



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

Southern Plains Network (SOPN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/380



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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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/>).

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Southern Plains Network (SOPN)

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 ten parks in the Southern Plains Network. None are larger than 100 square miles. The network includes a number of large urban centers to the southeast and less developed land to the northwest.

Total annual S and N emissions, by county, are shown in Maps E and F, respectively, for lands in and surrounding the Southern Plains Network. County-level S emissions varied within the network, ranging from less than 1 ton per square mile in most of the network to one small area emitting more than 100 tons per square mile. Annual county N emissions ranged from less than 1 to 20 tons per square mile throughout most of the network. There were some scattered areas with annual N deposition between 20 and 50 tons per square mile. There were many point sources of both SO₂ (Map G) and oxidized and reduced N (Map H) throughout this network. Most SO₂ emissions were less than a 5,000 tons per year. The larger point sources of SO₂ were in Texas and Oklahoma. Sources of oxidized N emissions within the network were mainly concentrated in Texas (Map H). Sources of reduced N were concentrated primarily in Kansas.

Urban centers within the network and within a 300-mile buffer around the network are shown in Map I. There are several large population centers in and near the network. The largest include Dallas, San Antonio (just outside the network boundary), Austin, Ft. Worth, and Oklahoma City.

Total S and N deposition patterns in and around the network are shown in Maps J and K. Included in this analysis are both wet and dry forms of deposition and both the oxidized and reduced N species. Total S deposition in most of the Southern Plains Network ranged from less than 2 kg S/ha/yr to up to 5 to 10 kg S/ha/yr. There were some scattered small areas with higher S deposition, one with more than 30 kg S/ha/yr. Total N deposition within the majority of this network ranged from less than 5 kg N/ha/yr to 10 to 15 kg N/ha/yr; a few scattered areas showed higher amounts. Both total S and total N deposition within this network generally increased from west to east.

Land cover in and around the network is shown in Map L. The predominant cover types within this network are varied, and include row crops, grassland/herbaceous, shrubland, pasture/hay, forest, and developed areas.

Land slope within the parks that occur in this network is shown in Map M. The slope for most of the parks is less than 10°; the terrain in two parks is steeper, with Capulin Volcano (CAVO) having average slope more than 30°.

Park lands requiring special protection against potential adverse impacts associated with acidic deposition are shown on Map N. Also shown on Map N are all federal lands designated as wilderness, both lands managed by NPS and lands managed by other federal agencies. The land designations used to identify this heightened protection included Class I designation under the

Clean Air Act Amendments and wilderness designation. There are no NPS Class I or wilderness areas in this network, and there are few wilderness areas outside NPS jurisdiction.

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 Southern Plains Network ranked near the median, in the third quintile among networks in Pollutant Exposure (Figure A). Emissions and deposition within the network were both moderate. The network Ecosystem Sensitivity ranking was Very Low, near the bottom of the lowest quintile among networks (Figure B). This is partially because this region is not known to have acid-sensitive surface waters and geology, and there are no sugar maple or red spruce trees in the I&M parks that occur in this network, the vegetation types expected to be especially sensitive to acidic deposition. In addition, there are no high elevation lakes and few low-order, high-elevation streams. This network ranked in the lowest quintile in Park Protection, having very little protected land (Figure C). In combination, the network rankings for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection yielded an overall Network Risk ranking that is at the low end of the distribution among networks (Figure D).

Because there are no I&M parks in this network that are larger than 100 square miles, figures are not shown to compare parks in this network with the larger parks throughout the NPS system. Relative ranks for all parks, including the smaller parks, are given in Table A and Appendix A.

Pollutant exposure varied from Very Low (two parks) to Moderate (six parks). The other two parks were ranked Low. Ecosystem Sensitivity was ranked in the second highest quintile for one park, Pecos (PECO). One park (Lake Meredith, LAMR) was ranked Moderate. The other parks were ranked Low (three parks) or Very Low (five parks) for this theme. All parks in this network were ranked in the middle quintile for Park Protection.

For the Summary Risk ranking, the parks in this network were ranked Very Low to Moderate for overall acidification risk.

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
Alibates Flint Quarries	Moderate	Low	Moderate	Moderate
Bent's Old Fort	Low	Very Low	Moderate	Low
Capulin Volcano	Very Low	Low	Moderate	Low
Chickasaw	Moderate	Low	Moderate	Moderate
Fort Larned	Moderate	Very Low	Moderate	Low
Fort Union	Very Low	Very Low	Moderate	Very Low
Lake Meredith	Moderate	Moderate	Moderate	Moderate
Lyndon B. Johnson	Moderate	Very Low	Moderate	Low
Pecos	Low	High	Moderate	Moderate
Washita Battlefield	Moderate	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).

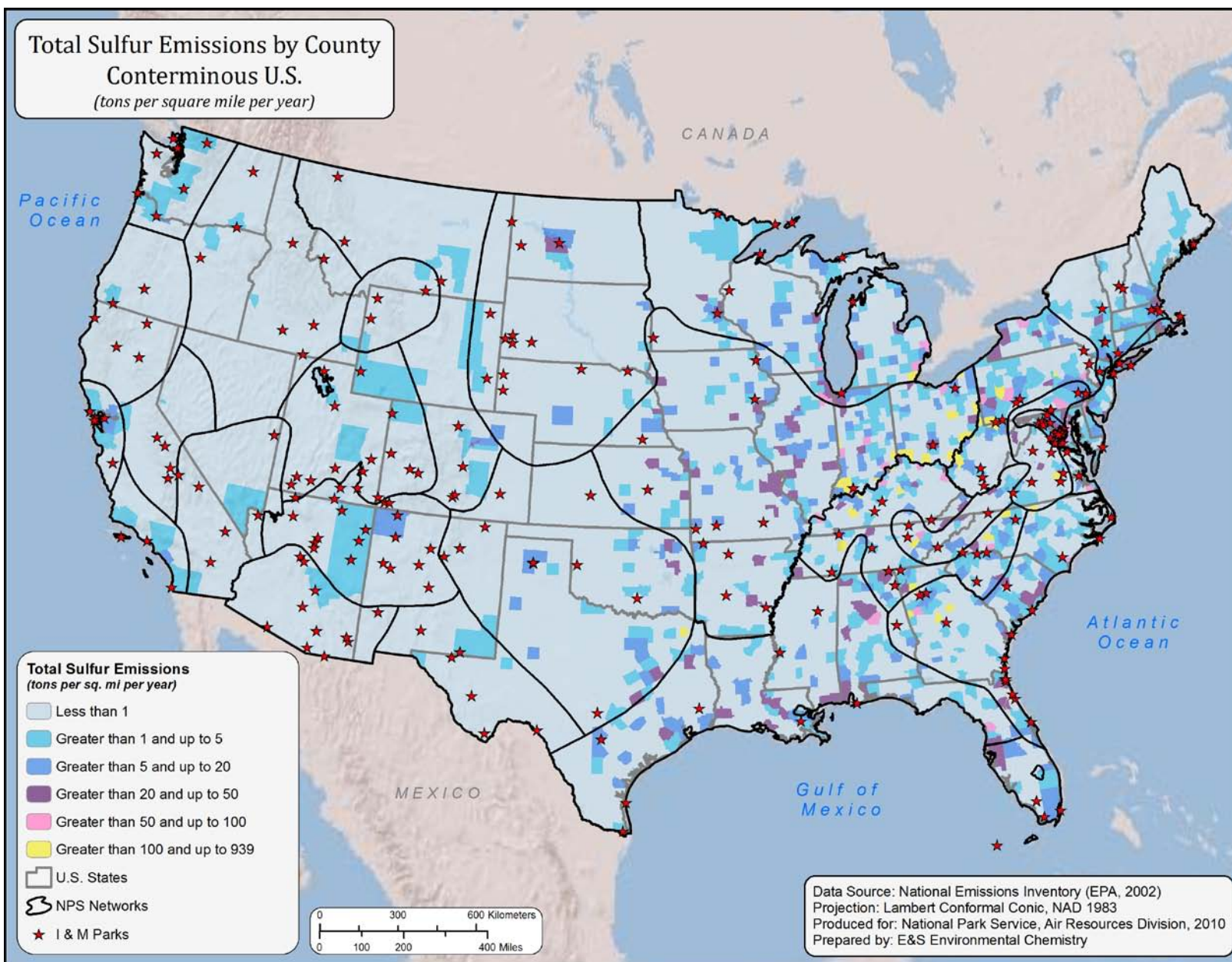
² Park name is printed in bold italic for parks larger than 100 square miles.

- 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

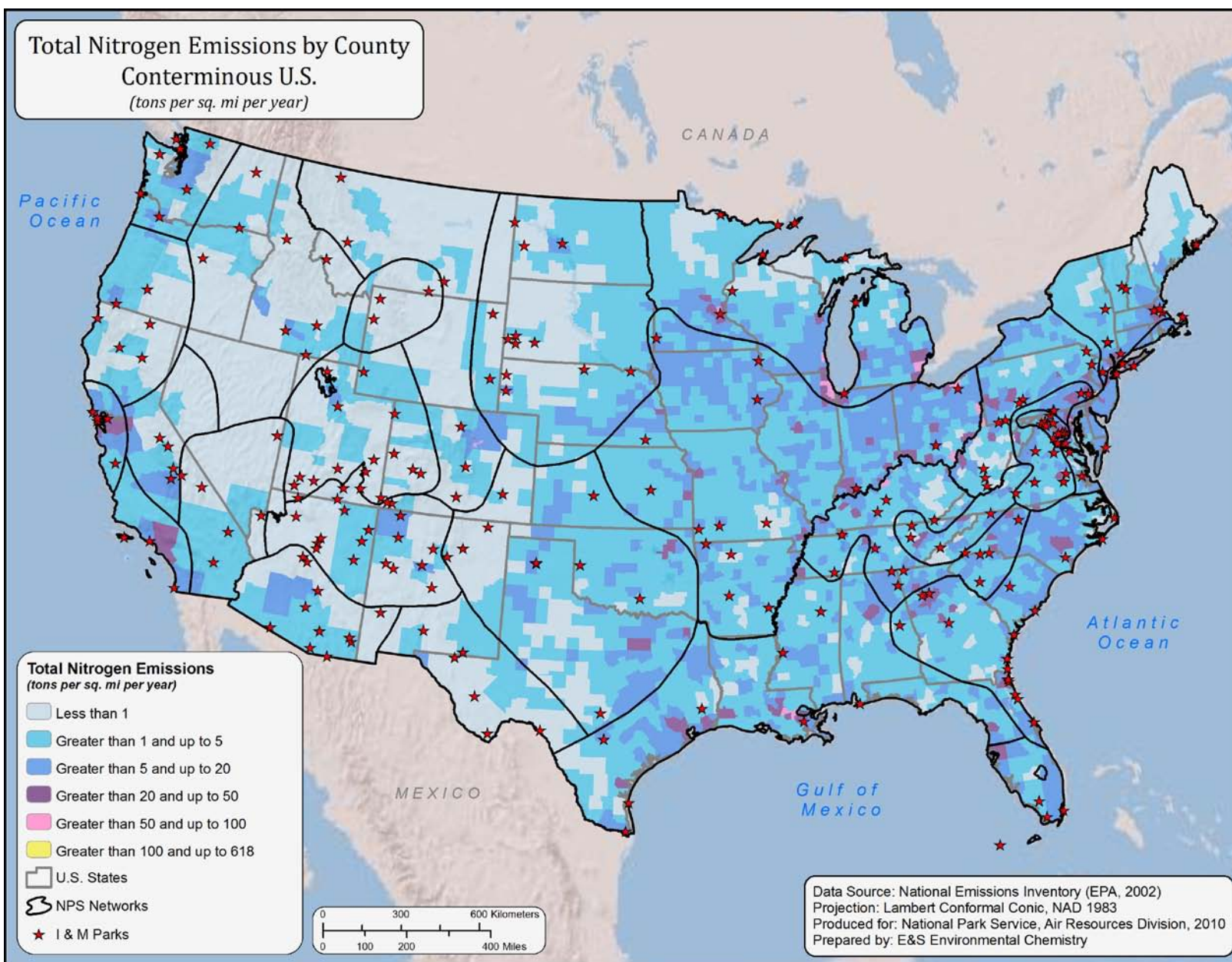
12-km CMAQ model projections for 2002. For the western half of the country, both wet and dry deposition values were derived from 36-km CMAQ model projections for 2002. NADP interpolations were performed using the approach of Grimm and Lynch (1997). CMAQ model projections were provided by Robin Dennis, 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. (Source of data: U.S. EPA National Elevation Dataset [<http://ned.usgs.gov/>])

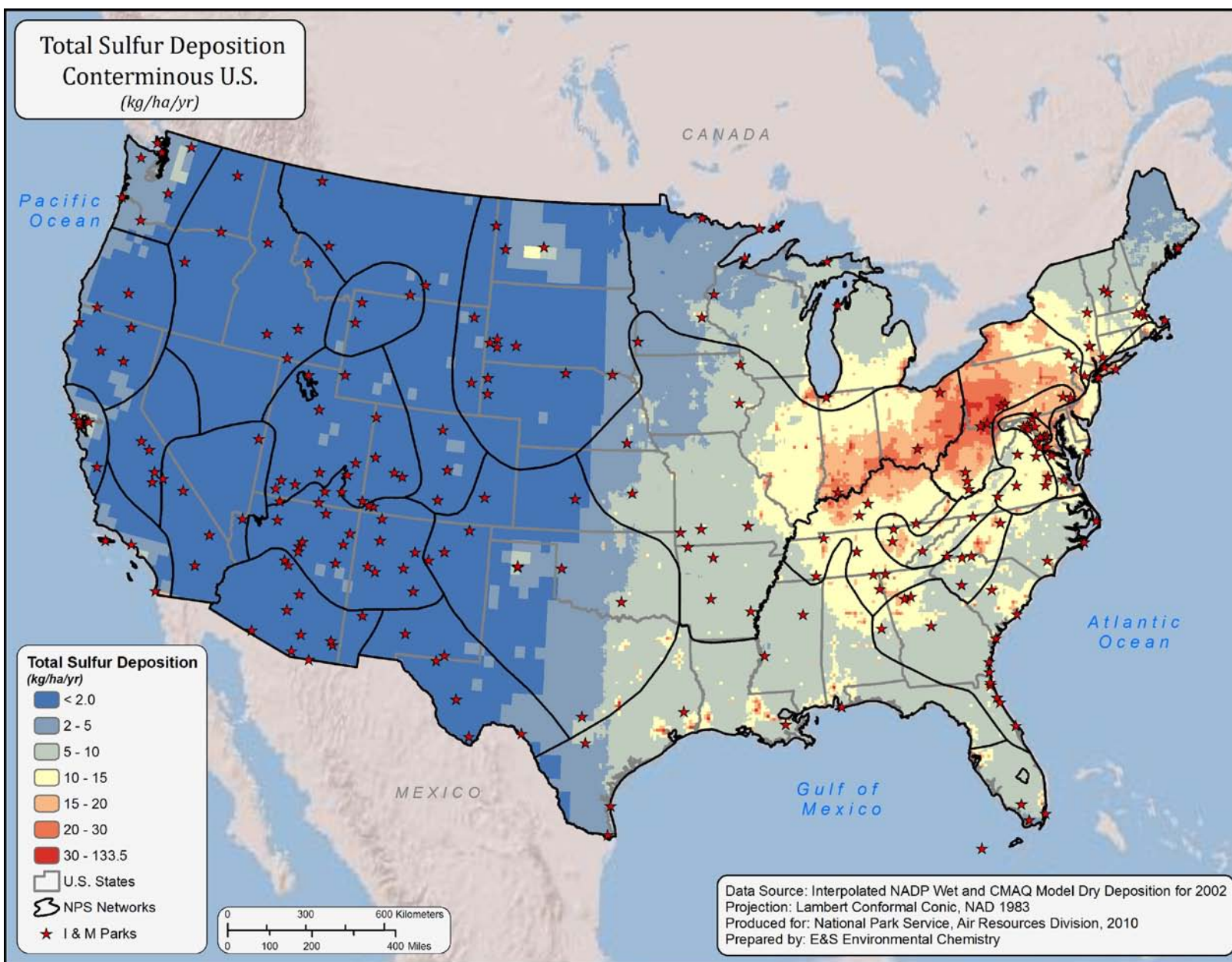
- Map N. Lands within the network that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; <http://nationalatlas.gov>] and NPS)
- Figure A. Network rankings for Pollutant Exposure, calculated as the average of scores for all Pollutant Exposure variables.
- Figure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



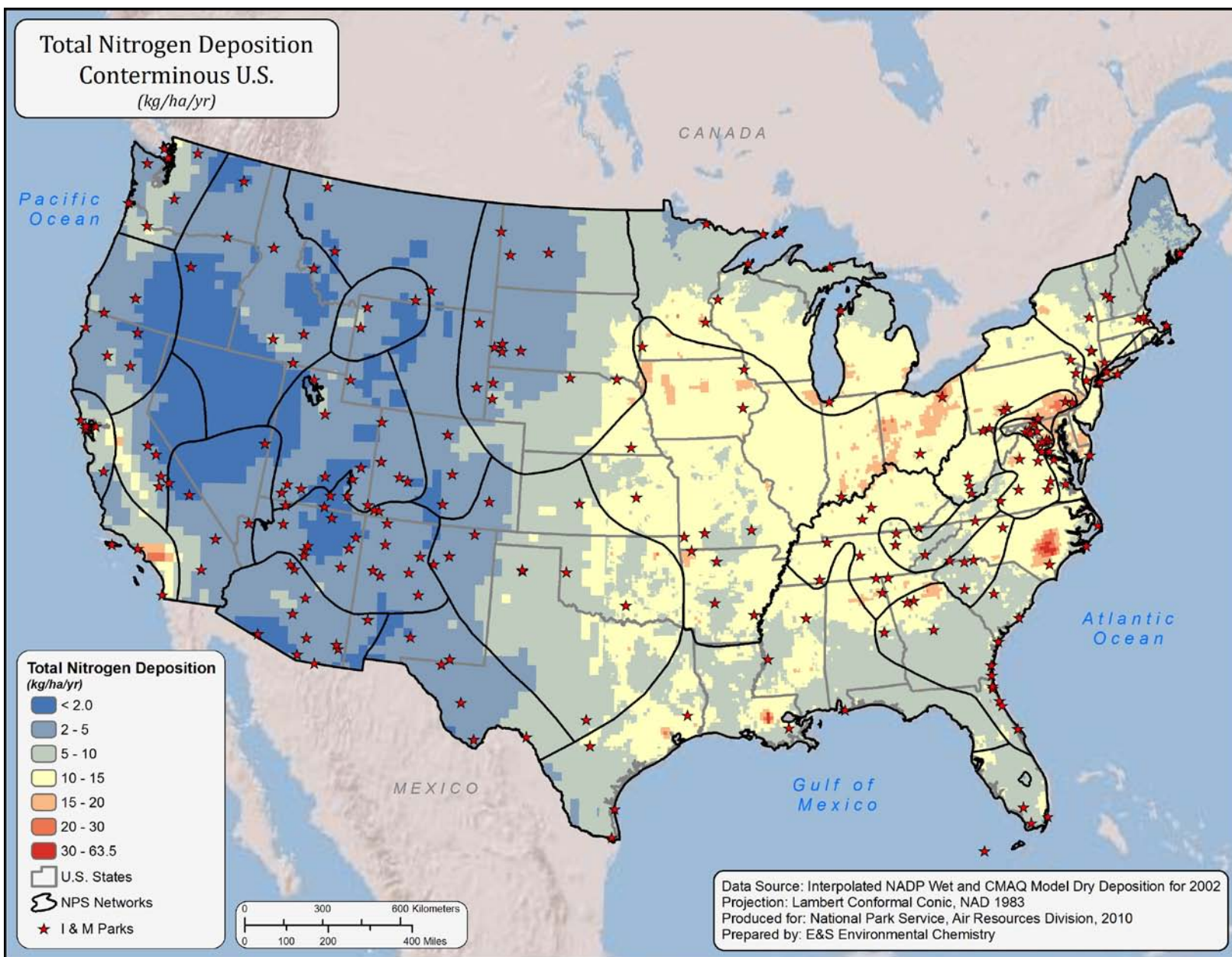
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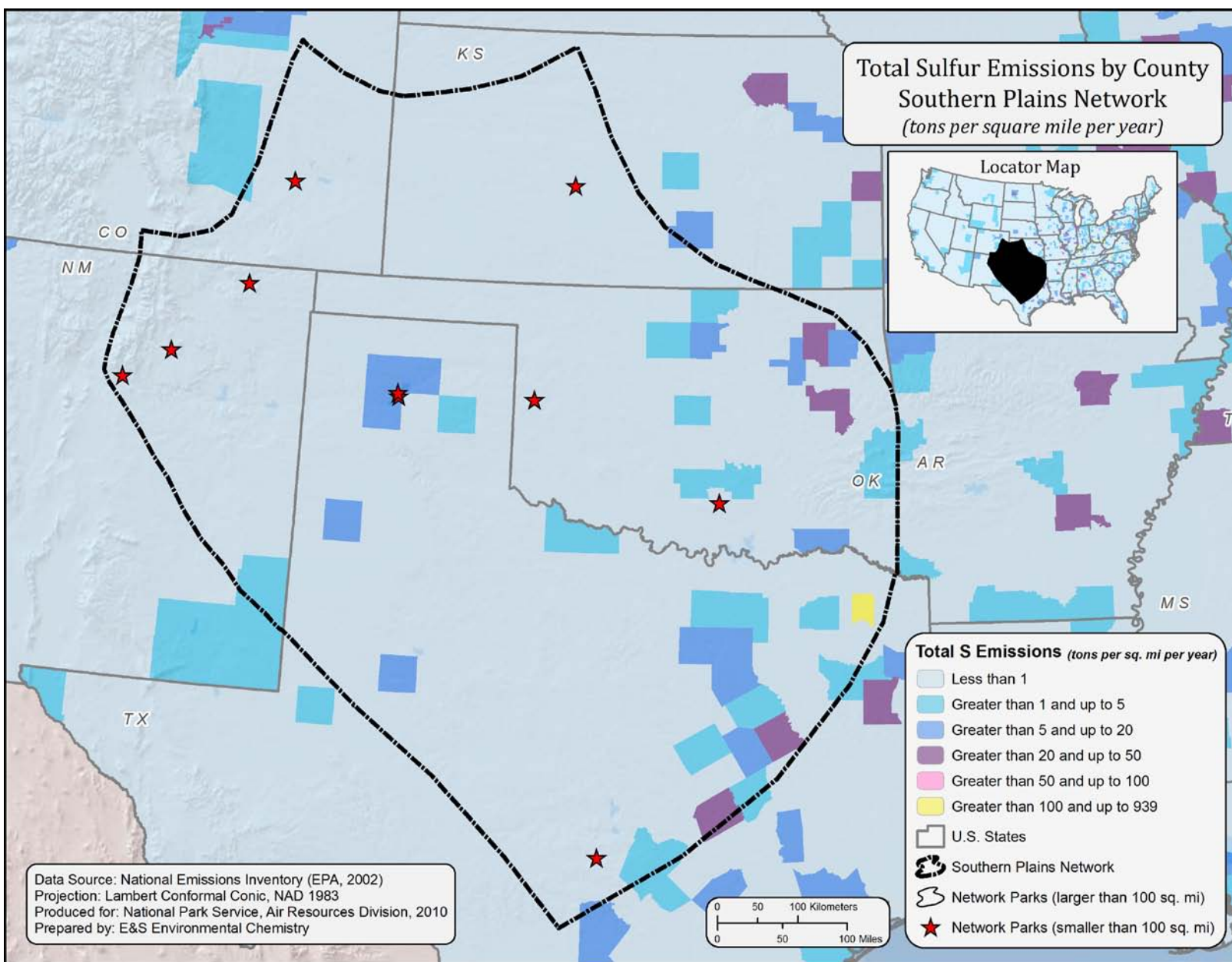
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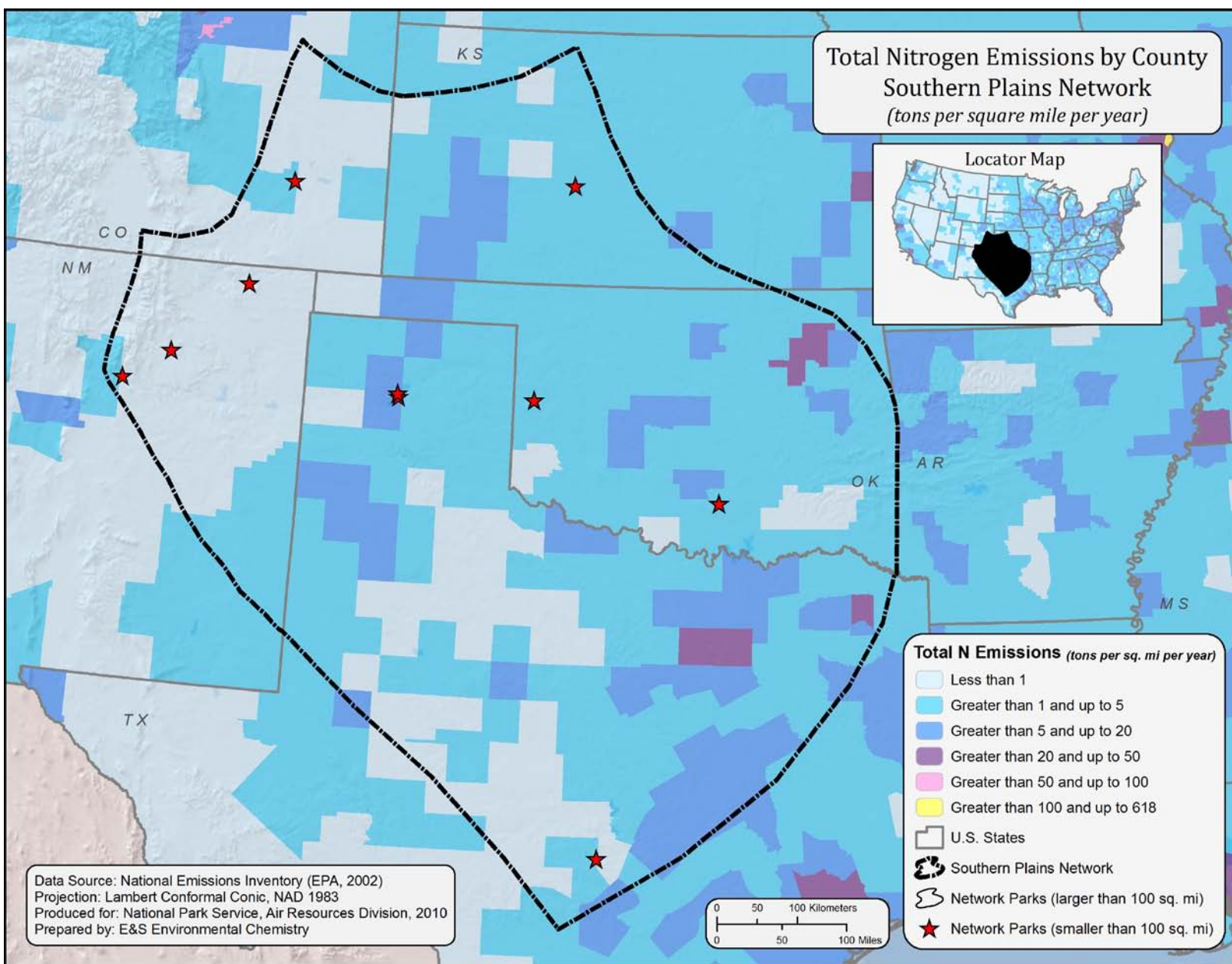
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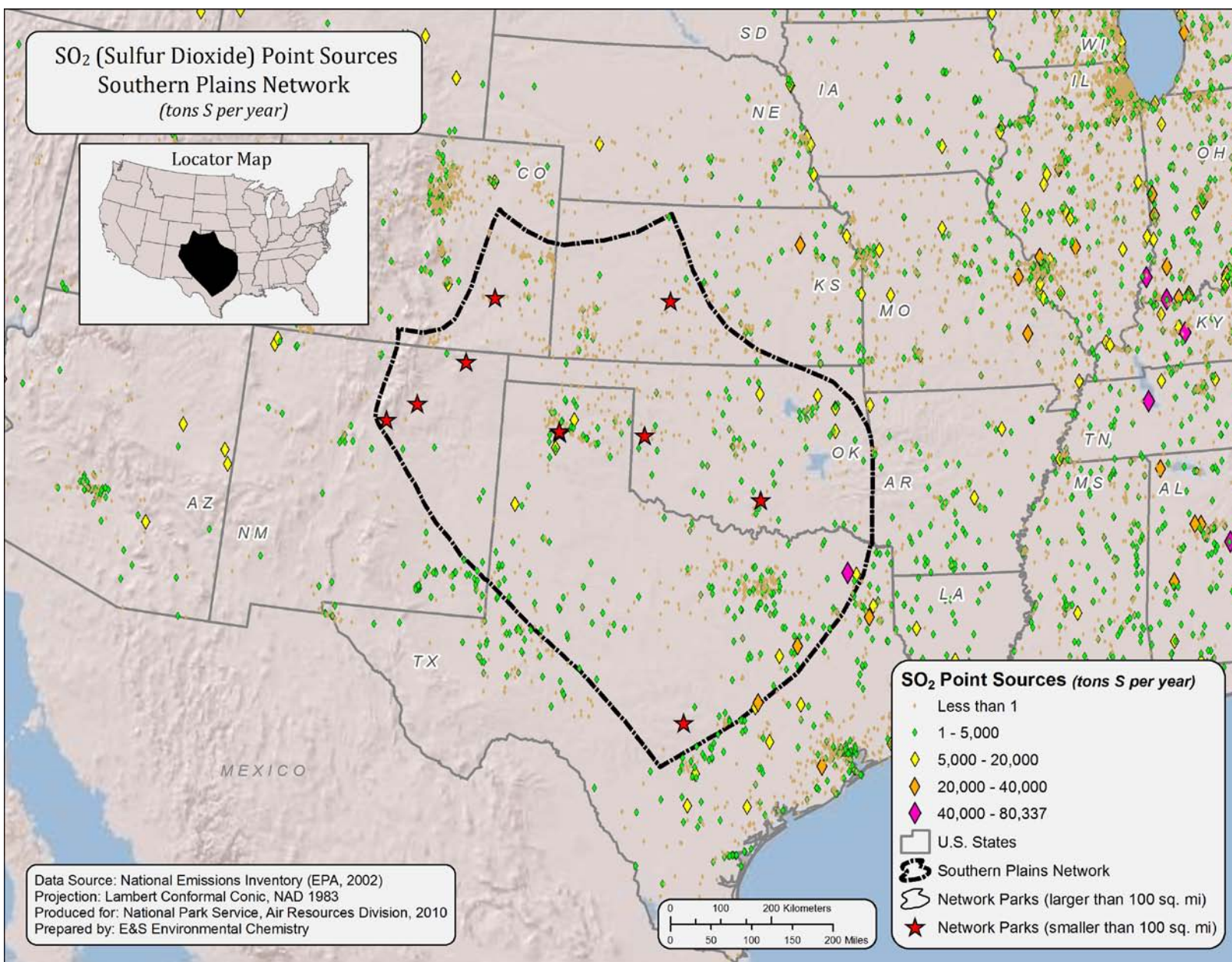
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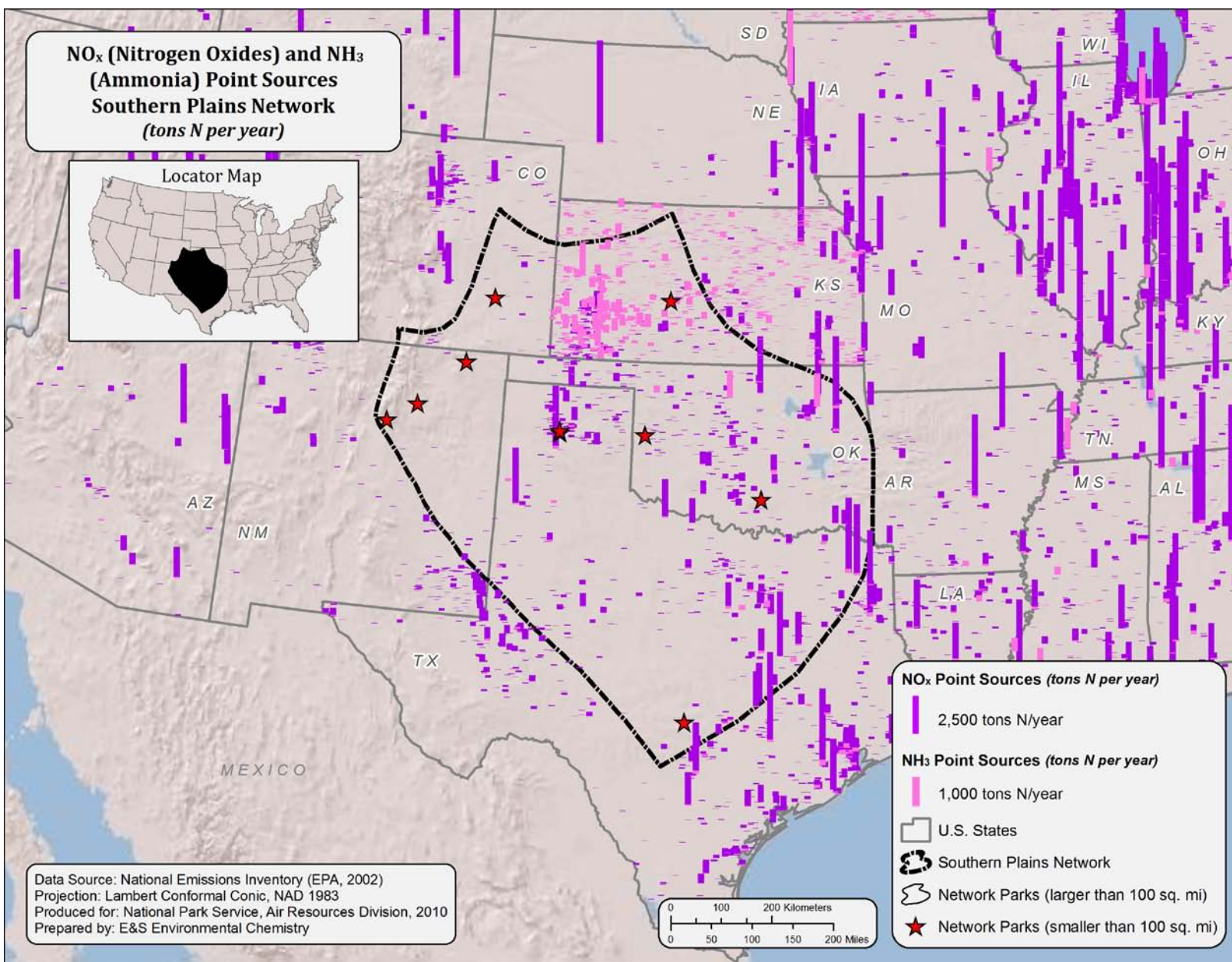
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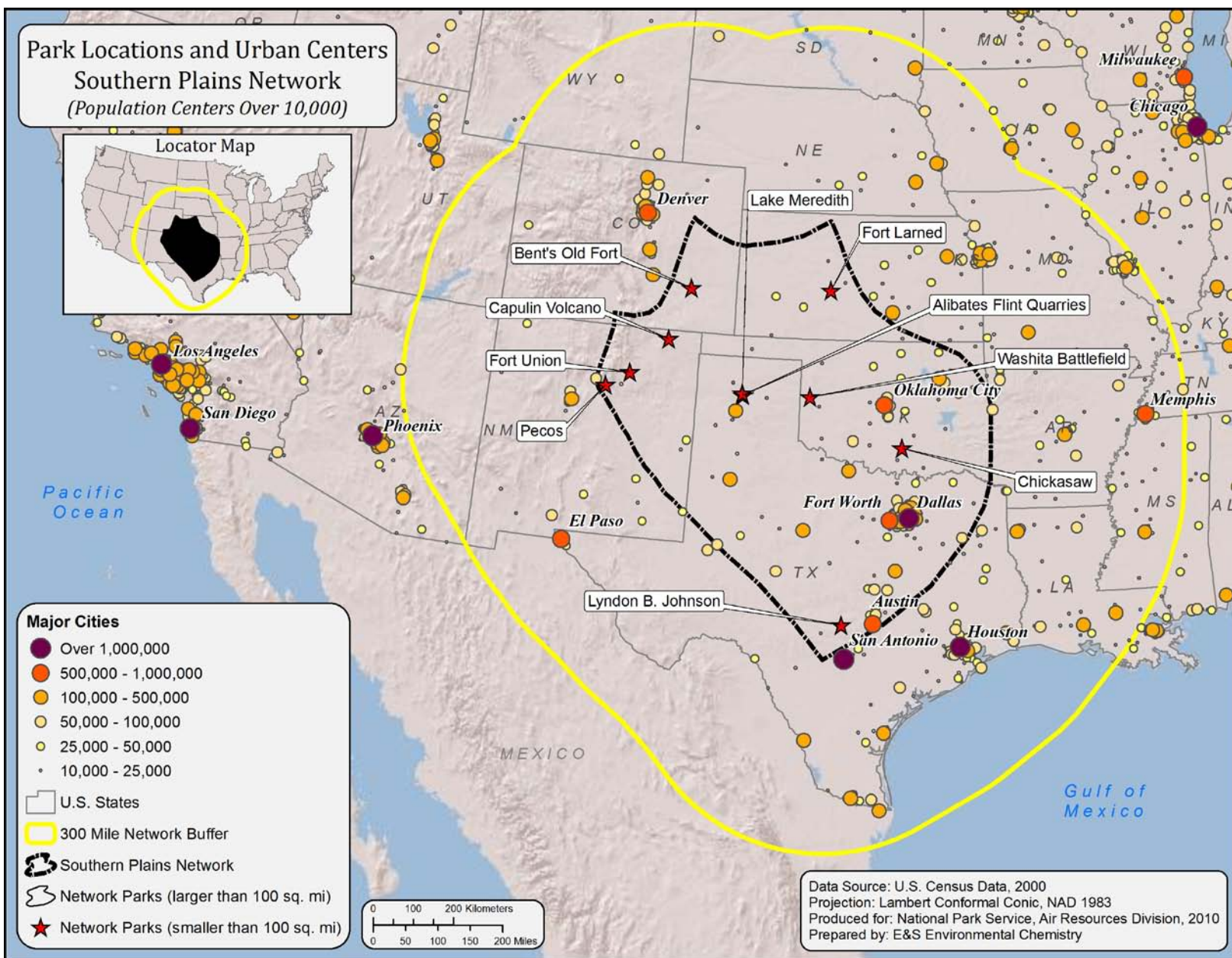
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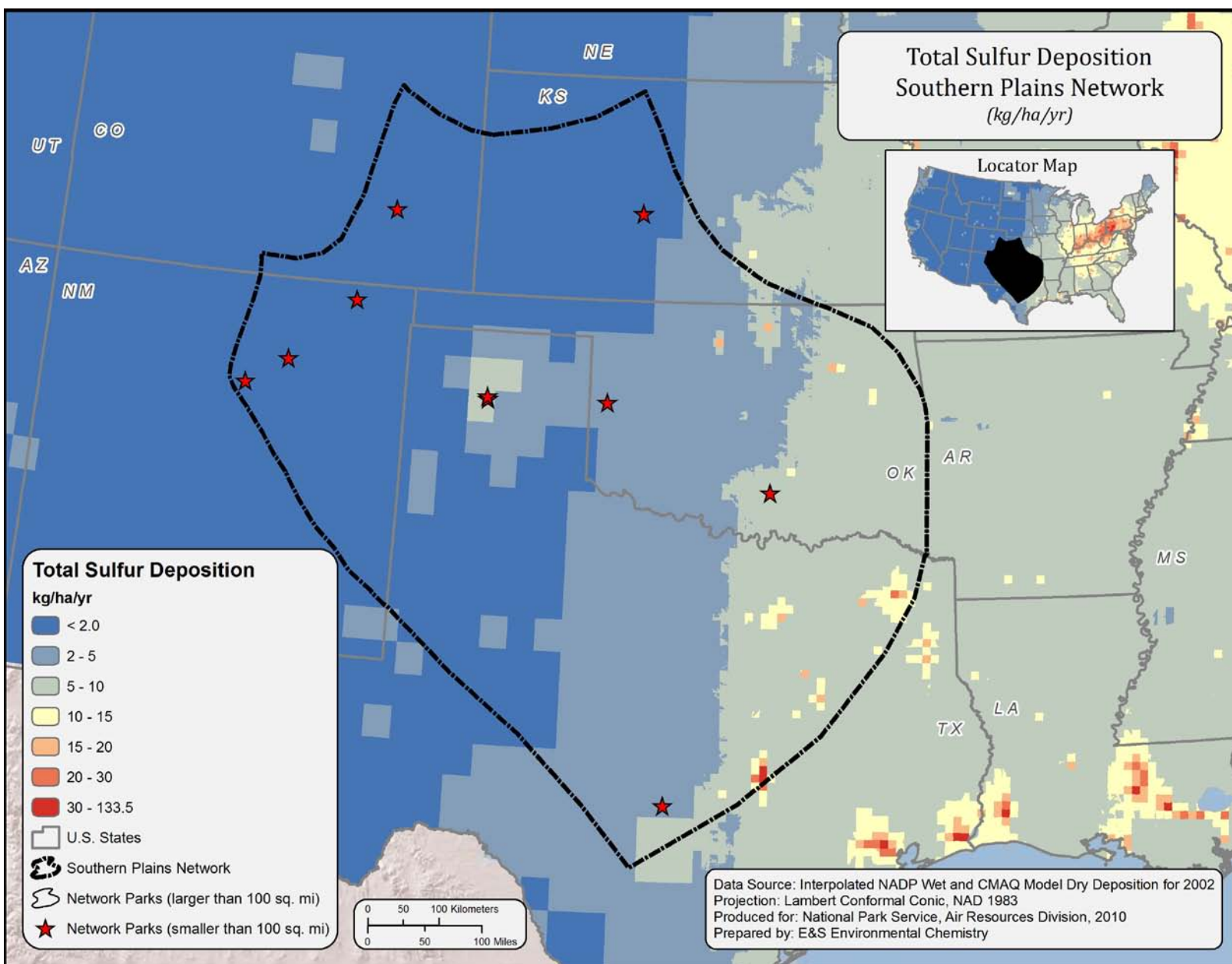
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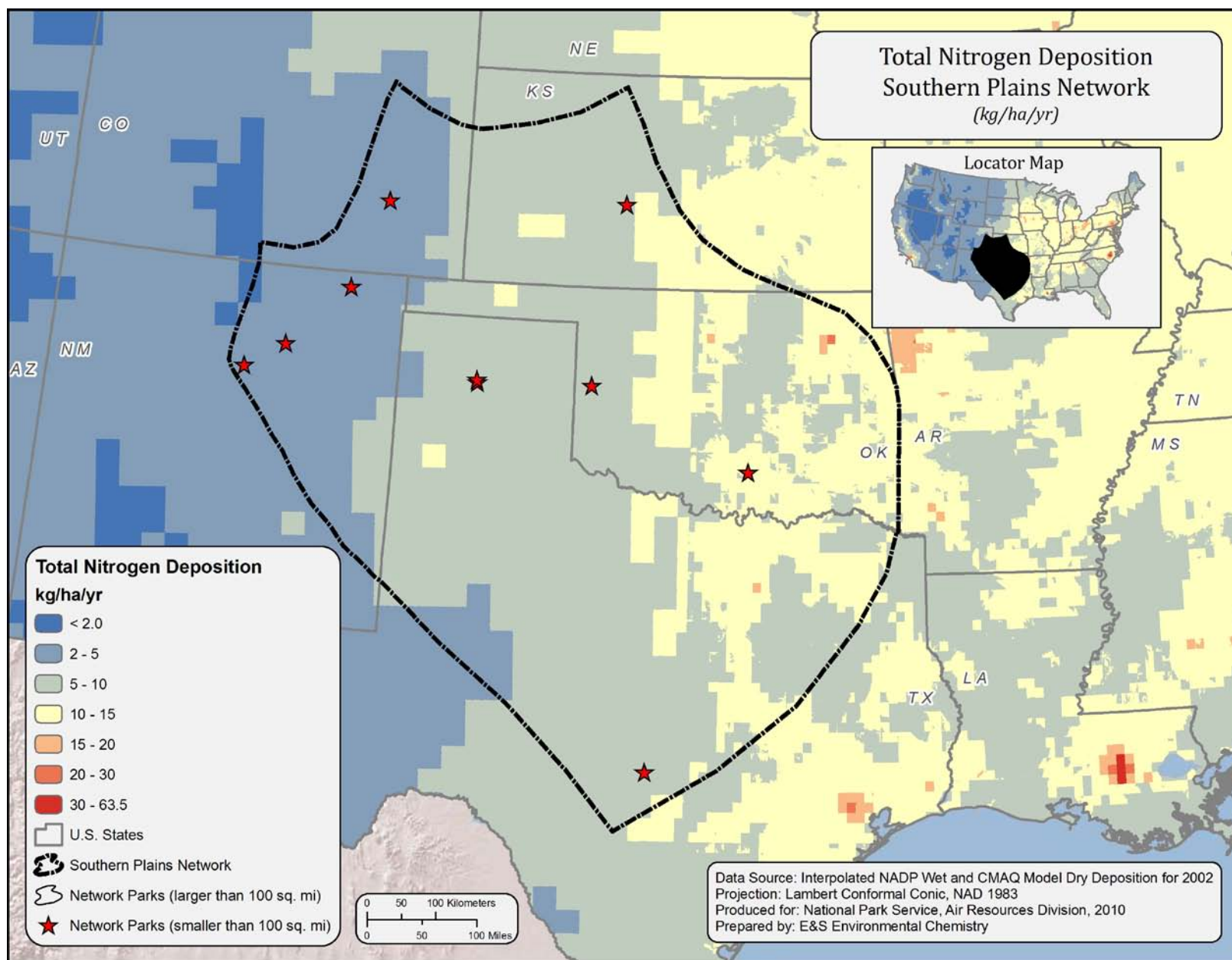
Map H



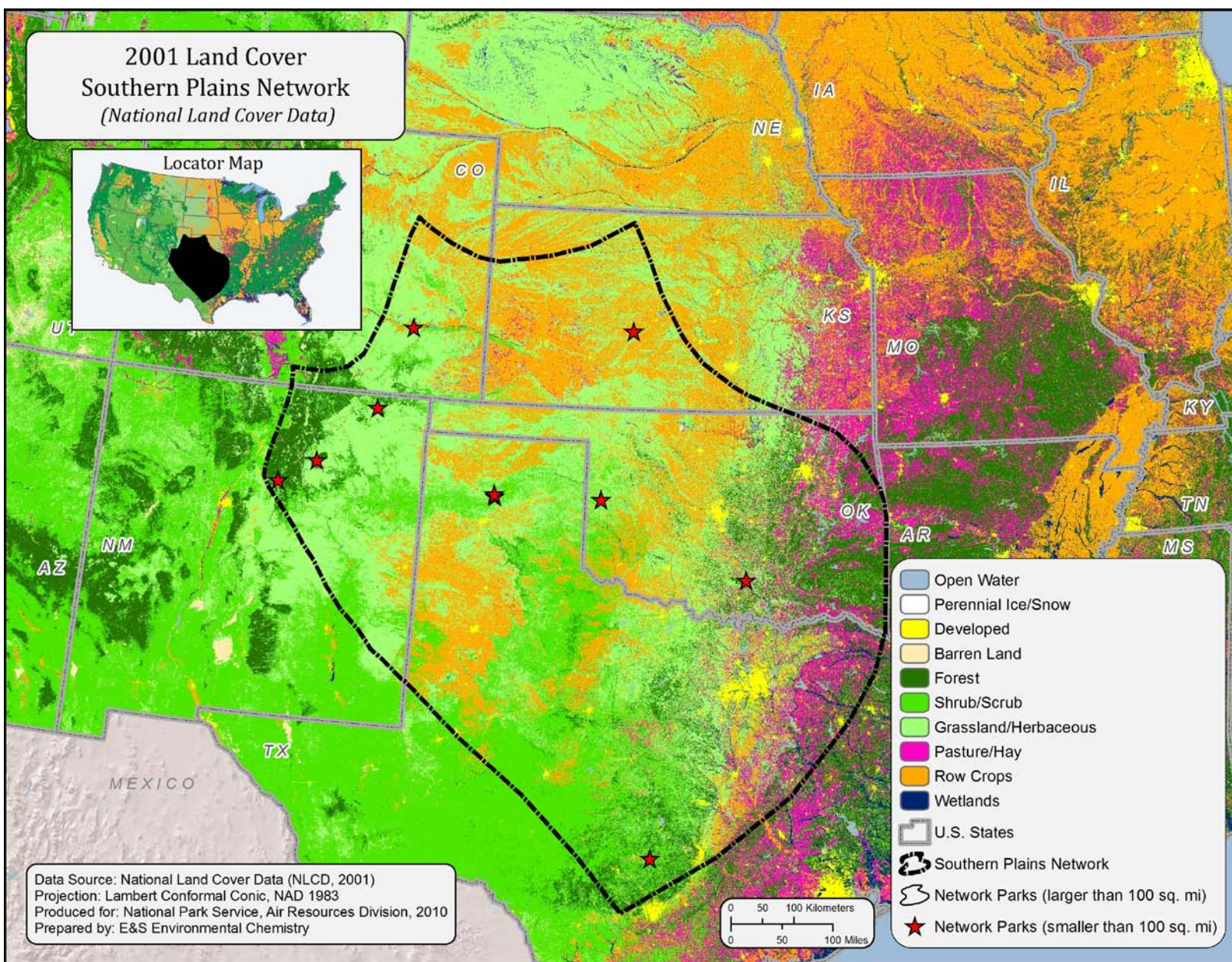
Map I



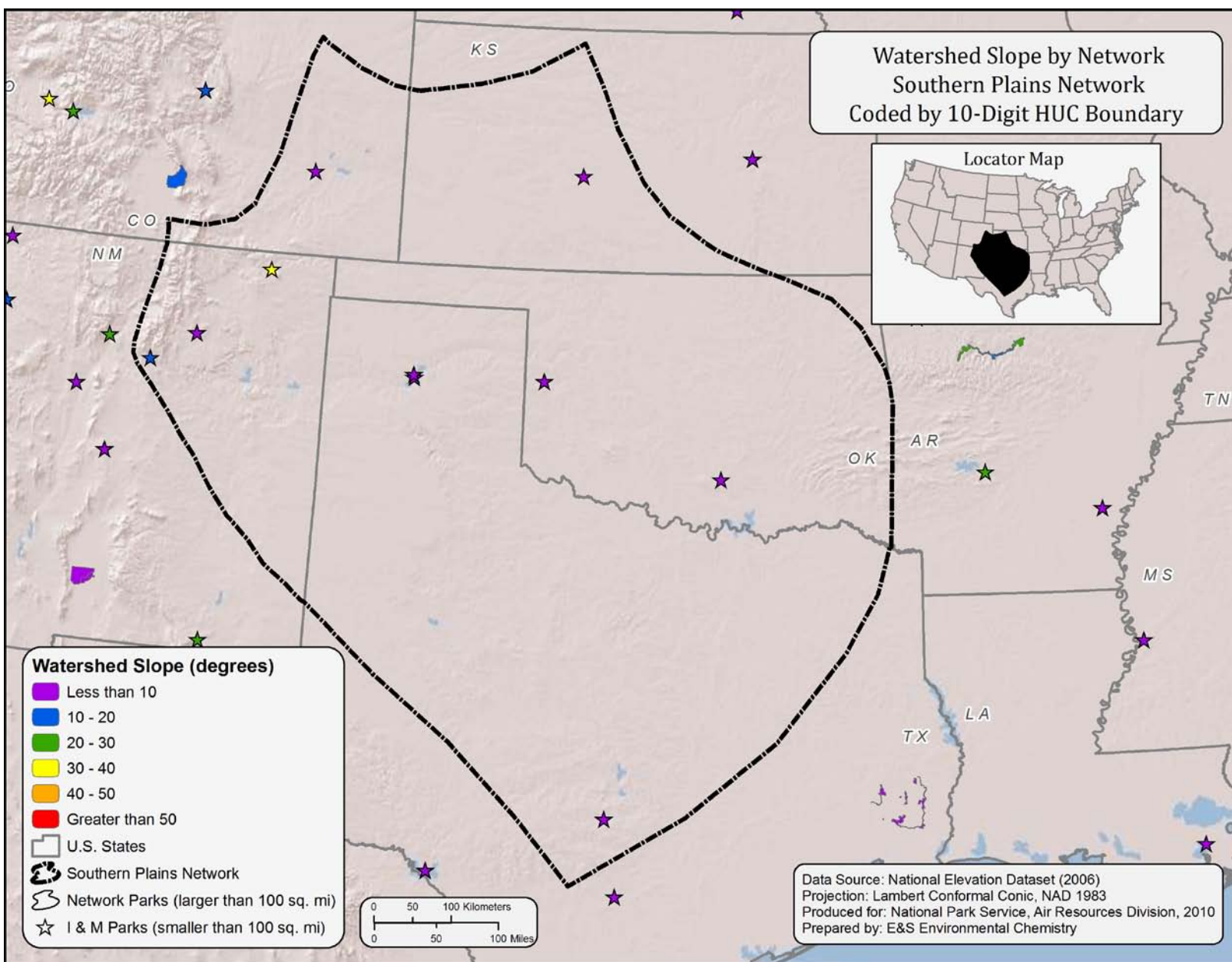
Map J



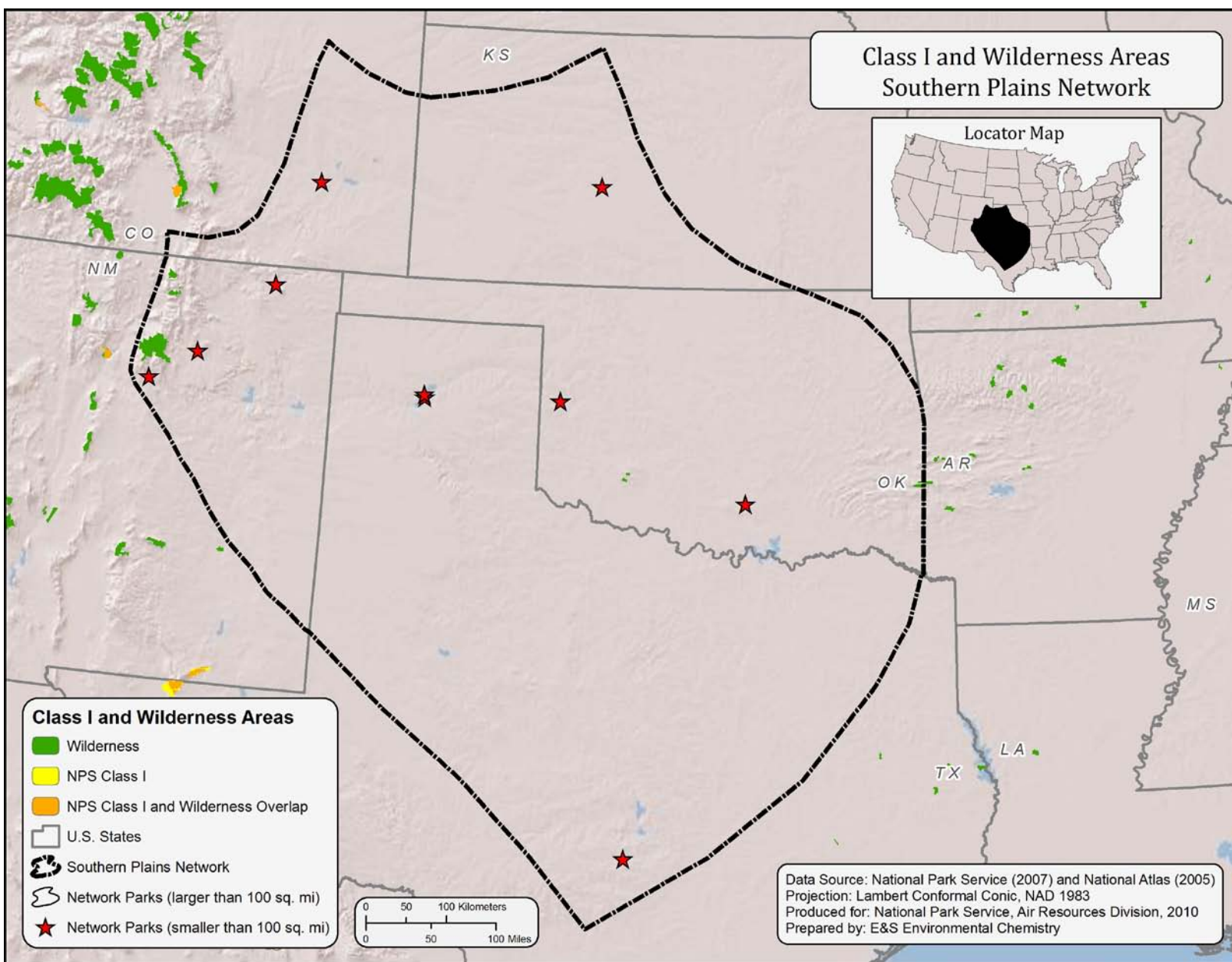
Map K



Map L



Map M



Map N

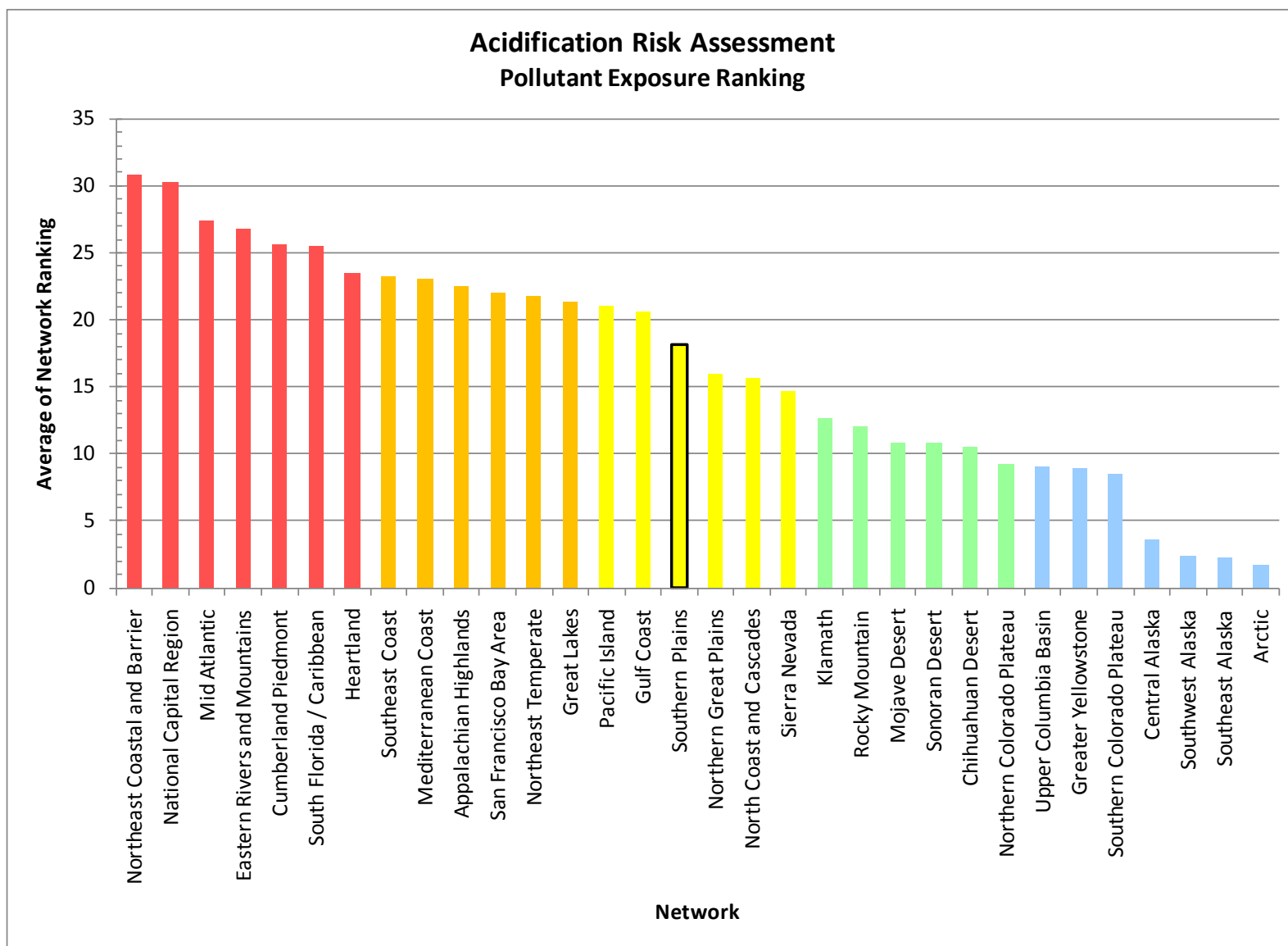


Figure A

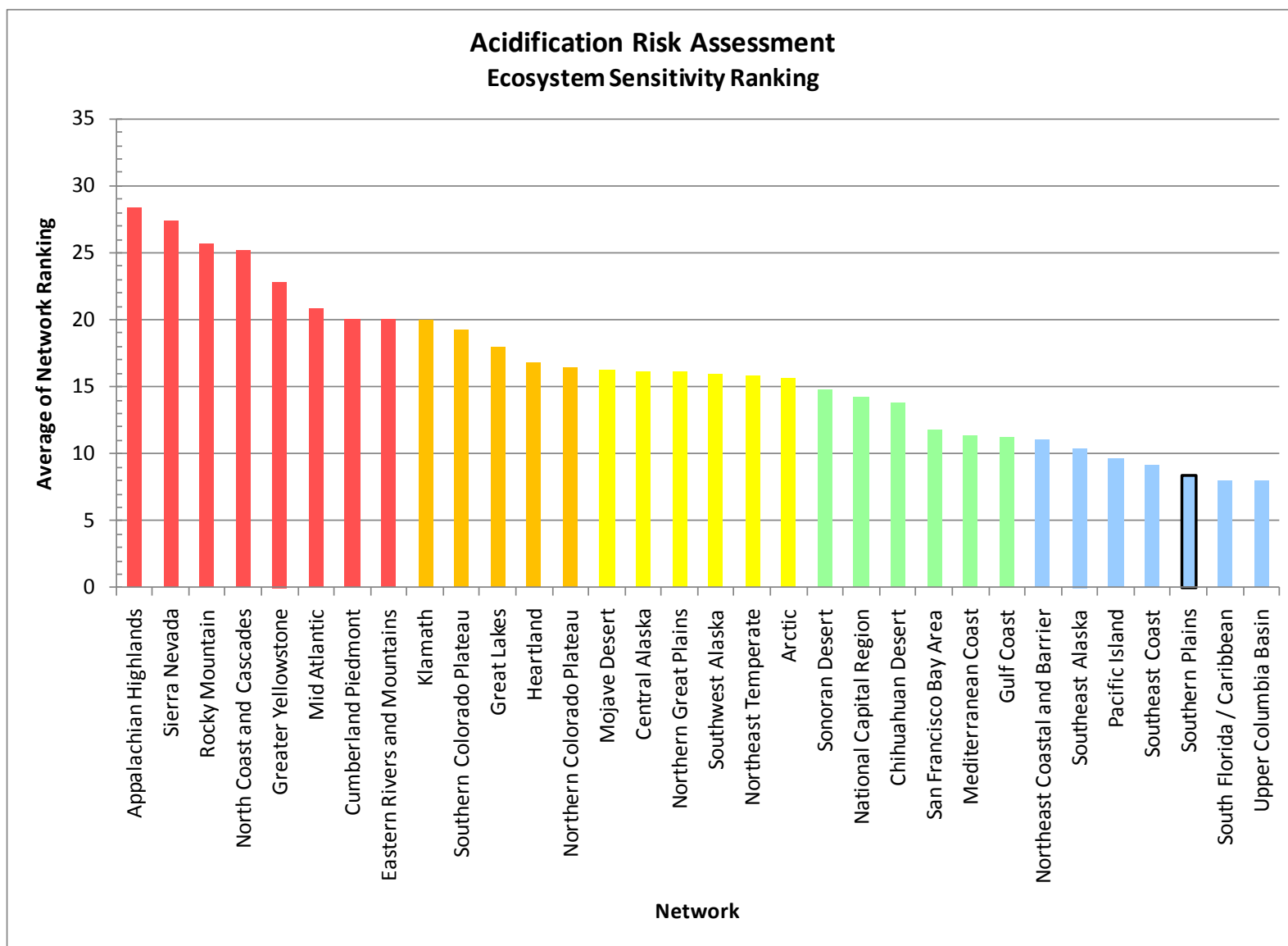


Figure B

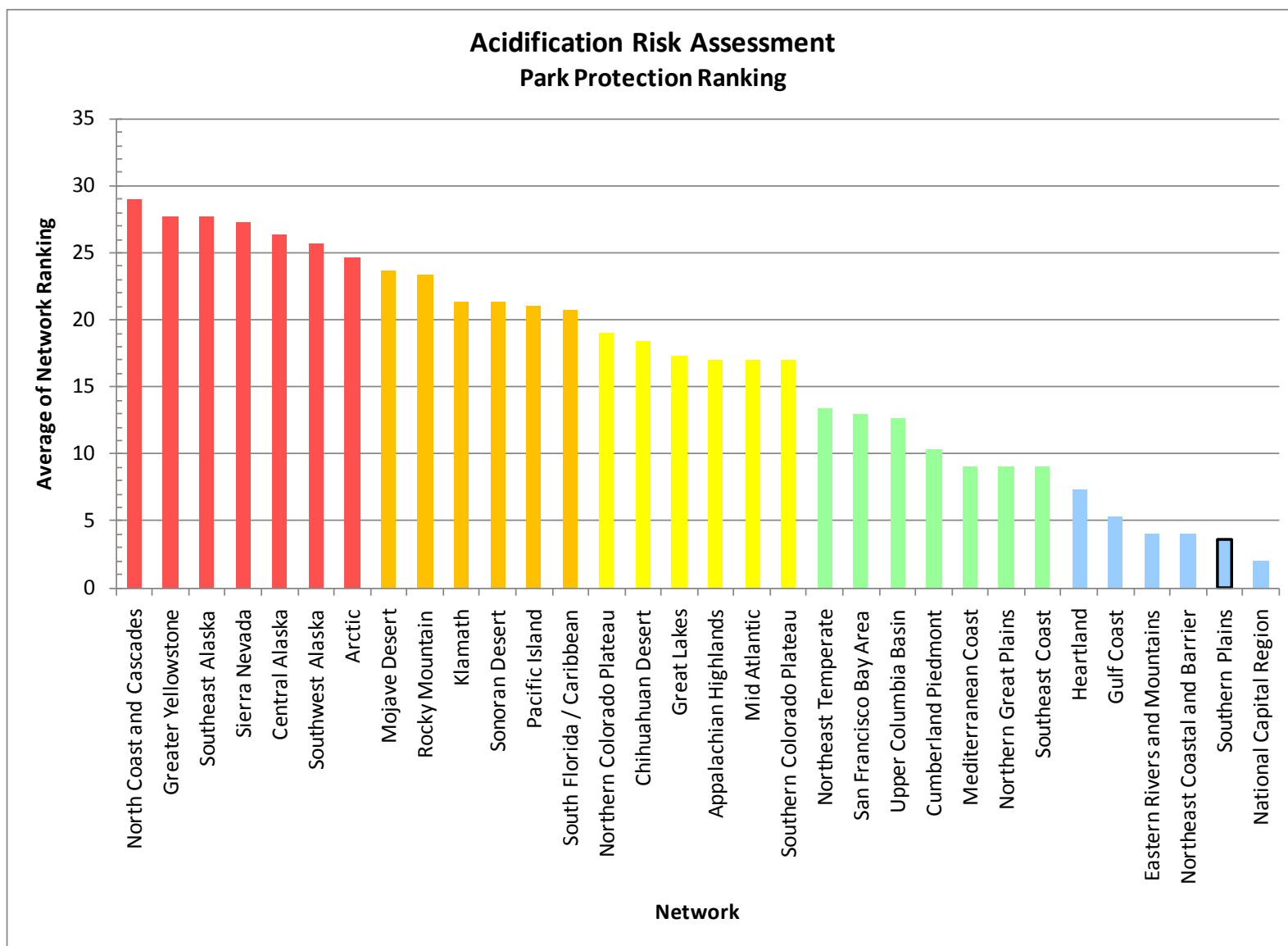


Figure C

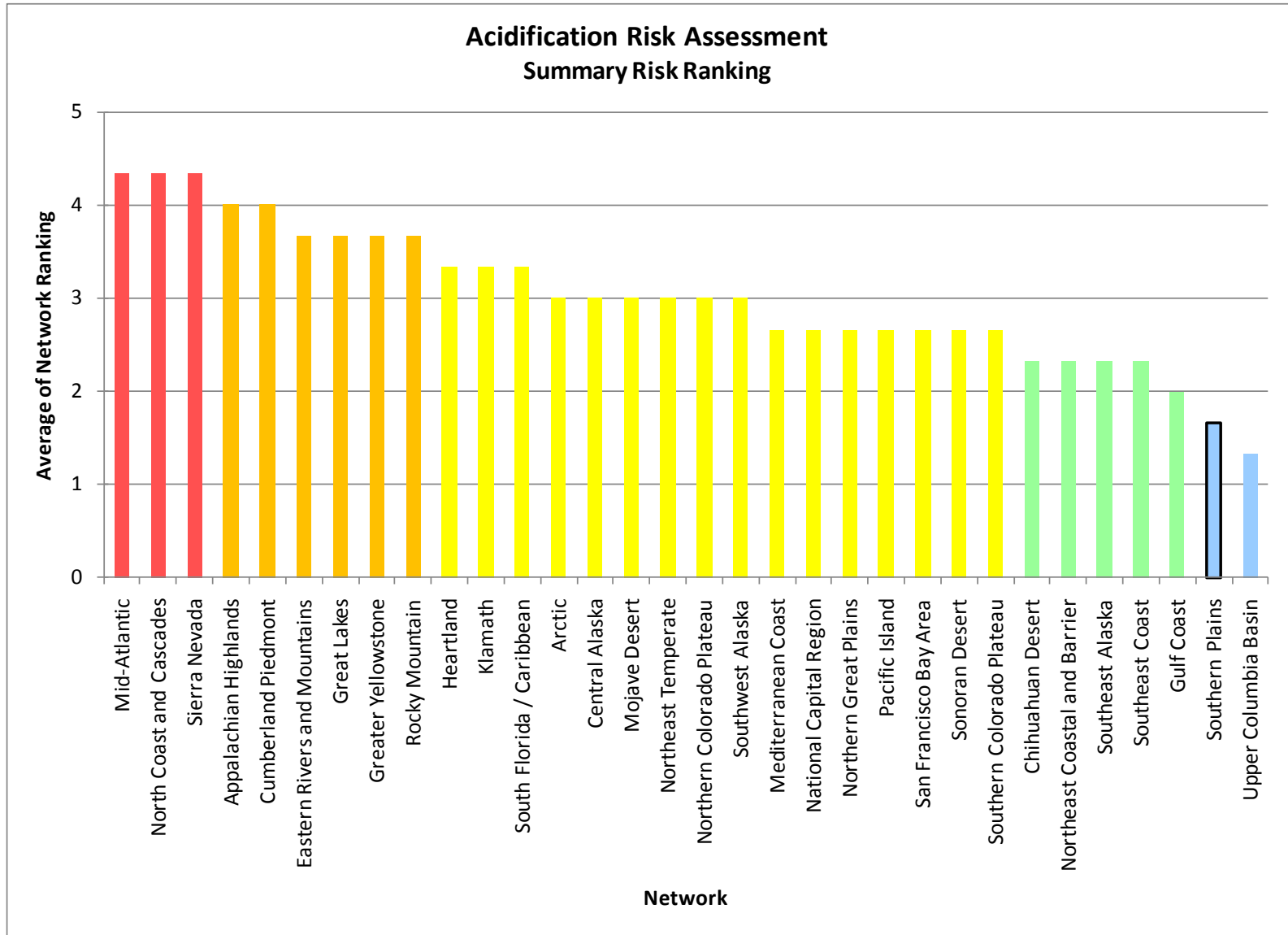


Figure D

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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