



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

Upper Columbia Basin Network (UCBN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/382



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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Upper Columbia Basin Network (UCBN)

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 eight parks in the Upper Columbia Basin Network. Two of them are larger than 100 square miles: Craters of the Moon (CRMO) and Lake Roosevelt (LARO).

Total annual S and N emissions, by county, are shown in Maps E and F, respectively, for lands in and surrounding the Upper Columbia Basin Network. County level S emissions were generally low, mostly less than 1 ton per square mile, with a few small areas having emissions between 1 and 5 tons per square mile. County-level annual N emissions within the network were somewhat higher, generally ranging from less than 1 ton per square mile to more than 5 tons per square mile. There were a few small areas in Idaho where N emissions were between 5 and 20 tons per square mile. There were few point source emissions of SO₂ in the network, and they were relatively small: all but one emitted less than 5,000 tons S per year (Map G). Point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH₃) N are shown in Map H. There were few N point sources of any magnitude in this network.

Urban centers within the network and within a 300-mile buffer around the network are shown in Map I. There are only two population centers larger than 100,000 and none larger than 500,000 within the network. There are several large urban centers within the 300-mile buffer, including Seattle, Portland, San Francisco, and San Jose.

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 is low throughout the entire network, less than 2 kg S/ha/yr. Total N deposition within most of the network ranged from less than 2 kg N/ha/yr to 2 to 5 kg N/ha/yr, with pockets of estimated deposition higher than that.

Land cover in and around the network is shown in Map L. The predominant cover types within this network are generally quite varied. They include mainly forest and row crops in the north, and shrubland and grassland/herbaceous in the south.

Land slope within parks that occur in this network is shown in Map M. Park land slope is less than 10° in CRMO and between 10° and 20° in LARO. Average slope is steeper, between 20° and 30°, in all of the smaller parks except Whitman Mission (WHMI), where slope is less than 10°.

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 or wilderness area

managed by NPS in this network is a small area in CRMO. There is, however, substantial wilderness 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 Upper Columbia Basin Network ranked in the lowest quintile among networks in S and N-Pollutant Exposure (Figure A). Emissions and deposition of both S and N within the network are low. The network Ecosystem Sensitivity ranking was the lowest of all networks (Figure B). This is because the network is not located in an area of known acid sensitivity, there is no vegetation coverage in the I&M parks that includes vegetation types expected to be especially sensitive to acidic deposition, and there are no high-elevation lakes and few low-order, high-elevation streams. This network ranked in 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 yielded an overall Network Risk ranking that is the lowest of all networks (Figure D). The overall level of concern for acidification effects on I&M parks within this network is considered Very Low.

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

Two of the parks in the Upper Columbia Basin Network were ranked in the second lowest quintile for Pollutant Exposure: Hagerman Fossil Beds (HAFO) and WHMI; neither is large. The other parks in the network were ranked in the lowest quintile for this theme (Table A, Figure E). Ecosystem Sensitivity rankings varied, with CRMO and WHMI ranked in the lowest quintile, and City of Rocks (CIRO) ranked in the second highest. The other five parks were ranked in the middle quintile for Ecosystem Sensitivity (Moderate risk). All of the parks except CRMO were ranked in the middle quintile for Park Protection; CRMO was ranked High, in the second highest quintile.

The Summary Risk ranked two small parks as Moderate. Other parks, including both of the larger parks (CRMO and LARO), were ranked Low for overall risk of acidification effects.

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
Big Hole	Very Low	Moderate	Moderate	Low
City of Rocks	Very Low	High	Moderate	Moderate
<i>Craters of the Moon</i>	Very Low	Very Low	High	Low
Hagerman Fossil Beds	Low	Moderate	Moderate	Moderate
John Day Fossil Beds	Very Low	Moderate	Moderate	Low
<i>Lake Roosevelt</i>	Very Low	Moderate	Moderate	Low
Nez Perce	Very Low	Moderate	Moderate	Low
Whitman Mission	Low	Very Low	Moderate	Low

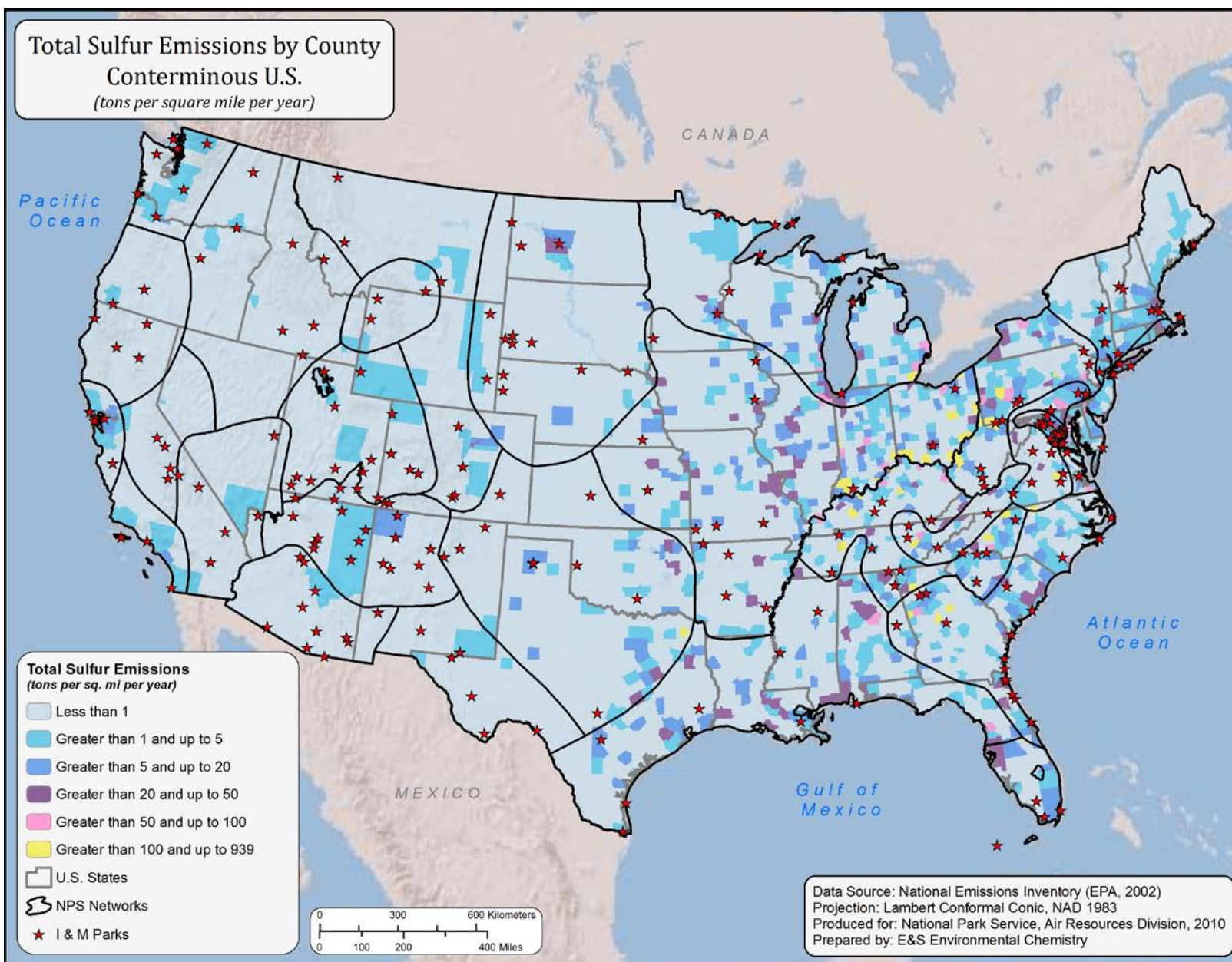
¹ Relative park rankings are designated according to quintile ranking, among all I&M Parks, from the lowest quintile (very low risk) to the highest quintile (very high risk).
² Park name is printed in bold italic for parks larger than 100 square miles.

- 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

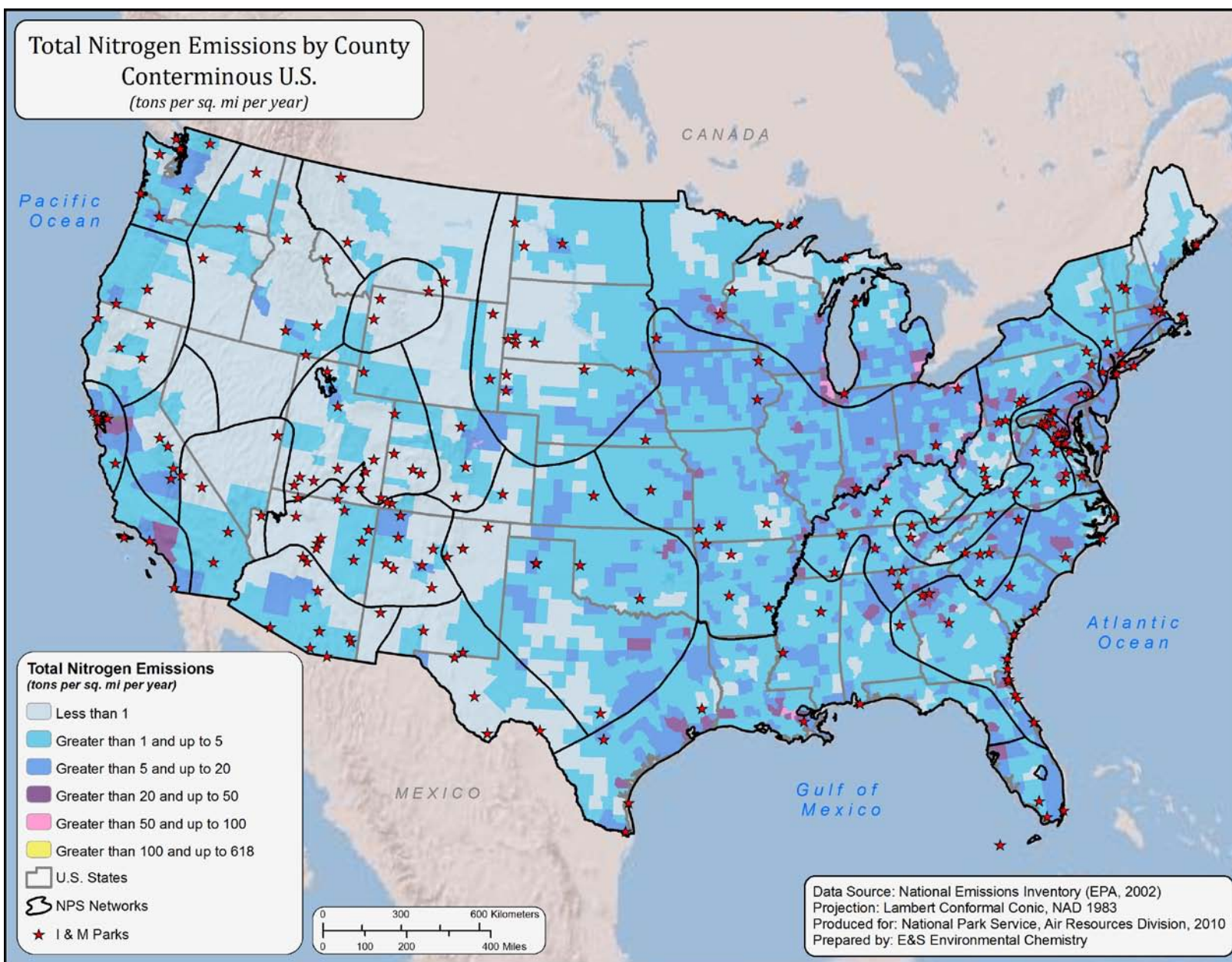
for 2002. NADP interpolations were performed using the approach of Grimm and Lynch (1997). CMAQ model projections were provided by Robin Dennis, U.S. EPA.

- 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. Some parks in this network are slightly larger than 100 mi², but yet too small to readily see the color within the park outline. These parks are represented on the map with a colored circle and a line from the circle indicating the park location. (Source of data: U.S. EPA National Elevation Dataset [<http://ned.usgs.gov/>])

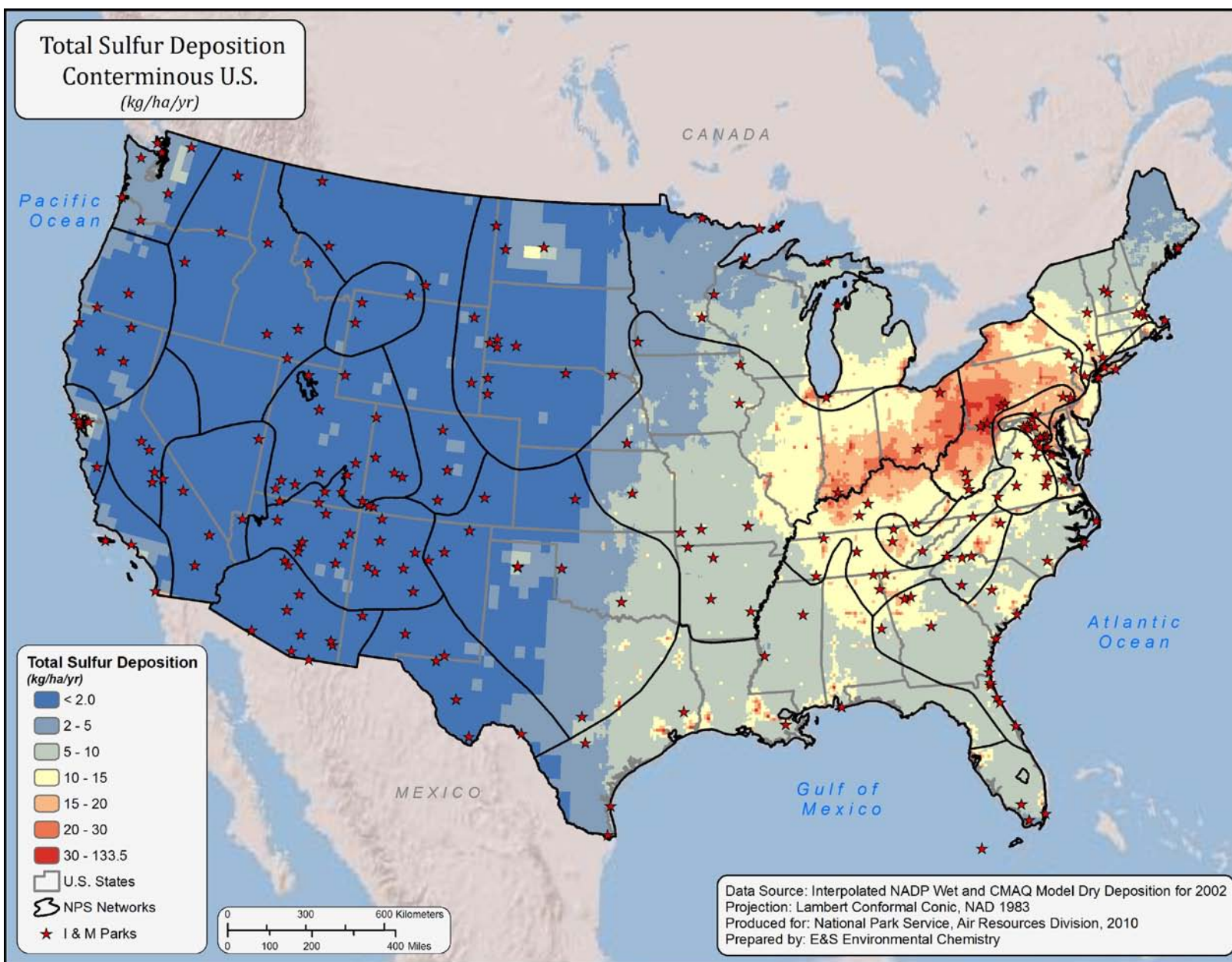
- Map N. Lands within the network that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; <http://nationalatlas.gov>] and NPS)
- Figure A. Network rankings for Pollutant Exposure, calculated as the average of scores for all Pollutant Exposure variables.
- Figure B. Network rankings for Ecosystem Sensitivity, calculated as the average of scores for all Ecosystem Sensitivity variables.
- Figure C. Network rankings for Park Protection, calculated as the average of scores for all Park Protection variables.
- Figure D. Summary Network Risk Ranking, calculated as the average of the quintile ranks for the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection themes.
- Figure E. Park rankings for Pollutant Exposure for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Pollutant Exposure variables.
- Figure F. Park rankings for Ecosystem Sensitivity for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Ecosystem Sensitivity variables.
- Figure G. Park rankings for Park Protection for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Park Protection variables.
- Figure H. Park rankings for Summary Risk for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of the quintile ranks for the Pollutant Exposure, Ecosystem Sensitivity, and Park Protection themes.



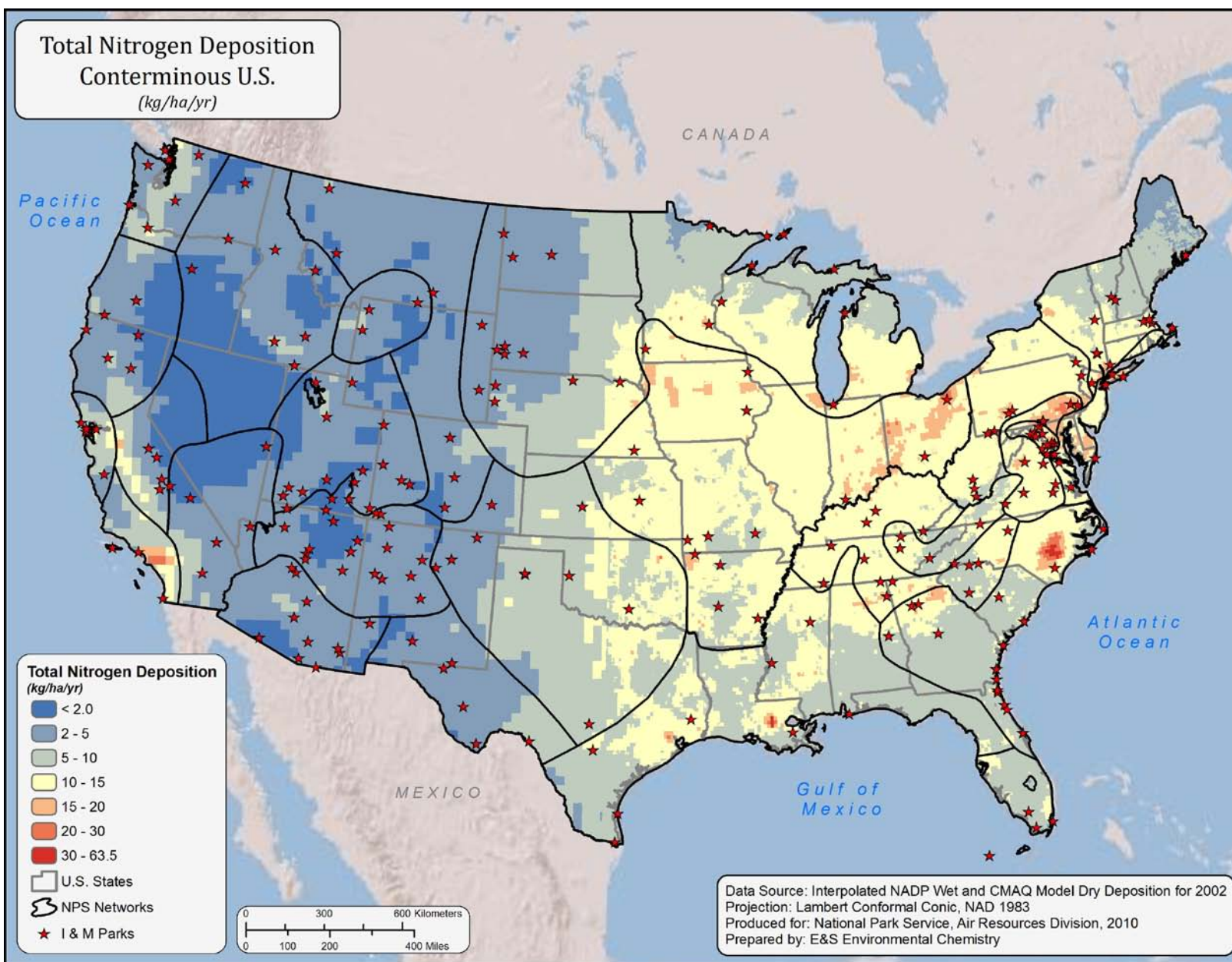
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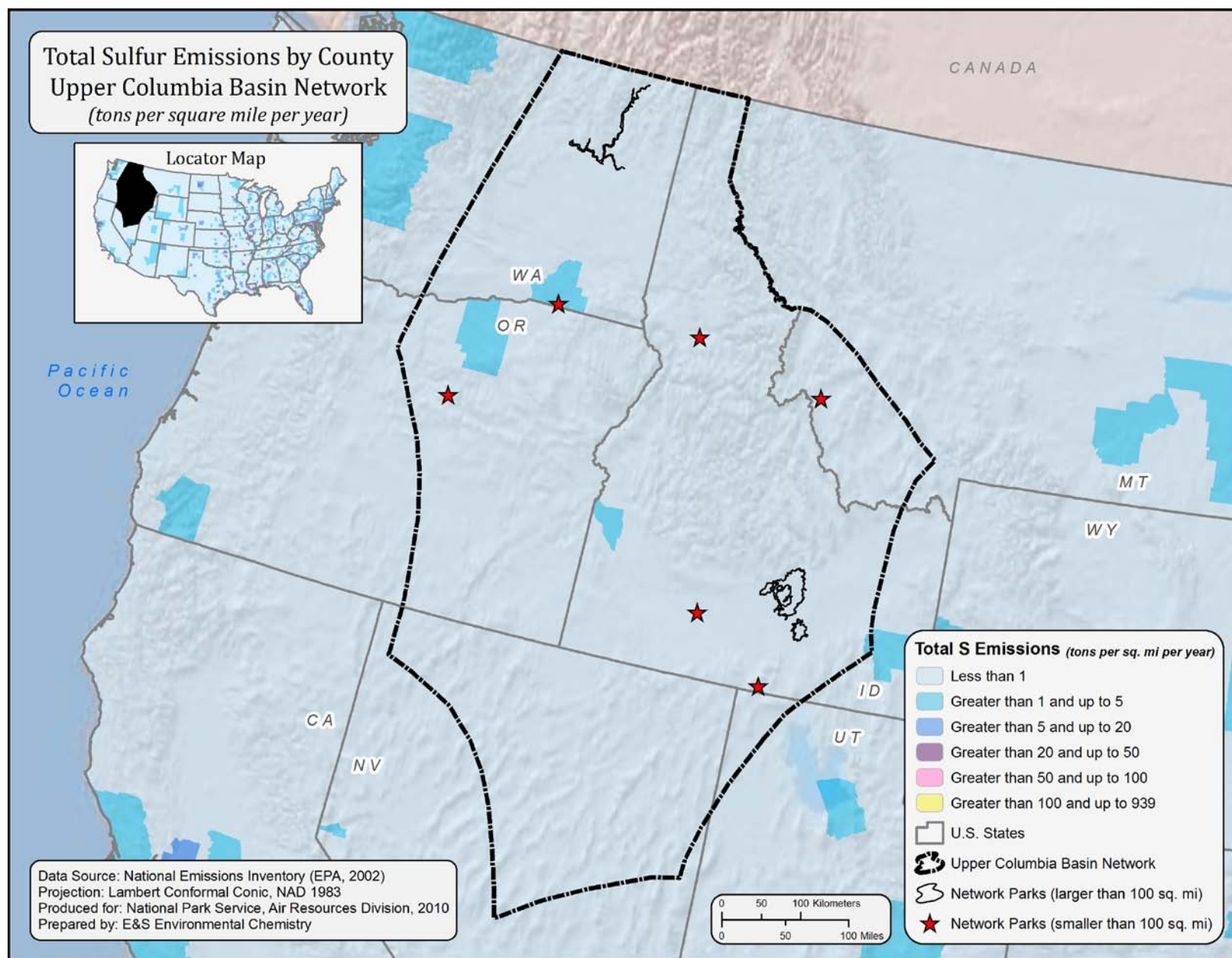
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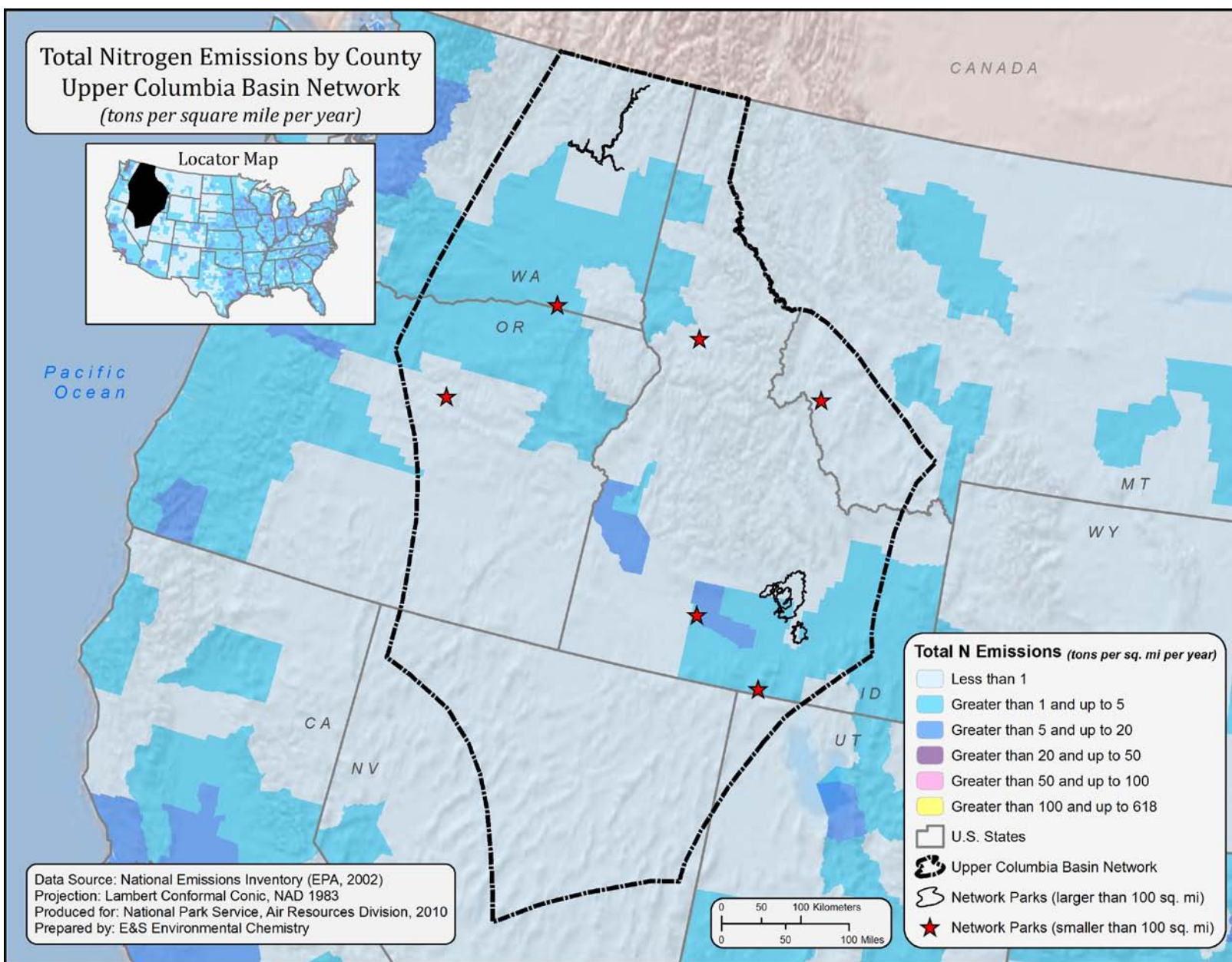
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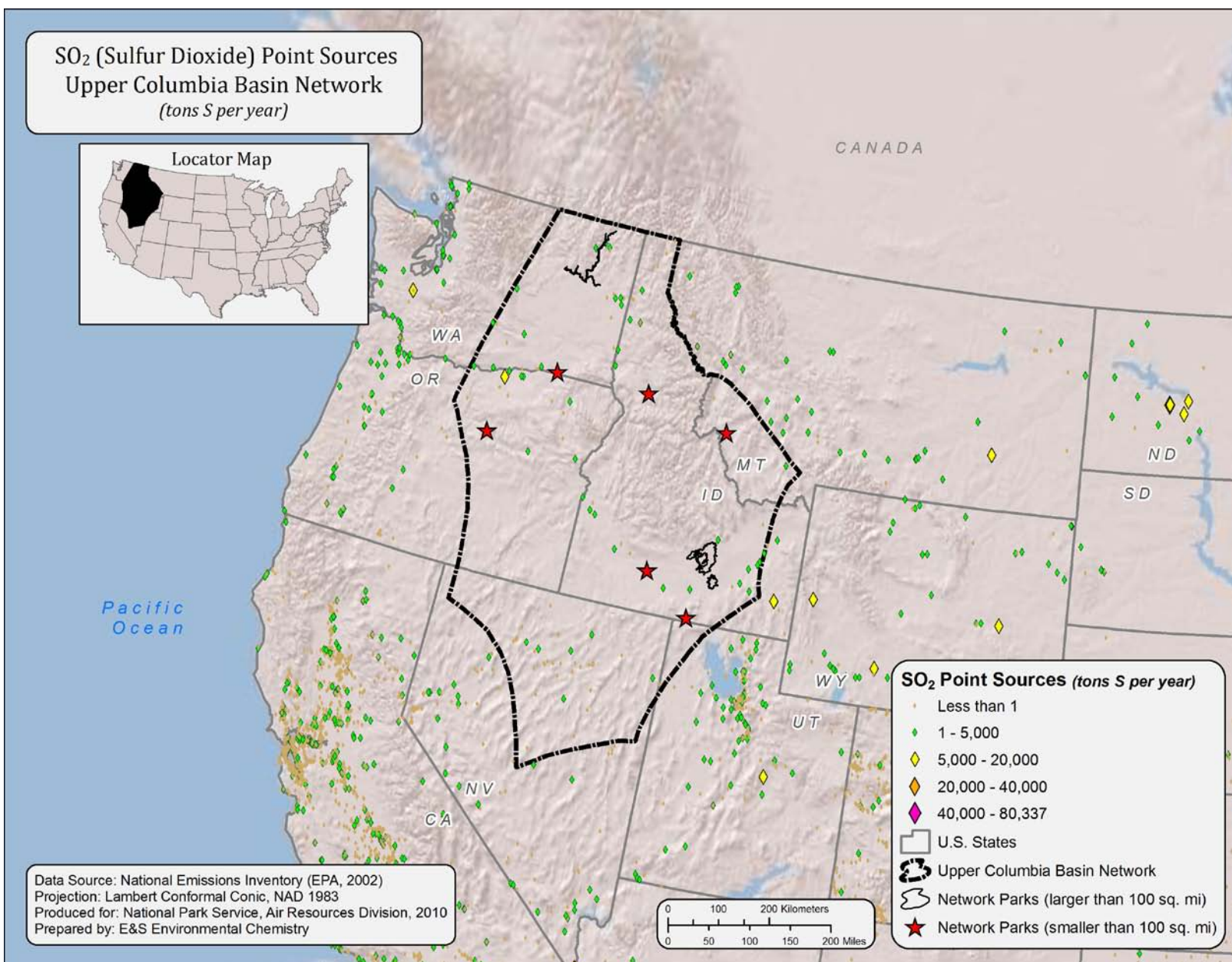
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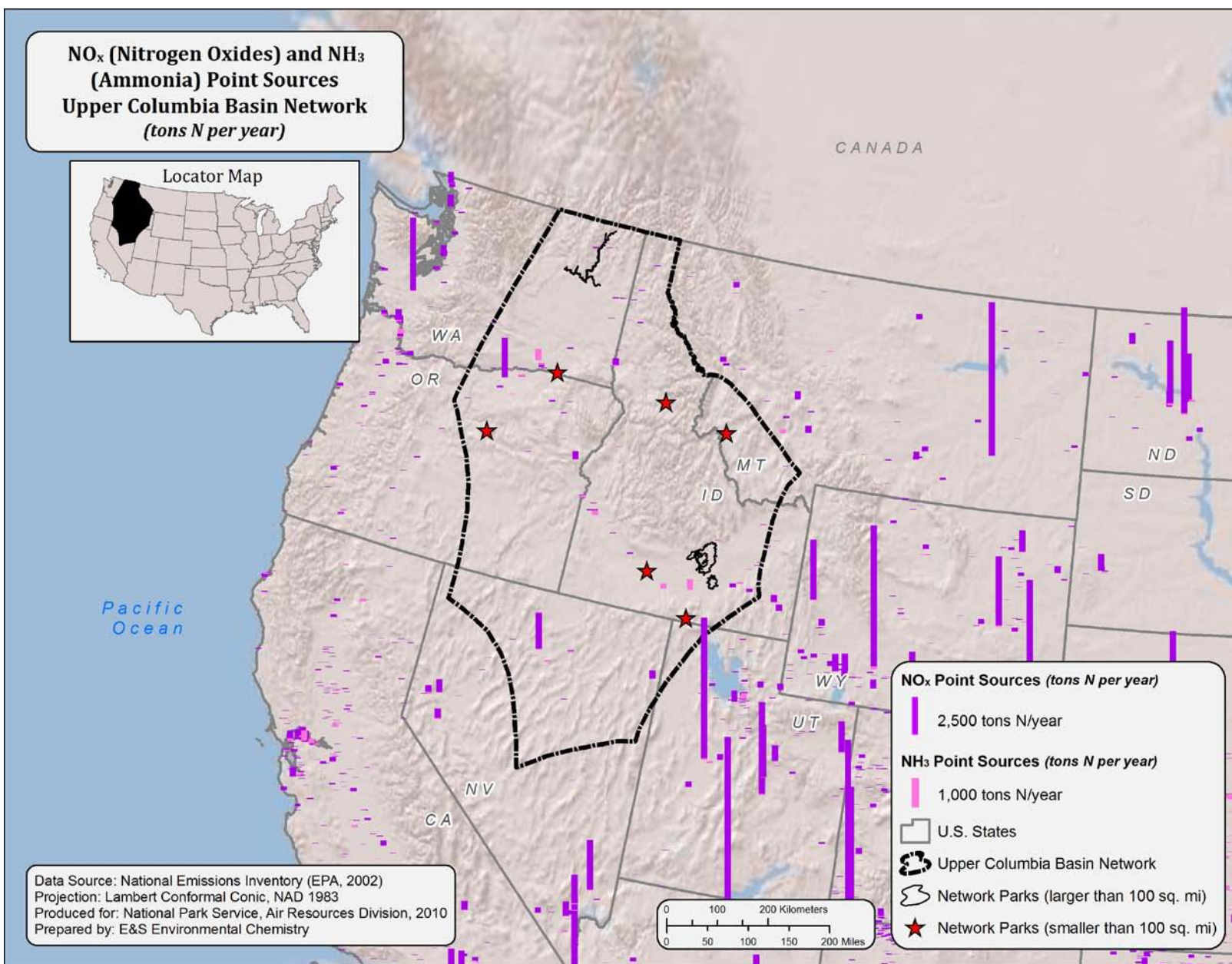
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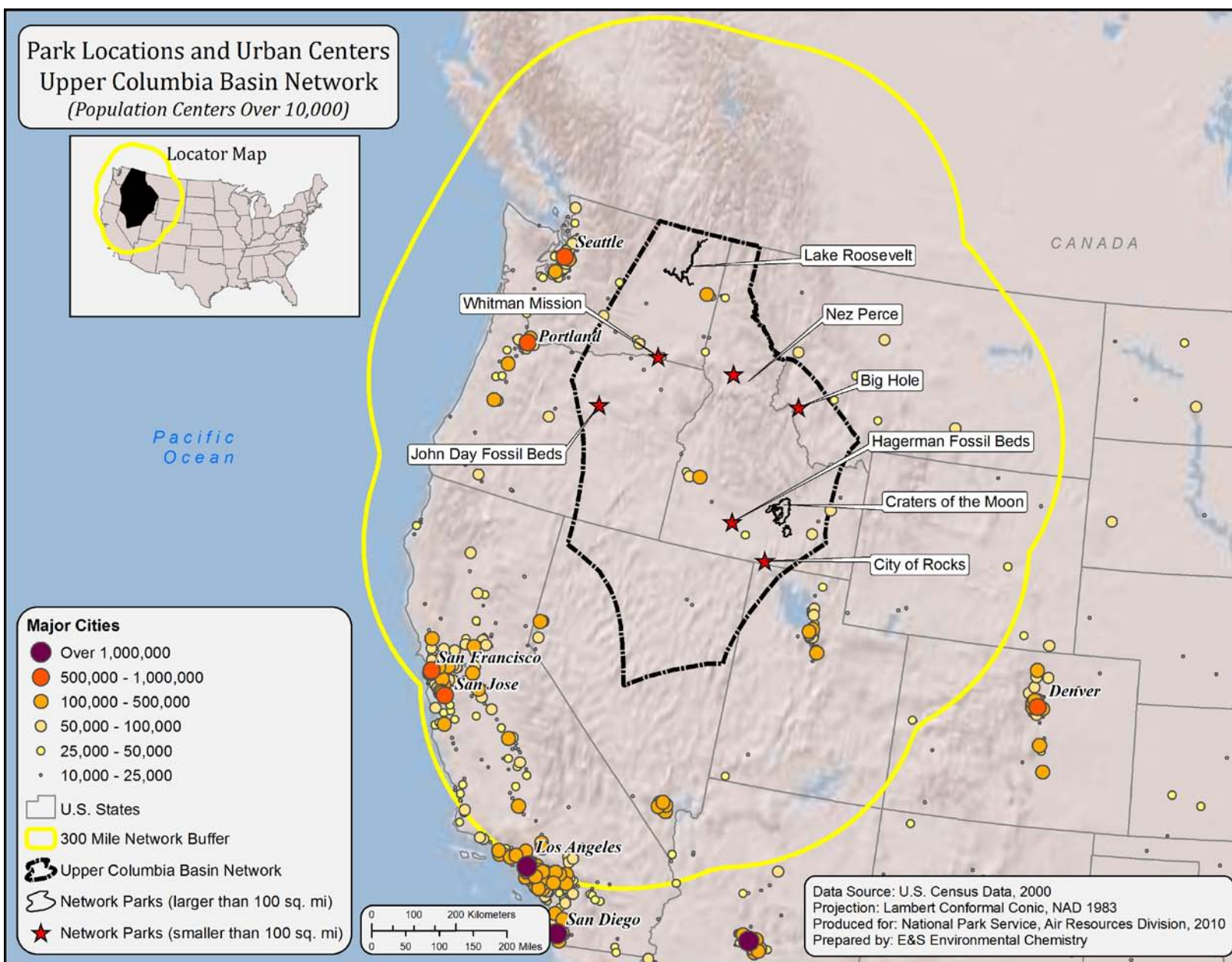
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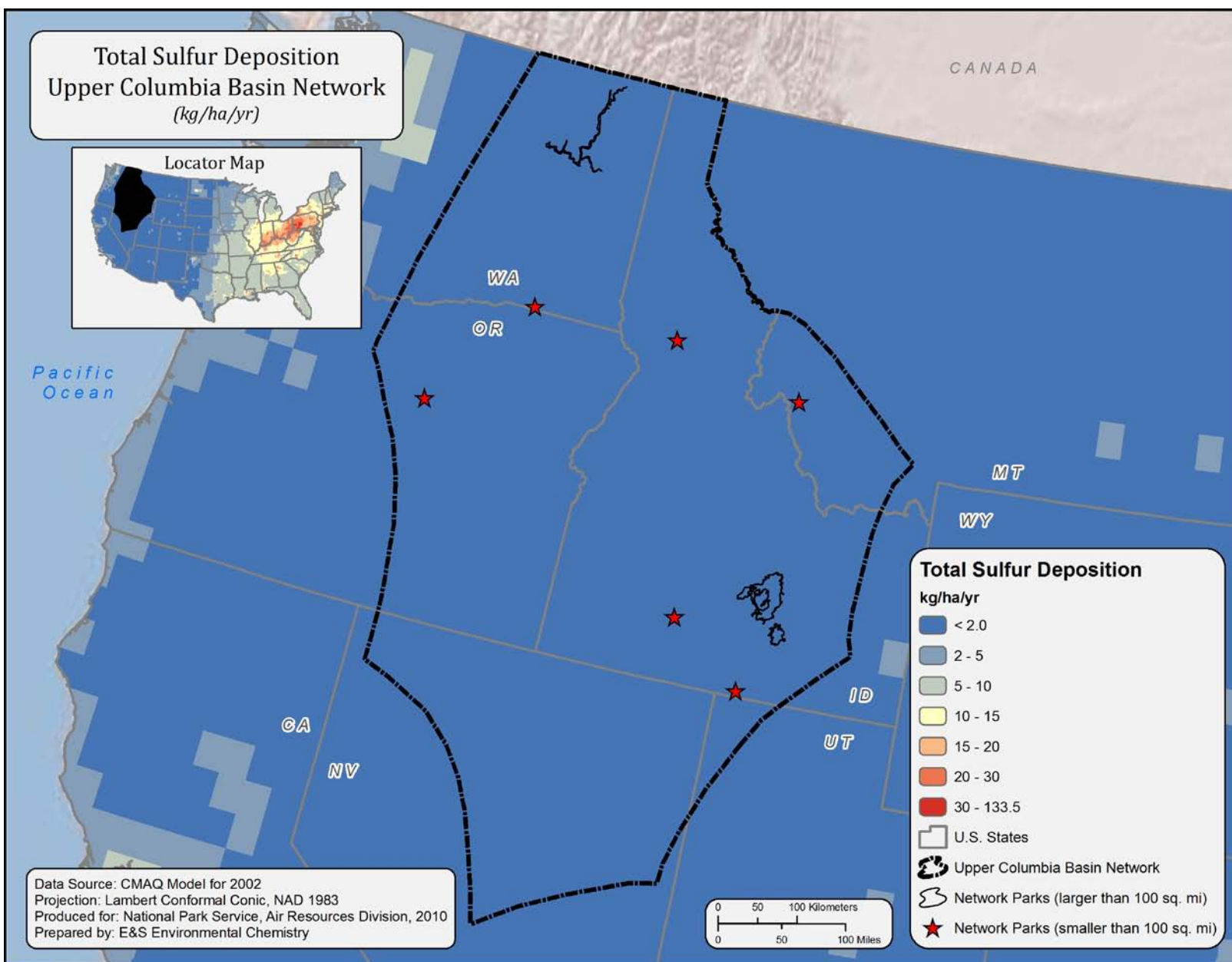
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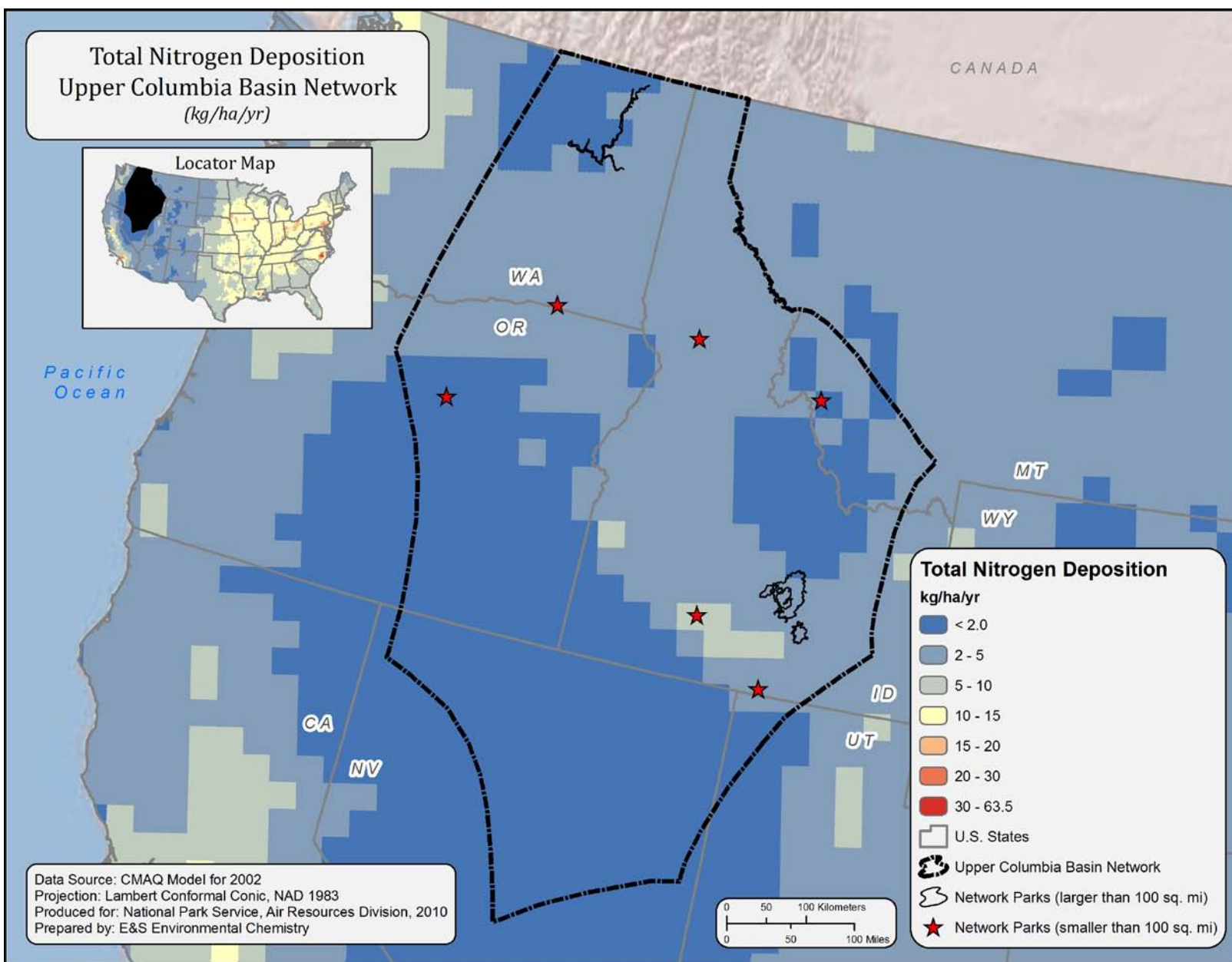
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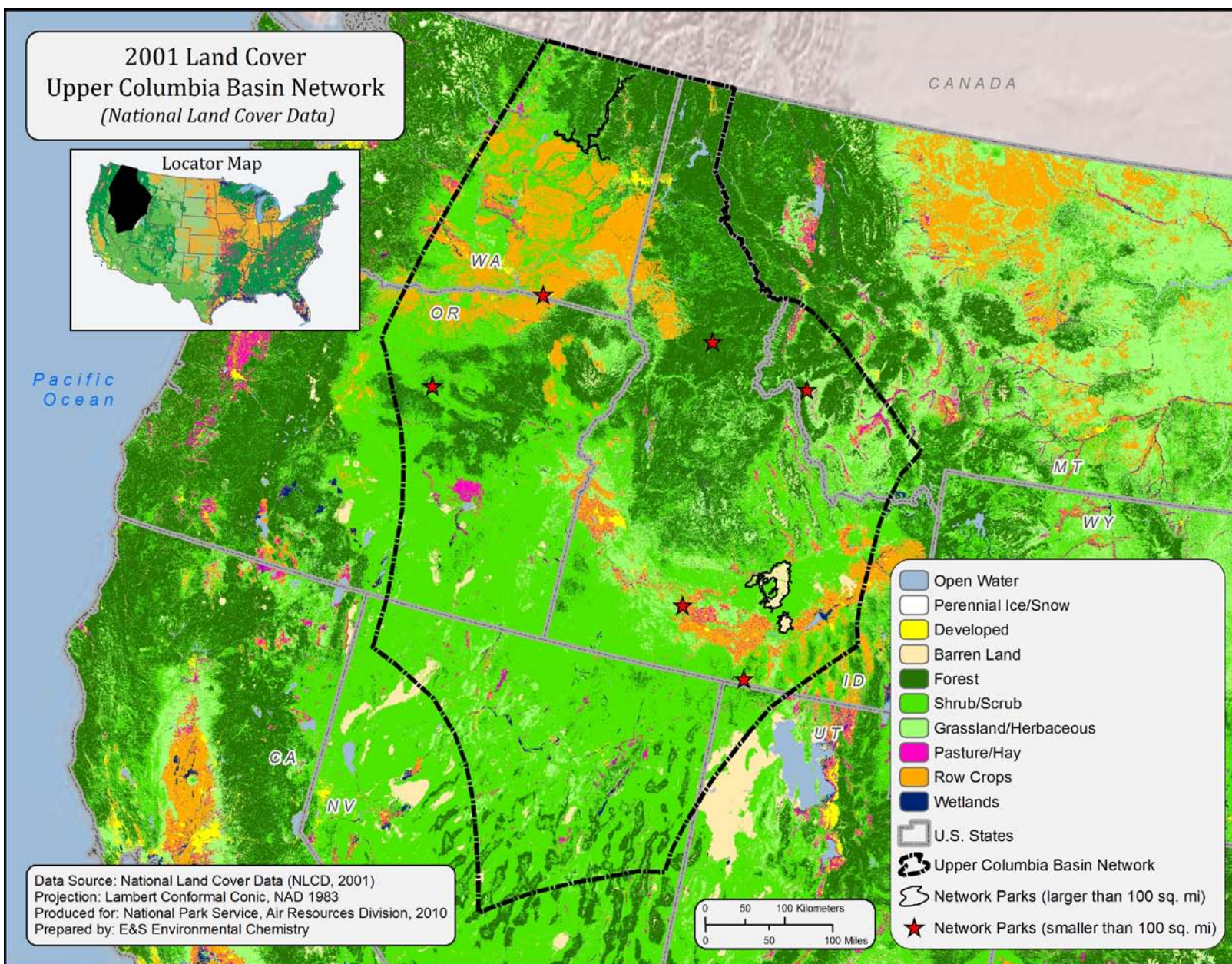
Map I



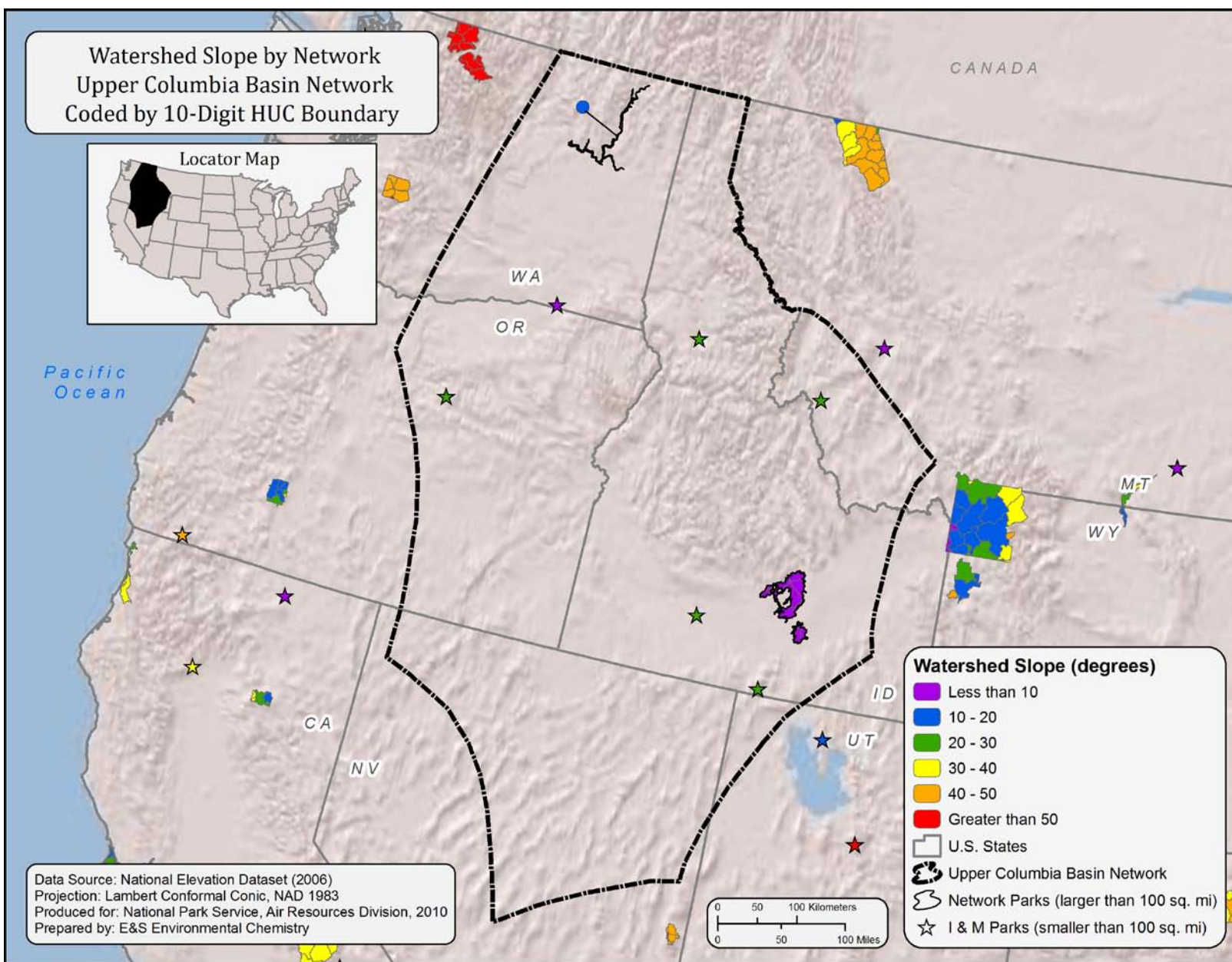
Map J



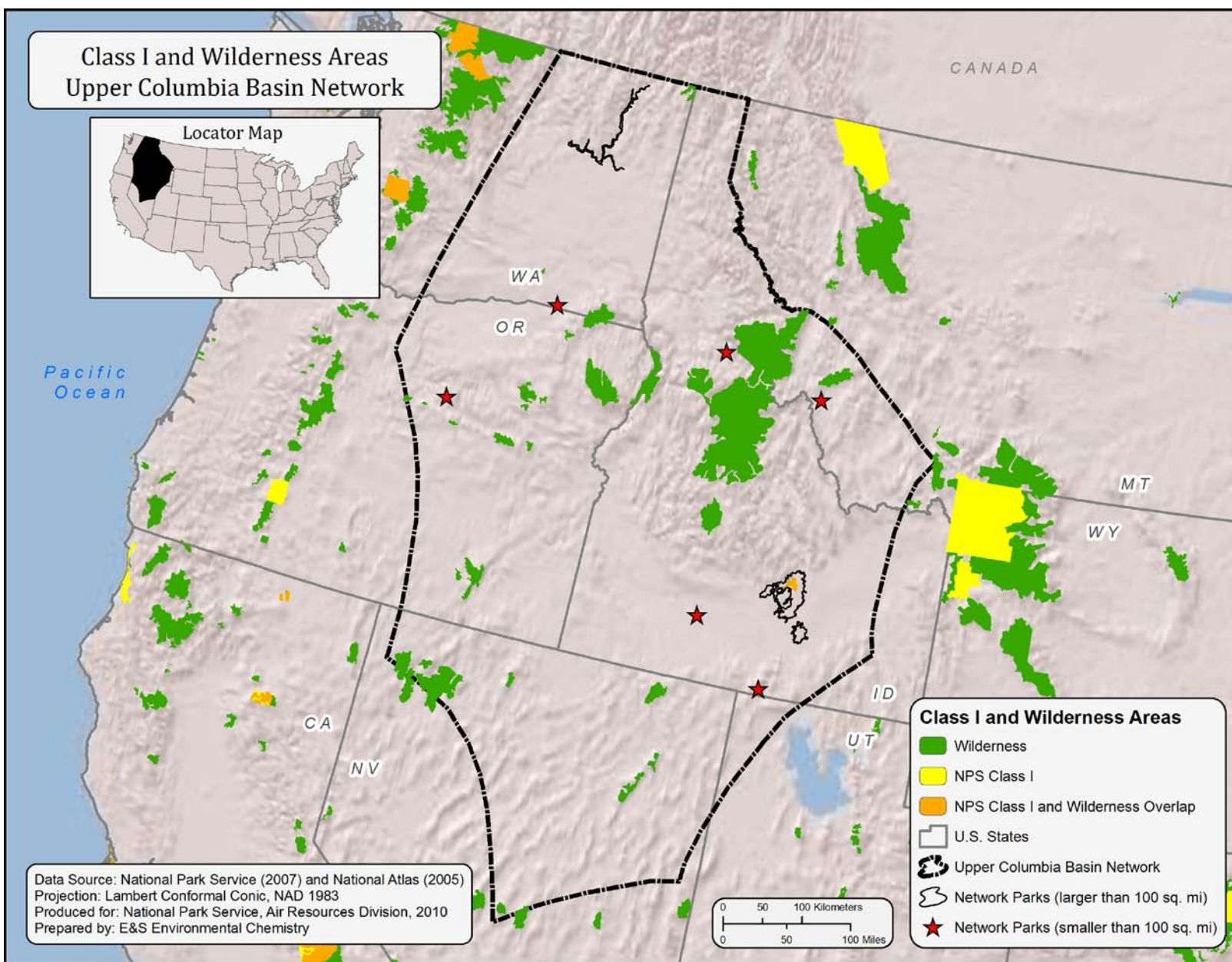
Map K



Map L



Map M



Map N

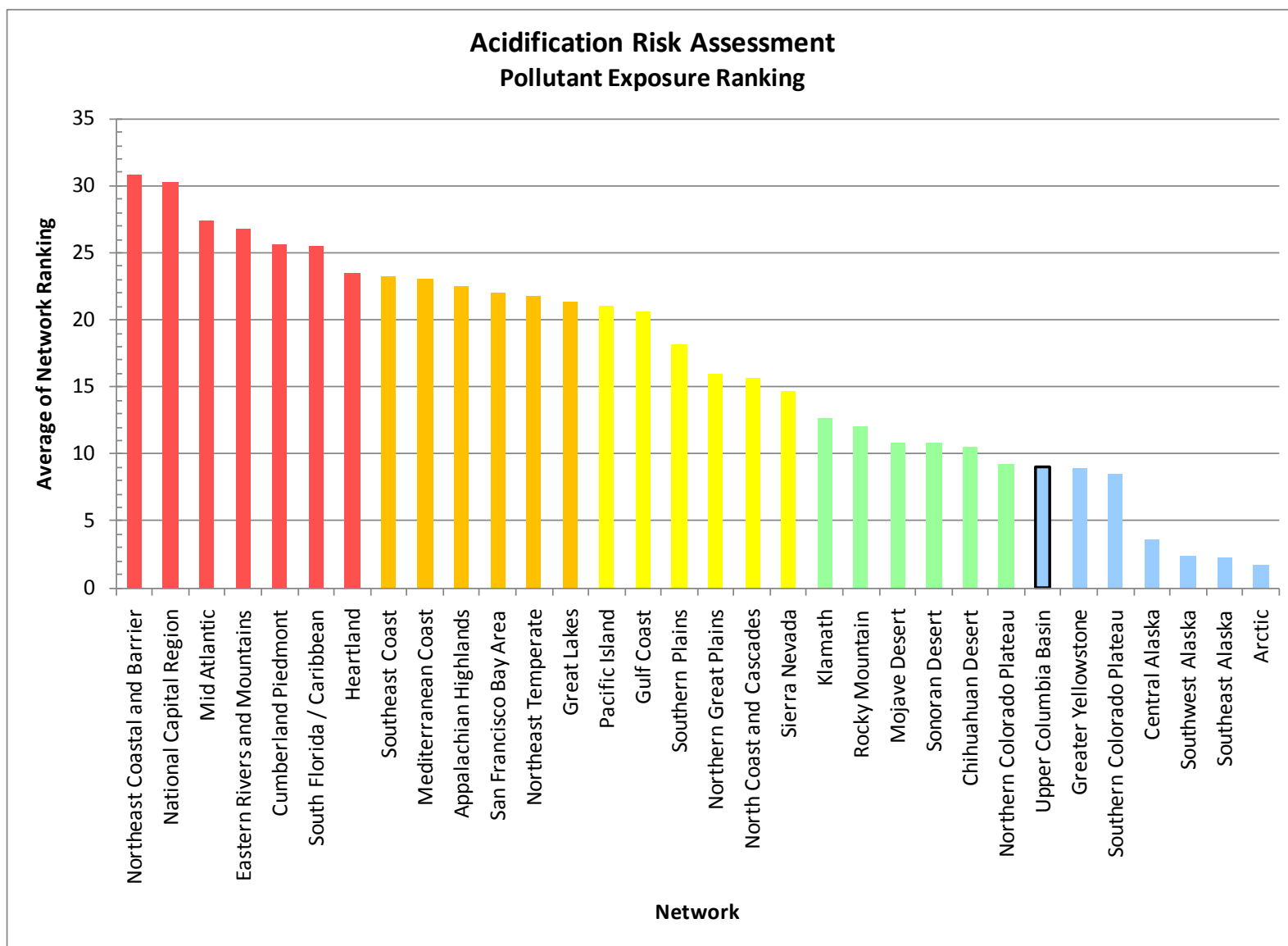


Figure A

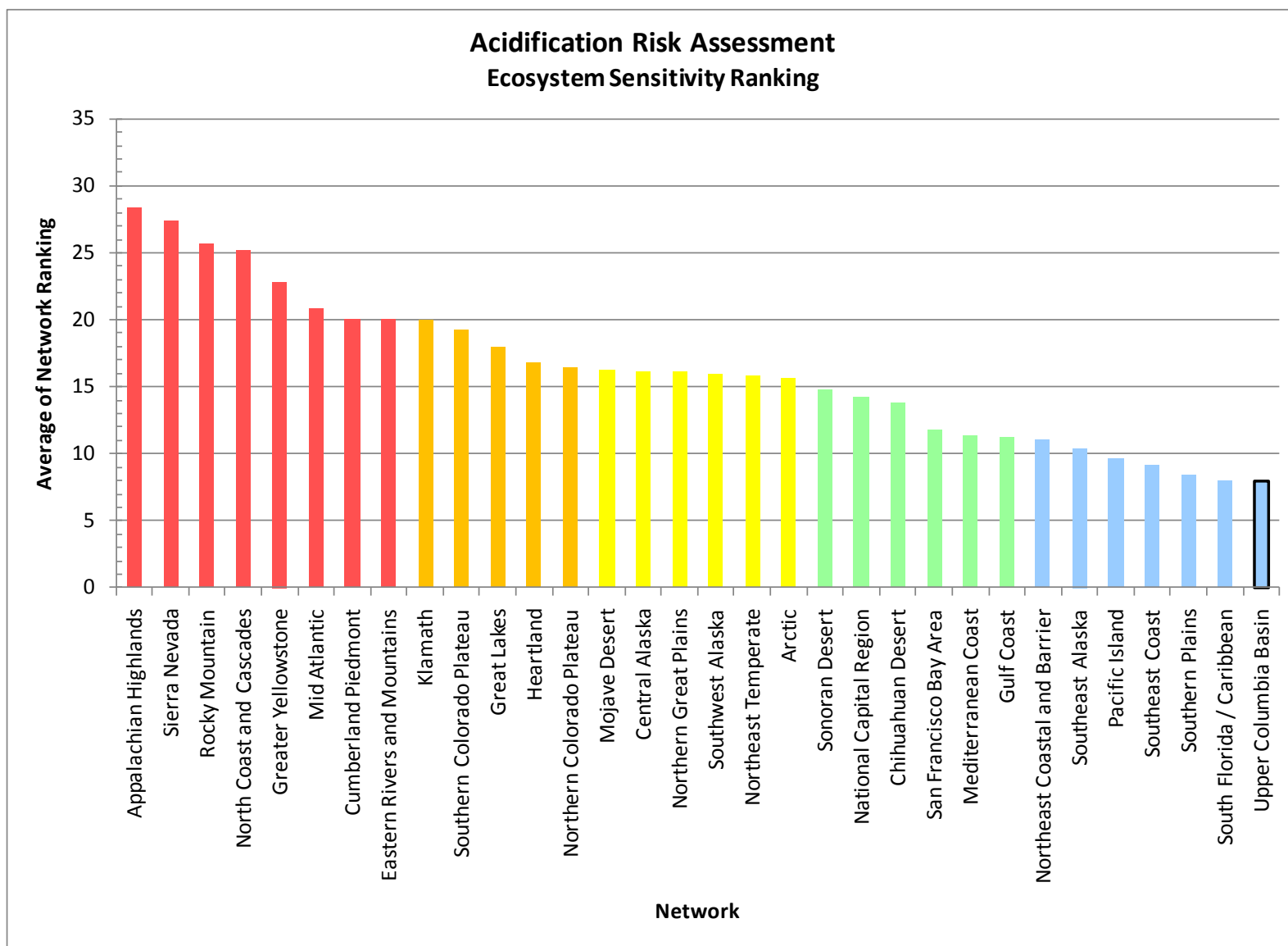


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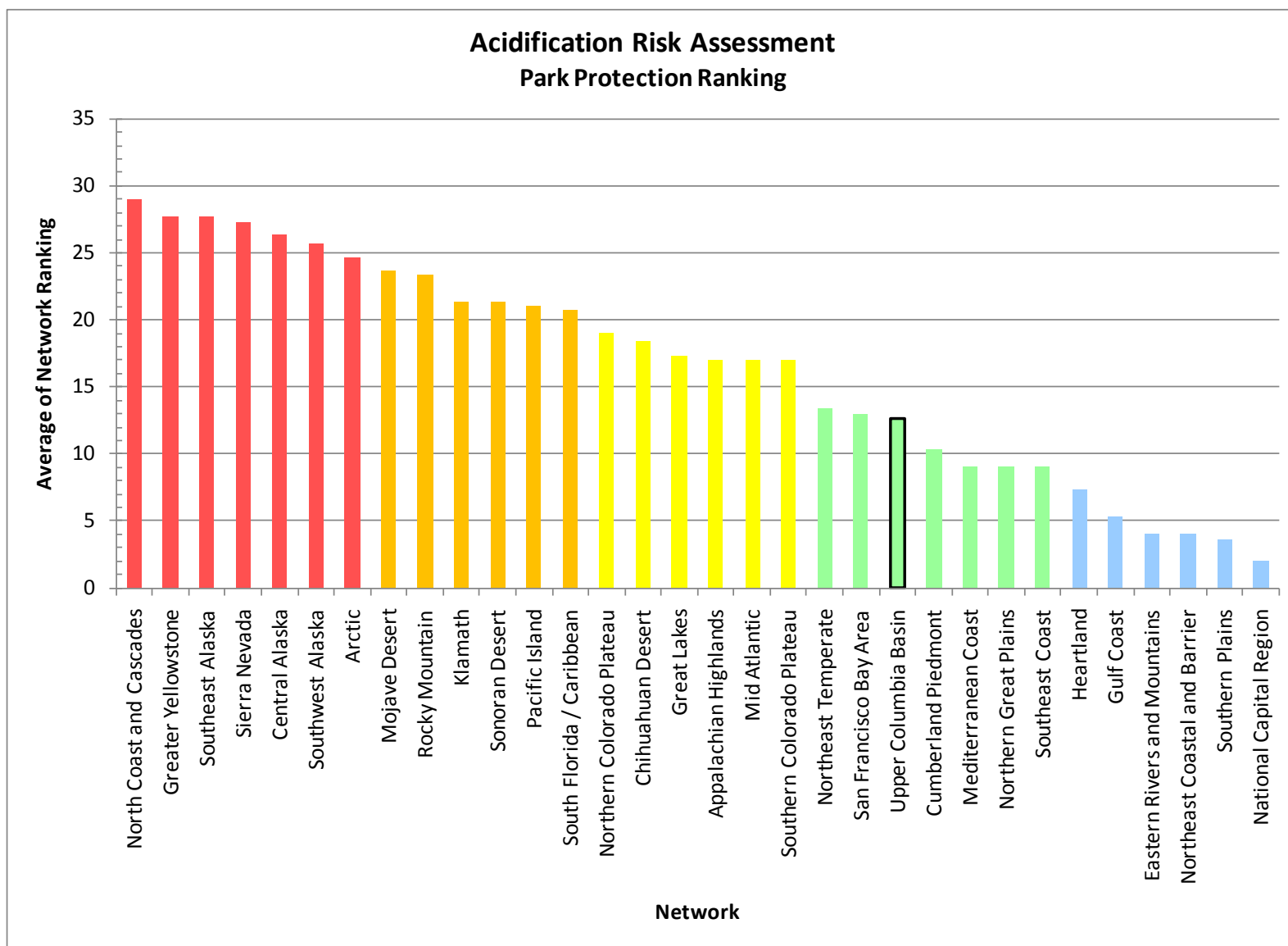


Figure C

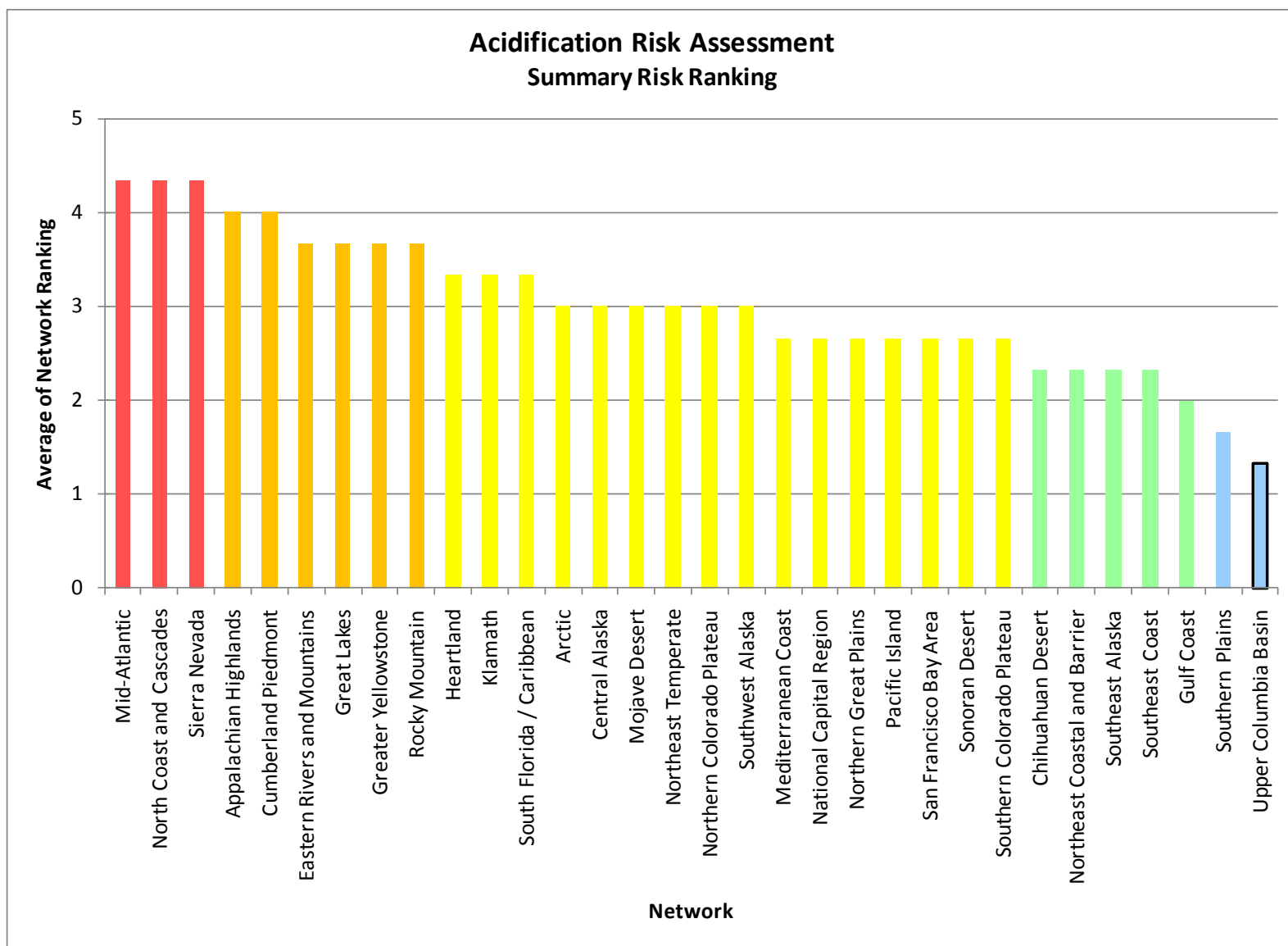


Figure D

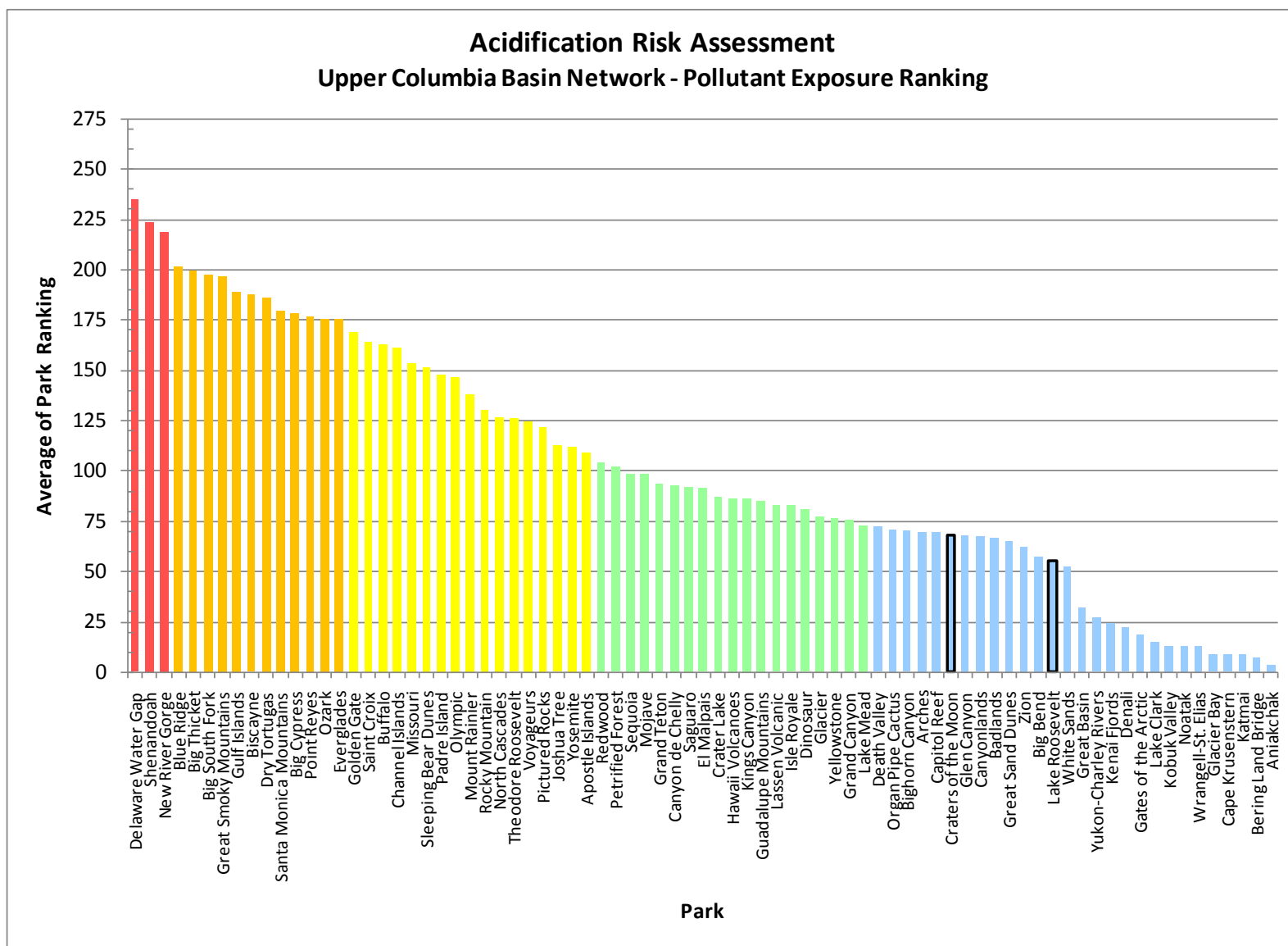


Figure E

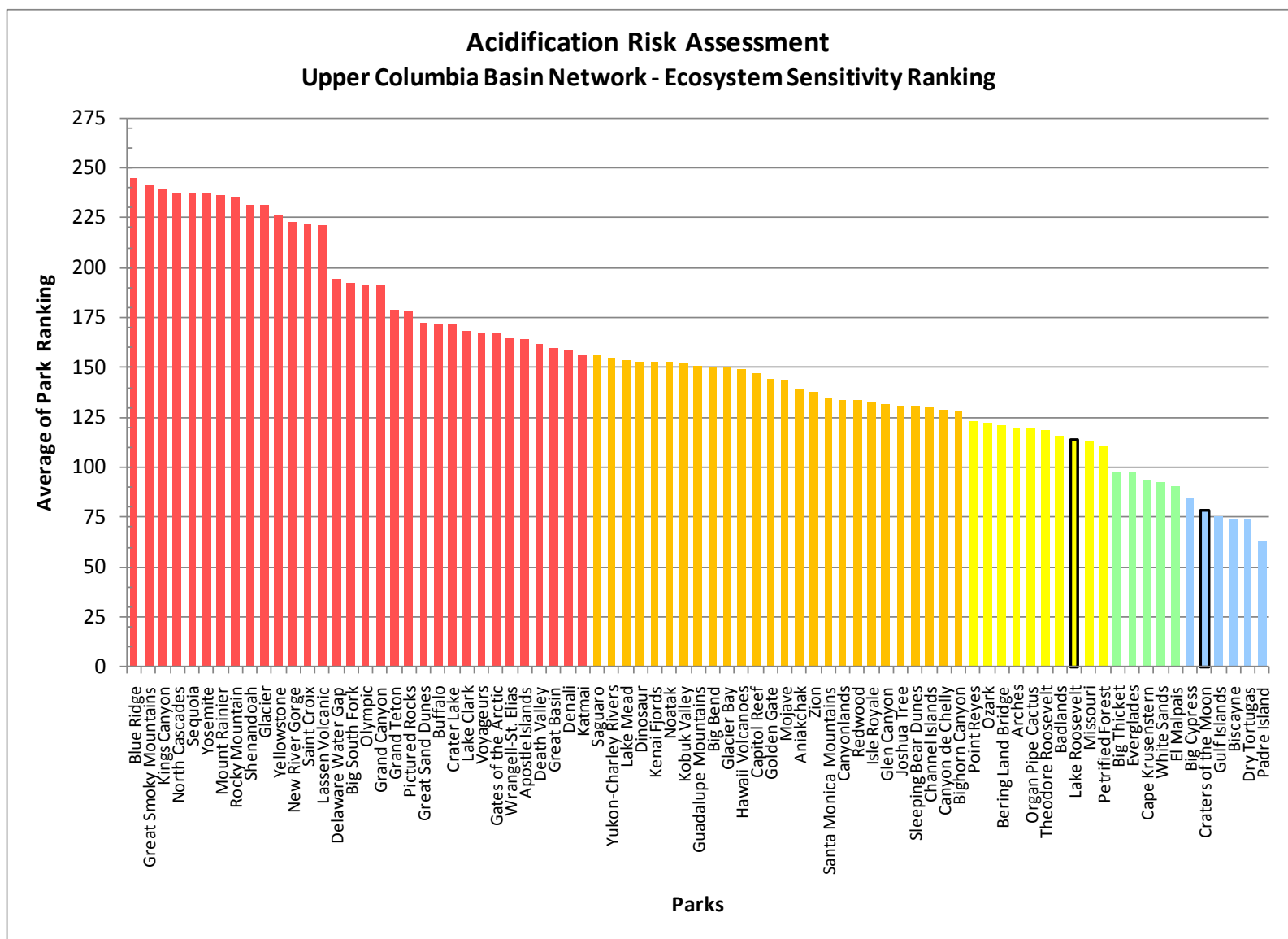


Figure F

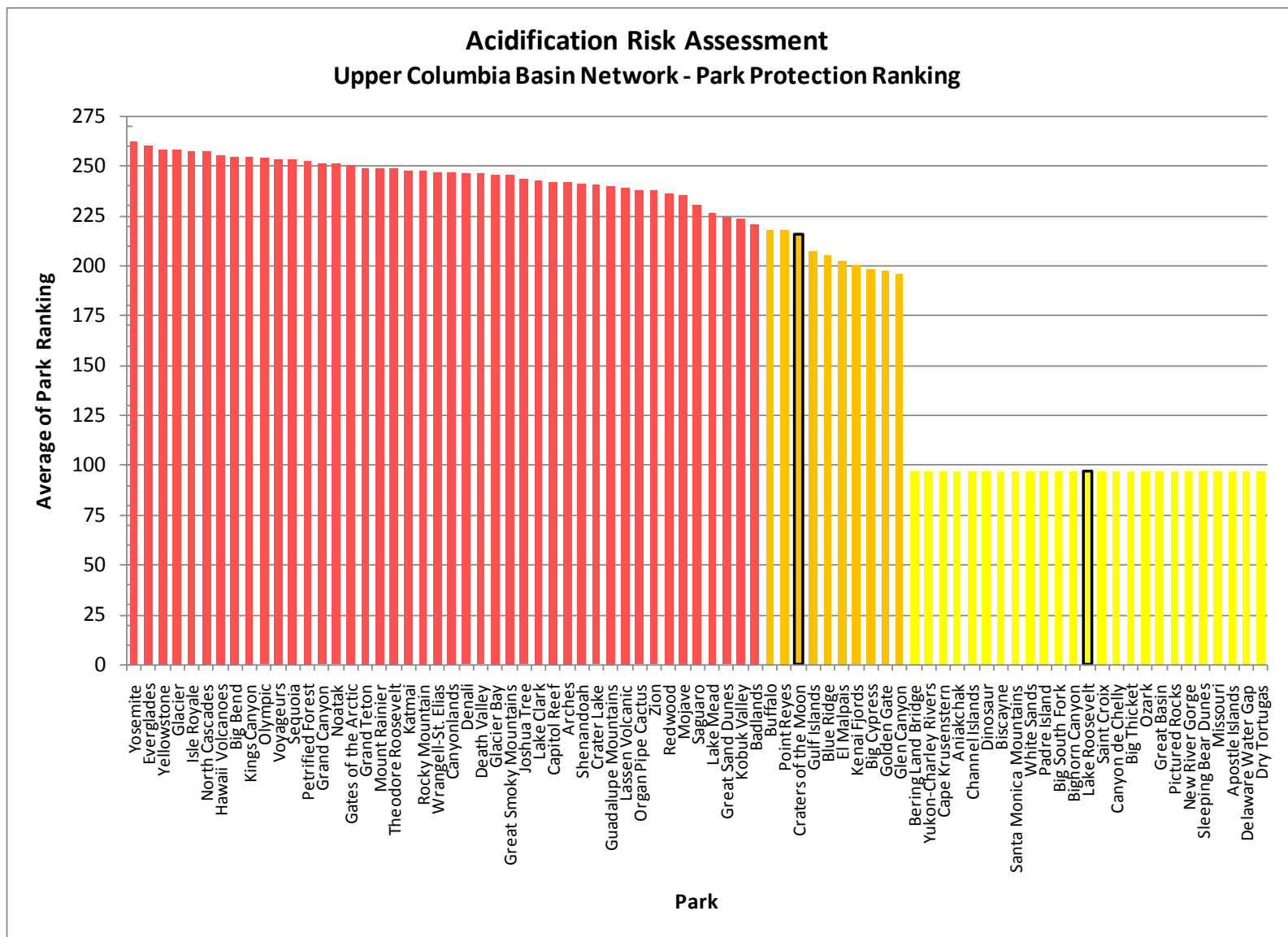


Figure G

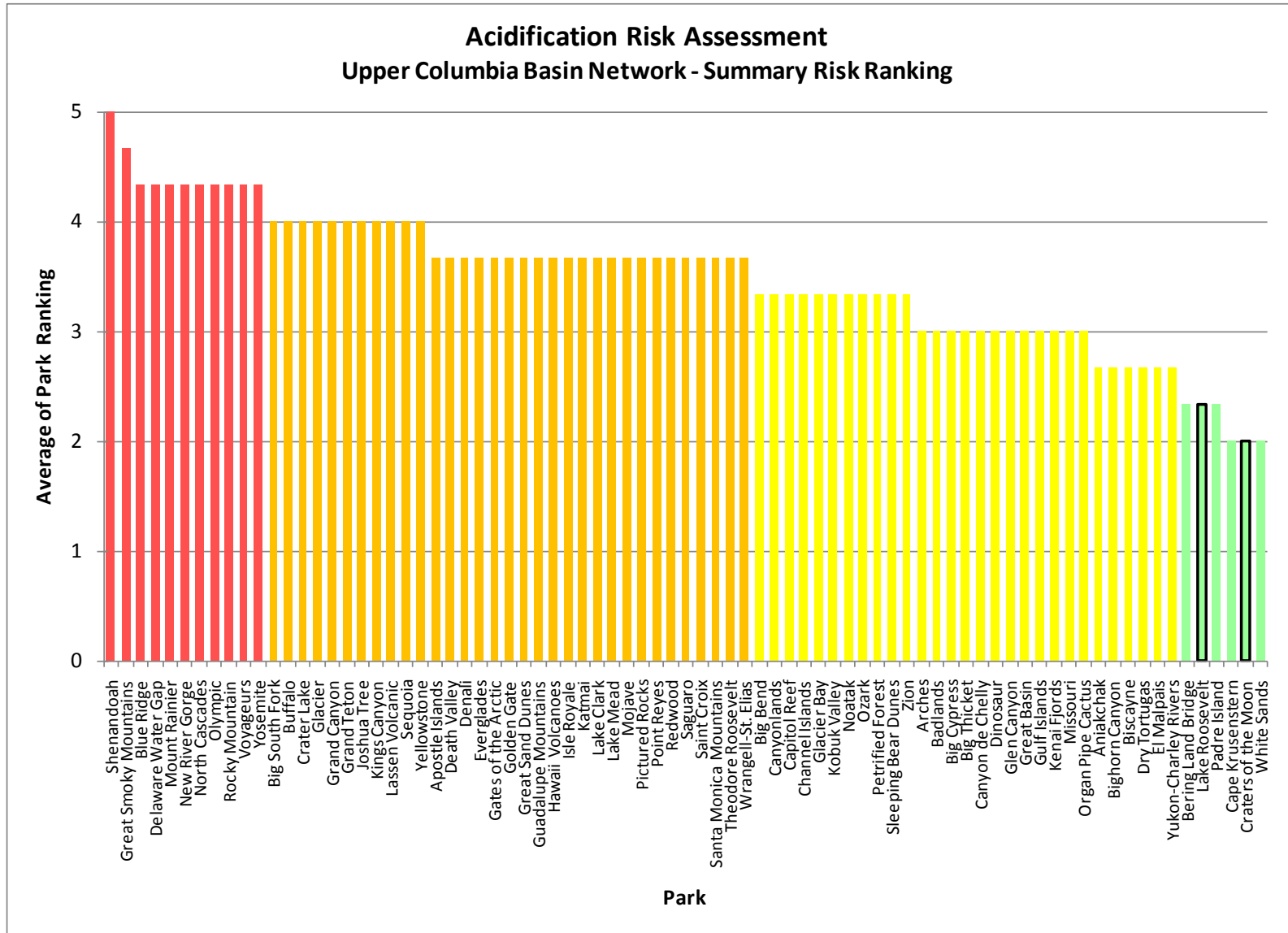


Figure H

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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