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

Northeast Temperate Network (NETN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/368

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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T. J. Sullivan
T. C. McDonnell
G. T. McPherson
S. D. Mackey
D. Moore

E&S Environmental Chemistry, Inc.
P.O. Box 609
Corvallis, OR 97339

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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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NPS 962/107404, April 2011

Northeast Temperate Network (NETN)

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 11 parks in the Northeast Temperate Network. None are larger than 100 square miles. This network includes heavily urbanized areas around New York City and Boston, as well as relatively undeveloped areas in northern New York, New Hampshire, Vermont, and Maine.

Total annual S and N emissions, by county, are shown in Maps E and F for lands in and surrounding the Northeast Temperate Network. Annual county-level S emissions were mostly less than 20 tons per square mile, with only a few small areas having higher levels. Portions of the network away from the coastal corridor, and the northeastern corner of the network, generally had low S emissions, less than 1 ton per square mile per year. County-level N emissions within the network ranged from less than 1 ton per square mile per year, mainly in the north, to greater than 100 tons per square mile per year in some of the densely urbanized areas in and around Boston and near New York City. However, annual county N emissions were generally less than 20 tons per square mile throughout all but the most heavily urbanized areas. Point source emissions of SO_2 and oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH_3) N are shown in Maps G and H, respectively. There are many point sources of SO_2 within this network, predominantly located in the heavily urbanized areas. Most emit less than 5,000 tons S per year. There are few N point sources of any magnitude (i.e., larger than 500 to 1,000 tons per year) within this network.

Urban centers within the network and within a 300-mile buffer around the network are shown in Map I. There is a large density of medium to large urban population centers, especially along the coastal corridor between Boston and Philadelphia. Elsewhere within the network, there are few population centers larger than 50,000 people.

Total S and total 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 and total N deposition within the network are both highly variable from north to south, ranging from between 2 and 5 kg N/ha/yr in northern Maine to between 10 and 15 kg N/ha/yr in much of the southern portion of the network. There are areas in the southern part of the network, especially around New York City, where both S and N deposition reach much higher levels.

Land cover in and around the network is shown in Map L. The predominant cover types within this network are generally forest in the north, developed land and forest in the south, and a mix of forest, pasture/hay, row crops, and developed land in the west.

Watershed slope for the parks in the network is shown in Map M. Six of the parks have low relief, with less than 10^o average slope. The remaining five parks have average slope between 10^o and 20^o.

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. The only Class I park is Acadia NP (ACAD). Only limited, relatively small, wilderness areas occur in this network, mostly in the mountains of New Hampshire and Vermont.

Park-specific maps are shown for ACAD for sensitive vegetation (Map P-1) and stream order (Map P-2). The predominant sensitive vegetation type is forest expected to contain red spruce (Map P-1). There is also some sugar maple present. These species are well known to be acid-sensitive. All of the streams in ACAD are first through third order. Such streams tend to be more likely to be sensitive to acidification than larger, higher-order streams.

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 Temperate Network ranked in the second highest quintile in Pollutant Exposure (Figure A). Emissions and deposition of both S and N within the network are moderately high. The network Ecosystem Sensitivity ranking was Moderate, within the middle quintile among networks (Figure B). This network ranked at the top of the second lowest quintile in Park Protection, having limited amounts of protected lands (Figure C).

In combination, the network rankings for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection yield an overall Network Risk ranking that was in the middle of the distribution among networks (Figure D).

Because there are no parks in this network that are larger than 100 square miles, the figures used to compare rankings among the larger parks are not shown for this network. Relative rankings for all parks, including the smaller parks, are given in Table A and Appendix A. Pollutant Exposure rankings for the individual parks in this network were variable, from Moderate (middle quintile) for four of the parks to Very High (highest quintile) for six parks. The Ecosystem Sensitivity rankings were also variable, from Low for one of the parks to Very High for four of the parks (Table A). Park Protection rankings were all Moderate, with the exception of ACAD, which was ranked Very High in Park Protection.

Park Summary rankings varied from Moderate for two of the parks (Boston Harbor [BOHA] and Saratoga [SARA]) to Very High for ACAD and Morristown (MORR). The rest of the parks were ranked High.

The Appalachian Trail (AT) corridor is not part of any particular network, but rather bisects a number of networks along its path between Maine and Georgia. We present data for the AT corridor here, as part of the Northeast Temperate Network. Total S emissions within the counties that border the AT corridor were generally less than 1 ton per square mile per year along most of the southern half and the northernmost fourth of the AT corridor. County-level S emissions

tended to be somewhat higher along the portion of the AT corridor that extends from southern Vermont to northern Virginia, with many counties showing annual S emissions between about 5 and 50 tons per square mile per year (Map AT-E). Total annual N emissions within the counties adjacent to the AT corridor varied from less than 1 ton per square mile to more than 20 tons per square mile (Map AT-F). Relatively large (more than 5,000 tons S per year) point sources of S were common near the AT corridor, especially in Pennsylvania, West Virginia, Ohio, and North Carolina (Map AT-G). Large point sources of N in proximity to the AT were almost exclusively oxidized N sources (Map AT-H). Few large N point sources were found adjacent to the AT north of New Jersey. To the south, however, there were many large NO_x point sources, both in close proximity to the corridor and in the Ohio River Valley to the west. Relatively large urban population centers (> 100,000 people) occur in relatively close proximity to the AT corridor along much of its length, with the exception of the northernmost portion in Maine (Map AT-I). The highest density of population centers along the corridor occurs between Boston and Washington, DC. Total S deposition was relatively low along the northern section of the corridor (less than 10 kg S/ha/yr). Estimated total S deposition was somewhat higher along the southern reaches of the corridor, from northern Virginia to Georgia. The highest S deposition estimates occurred between the border between New York and Connecticut and northern Virginia (Map AT-J). Total N deposition along the corridor was fairly low (2 to 5 kg N/ha/yr) in northern Maine, but was above 10 kg N/ha/yr along much of the corridor length between southern Vermont and southern Virginia (Map AT-K). Both S and N deposition were likely higher than is indicated on Maps AT-J and AT-K in the high-elevation sections of the AT corridor that pass through GRSM. This is because cloud deposition, which was not quantified for this assessment, can be substantial at high elevations in this park.

Most of the AT corridor is forested, especially in the north and in the south (Map AT-L). Substantial land areas classified as pasture/hay and some row crops and developed land occur in the middle section of the corridor. Because the AT follows ridgelines along much of its length, surface waters within the corridor tend to be primarily first and second order streams, rather than higher order streams or lakes. Although much of the trail location is forested, scattered meadows and wetlands also occur at some locations.

The AT corridor passes through Class I and wilderness areas, most notably within GRSM and Shenandoah National Park (SHEN; Map AT-N), both of which are designated as Class I. There are numerous wilderness areas scattered along the AT corridor, mainly along the northernmost section (in Vermont, New Hampshire, and Maine) and the southern section (in Virginia, North Carolina, Tennessee, and Georgia).

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
Acadia	Moderate	Very High	Very High	Very High
Boston Harbor Islands	Very High	Low	Moderate	Moderate
Home of Franklin D. Roosevelt	Very High	Moderate	Moderate	High
Marsh-Billings-Rockefeller	Moderate	Very High	Moderate	High
Minute Man	High	High	Moderate	High
Morristown	Very High	Very High	Moderate	Very High
Saint-Gaudens	Moderate	Very High	Moderate	High
Saratoga	Moderate	Moderate	Moderate	Moderate
Saugus Iron Works	Very High	High	Moderate	High
Vanderbilt Mansion	Very High	Moderate	Moderate	High
Weir Farm	Very High	High	Moderate	High

[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)

Map P-1. Park-specific map: sensitive vegetation types in ACAD. (Source of data: Landfire [http://www.landfire.gov/] and NPS Vegetation Survey)

Map P-2. Park-specific map: low-order streams in ACAD. (Source of data: U.S. EPA/USGS National Hydrography Dataset Plus [http://www.horizon-systems.com/nhdplus/])

Map AT-E. Total S emissions by county for lands surrounding the Appalachian Trail corridor, 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 AT-F. Total N emissions by county for lands surrounding the Appalachian Trail corridor, 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 AT-G. Major point source emissions of SO_2 for lands surrounding the Appalachian Trail corridor. (Source of data: EPA National Emissions Inventory, http://www.epa.gov/ttn/chief/net/2002inventory.html)

Map AT-H. Major point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH_3) N in and around the Appalachian Trail corridor. 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 AT-I. Urban centers having more than 10,000 people within the network and within a 300-mile buffer around the perimeter of the Appalachian Trail corridor. (Source of data: U.S. Census 2000)

Map AT-J. Total S deposition in and around the Appalachian Trail corridor. 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 AT-K. Total N deposition in and around the Appalachian Trail corridor. 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 AT-L. Land cover types in and around the Appalachian Trail corridor, based on the National Land Cover dataset. (Source of data: National Land Cover Dataset, http://www.mrlc.gov/nlcd_multizone_map.php)

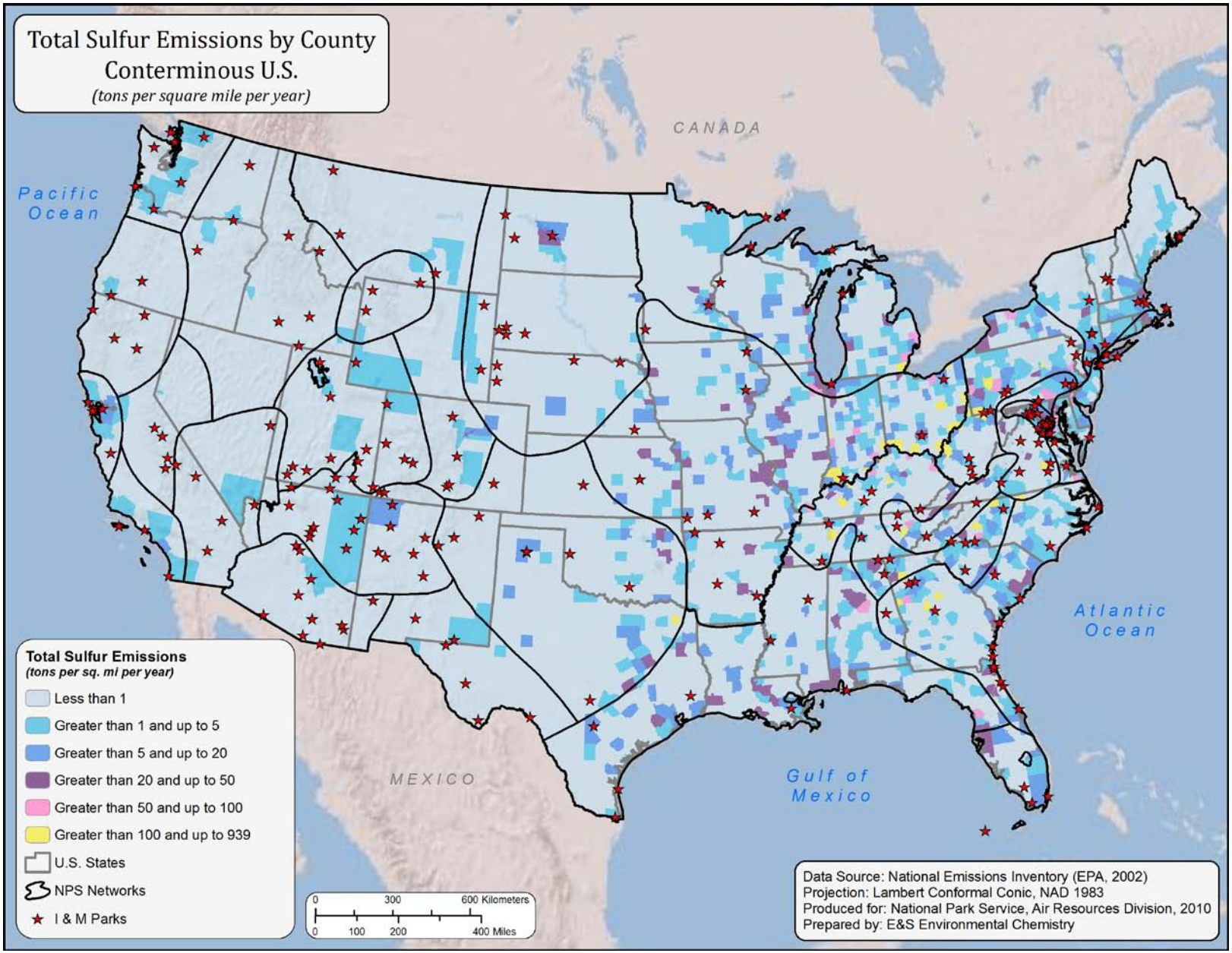
Map AT-N. Lands within the Appalachian Trail corridor that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; http://nationalatlas.gov] and NPS)

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

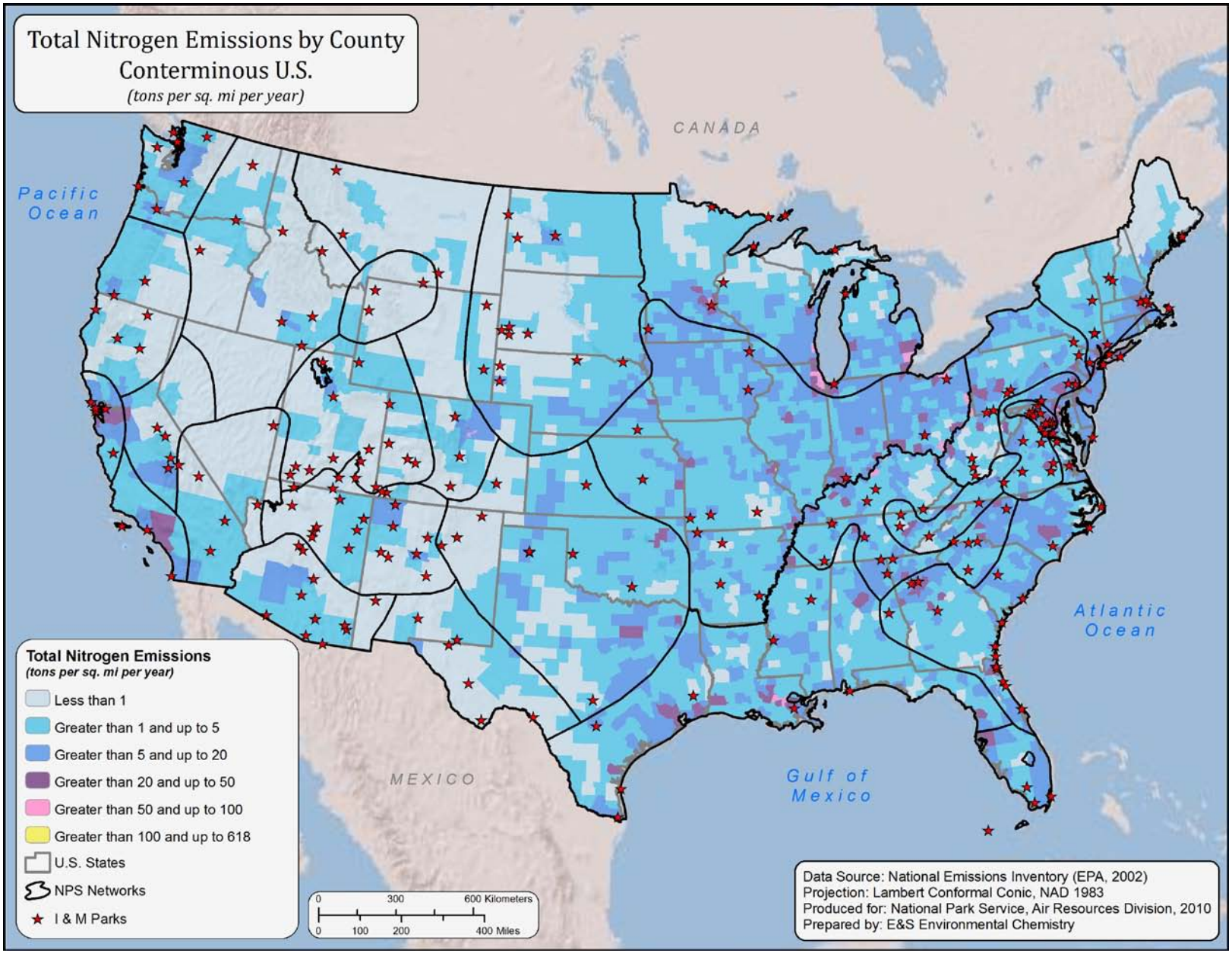
Figure B. Network rankings for Ecosystem Sensitivity, calculated as the average of scores for all Ecosystem Sensitivity variables.

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

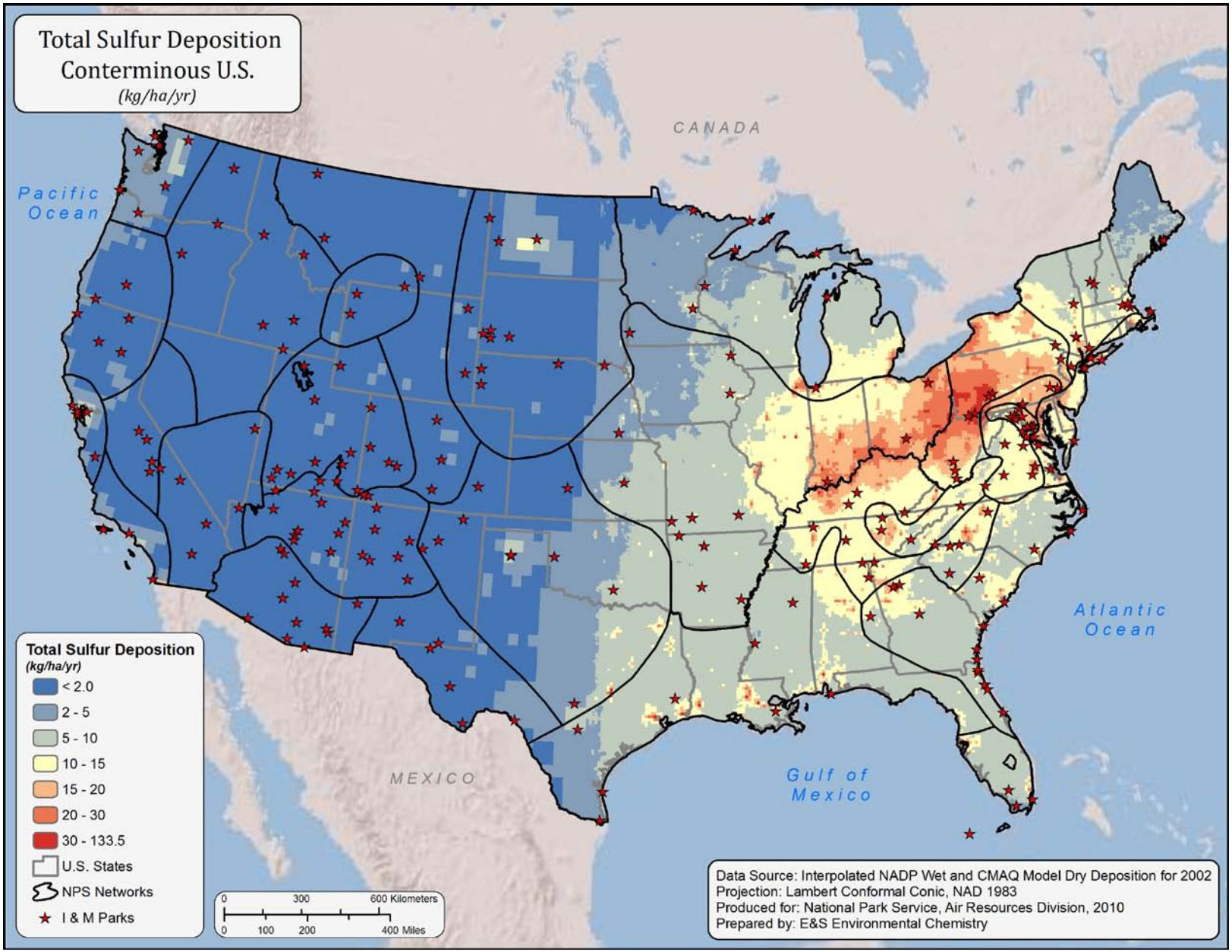
Figure D. Network Summary Risk rankings, calculated as the average of the quintile ranks for the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection themes.


Total Sulfur Emissions by County
Conterminous U.S.
(tons per square mile per year)
CANADA
Pacific Ocean
Atlantic Ocean
Gulf of Mexico
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

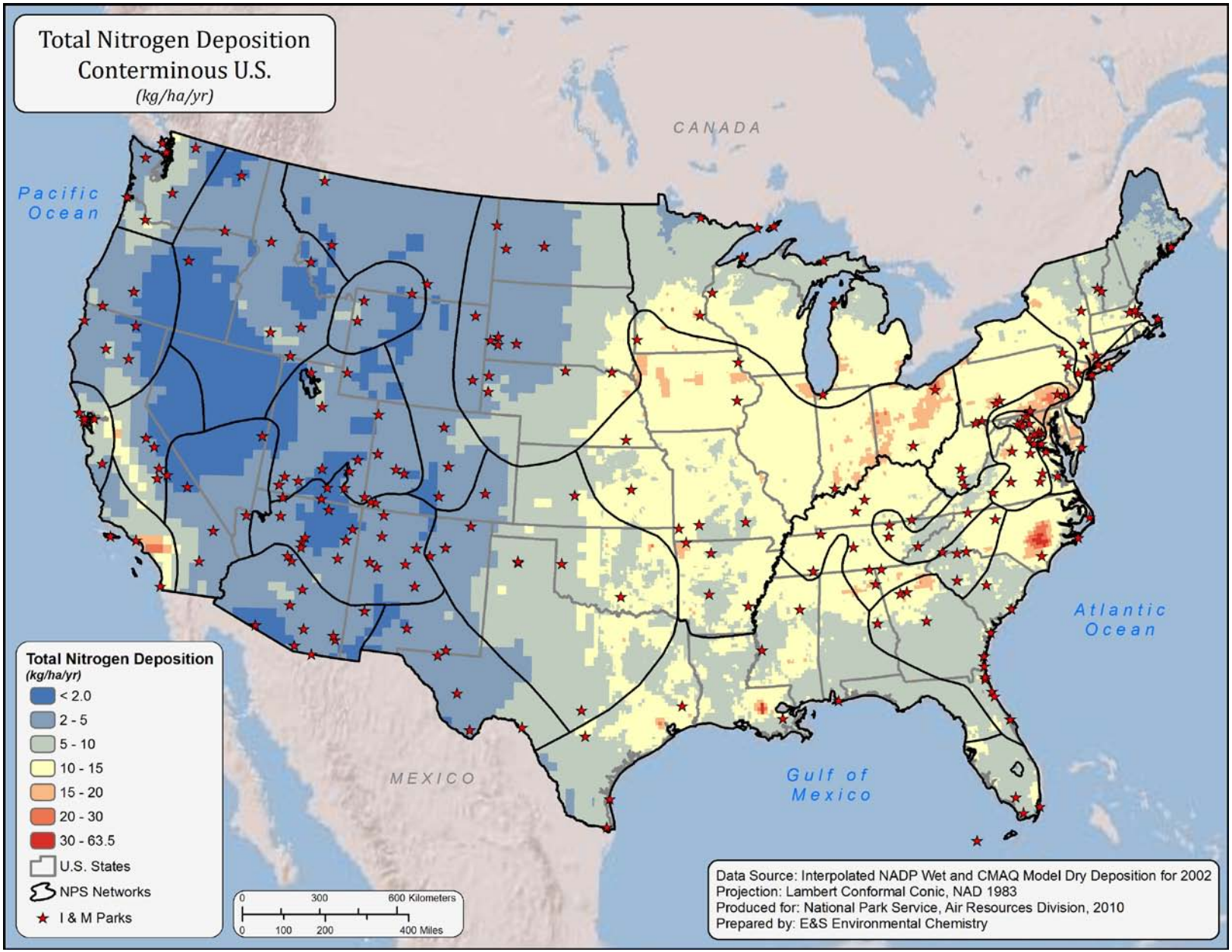
Map A


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

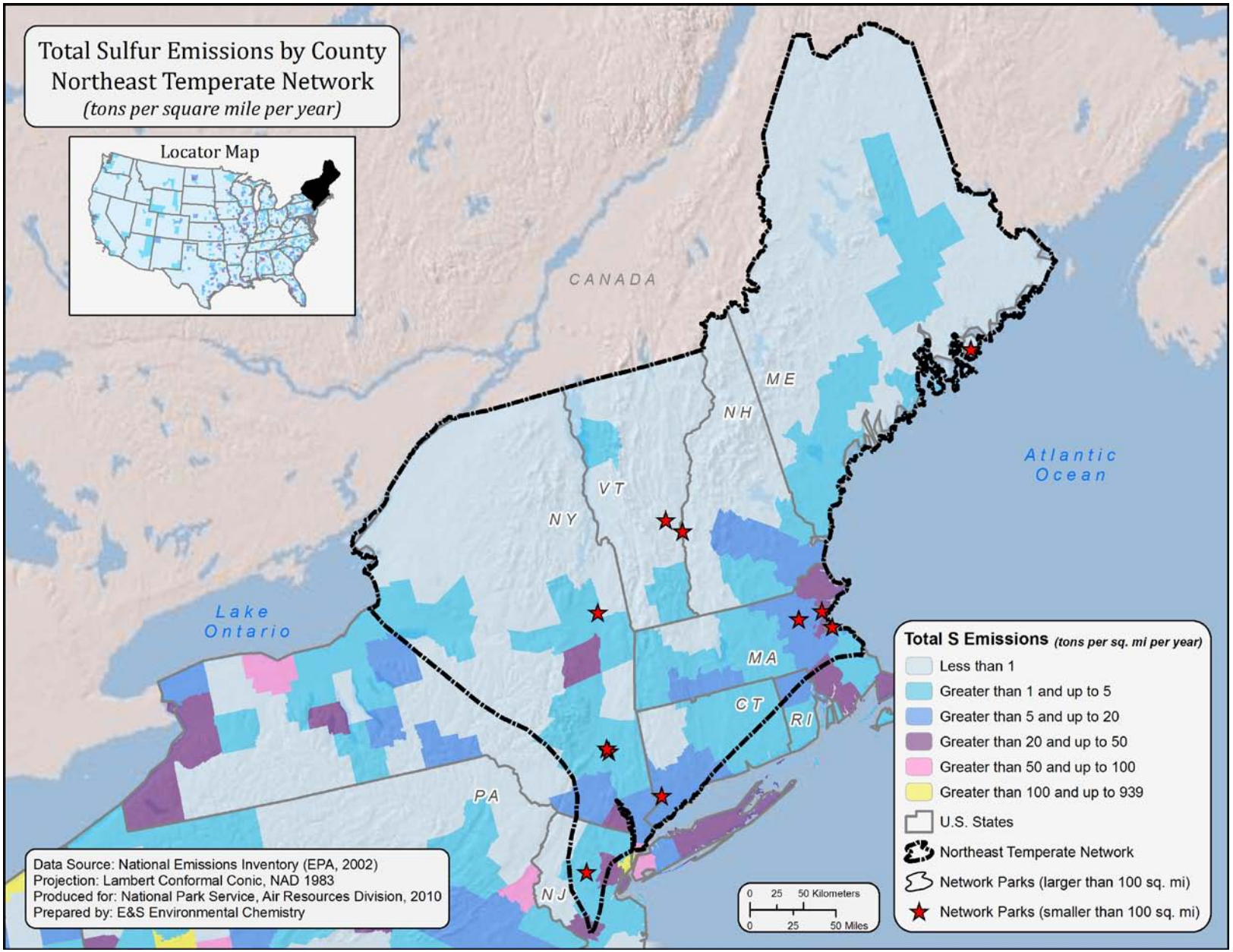
Map B


Total Sulfur Deposition
Conterminous U.S.
(kg/ha/yr)
CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
Gulf of 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

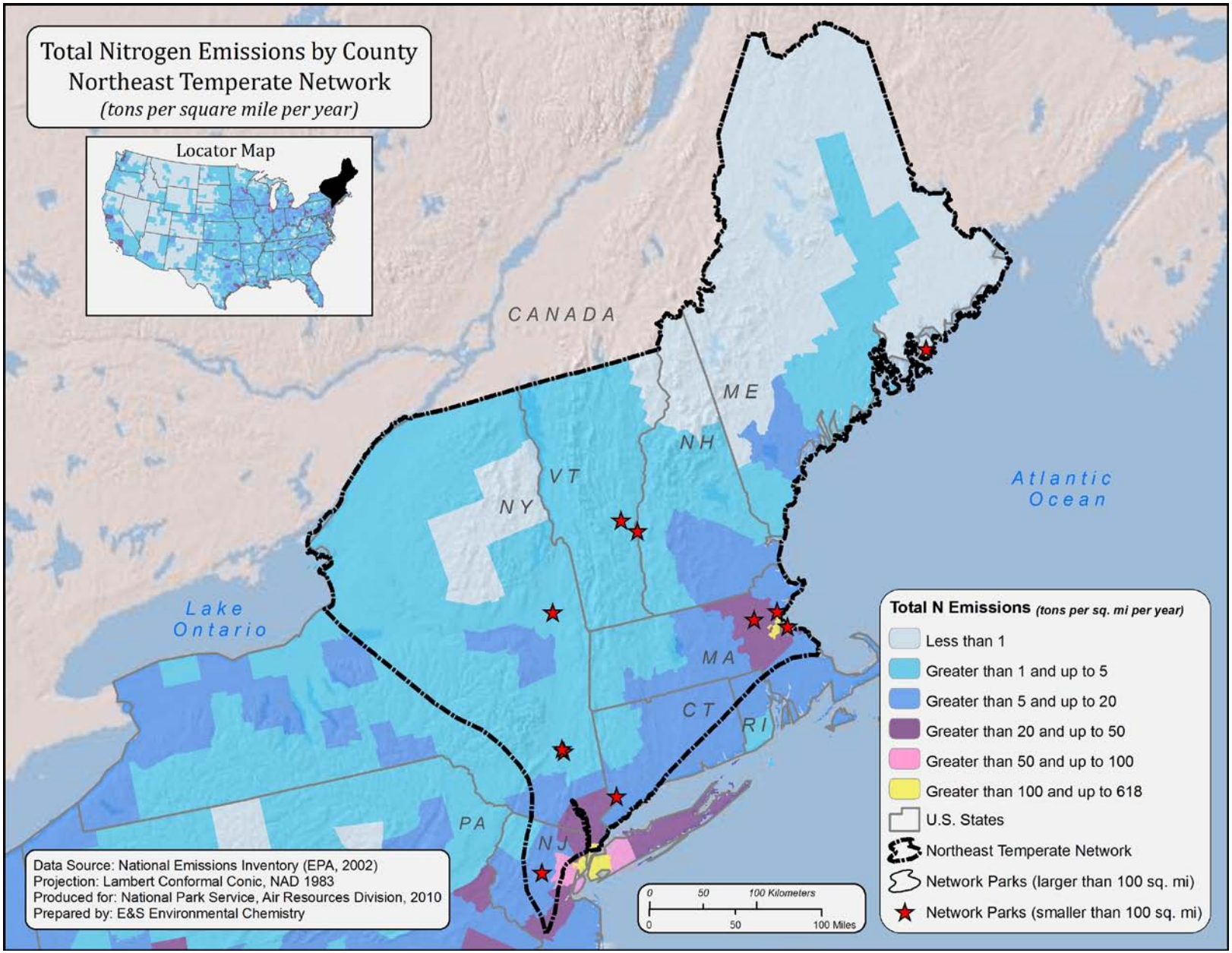
Map C


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

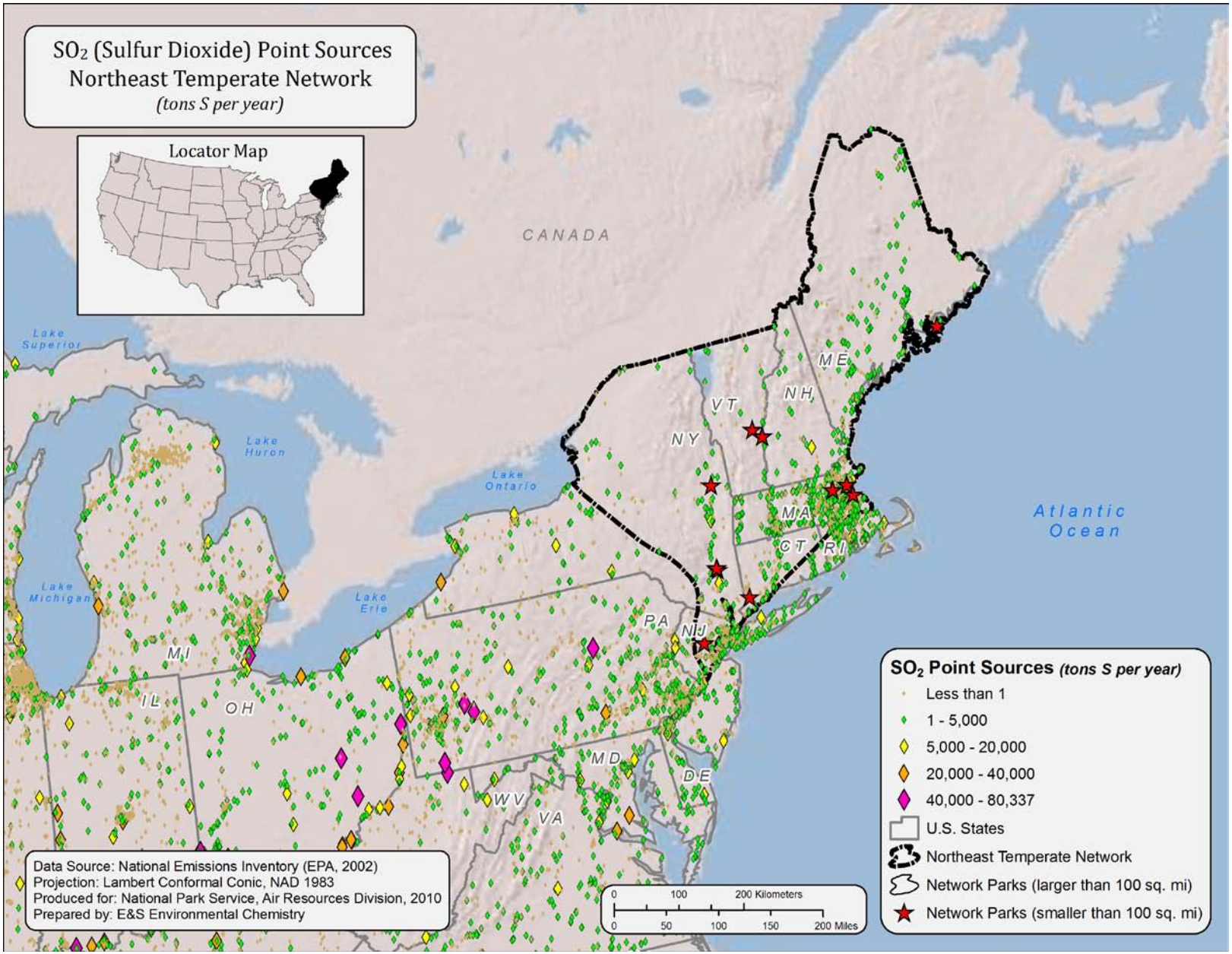
Map D


Total Sulfur Emissions by County
Northeast Temperate Network
(tons per square mile per year)
Locator Map
CANADA
ME
NH
VT
NY
MA
CT
RI
PA
NJ
Lake Ontario
Atlantic Ocean
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
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
0 25 50 Kilometers
0 25 50 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

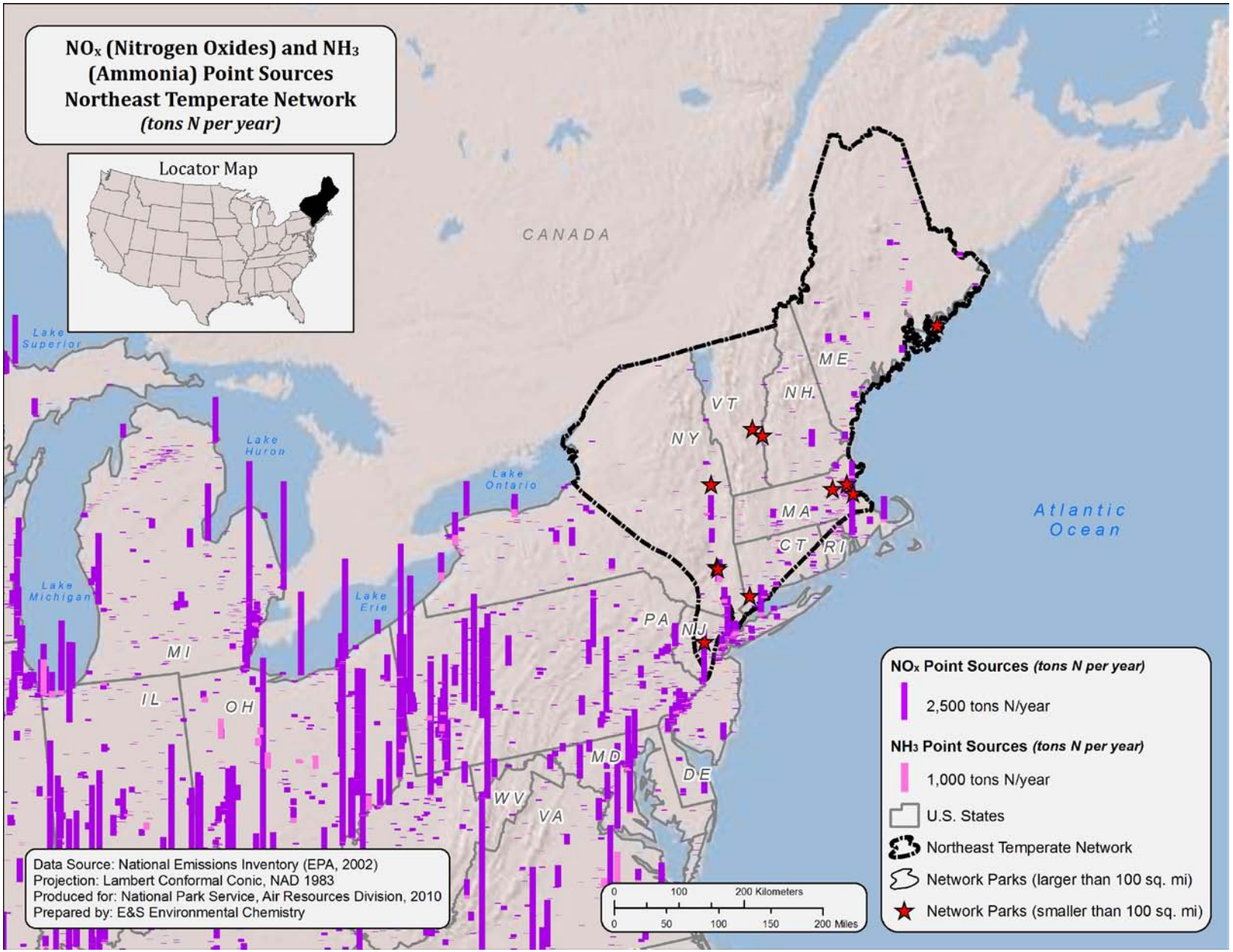
Map E


Total Nitrogen Emissions by County
Northeast Temperate Network
(tons per square mile per year)
Locator Map
CANADA
ME
NH
VT
NY
MA
CT
RI
PA
NJ
Lake Ontario
Atlantic Ocean
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
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
0 50 100 Kilometers
0 50 100 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

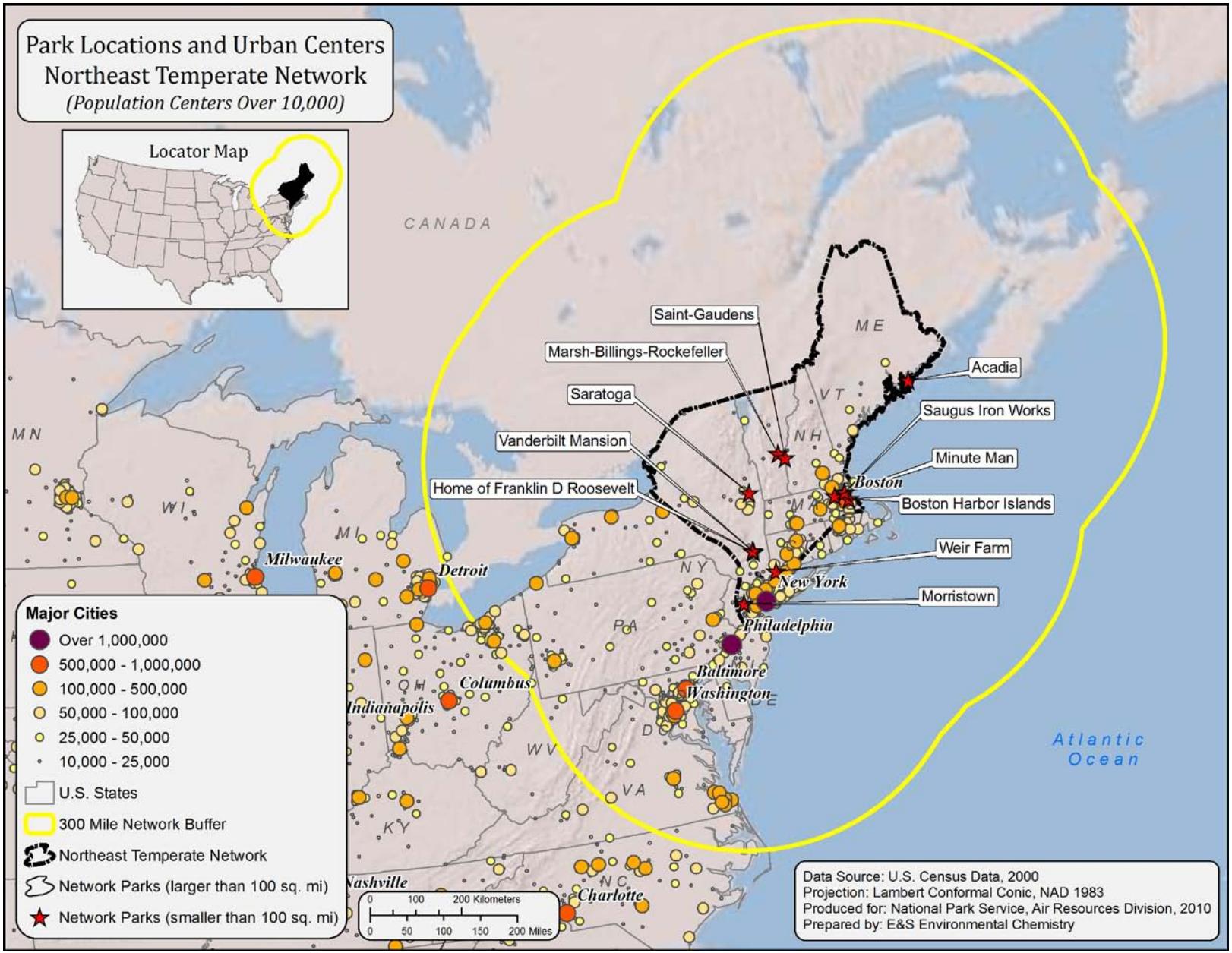
Map F


SO2 (Sulfur Dioxide) Point Sources
Northeast Temperate Network
(tons S per year)
Locator Map
CANADA
Lake Superior
Lake Huron
Lake Michigan
Lake Erie
Lake Ontario
Atlantic Ocean
ME
NH
VT
NY
MA
CT
RI
PA
NJ
MD
DE
WV
VA
OH
IL
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
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
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)

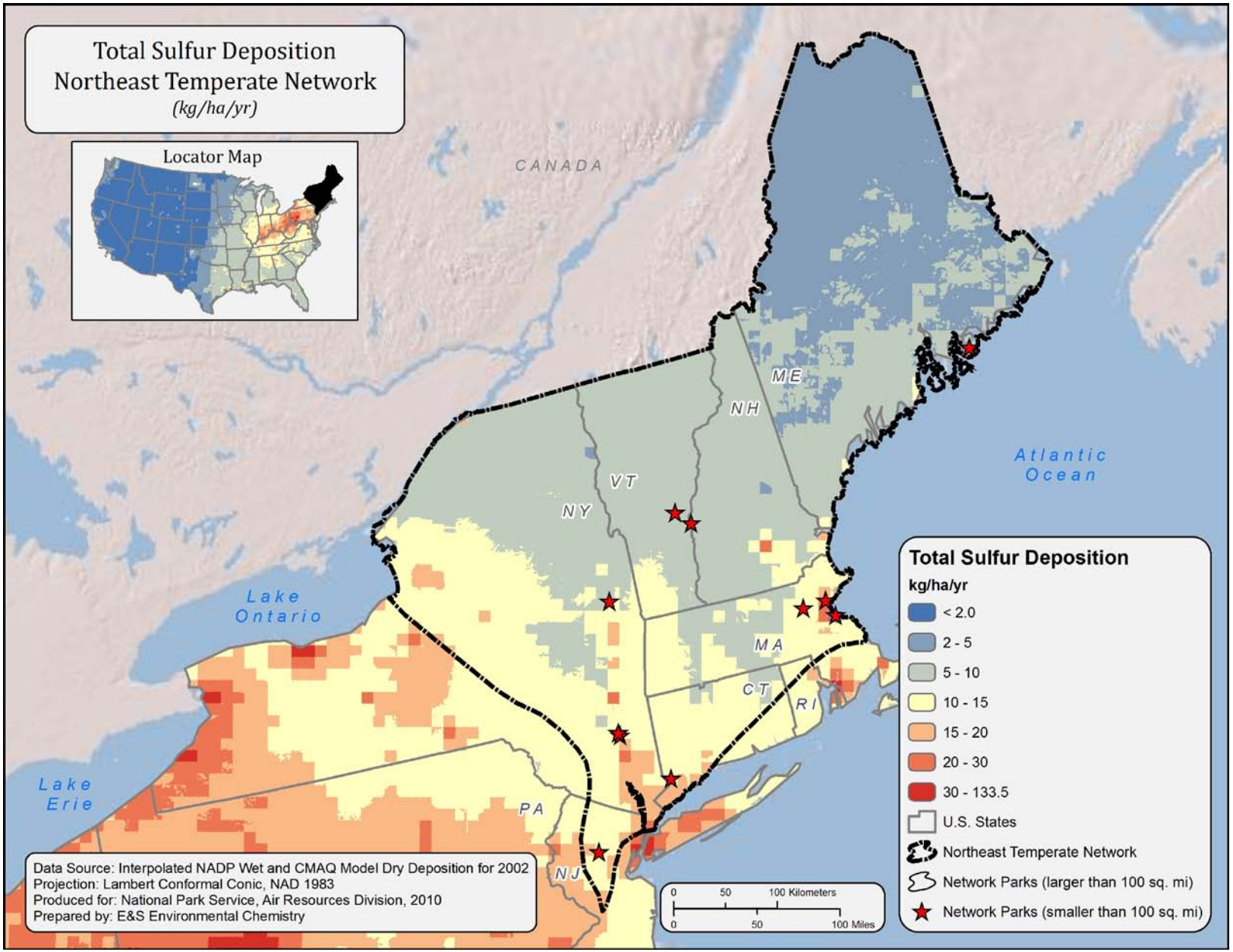
Map G


NOx (Nitrogen Oxides) and NH3 (Ammonia) Point Sources
Northeast Temperate Network
(tons N per year)
Locator Map
CANADA
Lake Superior
Lake Huron
Lake Michigan
Lake Erie
Lake Ontario
Atlantic Ocean
ME
NH
VT
NY
MA
CT
RI
PA
NJ
MI
IL
OH
MD
DE
WV
VA
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
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
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)

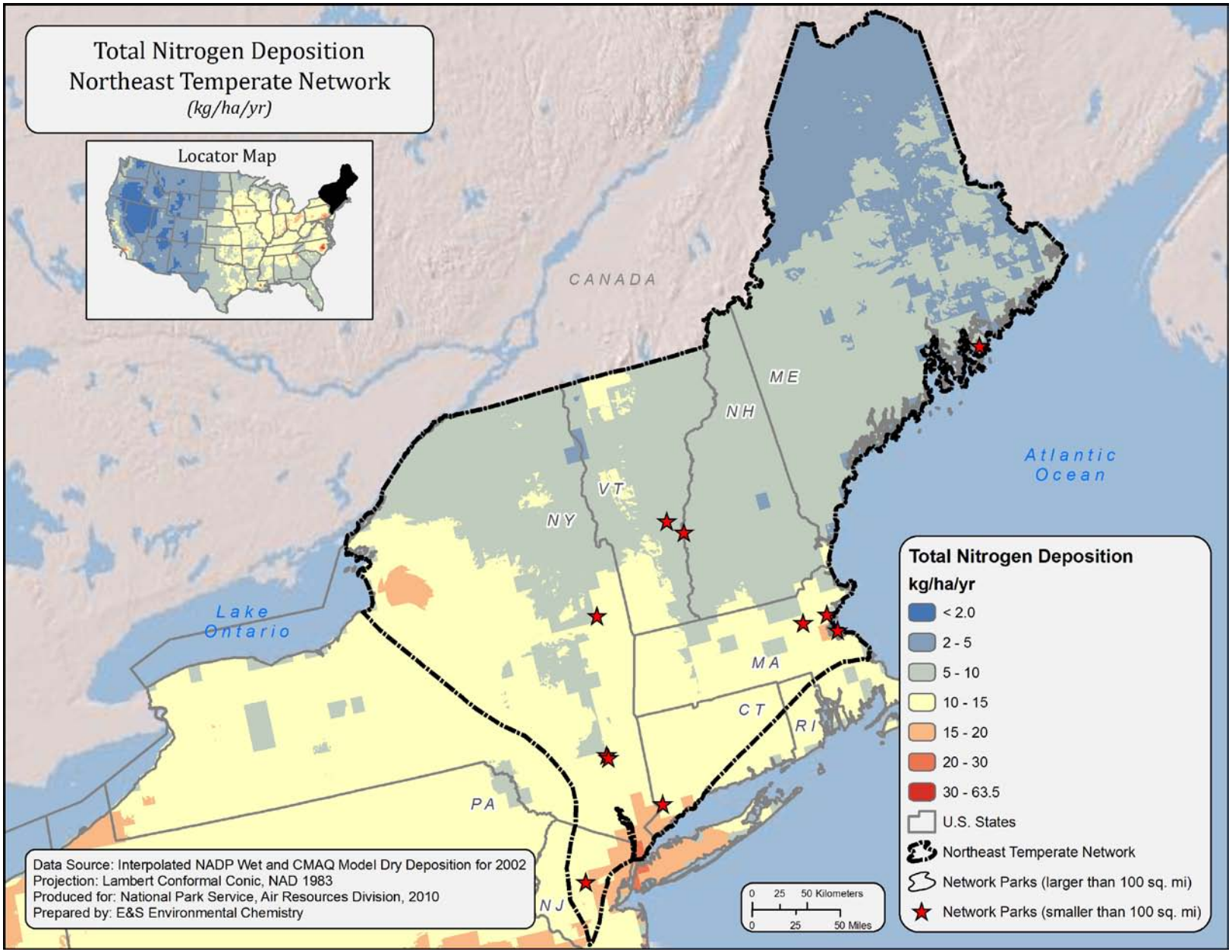
Map H


Park Locations and Urban Centers
Northeast Temperate Network
(Population Centers Over 10,000)
Locator Map
CANADA
Saint-Gaudens
Marsh-Billings-Rockefeller
Saratoga
Vanderbilt Mansion
Home of Franklin D Roosevelt
Acadia
Saugus Iron Works
Minute Man
Boston Harbor Islands
Weir Farm
Morristown
Boston
New York
Philadelphia
Baltimore
Washington
Milwaukee
Detroit
Columbus
Indianapolis
Charlotte
Atlantic Ocean
ME
VT
NH
MA
NY
PA
MD
DE
NJ
WV
VA
KY
OH
MI
WI
MN
NC
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 Temperate 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

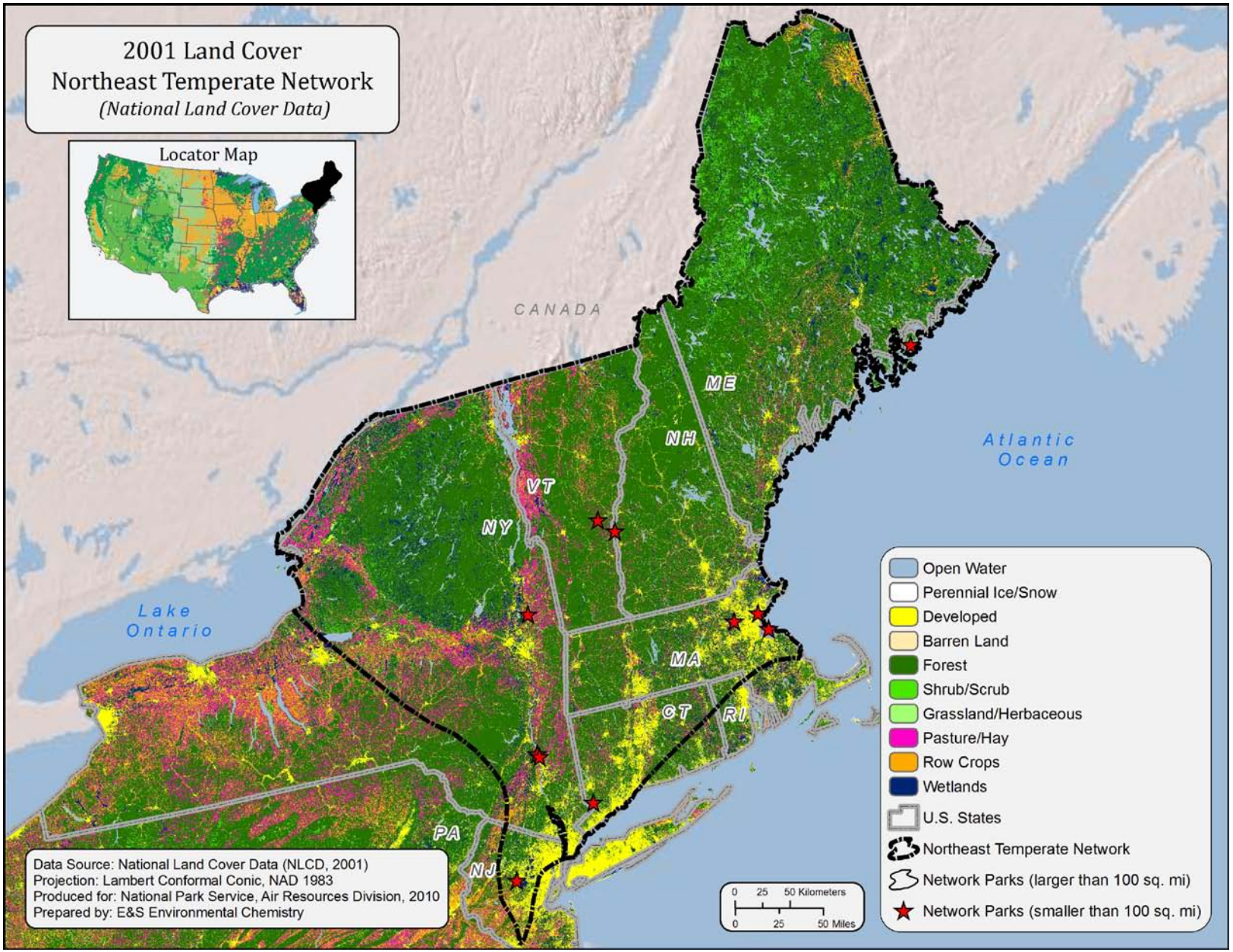
Map I


Total Sulfur Deposition
Northeast Temperate Network
(kg/ha/yr)
Locator Map
CANADA
ME
NH
VT
NY
MA
CT
RI
PA
NJ
Lake Ontario
Lake Erie
Atlantic Ocean
Total Sulfur Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 133.5
U.S. States
Northeast Temperate 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

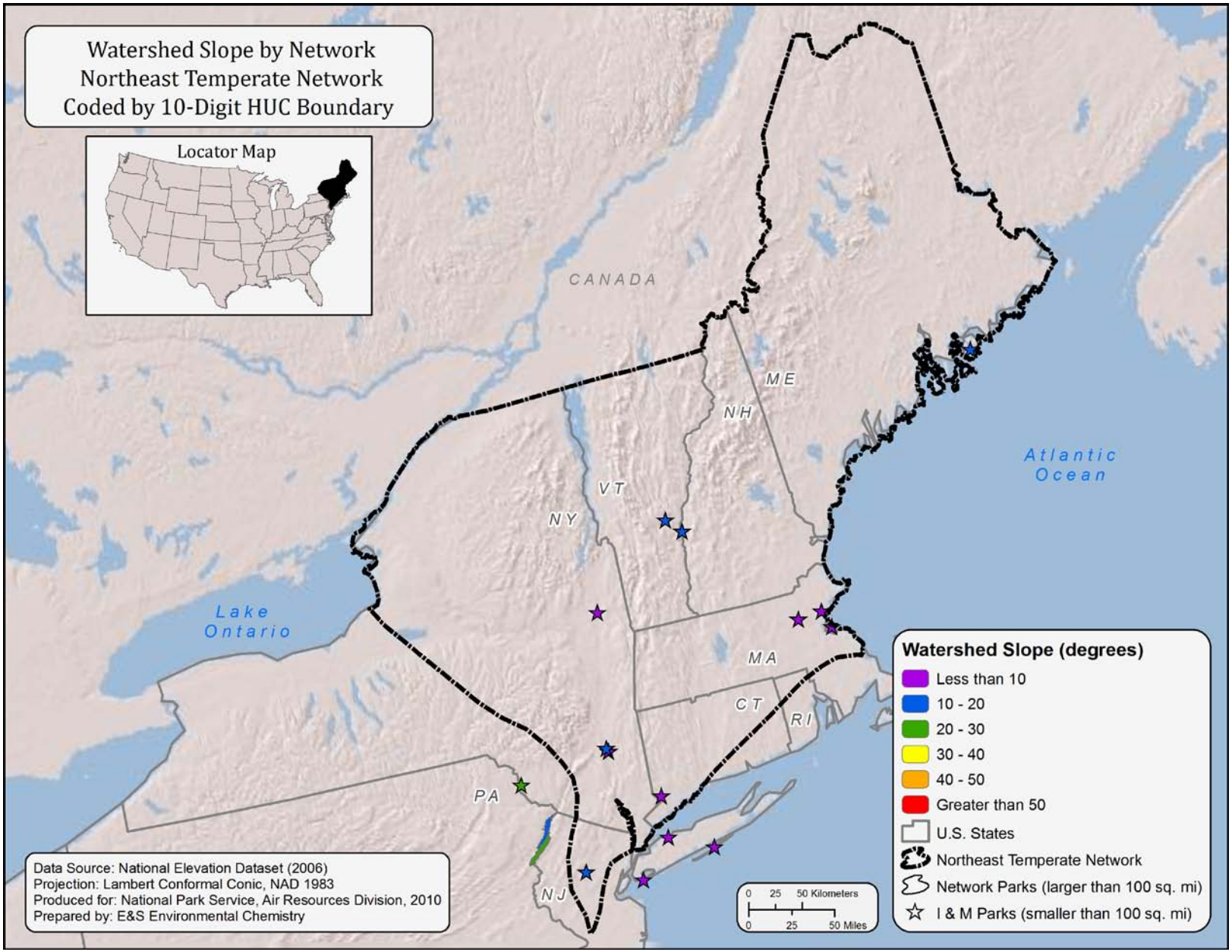
Map J


Total Nitrogen Deposition
Northeast Temperate Network
(kg/ha/yr)
Locator Map
CANADA
ME
NH
VT
NY
Atlantic Ocean
Lake Ontario
MA
CT
RI
PA
NJ
Total Nitrogen Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 63.5
U.S. States
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
0 25 50 Kilometers
0 25 50 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

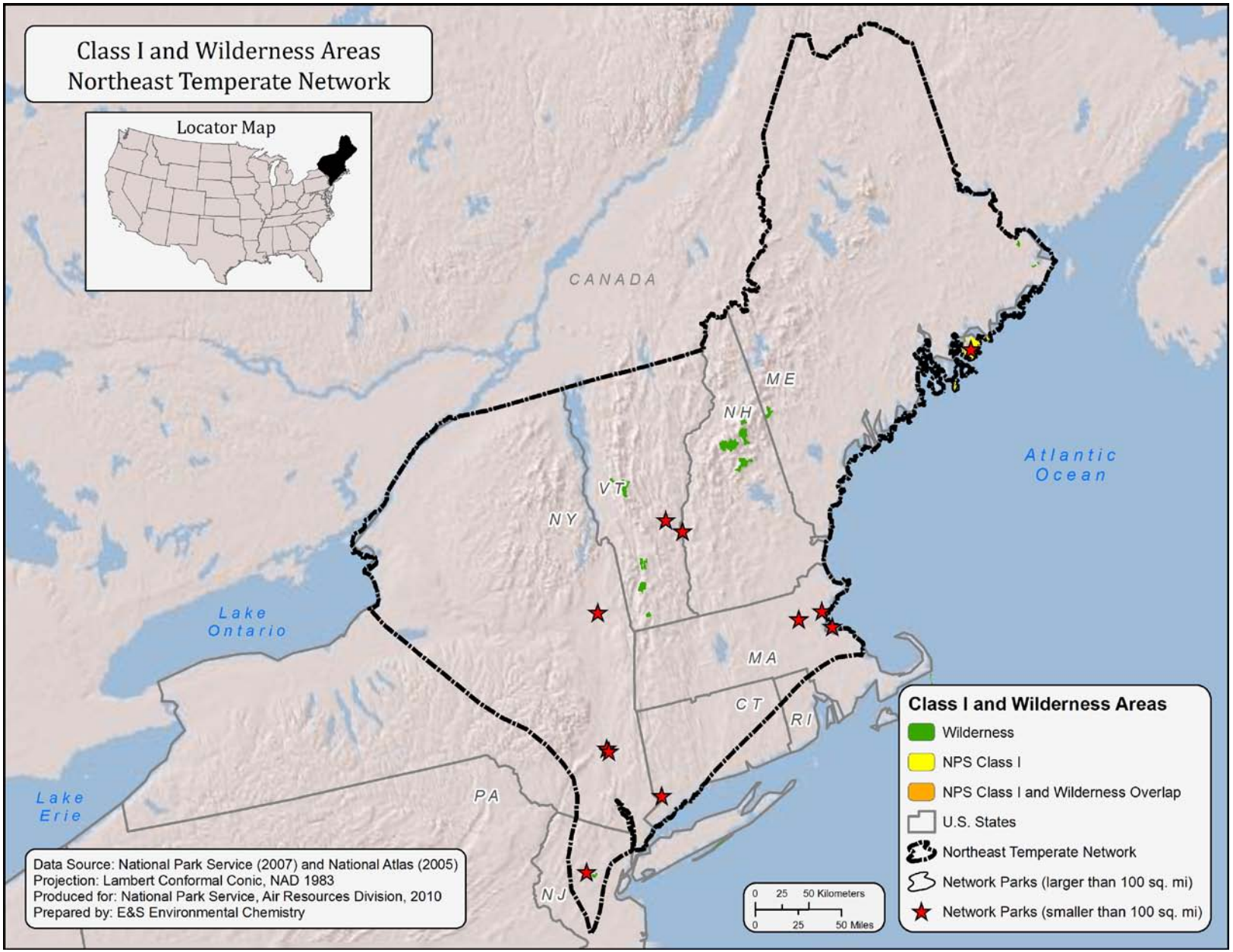
Map K


2001 Land Cover
Northeast Temperate Network
(National Land Cover Data)
Locator Map
CANADA
ME
NH
VT
NY
MA
CT
RI
PA
NJ
Lake Ontario
Atlantic Ocean
Open Water
Perennial Ice/Snow
Developed
Barren Land
Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Row Crops
Wetlands
U.S. States
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
0 25 50 Kilometers
0 25 50 Miles
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

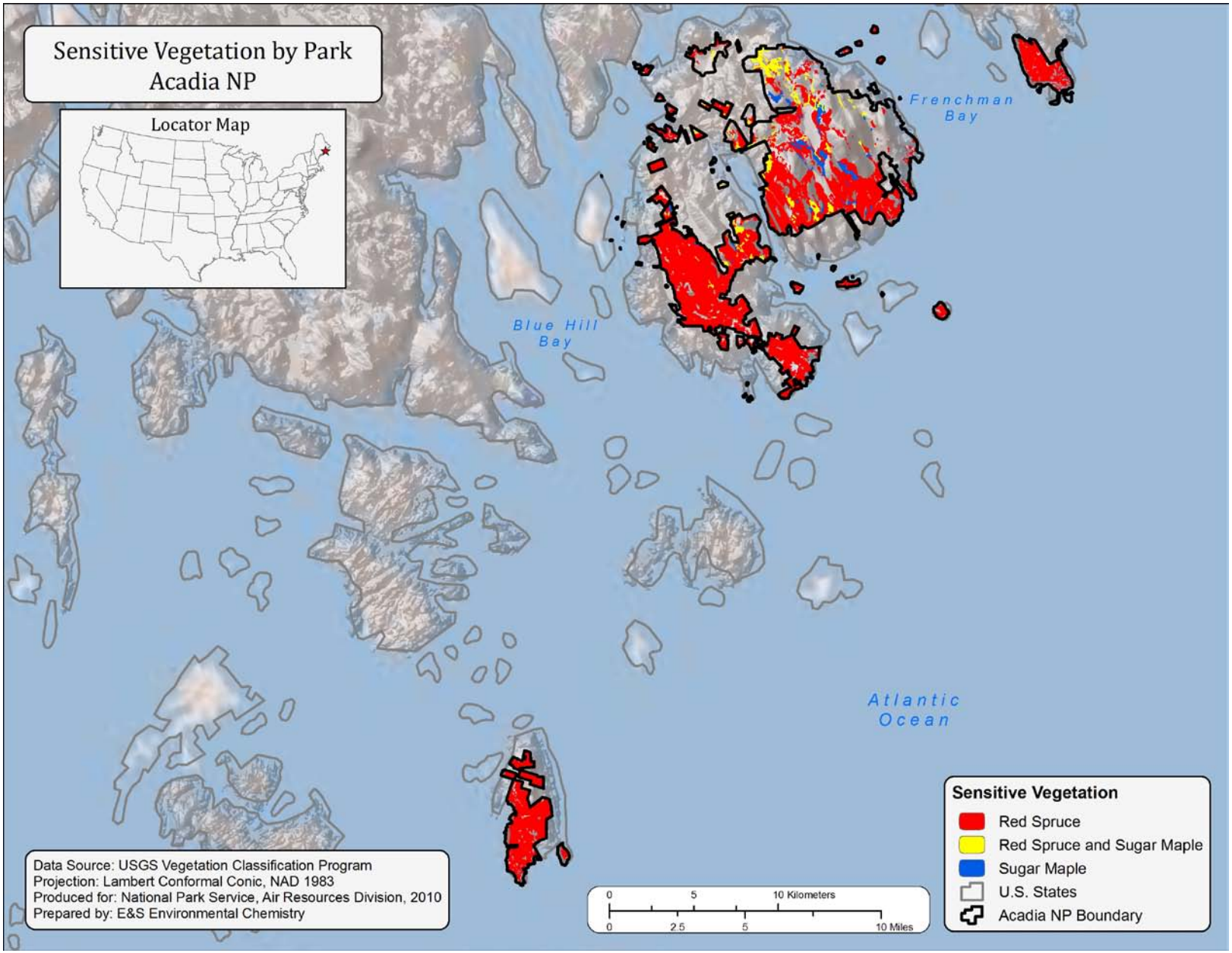
Map L


Watershed Slope by Network
Northeast Temperate Network
Coded by 10-Digit HUC Boundary
Locator Map
CANADA
ME
NH
VT
NY
Atlantic Ocean
Lake Ontario
MA
CT
RI
PA
NJ
Watershed Slope (degrees)
Less than 10
10 - 20
20 - 30
30 - 40
40 - 50
Greater than 50
U.S. States
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
I & M Parks (smaller than 100 sq. mi)
0 25 50 Kilometers
0 25 50 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

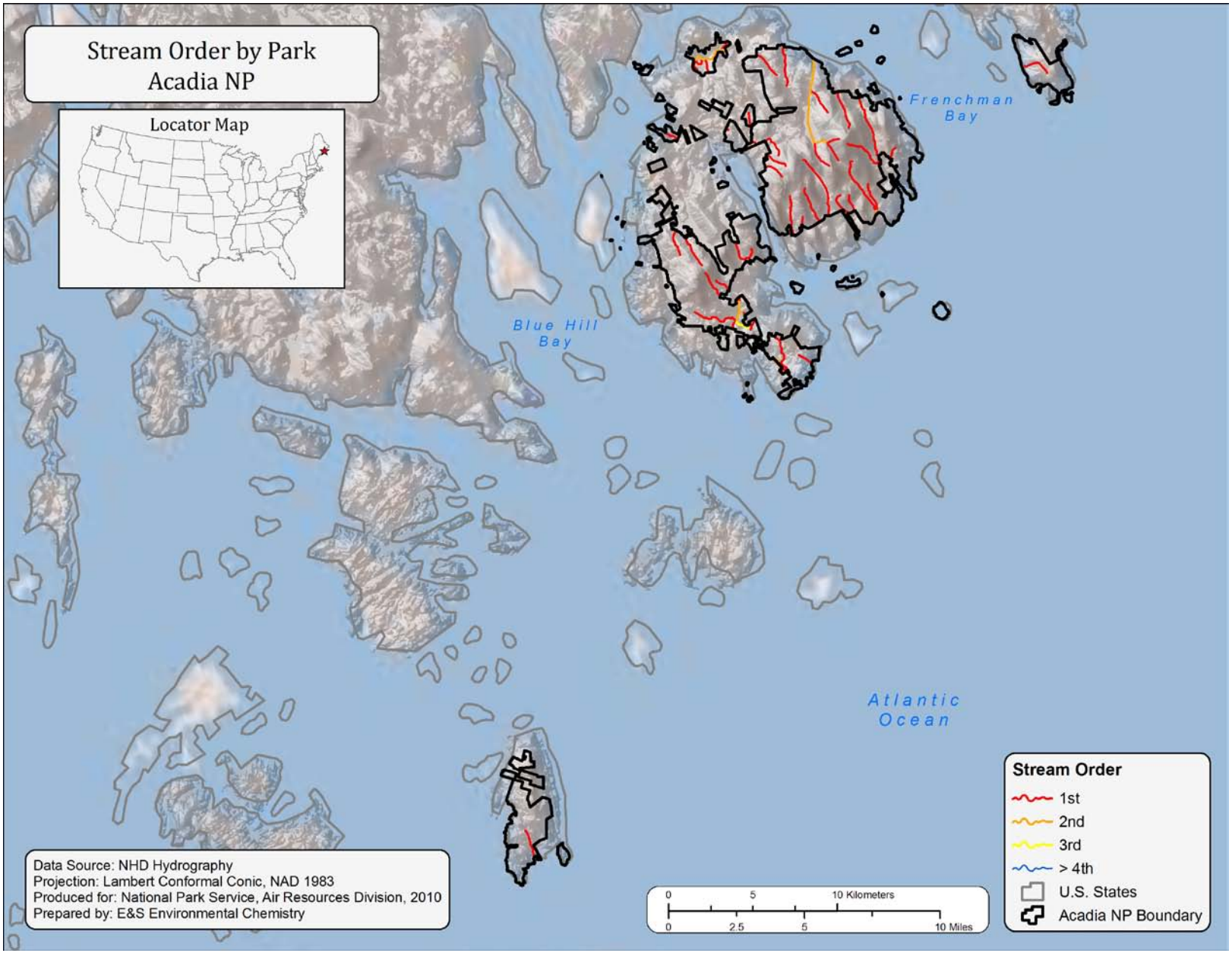
Map M


Class I and Wilderness Areas
Northeast Temperate Network
Locator Map
CANADA
ME
NH
VT
NY
MA
CT
RI
PA
NJ
Lake Ontario
Lake Erie
Atlantic Ocean
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 25 50 Kilometers
0 25 50 Miles
Class I and Wilderness Areas
Wilderness
NPS Class I
NPS Class I and Wilderness Overlap
U.S. States
Northeast Temperate Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)

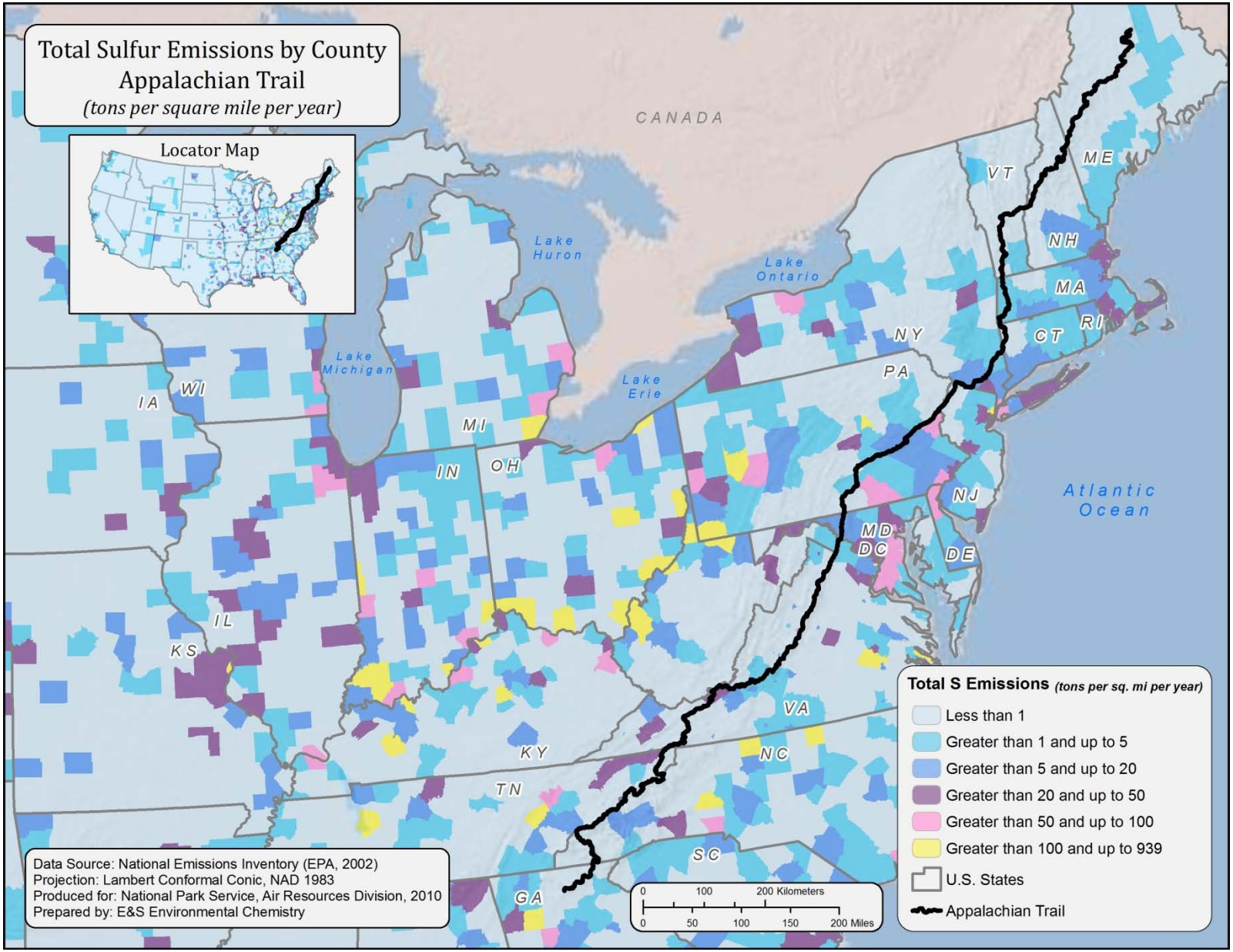
Map N


Sensitive Vegetation by Park
Acadia NP
Locator Map
Frenchman Bay
Blue Hill Bay
Atlantic Ocean
Data Source: USGS Vegetation Classification Program
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 5 10 Kilometers
0 2.5 5 10 Miles
Sensitive Vegetation
Red Spruce
Red Spruce and Sugar Maple
Sugar Maple
U.S. States
Acadia NP Boundary

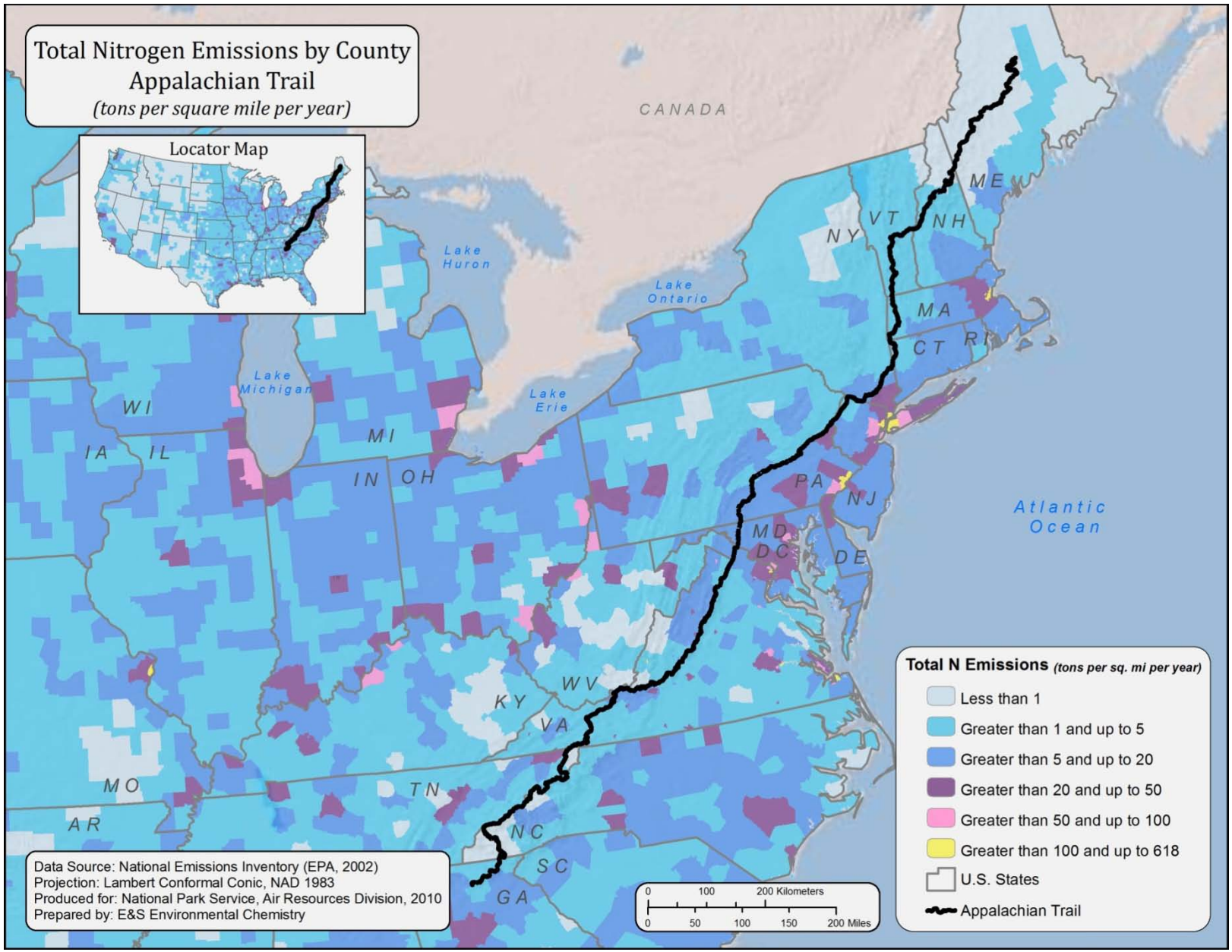
Map P-1


Stream Order by Park
Acadia NP
Locator Map
Frenchman Bay
Blue Hill Bay
Atlantic Ocean
Stream Order
1st
2nd
3rd
> 4th
U.S. States
Acadia NP Boundary
Data Source: NHD Hydrography
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
0 5 10 Kilometers
0 2.5 5 10 Miles

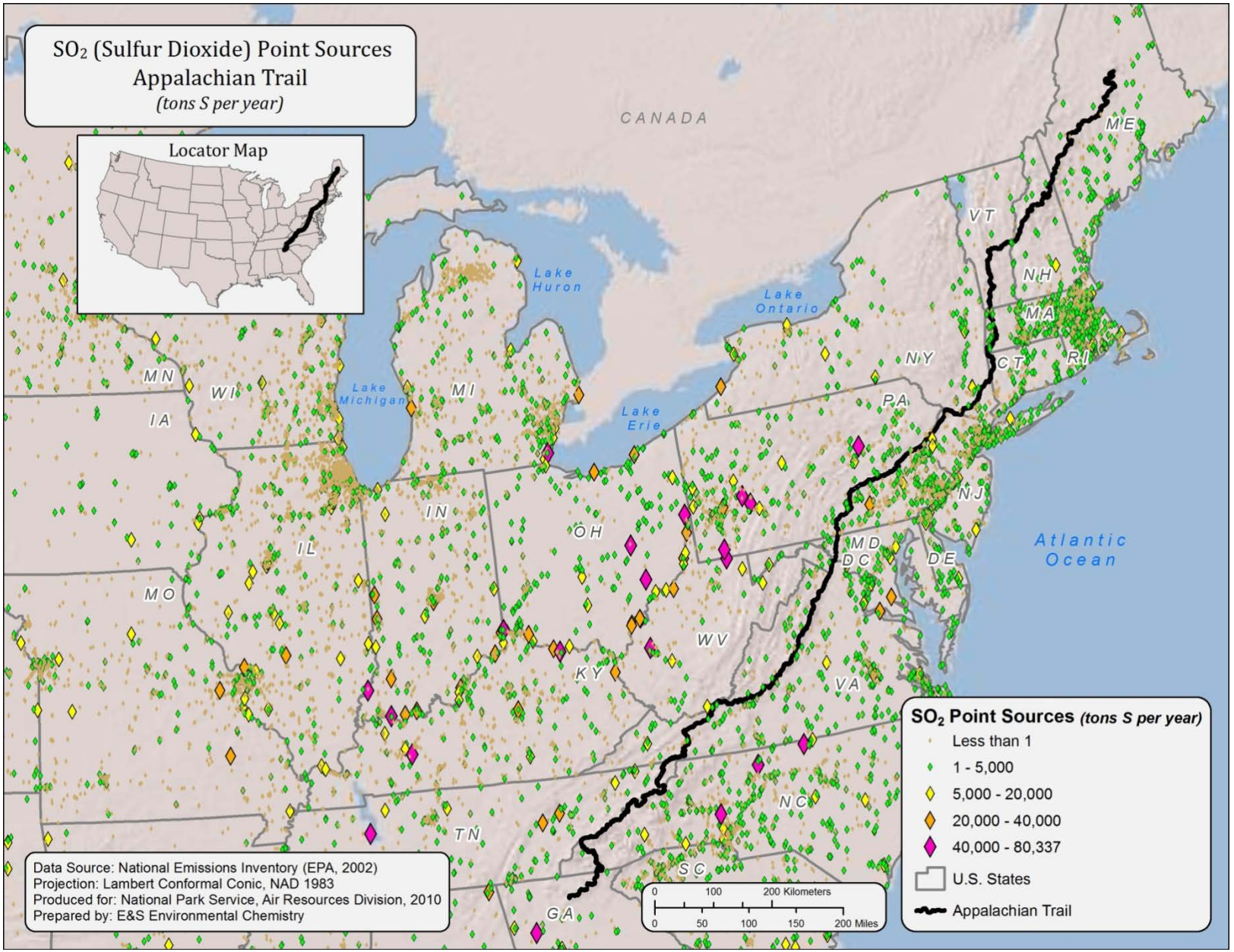
Map P-2


Total Sulfur Emissions by County
Appalachian Trail
(tons per square mile per year)
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
VT
ME
NH
MA
RI
CT
NY
PA
NJ
MD
DC
DE
VA
NC
SC
GA
KY
TN
OH
IN
MI
IL
WI
IA
KS
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
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
Appalachian Trail

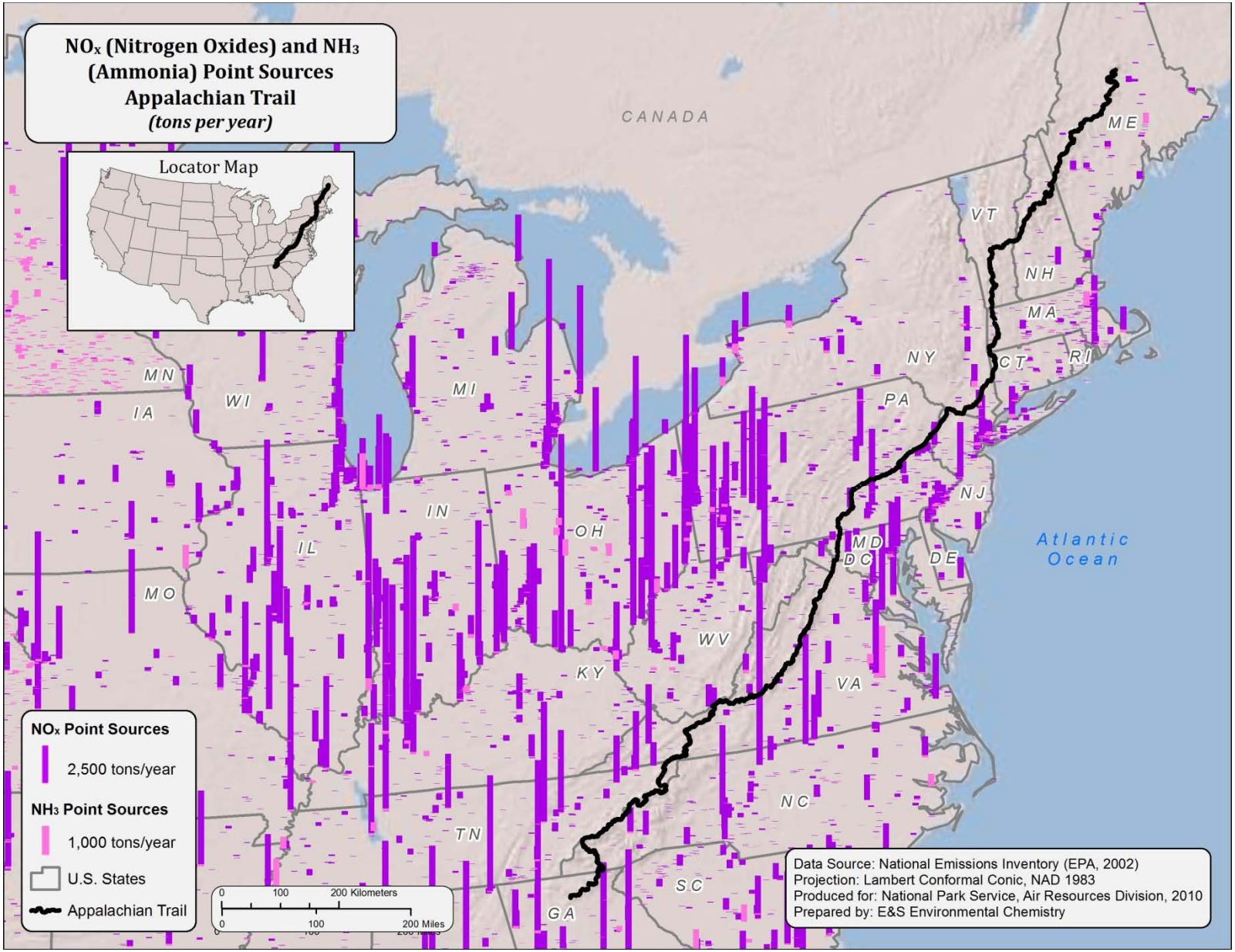
Map AT-E


Total Nitrogen Emissions by County
Appalachian Trail
(tons per square mile per year)
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
ME
NH
VT
NY
MA
CT
RI
PA
NJ
MD
DC
DE
WV
VA
KY
TN
NC
SC
GA
MO
AR
WI
IA
IL
MI
IN
OH
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
Appalachian Trail
0 100 200 Kilometers
0 50 100 150 200 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

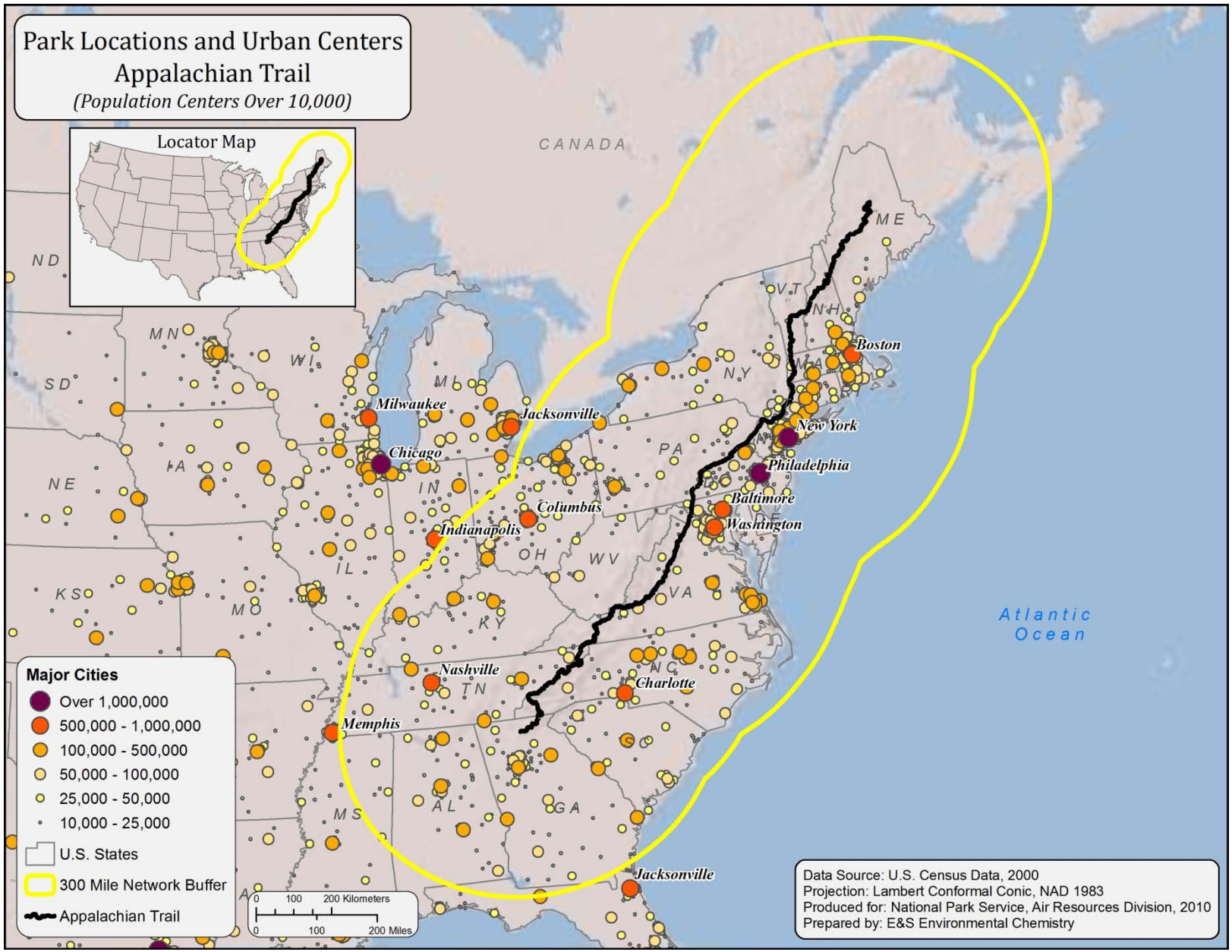
Map AT-F


SO2 (Sulfur Dioxide) Point Sources
Appalachian Trail
(tons S per year)
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
ME
VT
NH
MA
RI
CT
NY
PA
NJ
MD
DC
DE
VA
WV
NC
SC
GA
TN
KY
OH
IN
IL
MI
WI
MN
IA
MO
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
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
Appalachian Trail

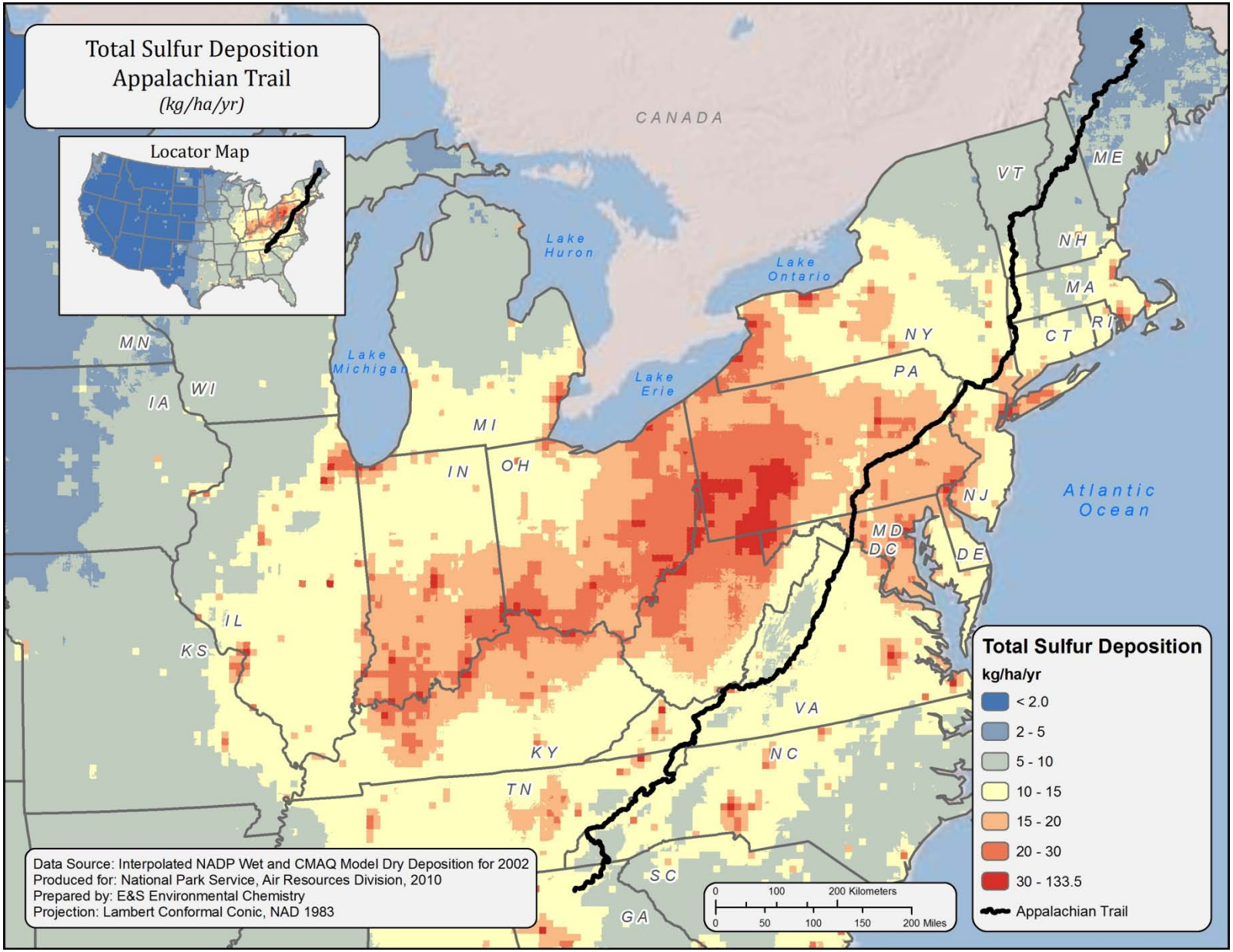
Map AT-G


NOx (Nitrogen Oxides) and NH3 (Ammonia) Point Sources
Appalachian Trail
(tons per year)
Locator Map
CANADA
ME
VT
NH
MA
RI
CT
NY
PA
NJ
MD
DC
DE
Atlantic Ocean
MN
WI
MI
IA
IL
IN
OH
WV
KY
VA
MO
TN
NC
SC
GA
NOx Point Sources
2,500 tons/year
NH3 Point Sources
1,000 tons/year
U.S. States
Appalachian Trail
0 100 200 Kilometers
0 100 200 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

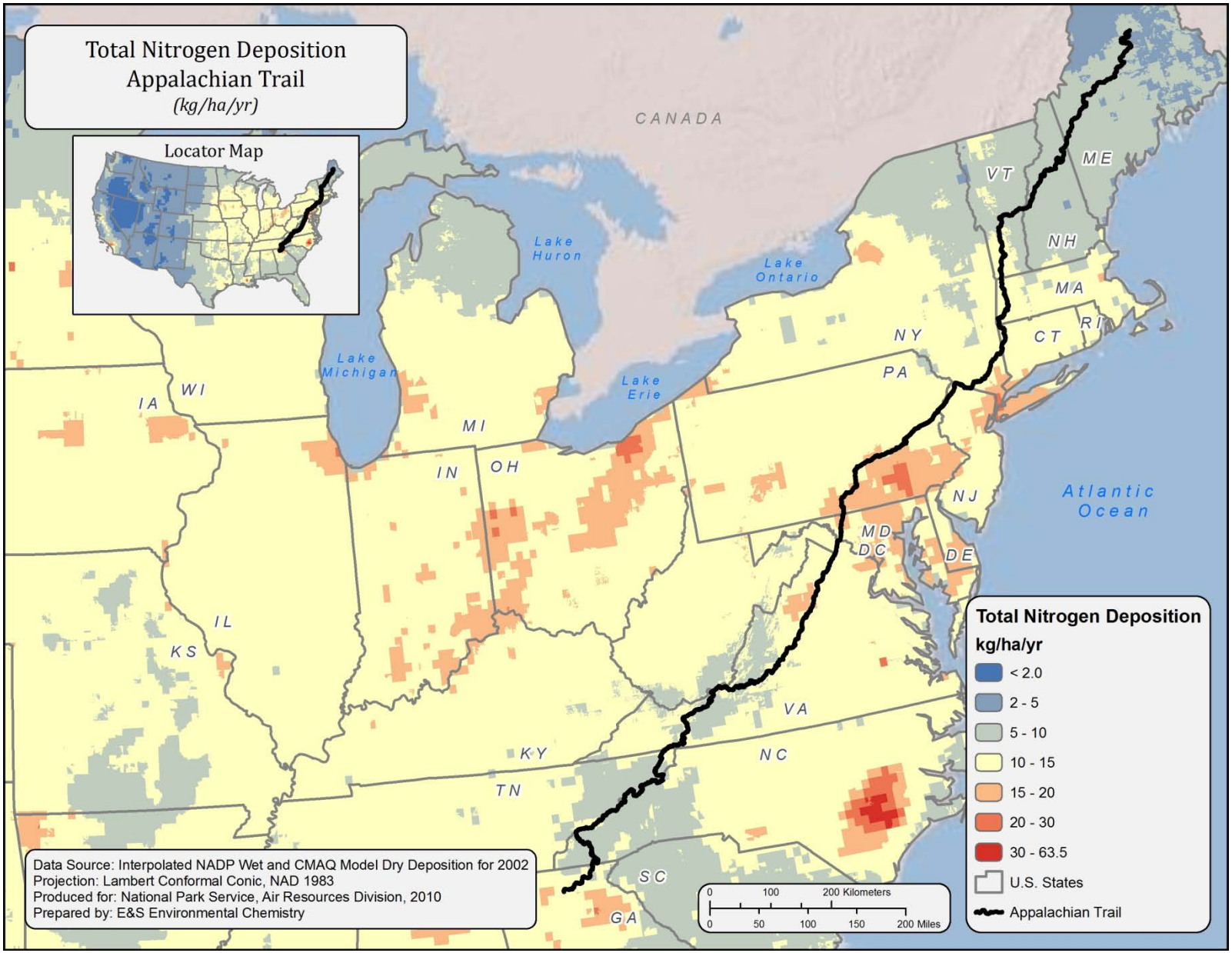
Map AT-H


Park Locations and Urban Centers
Appalachian Trail
(Population Centers Over 10,000)
Locator Map
CANADA
ME
VT
NH
MA
NY
PA
ND
MN
SD
WI
MI
NE
IA
IN
OH
WV
VA
KY
IL
MO
KS
TN
NC
SC
GA
AL
MS
Boston
New York
Philadelphia
Baltimore
Washington
Milwaukee
Chicago
Jacksonville
Columbus
Indianapolis
Nashville
Charlotte
Memphis
Jacksonville
Atlantic Ocean
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
Appalachian Trail
0 100 200 Kilometers
0 100 200 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

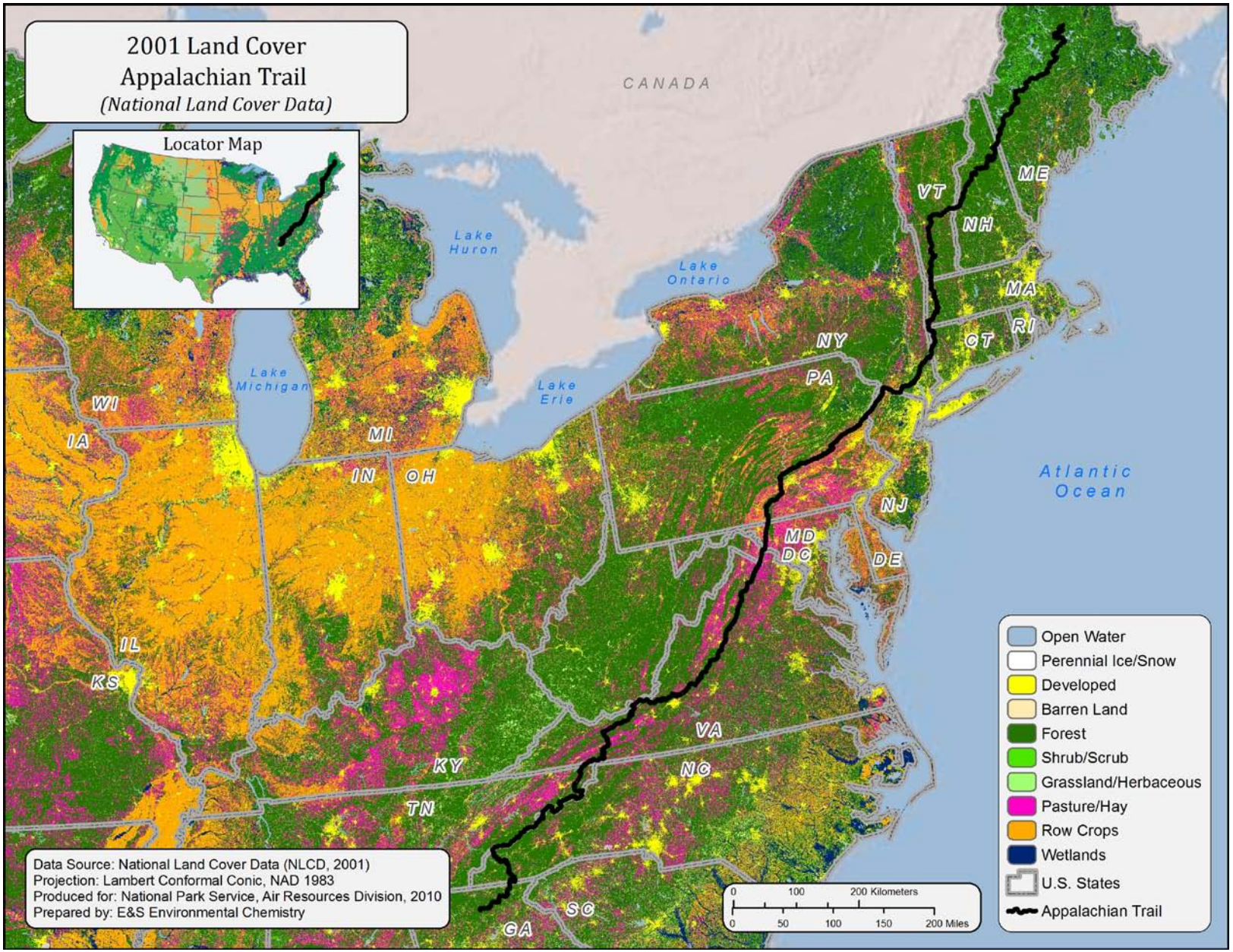
Map AT-I


Total Sulfur Deposition
Appalachian Trail
(kg/ha/yr)
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
MN
WI
IA
IL
KS
MI
IN
OH
KY
TN
VA
NC
SC
GA
PA
NY
VT
ME
NH
MA
CT
RI
NJ
MD
DC
DE
Total Sulfur Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 133.5
Appalachian Trail
0 100 200 Kilometers
0 50 100 150 200 Miles
Data Source: Interpolated NADP Wet and CMAQ Model Dry Deposition for 2002
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
Projection: Lambert Conformal Conic, NAD 1983

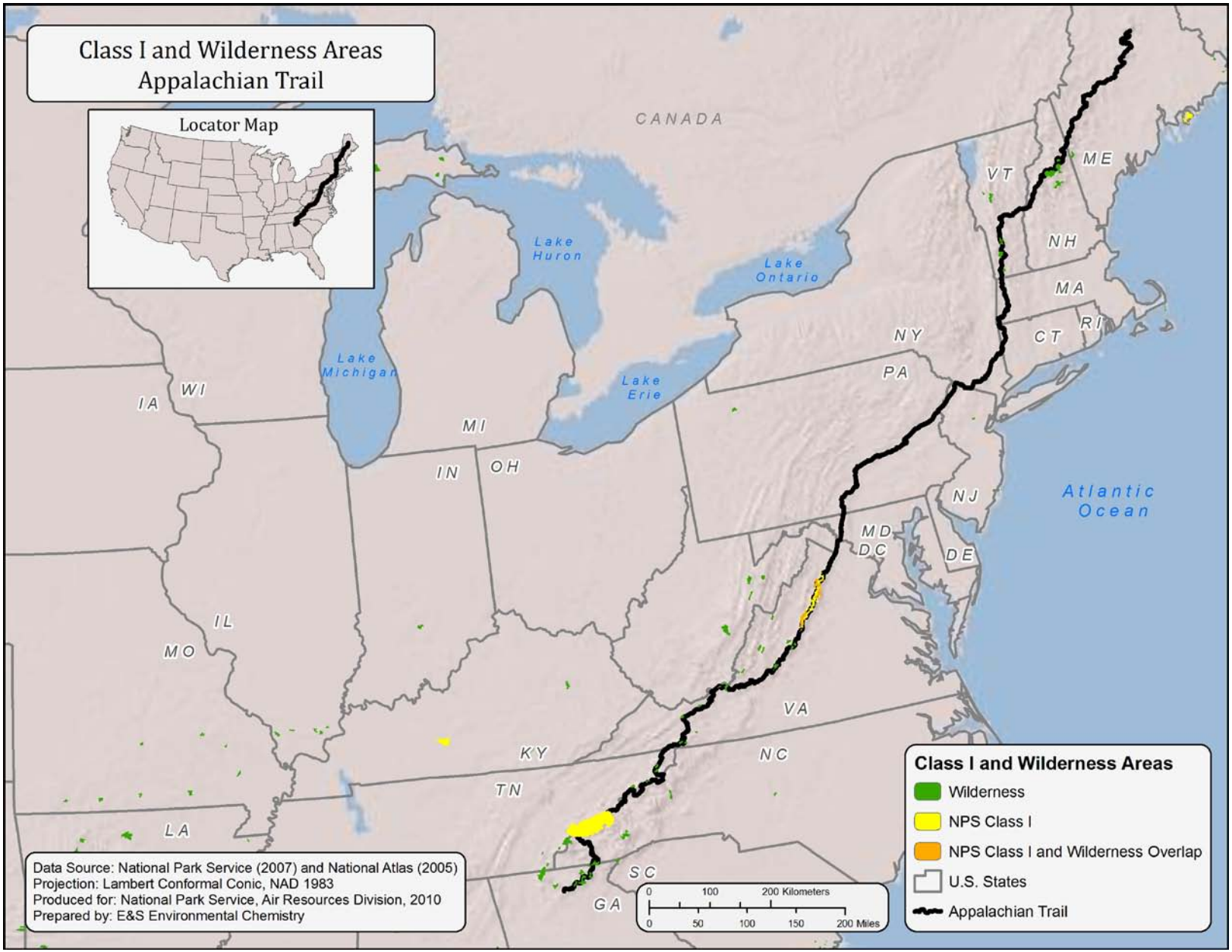
Map AT-J


Total Nitrogen Deposition
Appalachian Trail
(kg/ha/yr)
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
ME
VT
NH
MA
RI
CT
NY
PA
NJ
MD
DC
DE
VA
NC
SC
GA
KY
TN
OH
IN
MI
IL
WI
IA
KS
Total Nitrogen Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 63.5
U.S. States
Appalachian Trail
0 100 200 Kilometers
0 50 100 150 200 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 AT-K


2001 Land Cover
Appalachian Trail
(National Land Cover Data)
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
ME
VT
NH
MA
RI
CT
NY
PA
NJ
MD
DC
DE
VA
NC
SC
GA
KY
TN
OH
IN
MI
IL
WI
IA
KS
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
0 100 200 Kilometers
0 50 100 150 200 Miles
Open Water
Perennial Ice/Snow
Developed
Barren Land
Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Row Crops
Wetlands
U.S. States
Appalachian Trail

Map AT-L


Class I and Wilderness Areas
Appalachian Trail
Locator Map
CANADA
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Atlantic Ocean
ME
VT
NH
MA
RI
CT
NY
PA
NJ
MD
DC
DE
VA
NC
SC
GA
KY
TN
LA
MO
IL
IN
OH
MI
IA
WI
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
0 100 200 Kilometers
0 50 100 150 200 Miles
Class I and Wilderness Areas
Wilderness
NPS Class I
NPS Class I and Wilderness Overlap
U.S. States
Appalachian Trail

Map AT-N

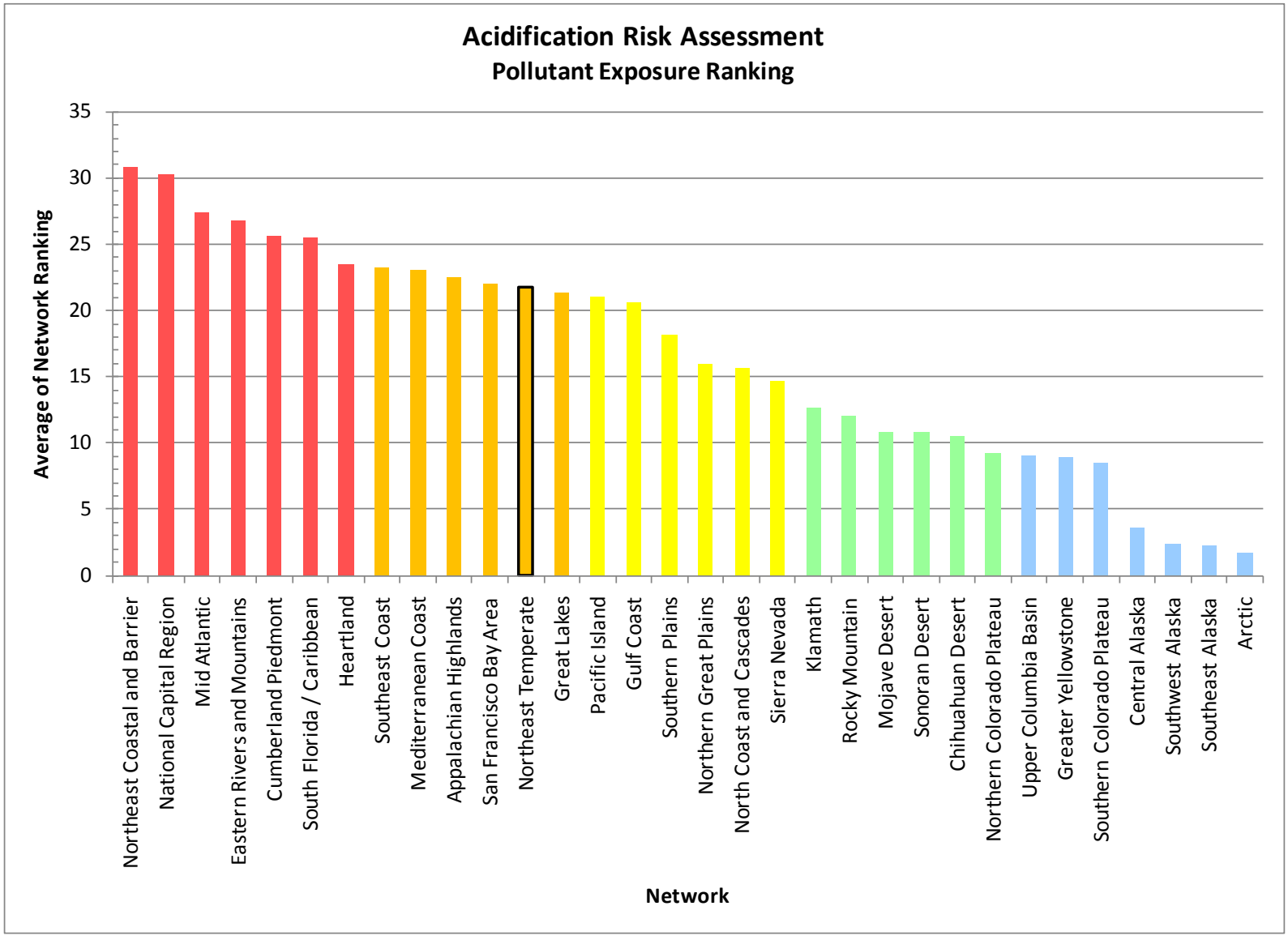

Acidification Risk Assessment
Pollutant Exposure Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
Northeast Coastal and Barrier
National Capital Region
Mid Atlantic
Eastern Rivers and Mountains
Cumberland Piedmont
South Florida / Caribbean
Heartland
Southeast Coast
Mediterranean Coast
Appalachian 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

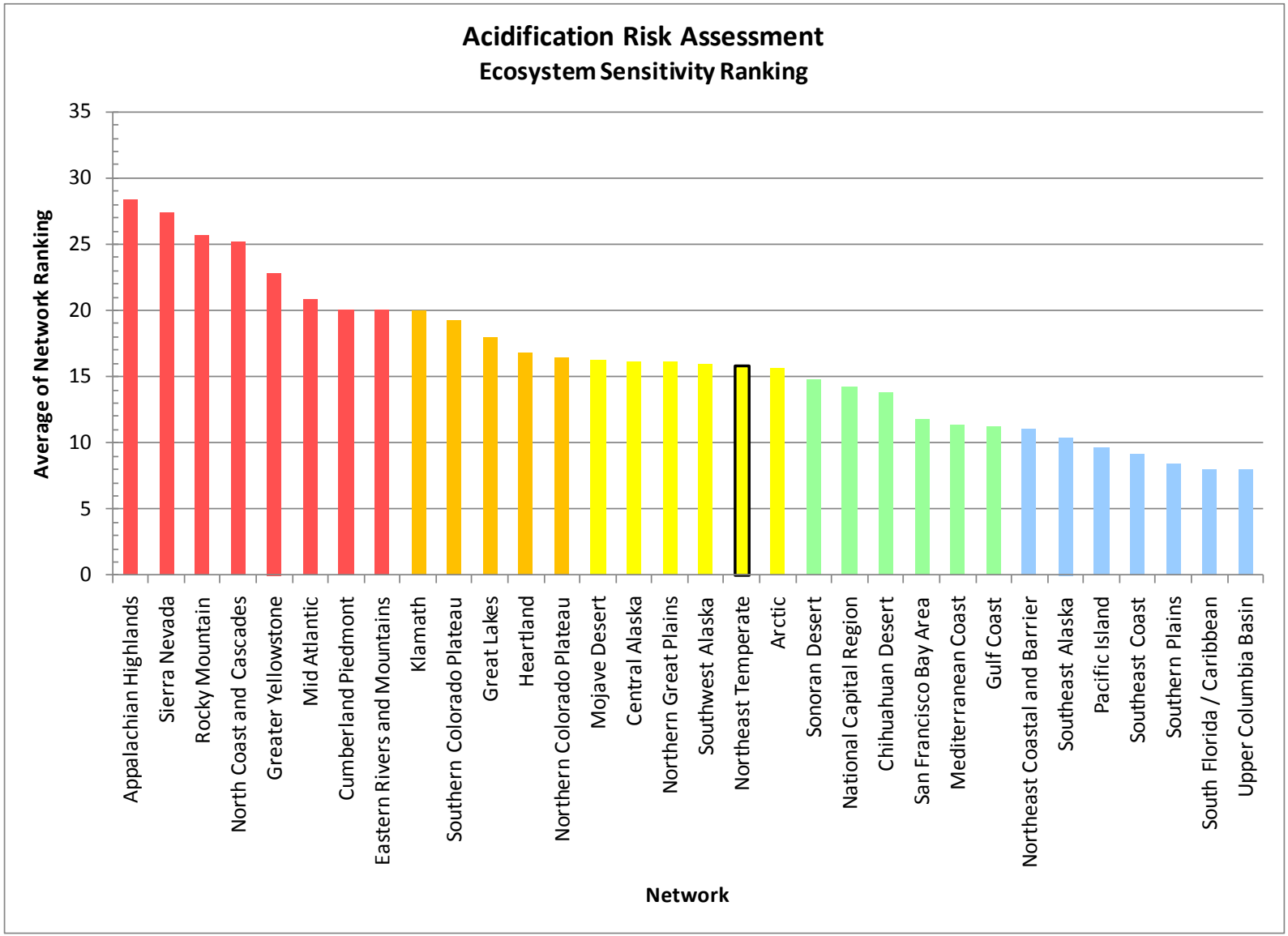

Acidification Risk Assessment
Ecosystem Sensitivity Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
Appalachian Highlands
Sierra Nevada
Rocky Mountain
North Coast and Cascades
Greater Yellowstone
Mid Atlantic
Cumberland Piedmont
Eastern Rivers and Mountains
Klamath
Southern Colorado Plateau
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

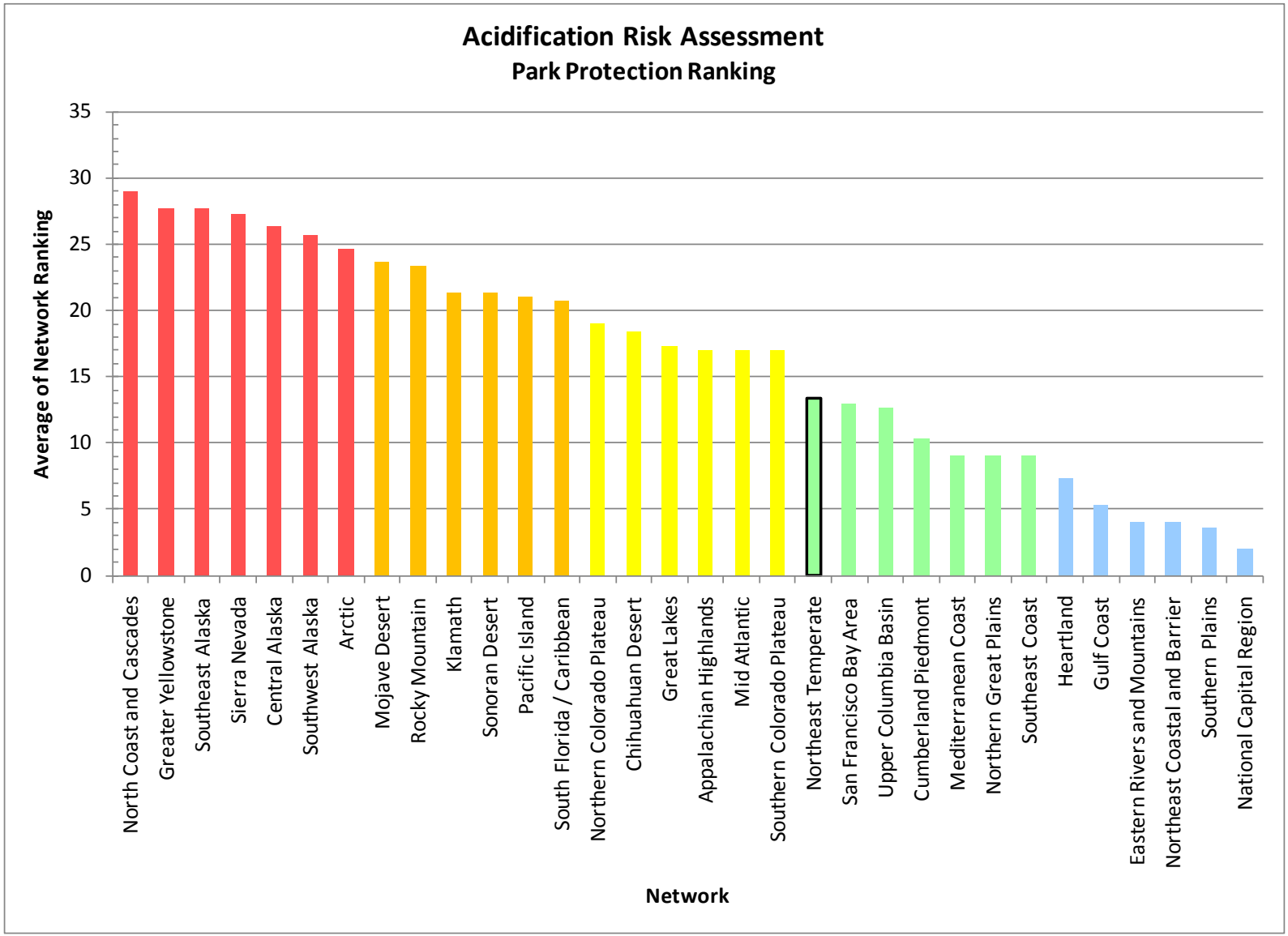

Acidification Risk Assessment
Park Protection Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
North Coast and Cascades
Greater Yellowstone
Southeast Alaska
Sierra Nevada
Central Alaska
Southwest Alaska
Arctic
Mojave Desert
Rocky Mountain
Klamath
Sonoran Desert
Pacific Island
South Florida / 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

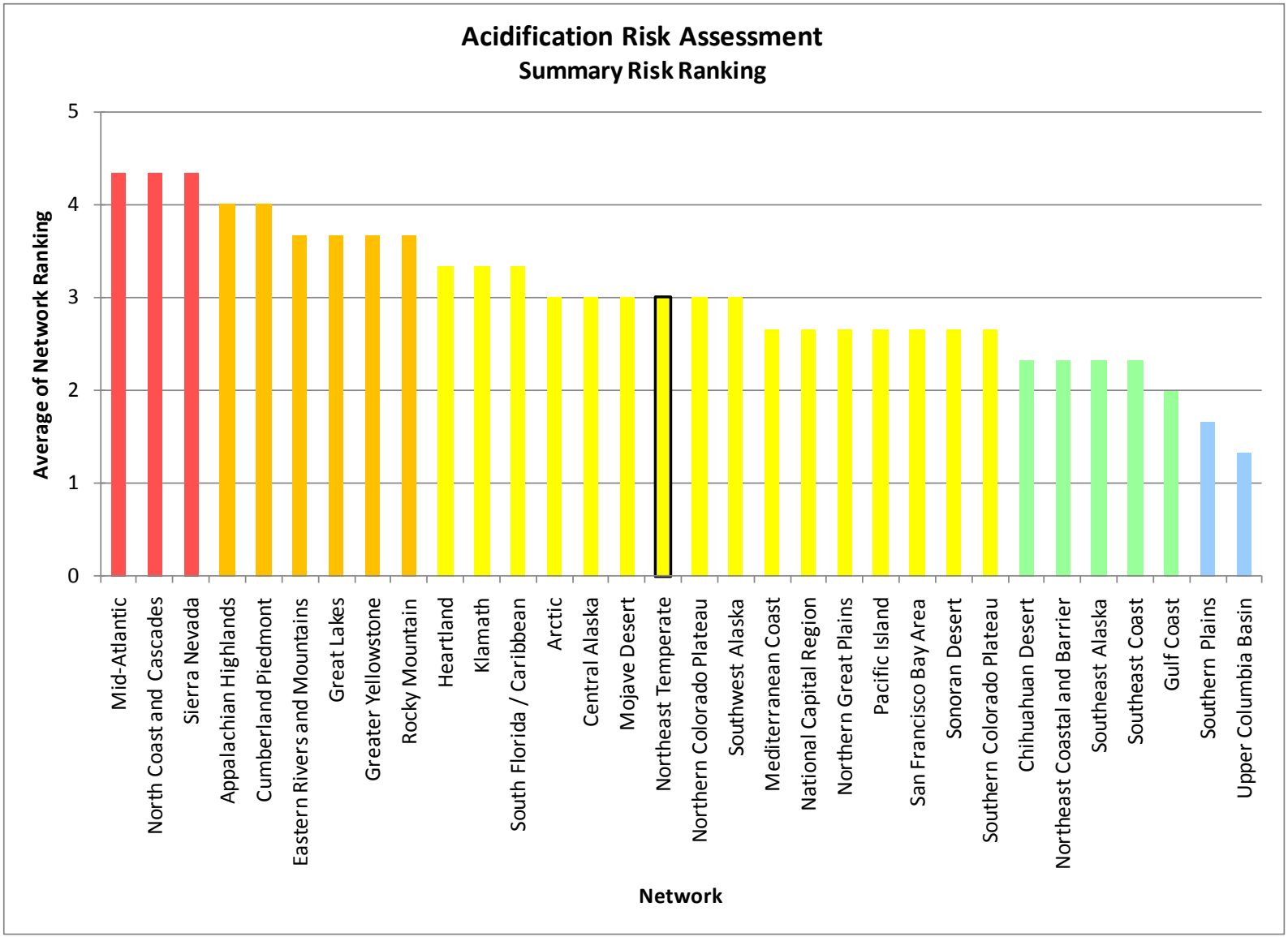

Acidification Risk Assessment
Summary Risk Ranking
Average of Network Ranking
0
1
2
3
4
5
Mid-Atlantic
North Coast and Cascades
Sierra Nevada
Appalachian Highlands
Cumberland Piedmont
Eastern Rivers and Mountains
Great Lakes
Greater Yellowstone
Rocky Mountain
Heartland
Klamath
South Florida / Caribbean
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 962/107404, April 2011

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
Air Resources Division
PO Box 25287
Denver, CO 80225

www.nature.nps.gov/air