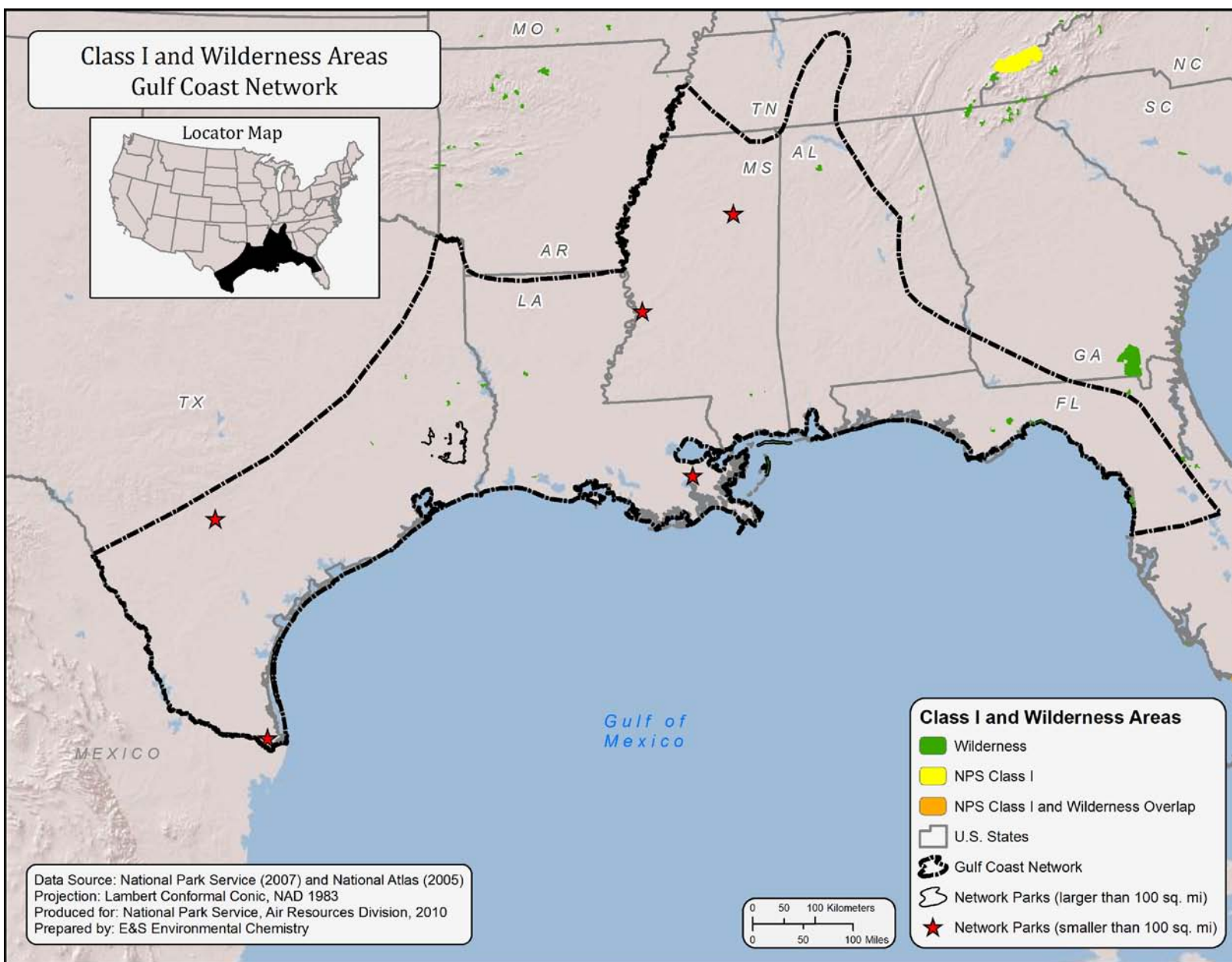
Map K



Map L



Map M



Map N

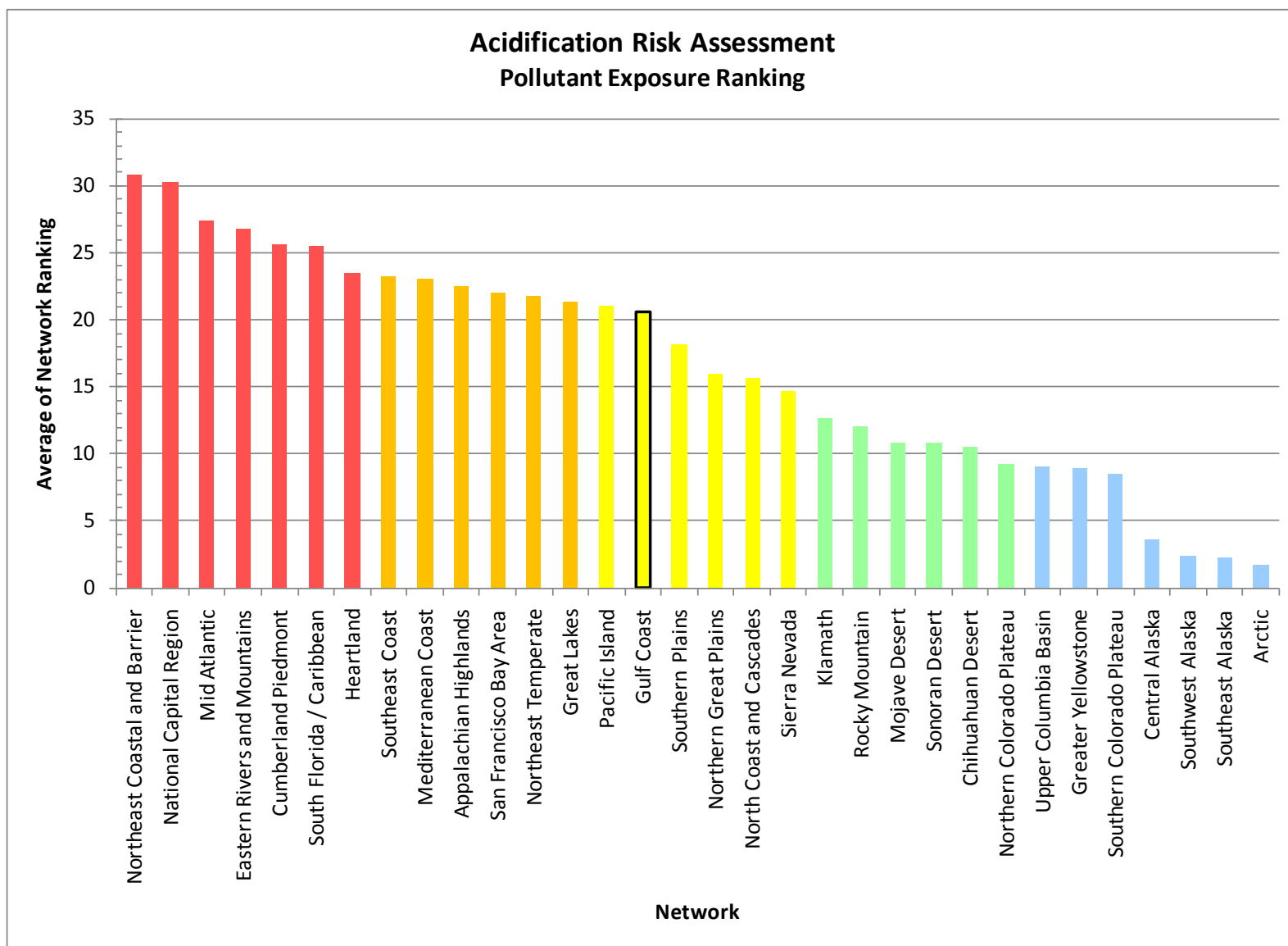


Figure A

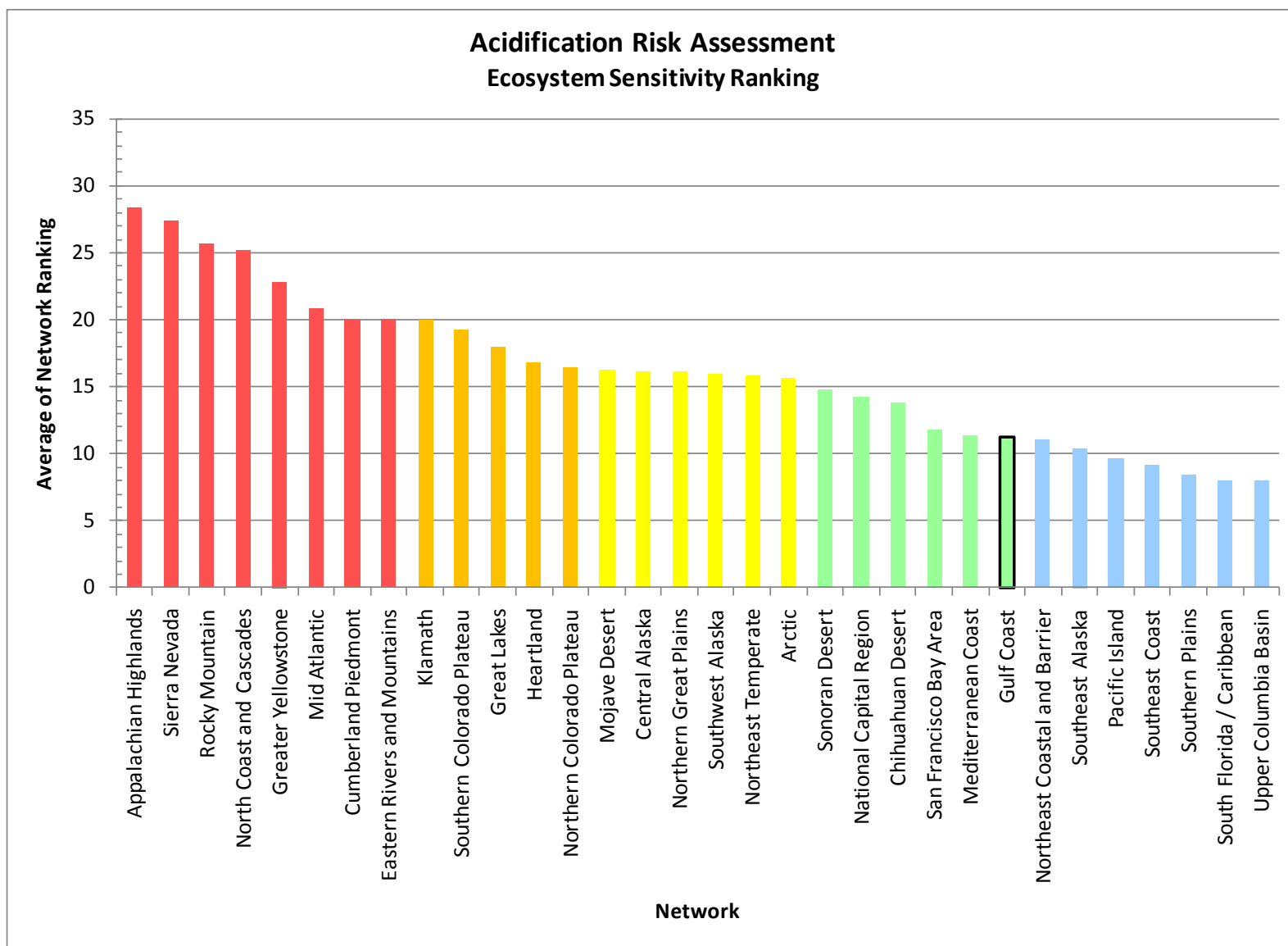


Figure B

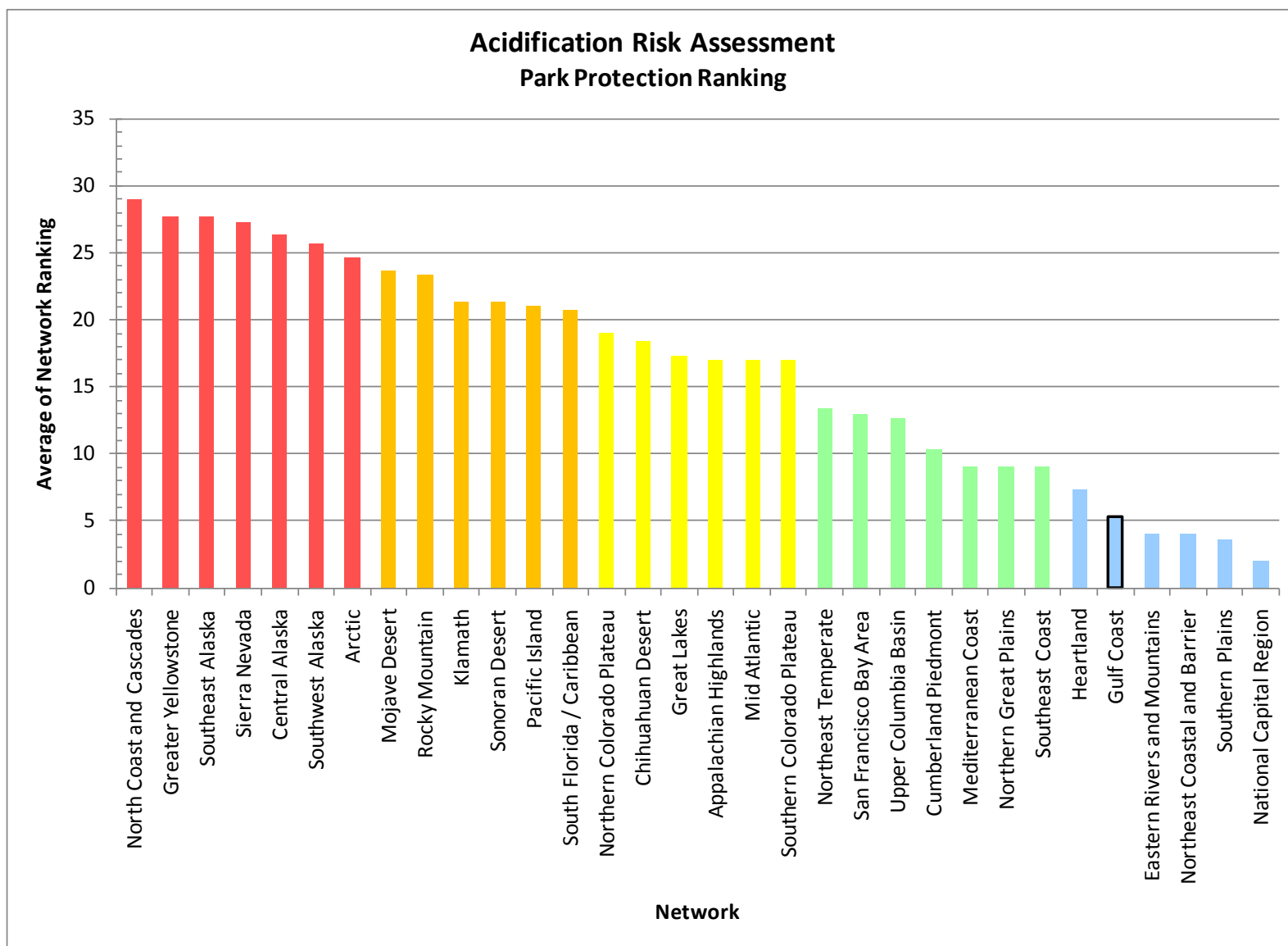


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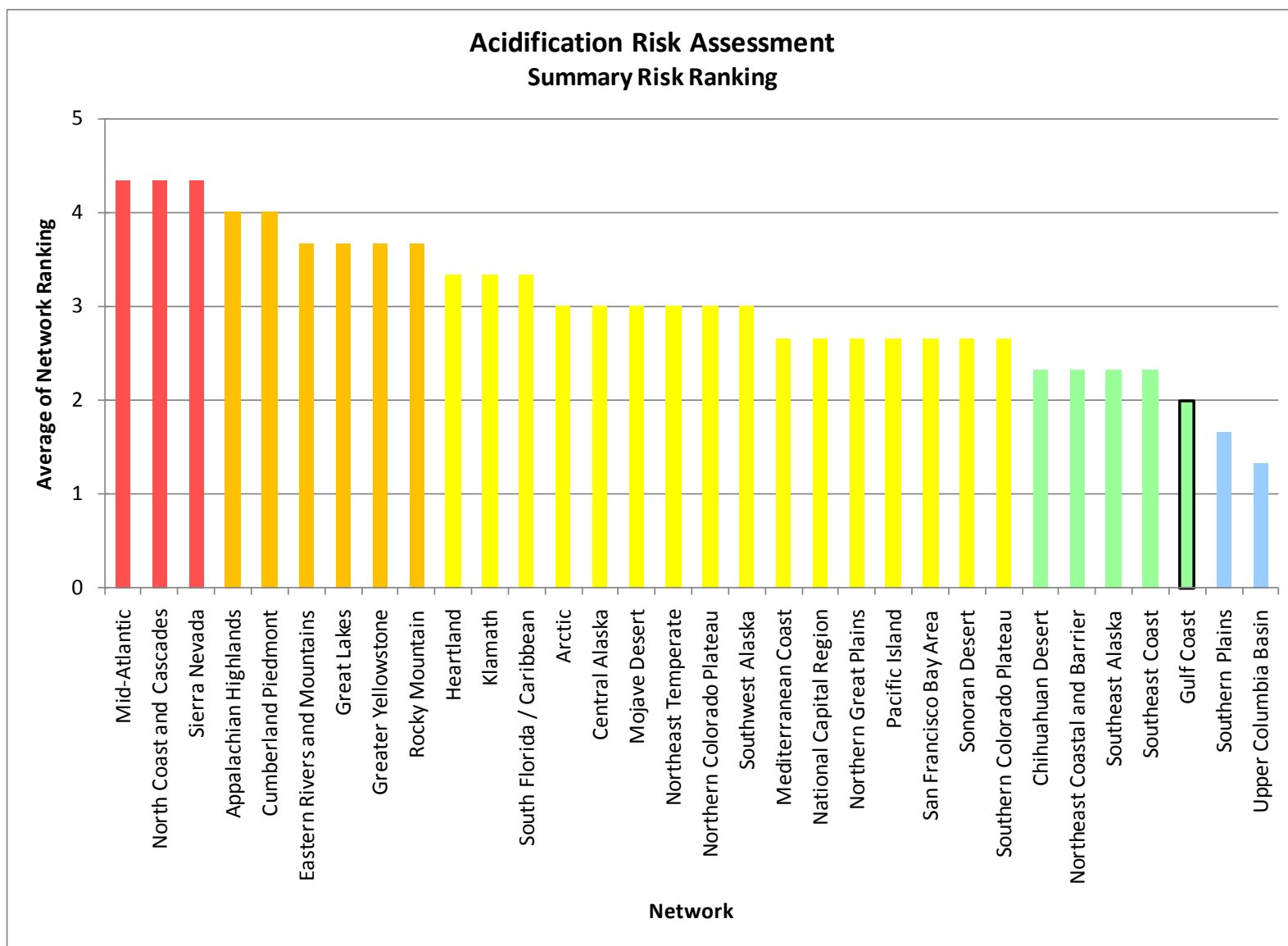


Figure D

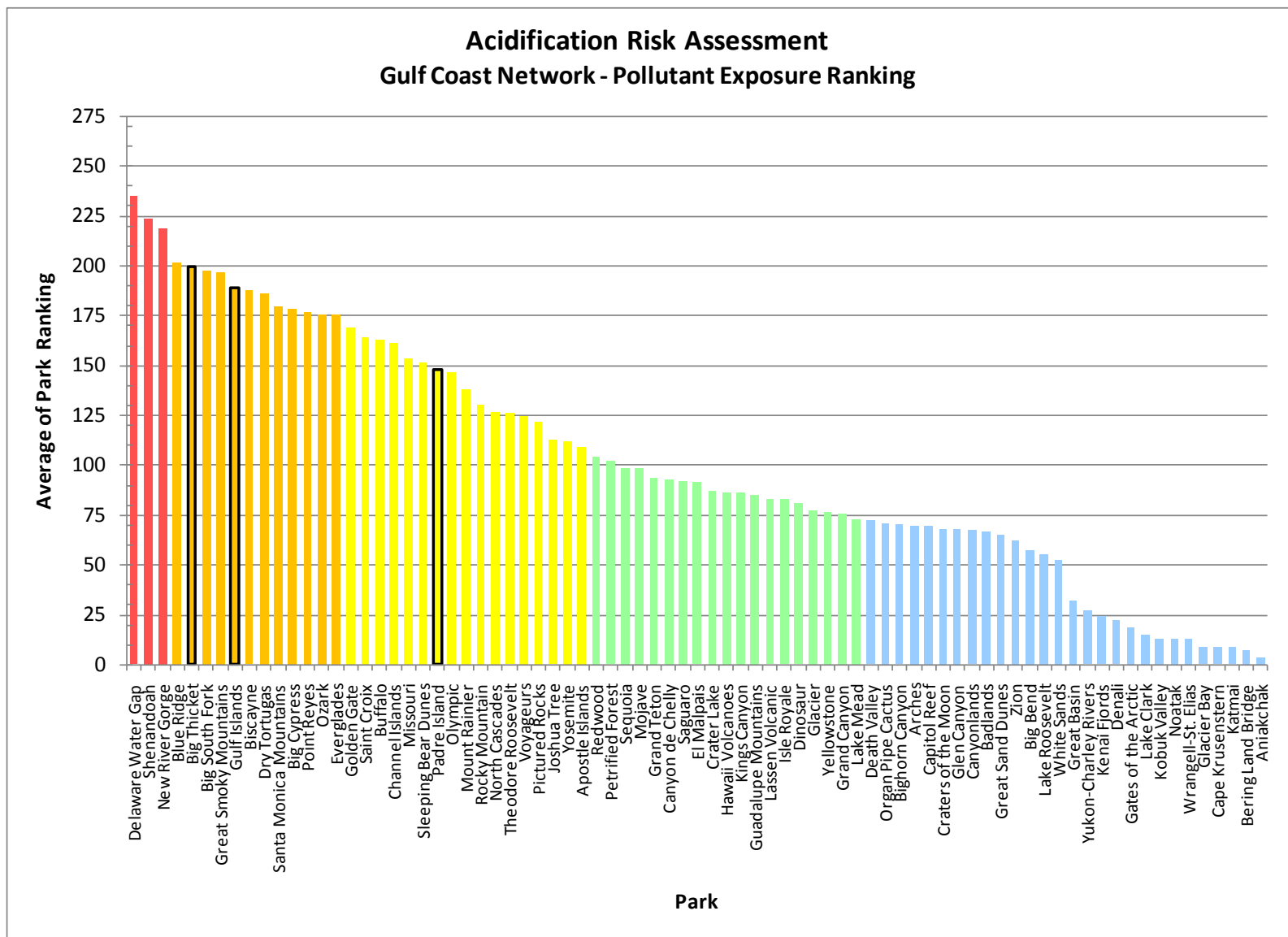


Figure E

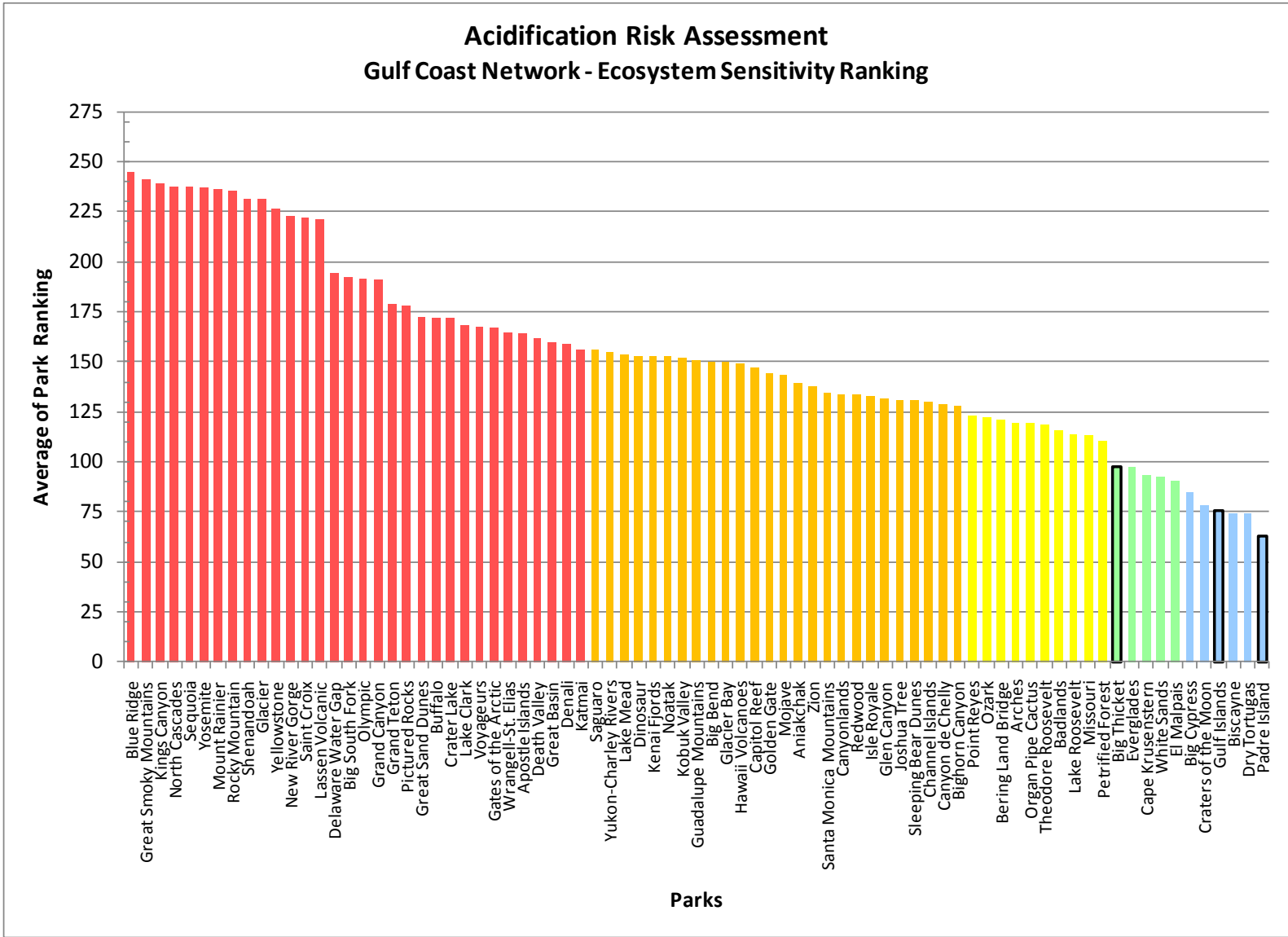


Figure F

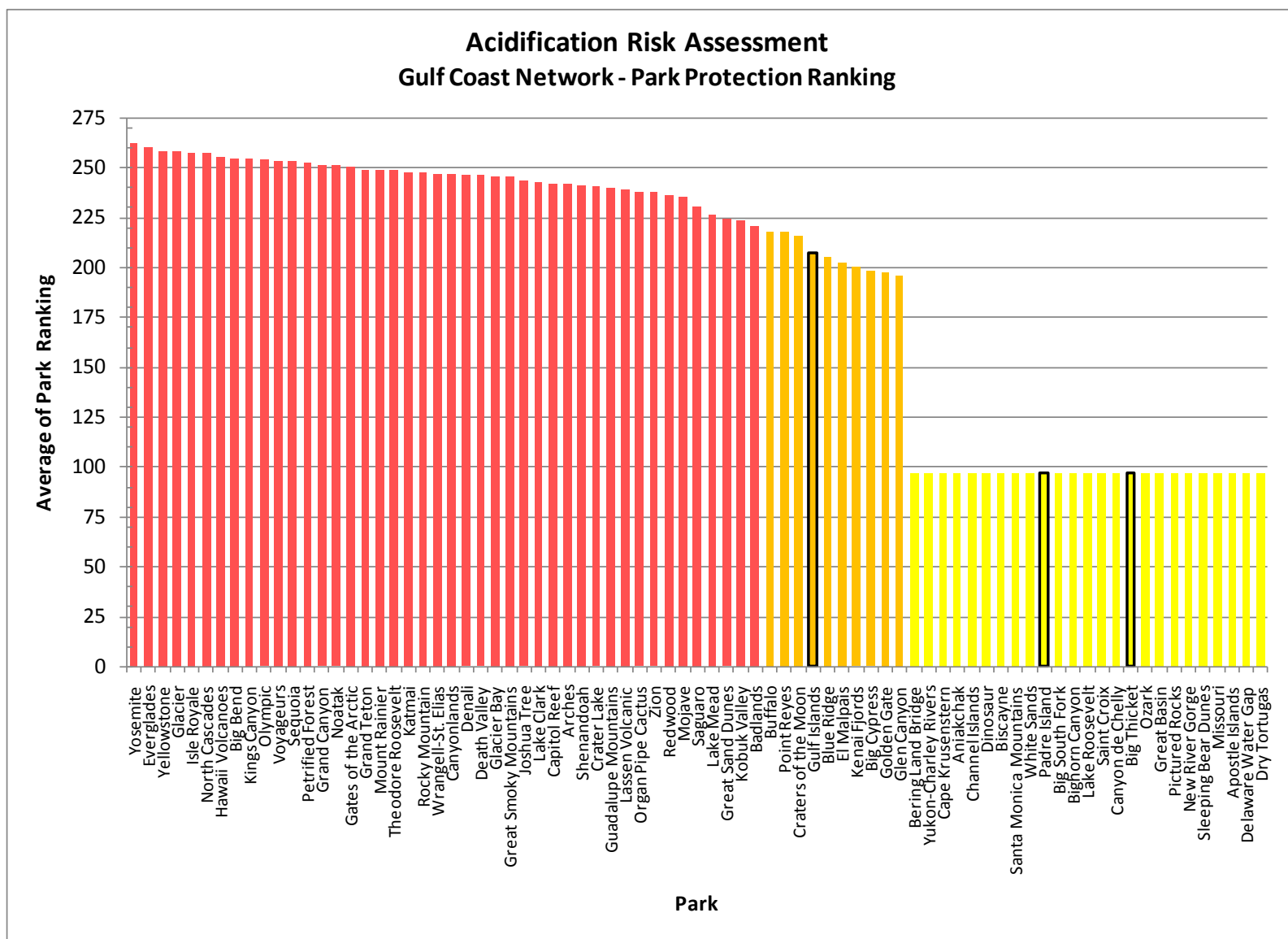


Figure G

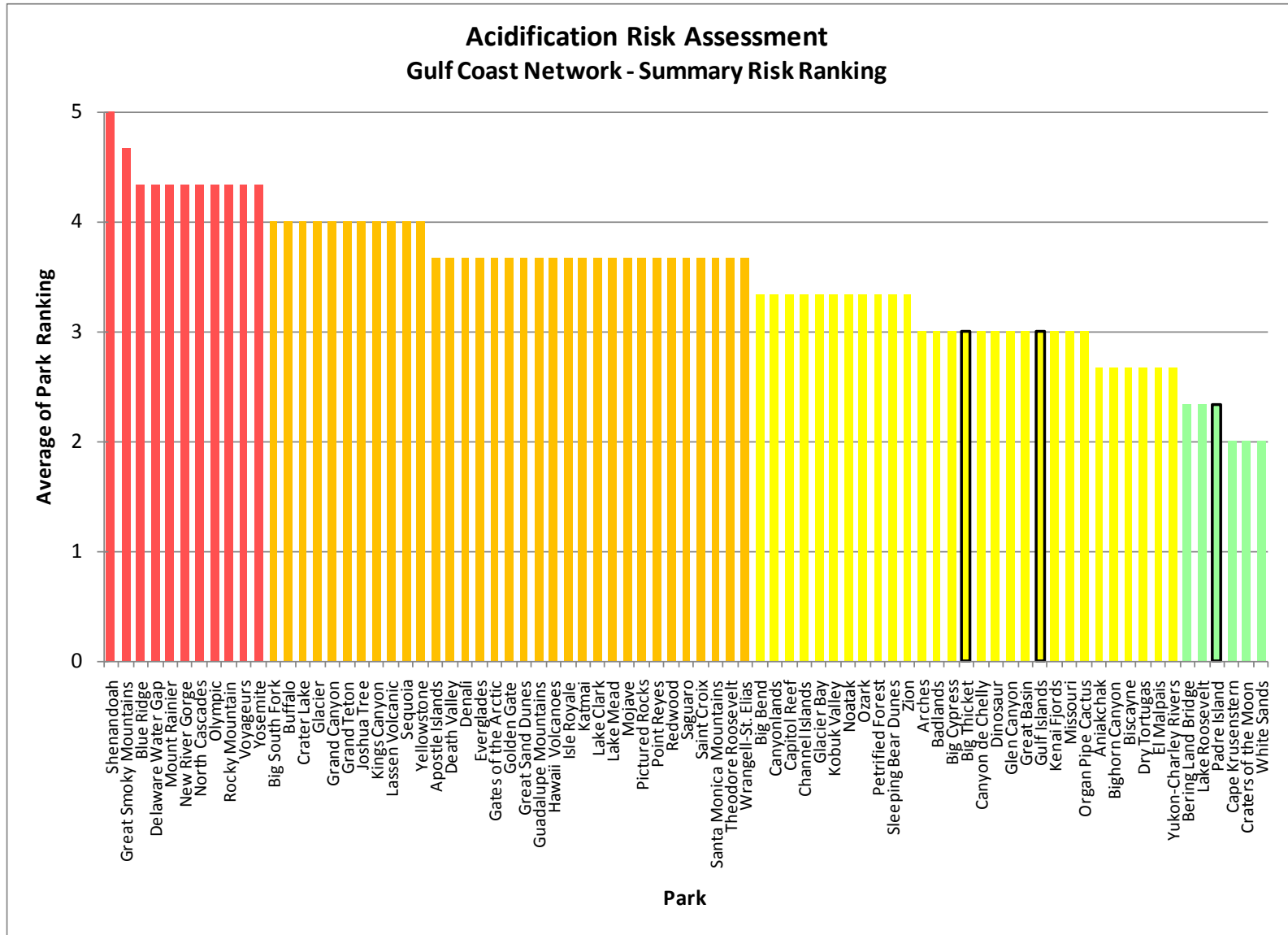


Figure H

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 910/107394, April 2011

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