National Park Service
U.S. Department of the Interior

Natural Resource Program Center

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

Cumberland Piedmont Network (CUPN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/354

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

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

Cumberland Piedmont Network (CUPN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/354

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U.S. Department of the Interior
National Park Service
Natural Resource Program Center
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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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NPS 910/107388, April 2011

Cumberland Piedmont Network (CUPN)

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.

The Cumberland Piedmont Network contains 14 parks. None are larger than 100 square miles.

Total S and N emissions, by county, are shown in Maps E and F, respectively, for lands in and surrounding the Cumberland Piedmont Network. County-level S emissions within the network generally ranged from less than 1 ton per square mile per year to in the range of 50 to 100 tons per square miles per year, with a few counties in the network emitting more than 100 tons per square mile per year. Most counties emitted less than 1 ton per square mile per year of S (Map E). Annual county-level N 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 throughout most of the network (Map F). Individual point source emissions of SO_2 are shown in Map G. There were several point sources of substantial magnitude within the network, with some emitting more than 40,000 tons of S per year. There were also many S point sources of considerable magnitude located in close proximity to the network, mostly to the north and south (Map G). Point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH_3) N are shown in Map H. The larger (greater than 5,000 tons per year) N emissions point sources were consistently sources of oxidized, rather than reduced, N, and there were many located in, and in close proximity to, the network.

Urban centers within the network and within a 300-mile buffer around the network are shown in Map I. There are many large population centers (> 500,000 people) in and near the network, including Charlotte, Nashville, Memphis, Indianapolis, and Columbus.

Total S and N deposition in and around the network are shown in Maps J and K, respectively. Included in this analysis are both wet and dry forms of deposition and both the oxidized and reduced N species. Total S deposition throughout most of the network generally ranged from about 10 to 15 kg S/ha/yr (Map J). Some areas of the network, predominately in the northern part, were estimated to receive as high as 20 to 30 kg S/ha/yr. 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 (Map K). 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 L. The predominant cover types within this network are generally pasture/hay, forest, and row crop. There are also many smaller developed areas.

Land slope is shown in Map M. Most of the parks in the network tend to have relatively low relief, less than 20^o average slope. Two parks, Cumberland Gap (CUGA) and Russell Cave (RUCA), exhibit slopes in the range of 30^o to 40^o (Map M).

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 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 ranked in the top quintile among networks in Pollutant Exposure (Figure A). Sulfur and N emissions and deposition within the network were very high. The network Ecosystem Sensitivity ranking was also in the highest quintile (Figure B). The network contains a high-elevation lake and acid-sensitive vegetation, as well as areas known to have acid-sensitive surface waters and/or geology This network ranked 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 yielded an overall network Summary Risk ranking that was relatively high among networks (Figure D). The overall level of concern for acid effects on I&M parks within this network is considered High.

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 and Appendix A.

All parks in the network ranked High or Very High in Pollutant Exposure. Emissions upwind of this network and atmospheric S and N deposition within the network were relatively high. Mammoth Cave (MACA), in particular, is known to have experienced significant visibility degradation in response to emissions of air pollutants. Ecosystem Sensitivity for the parks in this network varied considerably, ranging from Very Low to Very High. All parks except MACA were ranked Moderate for Park Protection; MACA was ranked Very High. For overall Summary Risk from acidic atmospheric deposition, six parks were ranked Moderate, five parks were ranked High, and three parks (including MACA) were ranked Very High.

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
Abraham Lincoln Birthplace	Very High	Moderate	Moderate	High
Carl Sandburg Home	High	Very High	Moderate	High
Chickamauga and Chattanooga	Very High	Very High	Moderate	Very High
Cowpens	High	Very Low	Moderate	Moderate
Cumberland Gap	High	Very High	Moderate	High
Fort Donelson	Very High	Moderate	Moderate	High
Guilford Courthouse	Very High	Very Low	Moderate	Moderate
Kings Mountain	High	Low	Moderate	Moderate
Little River Canyon	Very High	Very High	Moderate	Very High
Mammoth Cave	Very High	High	Very High	Very High
Ninety Six	High	Very Low	Moderate	Moderate
Russell Cave	Very High	High	Moderate	High
Shiloh	High	Low	Moderate	Moderate
Stones River	High	Very 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, NH_3) 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, NH_3) 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, NH_3) N. (Source of data: EPA National Emissions Inventory, http://www.epa.gov/ttn/chief/net/2002inventory.html)

Map G. Major point source emissions of SO_2 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, NH_3) 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, NH_3) 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/])

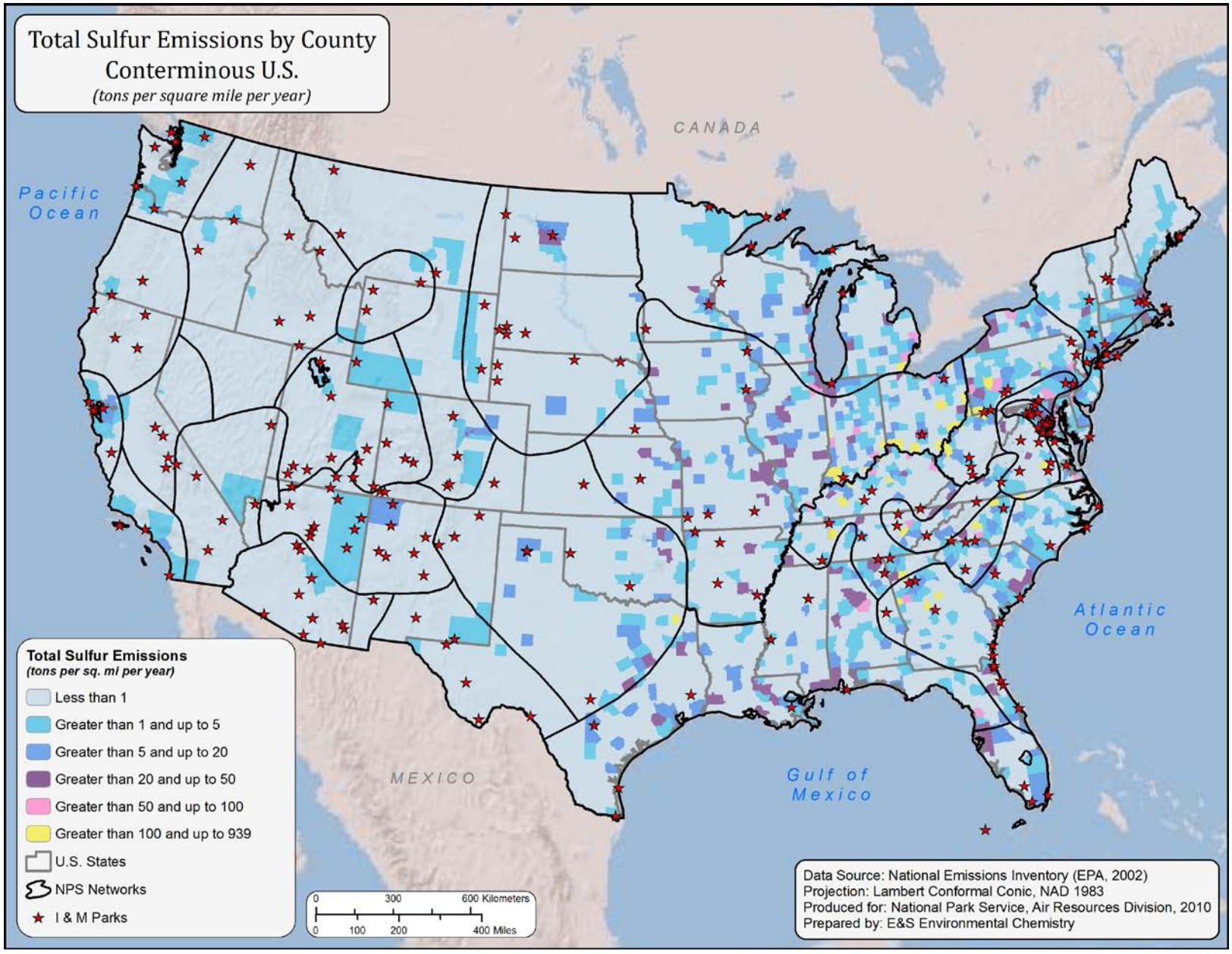
Map N. Lands within the network that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; http://nationalatlas.gov] and NPS)

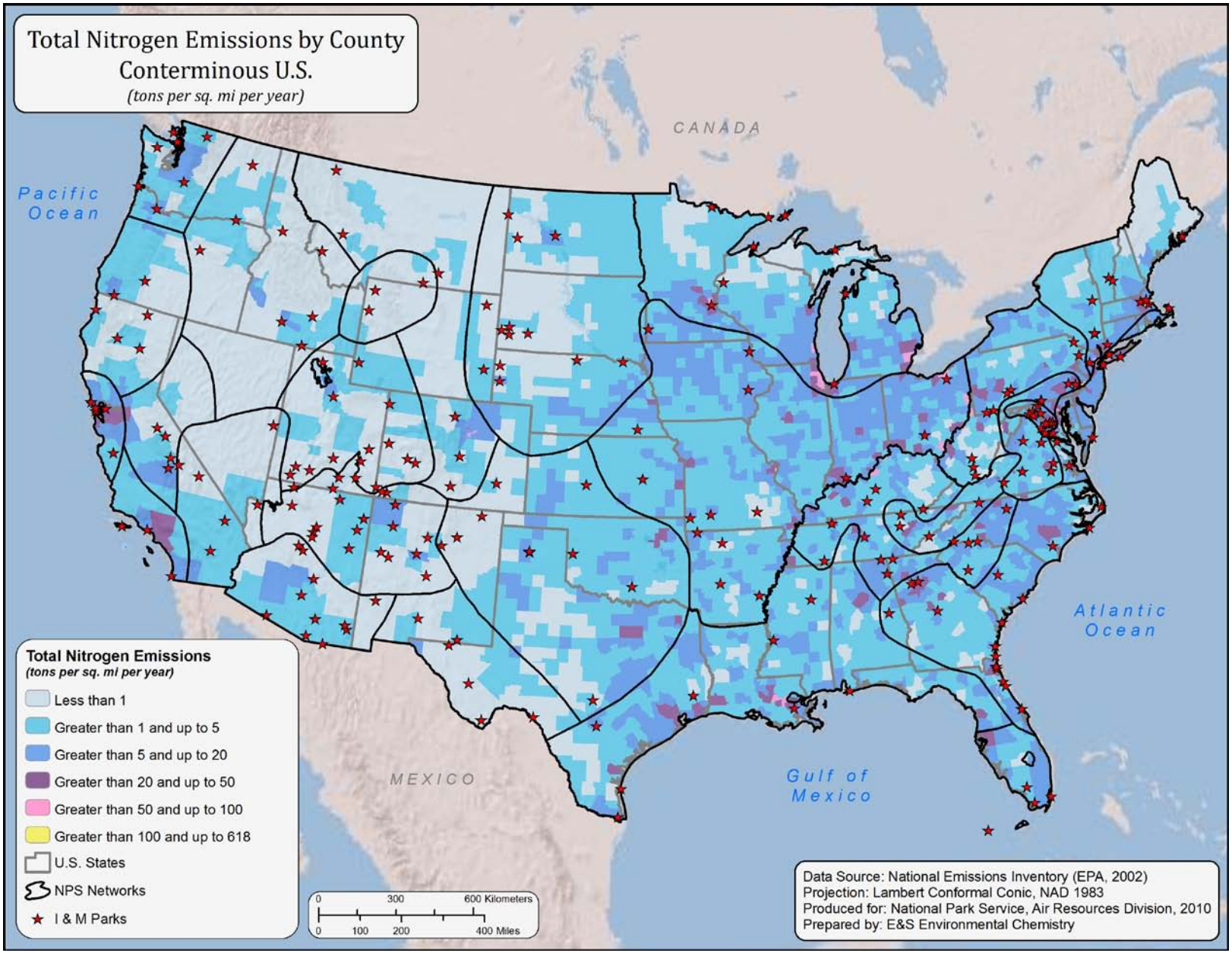
Figure A. Network rankings for Pollutant Exposure, calculated as the average of scores for all Pollutant Exposure variables.

Figure B. Network rankings for Ecosystem Sensitivity, calculated as the average of scores for all Ecosystem Sensitivity variables.

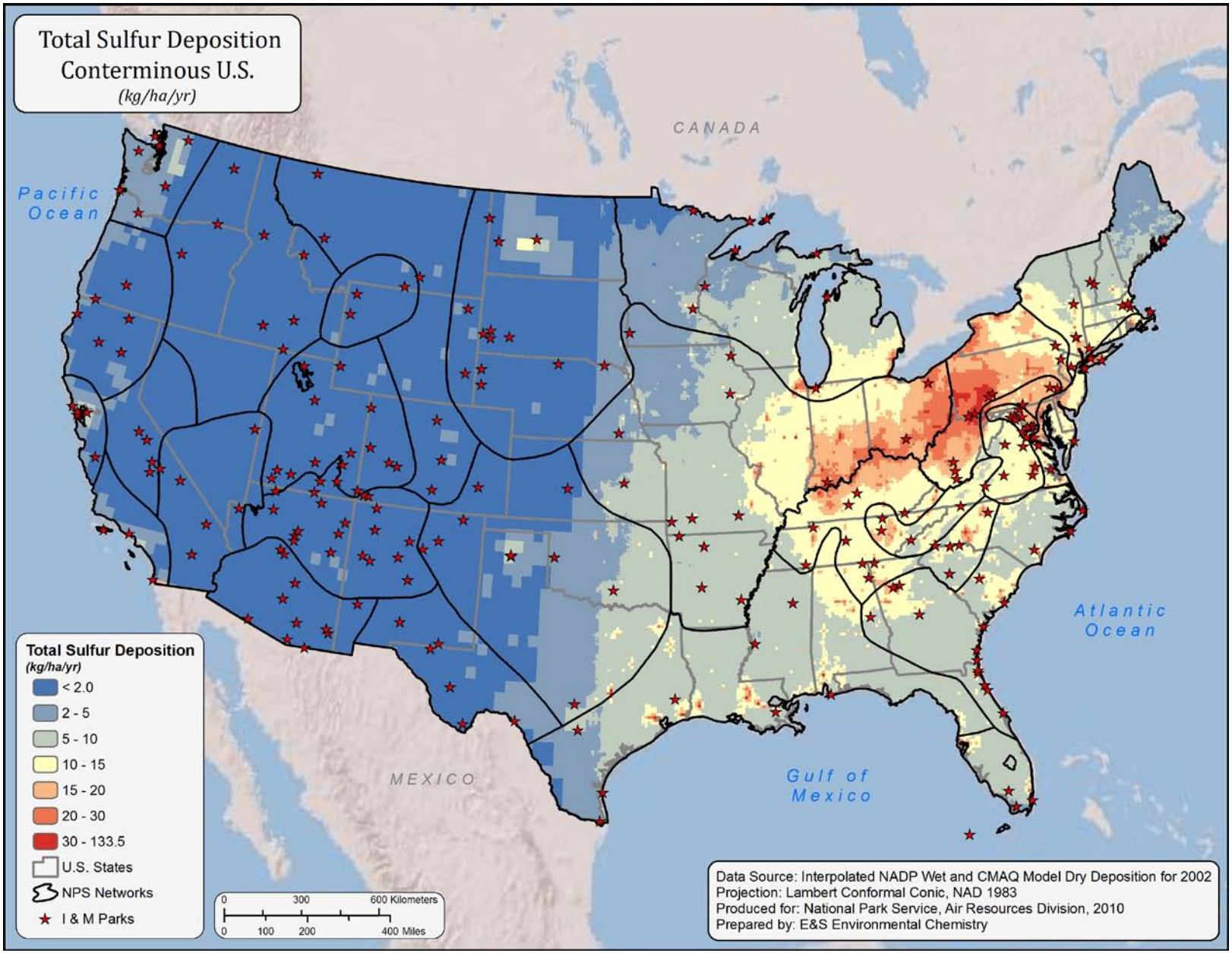
Figure C. Network rankings for Park Protection, calculated as the average of scores for all Park Protection variables.

Figure D. Network Summary Risk rankings, calculated as the average of the quintile ranks for the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection themes.

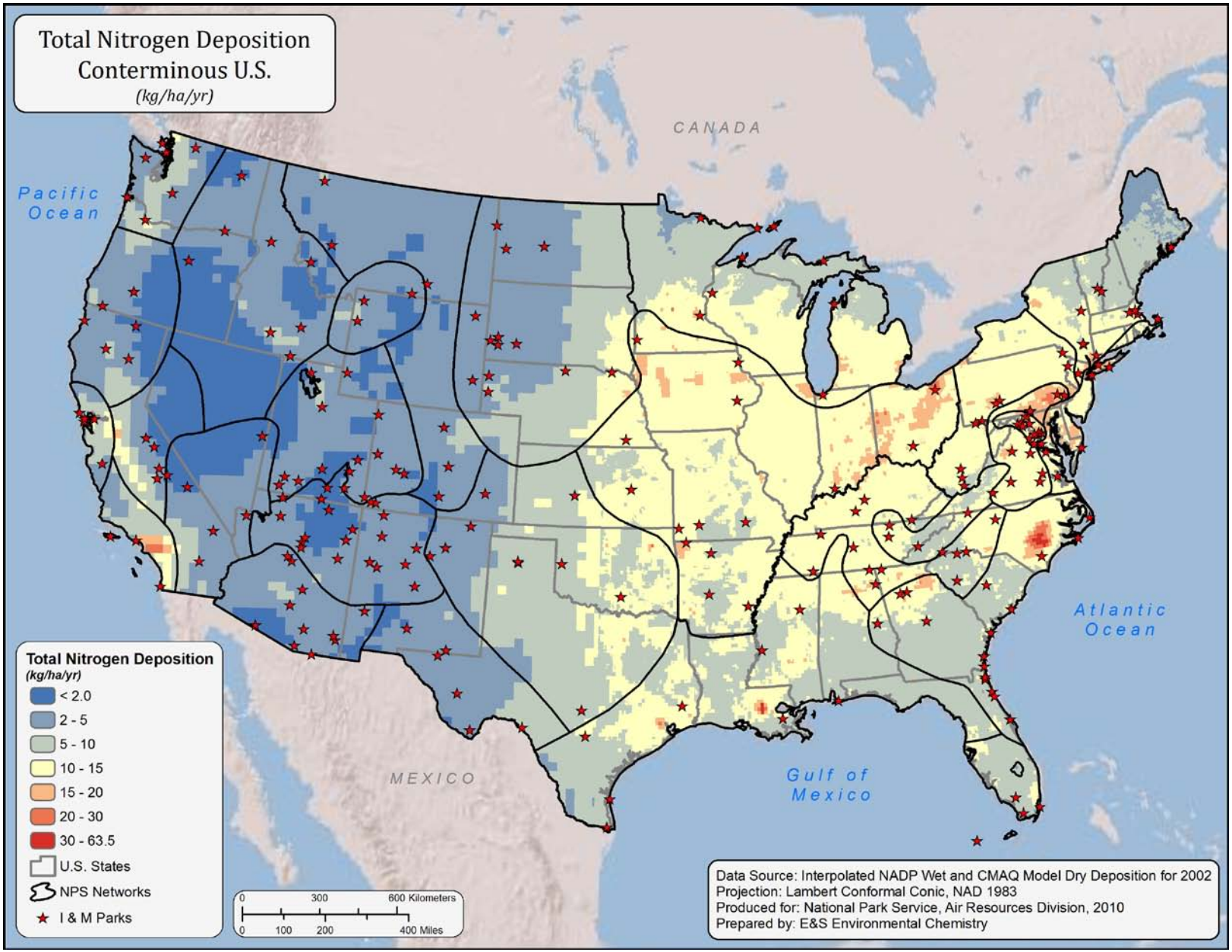

Total Sulfur Emissions by County
Conterminous U.S.
(tons per square mile per year)
CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
Gulf of Mexico
Total Sulfur Emissions
(tons per sq. mi per year)
Less than 1
Greater than 1 and up to 5
Greater than 5 and up to 20
Greater than 20 and up to 50
Greater than 50 and up to 100
Greater than 100 and up to 939
U.S. States
NPS Networks
I & M Parks
0 300 600 Kilometers
0 100 200 400 Miles
Data Source: National Emissions Inventory (EPA, 2002)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry


Total Nitrogen Emissions by County
Conterminous U.S.
(tons per sq. mi per year)
CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
Gulf of Mexico
Total Nitrogen Emissions
(tons per sq. mi per year)
Less than 1
Greater than 1 and up to 5
Greater than 5 and up to 20
Greater than 20 and up to 50
Greater than 50 and up to 100
Greater than 100 and up to 618
U.S. States
NPS Networks
I & M Parks
0 300 600 Kilometers
0 100 200 400 Miles
Data Source: National Emissions Inventory (EPA, 2002)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry

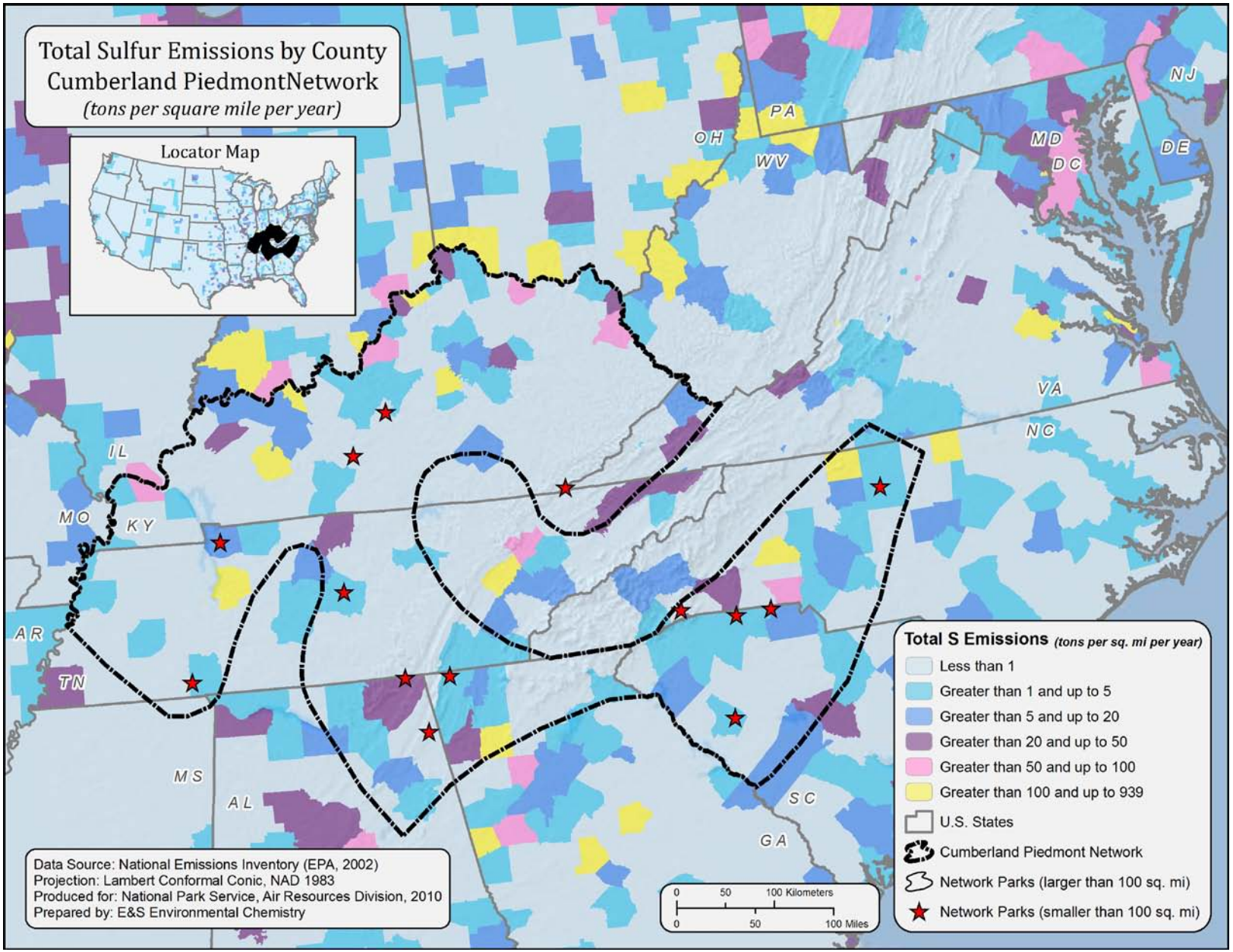
Map B


Total Sulfur Deposition
Conterminous U.S.
(kg/ha/yr)
CANADA
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
MEXICO
Total Sulfur Deposition
(kg/ha/yr)
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 133.5
U.S. States
NPS Networks
I & M Parks
0 300 600 Kilometers
0 100 200 400 Miles
Data Source: Interpolated NADP Wet and CMAQ Model Dry Deposition for 2002
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry

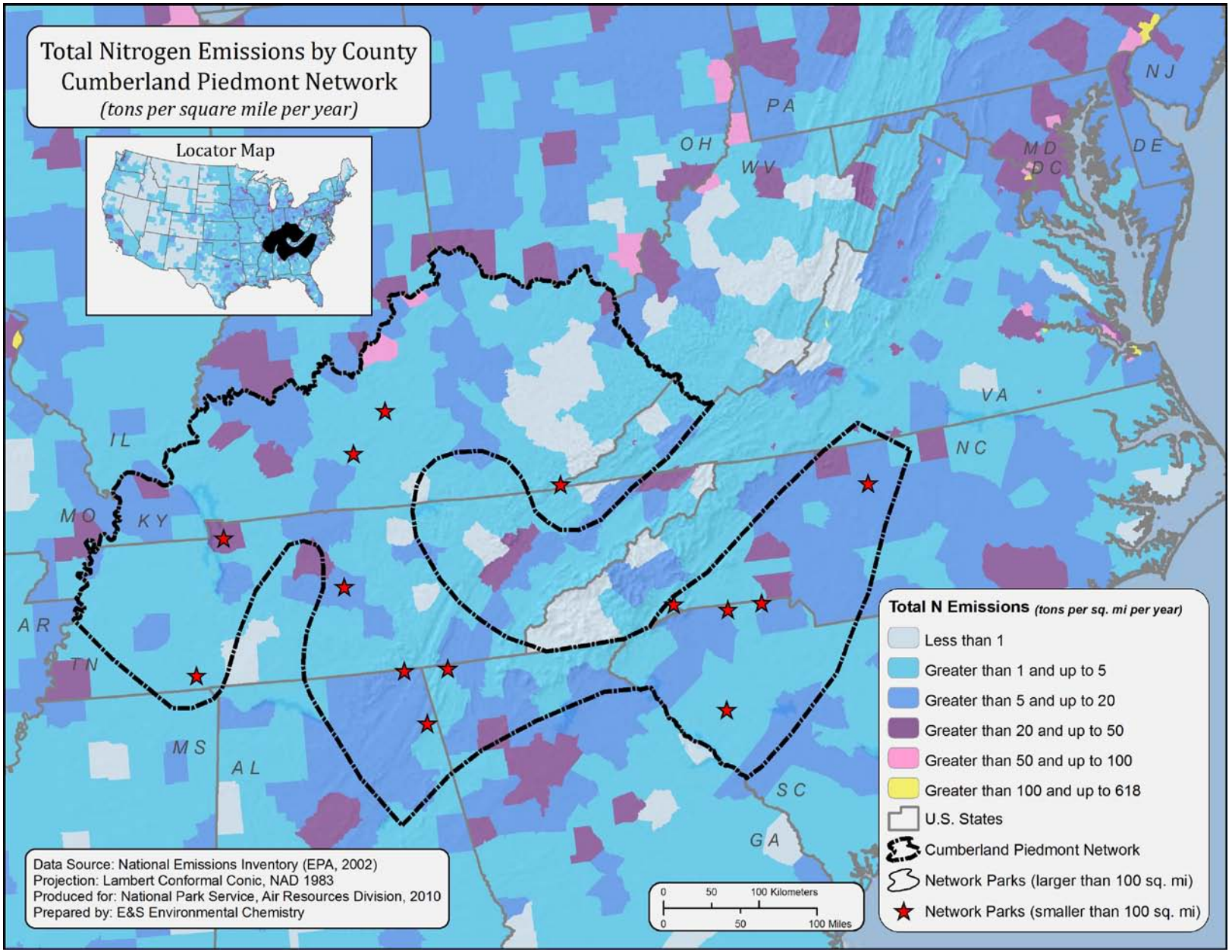
Map C


Total Nitrogen Deposition
Conterminous U.S.
(kg/ha/yr)
CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
Gulf of Mexico
Total Nitrogen Deposition
(kg/ha/yr)
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 63.5
U.S. States
NPS Networks
I & M Parks
0 300 600 Kilometers
0 100 200 400 Miles
Data Source: Interpolated NADP Wet and CMAQ Model Dry Deposition for 2002
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry

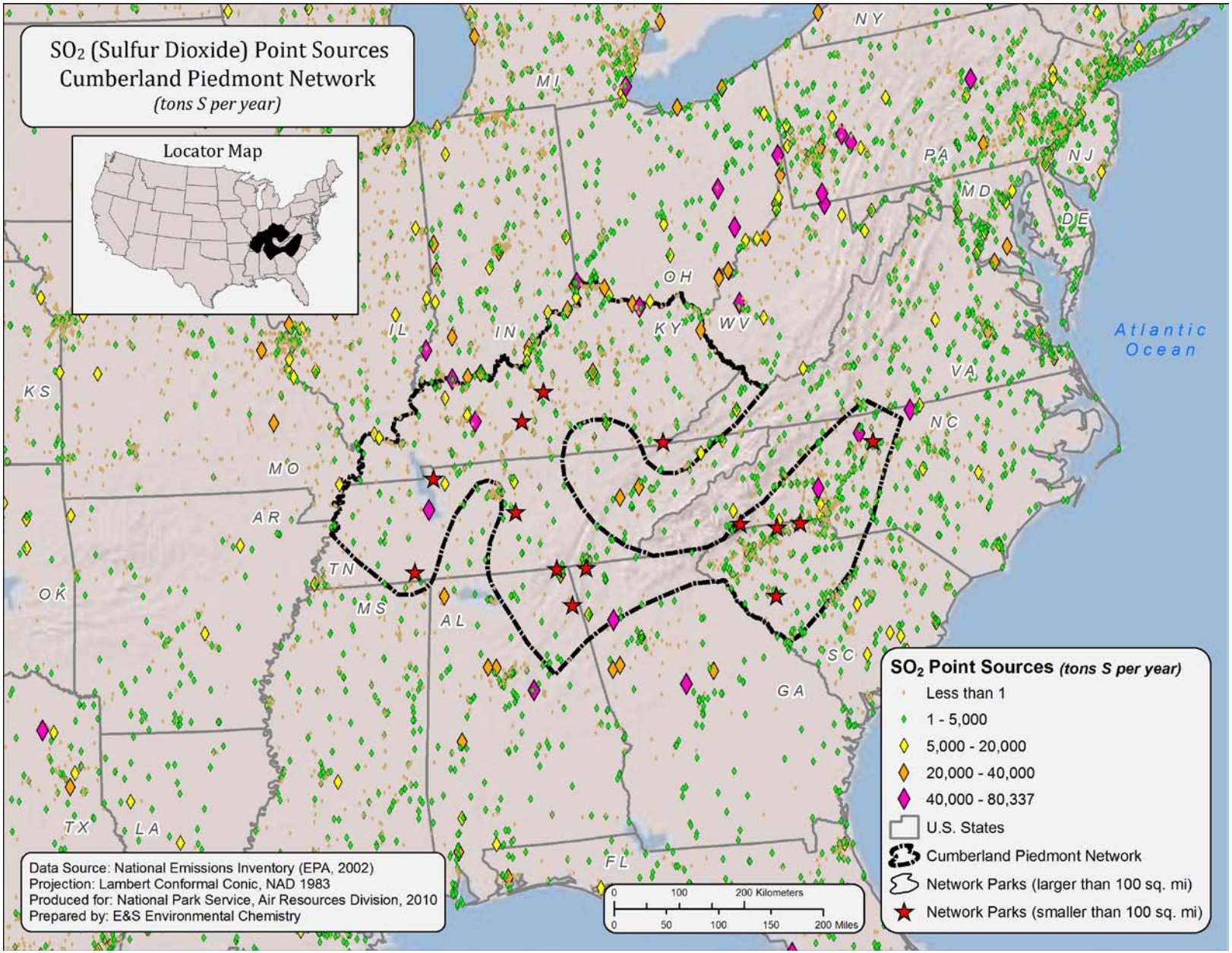
Map D


Total Sulfur Emissions by County
Cumberland PiedmontNetwork
(tons per square mile per year)
Locator Map
PA
OH
WV
MD
DC
DE
NJ
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Total S Emissions (tons per sq. mi per year)
Less than 1
Greater than 1 and up to 5
Greater than 5 and up to 20
Greater than 20 and up to 50
Greater than 50 and up to 100
Greater than 100 and up to 939
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: National Emissions Inventory (EPA, 2002)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 50 100 Kilometers
0 50 100 Miles

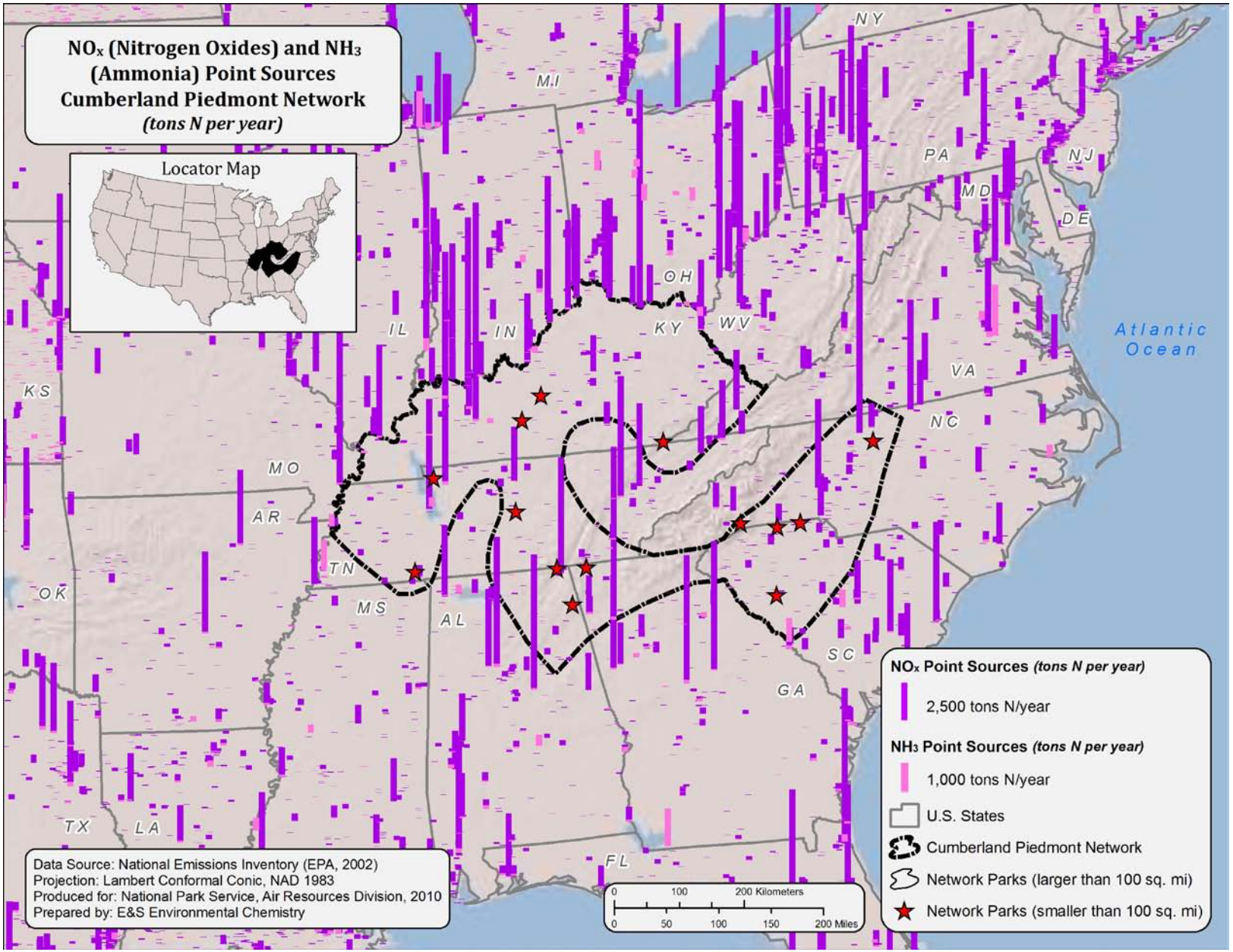
Map E


Total Nitrogen Emissions by County
Cumberland Piedmont Network
(tons per square mile per year)
Locator Map
PA
OH
WV
MD
DC
DE
NJ
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Total N Emissions (tons per sq. mi per year)
Less than 1
Greater than 1 and up to 5
Greater than 5 and up to 20
Greater than 20 and up to 50
Greater than 50 and up to 100
Greater than 100 and up to 618
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: National Emissions Inventory (EPA, 2002)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 50 100 Kilometers
0 50 100 Miles

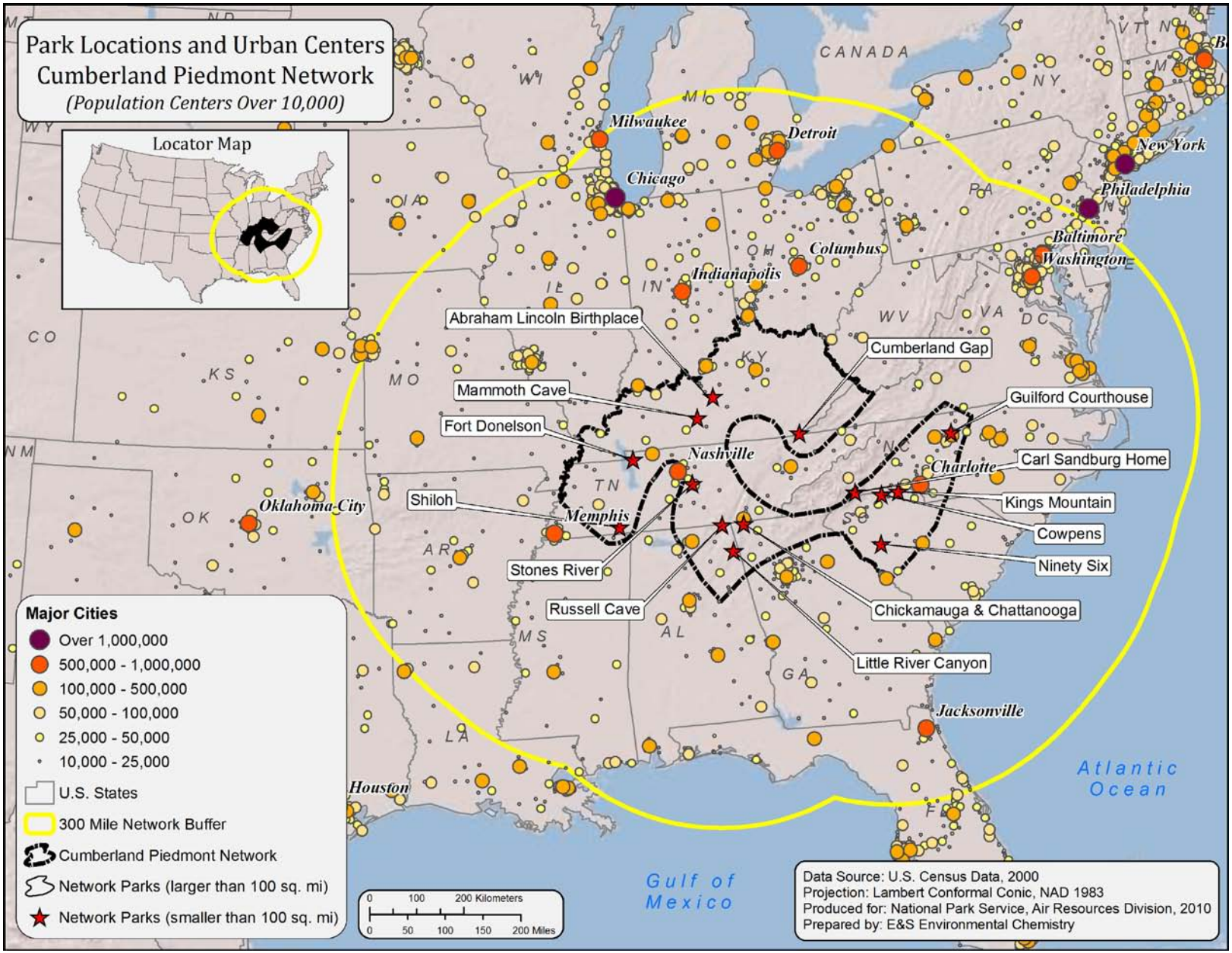
Map F


SO2 (Sulfur Dioxide) Point Sources
Cumberland Piedmont Network
(tons S per year)
Locator Map
NY
MI
PA
NJ
MD
DE
OH
WV
KY
IN
IL
VA
NC
Atlantic Ocean
KS
MO
AR
TN
MS
AL
SC
GA
OK
TX
LA
FL
SO2 Point Sources (tons S per year)
Less than 1
1 - 5,000
5,000 - 20,000
20,000 - 40,000
40,000 - 80,337
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: National Emissions Inventory (EPA, 2002)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 100 200 Kilometers
0 50 100 150 200 Miles

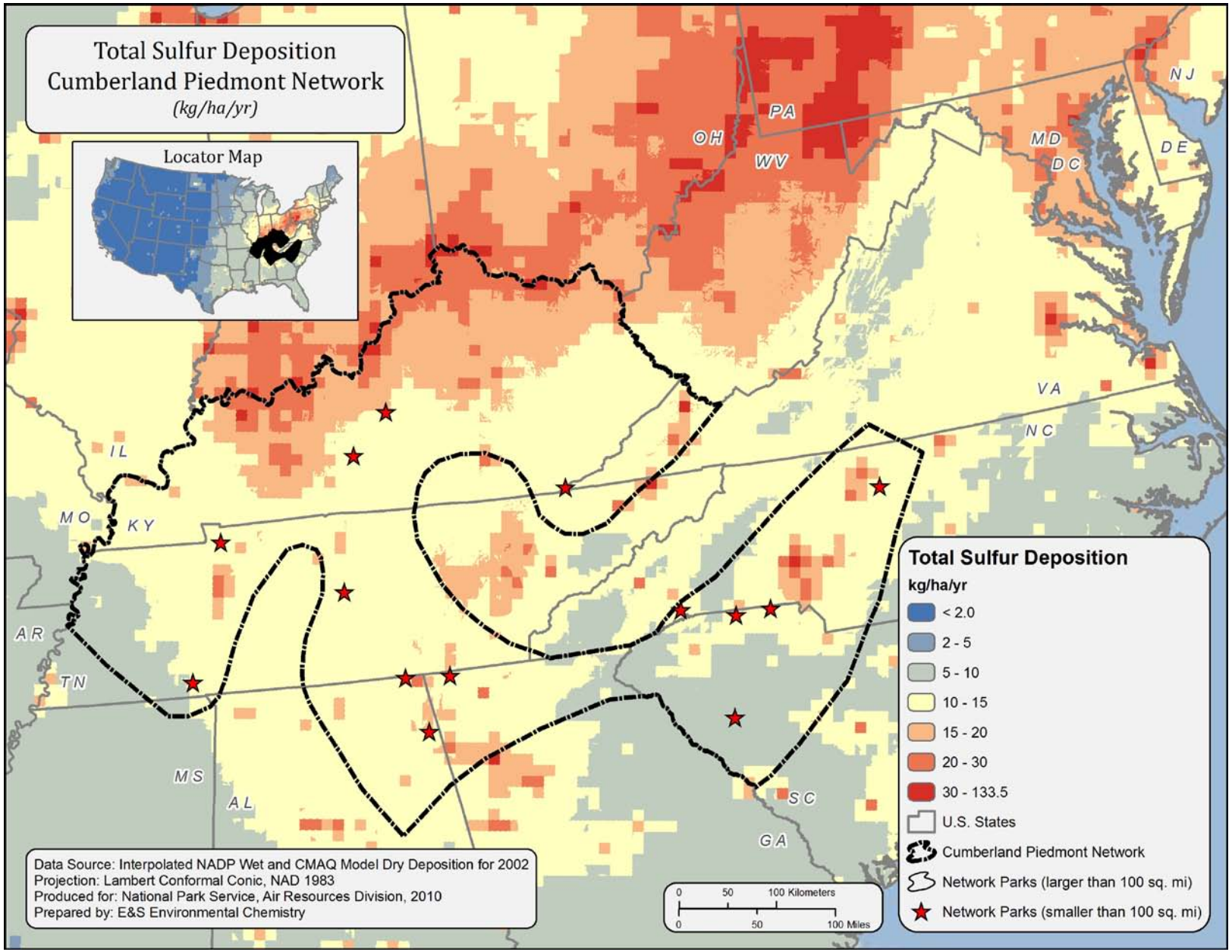
Map G


NOx (Nitrogen Oxides) and NH3 (Ammonia) Point Sources
Cumberland Piedmont Network
(tons N per year)
Locator Map
NY
MI
PA
NJ
MD
DE
OH
WV
KY
IN
IL
KS
MO
AR
TN
MS
AL
OK
TX
LA
GA
FL
SC
NC
VA
Atlantic Ocean
NOx Point Sources (tons N per year)
2,500 tons N/year
NH3 Point Sources (tons N per year)
1,000 tons N/year
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: National Emissions Inventory (EPA, 2002)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 100 200 Kilometers
0 50 100 150 200 Miles

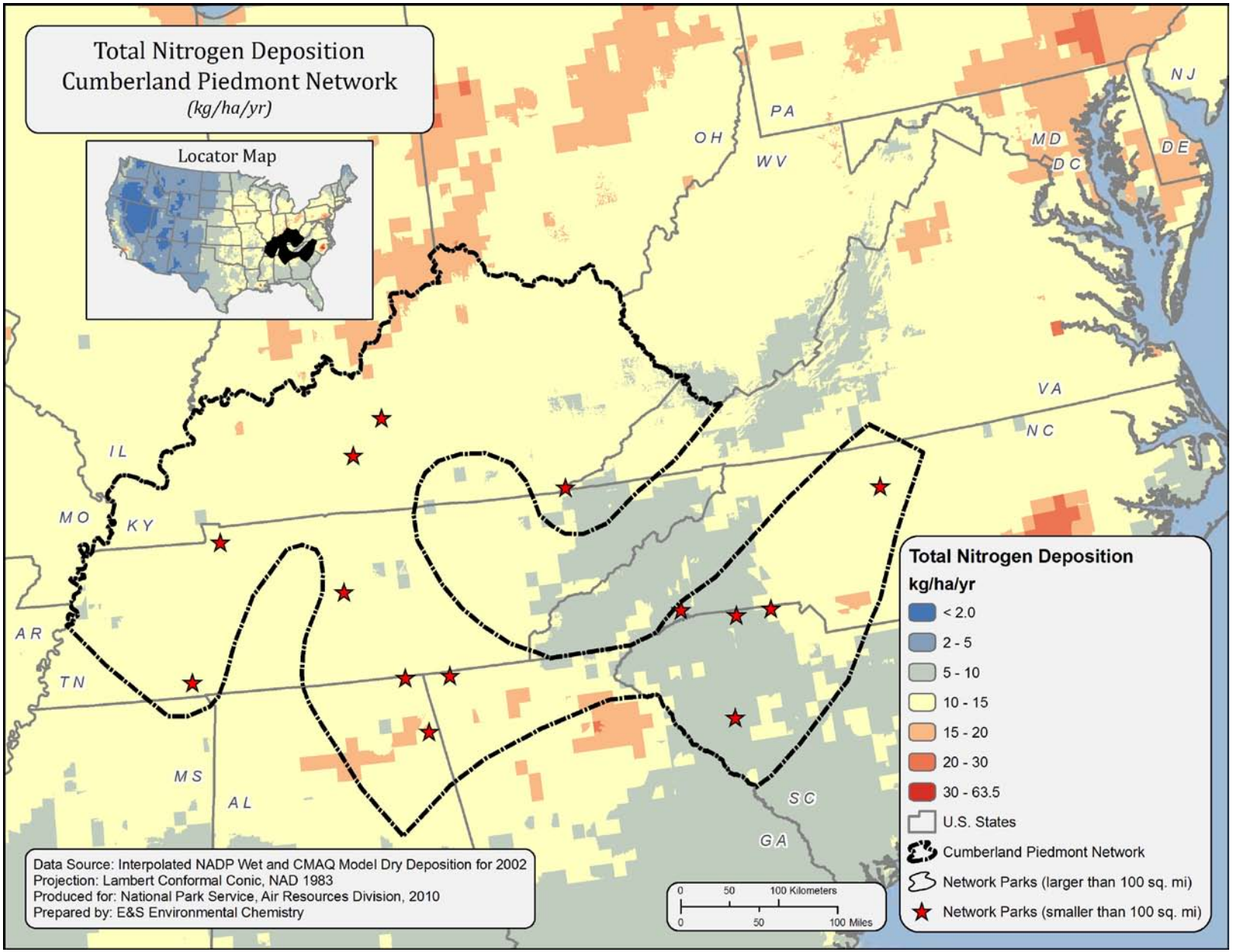
Map H


Park Locations and Urban Centers
Cumberland Piedmont Network
(Population Centers Over 10,000)
Locator Map
CANADA
Milwaukee
Detroit
Chicago
New York
Philadelphia
Baltimore
Washington
Columbus
Indianapolis
Abraham Lincoln Birthplace
Cumberland Gap
Mammoth Cave
Guilford Courthouse
Fort Donelson
Nashville
Charlotte
Carl Sandburg Home
Shiloh
Kings Mountain
Memphis
Cowpens
Ninety Six
Stones River
Russell Cave
Chickamauga & Chattanooga
Little River Canyon
Jacksonville
Oklahoma City
Houston
Atlantic Ocean
Gulf of Mexico
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
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
0 100 200 Kilometers
0 50 100 150 200 Miles
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

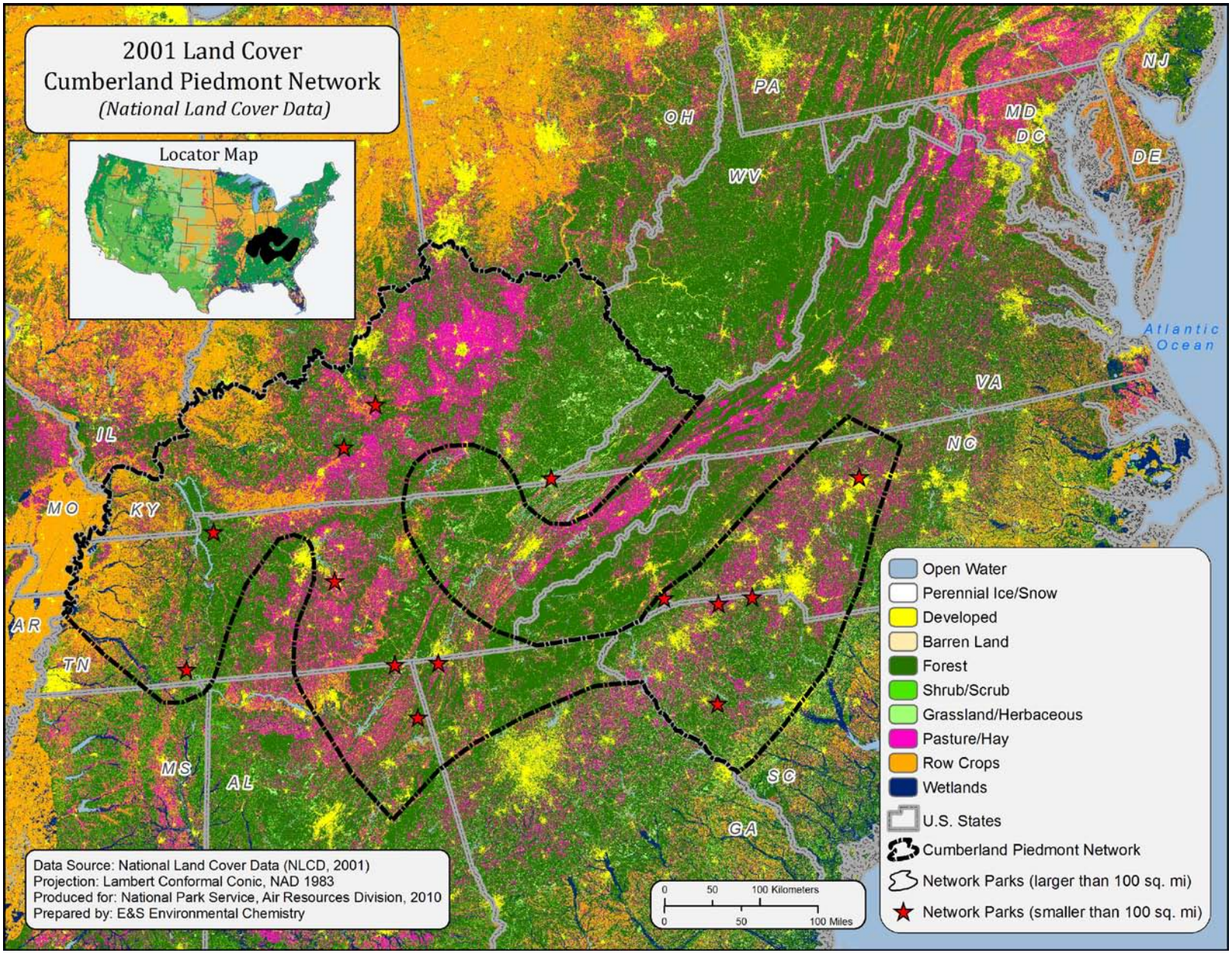
Map I


Total Sulfur Deposition
Cumberland Piedmont Network
(kg/ha/yr)
Locator Map
PA
OH
WV
MD
DC
DE
NJ
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Total Sulfur Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 133.5
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: Interpolated NADP Wet and CMAQ Model Dry Deposition for 2002
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 50 100 Kilometers
0 50 100 Miles

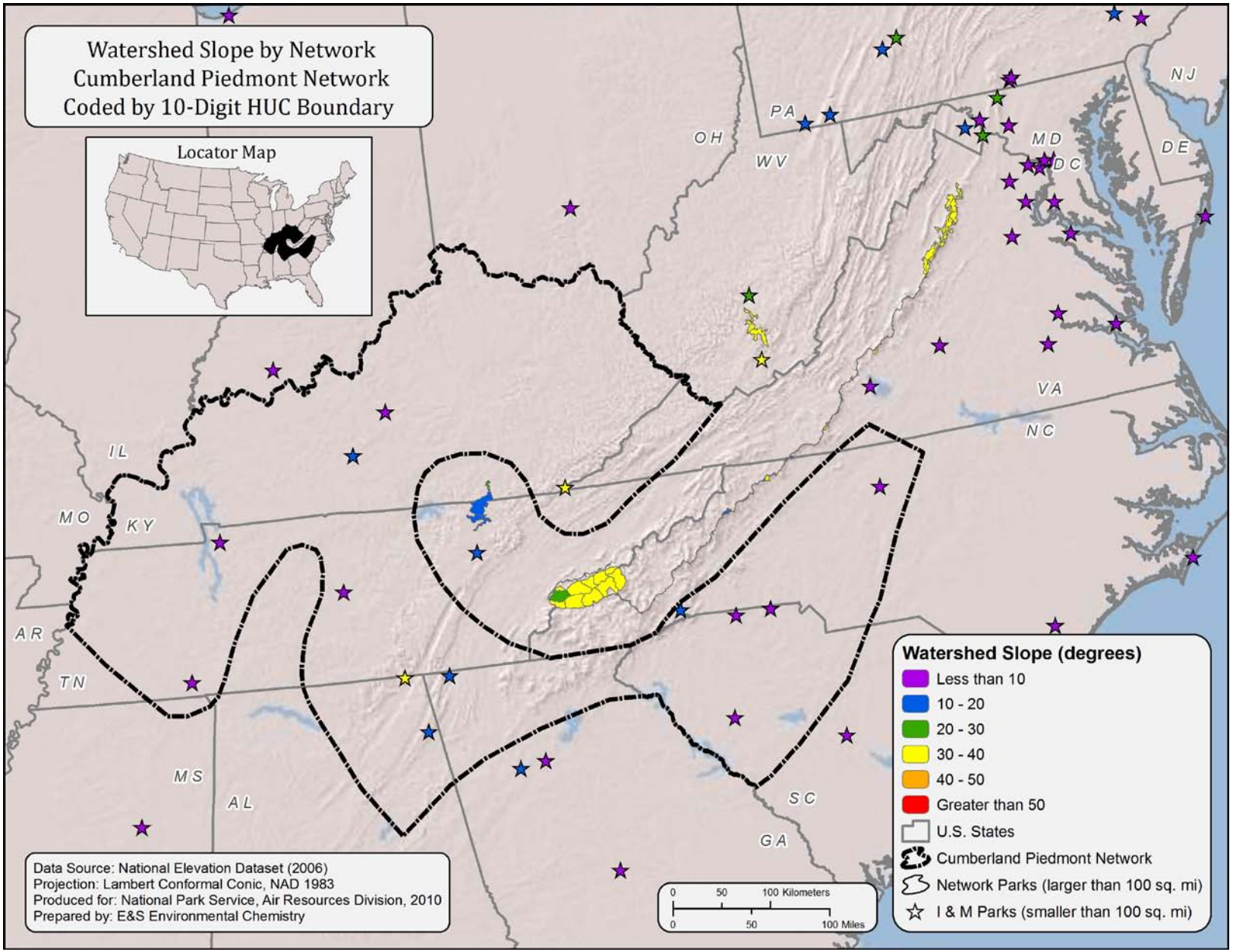
Map J


Total Nitrogen Deposition
Cumberland Piedmont Network
(kg/ha/yr)
Locator Map
PA
OH
WV
MD
DC
DE
NJ
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Total Nitrogen Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 63.5
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: Interpolated NADP Wet and CMAQ Model Dry Deposition for 2002
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 50 100 Kilometers
0 50 100 Miles

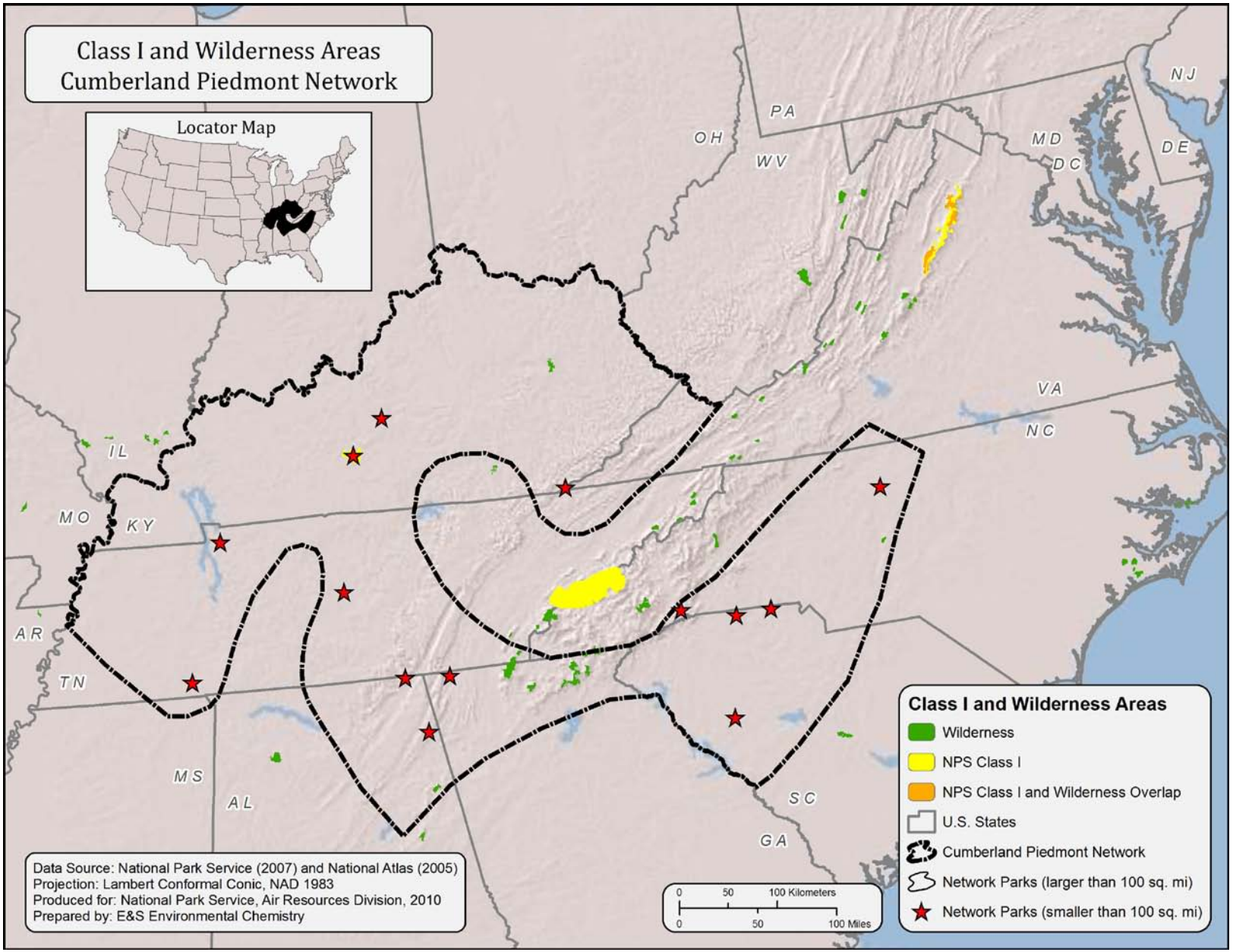
Map K


2001 Land Cover
Cumberland Piedmont Network
(National Land Cover Data)
Locator Map
PA
NJ
OH
MD
DC
DE
WV
Atlantic Ocean
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Open Water
Perennial Ice/Snow
Developed
Barren Land
Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Row Crops
Wetlands
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: National Land Cover Data (NLCD, 2001)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 50 100 Kilometers
0 50 100 Miles

Map L


Watershed Slope by Network
Cumberland Piedmont Network
Coded by 10-Digit HUC Boundary
Locator Map
PA
OH
WV
MD
DC
DE
NJ
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Watershed Slope (degrees)
Less than 10
10 - 20
20 - 30
30 - 40
40 - 50
Greater than 50
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
I & M Parks (smaller than 100 sq. mi)
0 50 100 Kilometers
0 50 100 Miles
Data Source: National Elevation Dataset (2006)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry

Map M


Class I and Wilderness Areas
Cumberland Piedmont Network
Locator Map
PA
OH
WV
MD
DC
DE
NJ
VA
NC
IL
MO
KY
AR
TN
MS
AL
SC
GA
Class I and Wilderness Areas
Wilderness
NPS Class I
NPS Class I and Wilderness Overlap
U.S. States
Cumberland Piedmont Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Data Source: National Park Service (2007) and National Atlas (2005)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 50 100 Kilometers
0 50 100 Miles

Map N

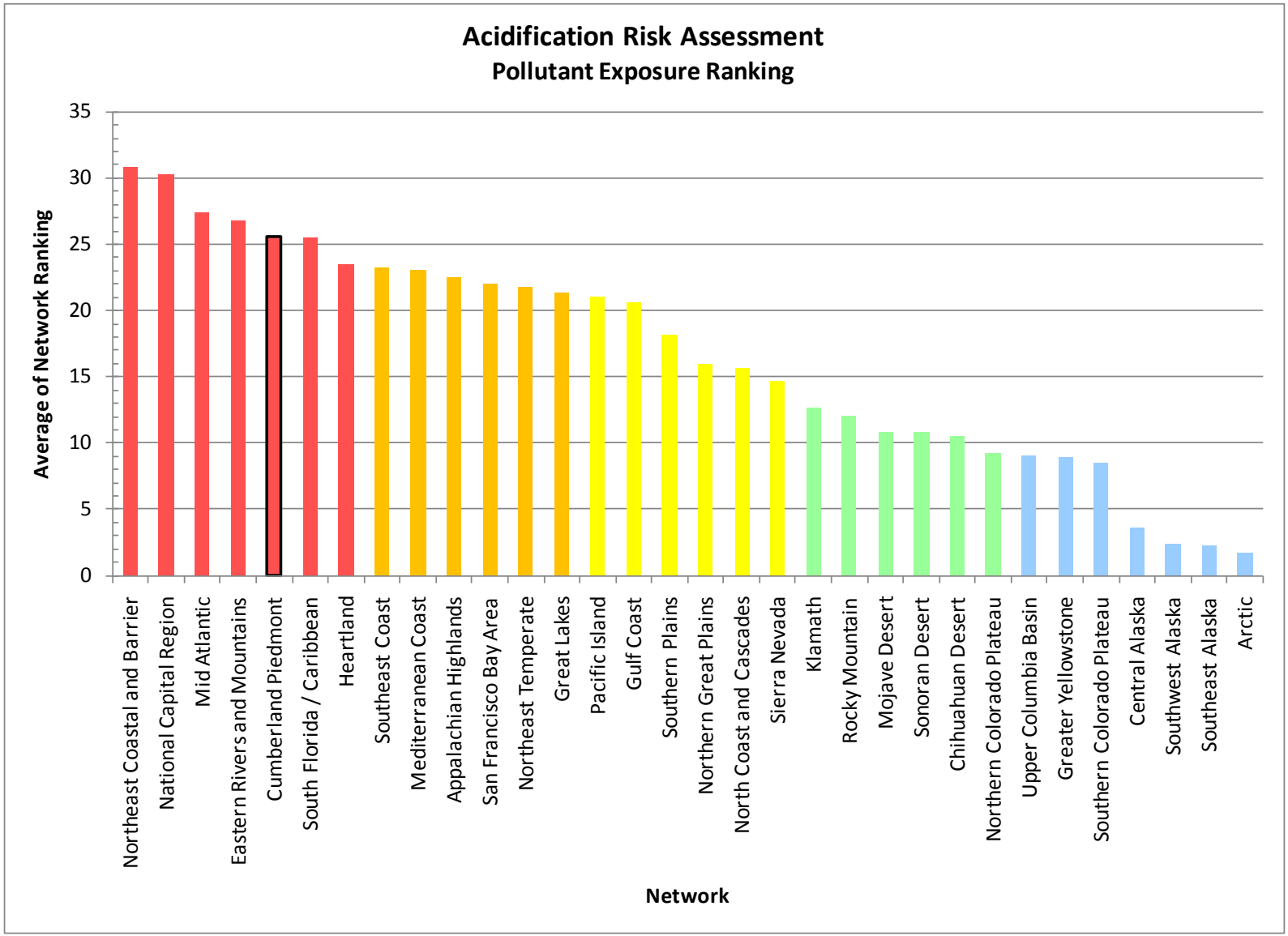

Acidification Risk Assessment
Pollutant Exposure Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
Northeast Coastal and Barrier
National Capital Region
Mid Atlantic
Eastern Rivers and Mountains
Cumberland Piedmont
South Florida / Caribbean
Heartland
Southeast Coast
Mediterranean Coast
Appalachian Highlands
San Francisco Bay Area
Northeast Temperate
Great Lakes
Pacific Island
Gulf Coast
Southern Plains
Northern Great Plains
North Coast and Cascades
Sierra Nevada
Klamath
Rocky Mountain
Mojave Desert
Sonoran Desert
Chihuahuan Desert
Northern Colorado Plateau
Upper Columbia Basin
Greater Yellowstone
Southern Colorado Plateau
Central Alaska
Southwest Alaska
Southeast Alaska
Arctic
Network

Figure A

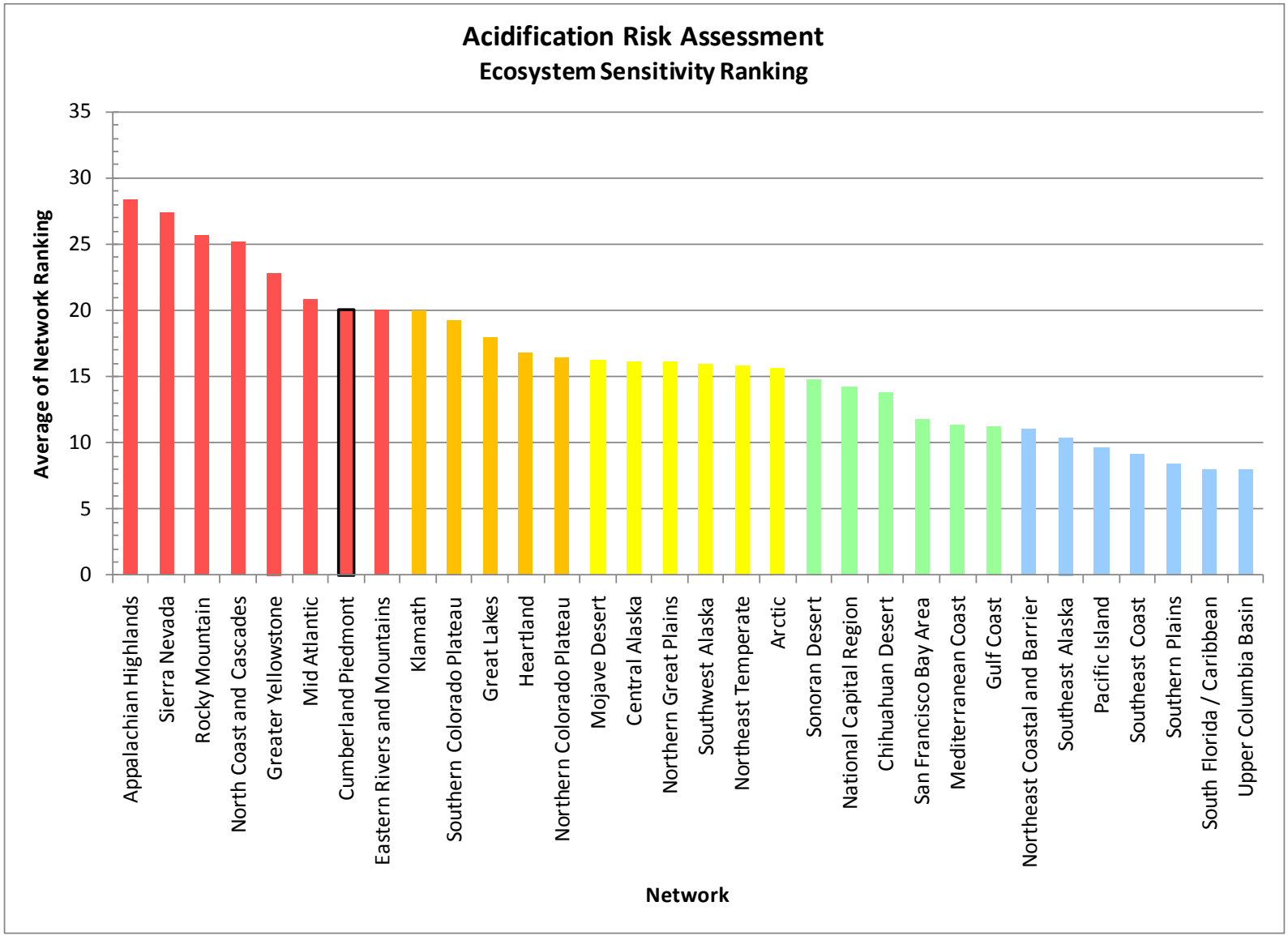

Acidification Risk Assessment
Ecosystem Sensitivity Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
Appalachian Highlands
Sierra Nevada
Rocky Mountain
North Coast and Cascades
Greater Yellowstone
Mid Atlantic
Cumberland Piedmont
Eastern Rivers and Mountains
Klamath
Southern Colorado Plateau
Great Lakes
Heartland
Northern Colorado Plateau
Mojave Desert
Central Alaska
Northern Great Plains
Southwest Alaska
Northeast Temperate
Arctic
Sonoran Desert
National Capital Region
Chihuahuan Desert
San Francisco Bay Area
Mediterranean Coast
Gulf Coast
Northeast Coastal and Barrier
Southeast Alaska
Pacific Island
Southeast Coast
Southern Plains
South Florida / Caribbean
Upper Columbia Basin
Network

Figure B

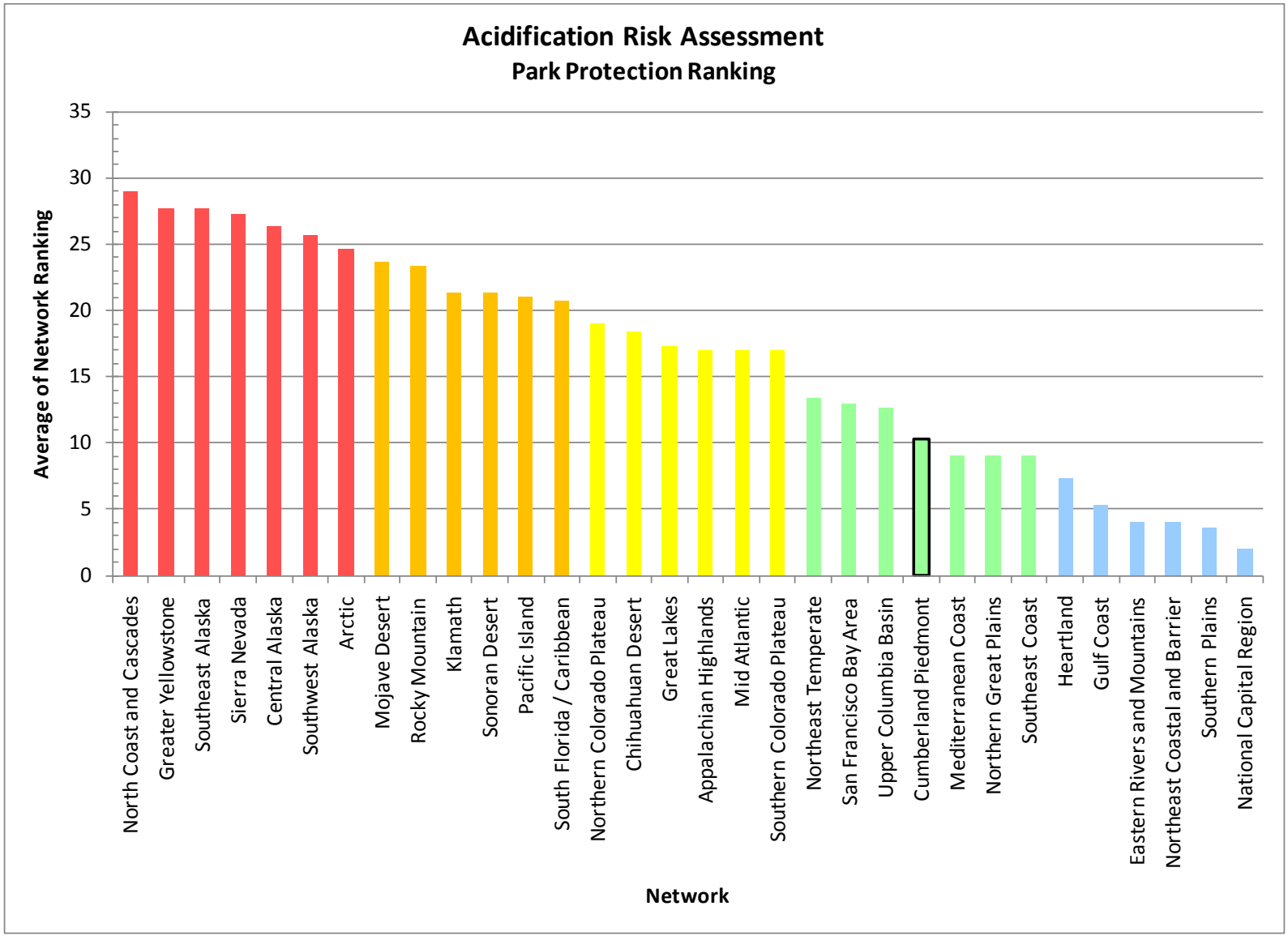

Acidification Risk Assessment
Park Protection Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
North Coast and Cascades
Greater Yellowstone
Southeast Alaska
Sierra Nevada
Central Alaska
Southwest Alaska
Arctic
Mojave Desert
Rocky Mountain
Klamath
Sonoran Desert
Pacific Island
South Florida / Caribbean
Northern Colorado Plateau
Chihuahuan Desert
Great Lakes
Appalachian Highlands
Mid Atlantic
Southern Colorado Plateau
Northeast Temperate
San Francisco Bay Area
Upper Columbia Basin
Cumberland Piedmont
Mediterranean Coast
Northern Great Plains
Southeast Coast
Heartland
Gulf Coast
Eastern Rivers and Mountains
Northeast Coastal and Barrier
Southern Plains
National Capital Region
Network

Figure C

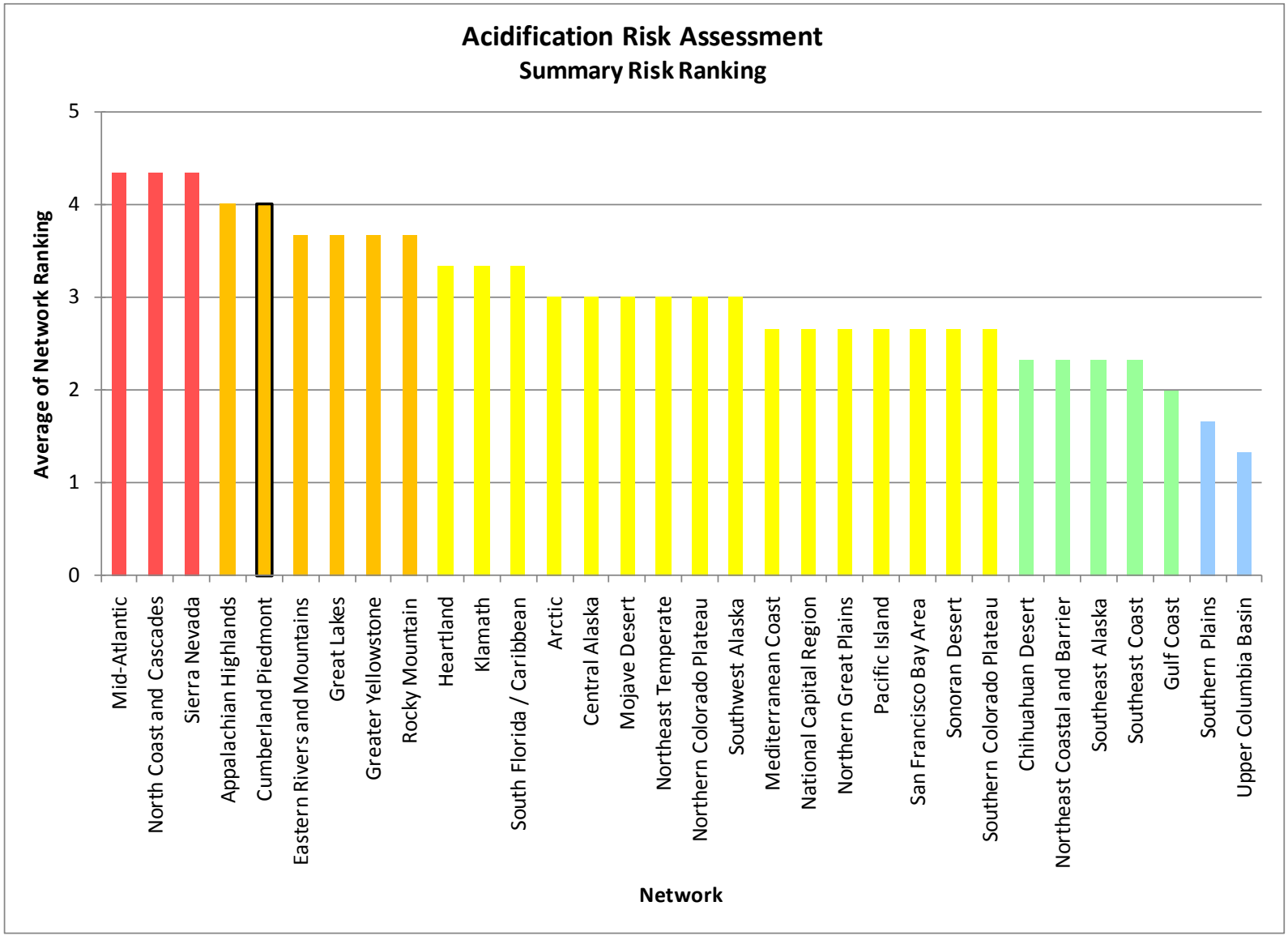

Acidification Risk Assessment
Summary Risk Ranking
Average of Network Ranking
0
1
2
3
4
5
Mid-Atlantic
North Coast and Cascades
Sierra Nevada
Appalachian Highlands
Cumberland Piedmont
Eastern Rivers and Mountains
Great Lakes
Greater Yellowstone
Rocky Mountain
Heartland
Klamath
South Florida / Caribbean
Arctic
Central Alaska
Mojave Desert
Northeast Temperate
Northern Colorado Plateau
Southwest Alaska
Mediterranean Coast
National Capital Region
Northern Great Plains
Pacific Island
San Francisco Bay Area
Sonoran Desert
Southern Colorado Plateau
Chihuahuan Desert
Northeast Coastal and Barrier
Southeast Alaska
Southeast Coast
Gulf Coast
Southern Plains
Upper Columbia Basin
Network

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 910/107388, April 2011

National Park Service
U.S. Department of the Interior

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