



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

Southwest Alaska Network (SWAN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/381



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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Southwest Alaska Network (SWAN)

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, respectively, for the year 2002. Maps C and D show total S and N deposition, again for the year 2002. Regional deposition data are not available for Alaska, but deposition would be expected to be very low throughout most, but not necessarily all, of Alaska.

There are five parks in the Southwest Alaska Network. Four of them are larger than 100 square miles: Aniakchak (ANIA), Katmai (KATM), Kenai Fjords (KEFJ), and Lake Clark (LACL). The smaller park is Alagnak (ALAG).

Total annual S and N emissions, by county, are shown in Maps E and F, respectively, for lands in and surrounding the Southwest Alaska Network. County-level emissions of both S and N within the network were uniformly less than 1 ton per square mile. Maps G and H show point source emissions of SO₂ (Map G) and oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH₃) N (Map H). There were few point sources of emissions in this network, and those that do occur tend to be small.

Urban centers within the network and within a 300-mile buffer around the network are shown in Map I. There are no large population centers within the network and only one in proximity to the network.

Maps J and K showing total S and total N deposition in and around the network are not shown because there are no regional deposition data for Alaska. Given the small number of point sources and population centers, acidic deposition is expected to be low.

There are five active NADP/NTN wet deposition monitoring sites in Alaska: Poker Creek, Juneau, Denali National Park, Gates of the Arctic National Park, and KATM, with data collected since 1980 at Denali and since 1993 at Poker Creek. The other three monitoring sites have been added within the last decade. There are also Clean Air Status and Trends Network (CASTNET) dry deposition measurements at Denali and Poker Flats. At all monitored sites in Alaska, wet N deposition has consistently been less than 1 kg N/ha/yr, and it has been less than 0.5 kg N/ha/yr at all monitored sites except Juneau. Wet S deposition has been slightly higher than 1 kg S/ha/yr at Juneau, but less than that at the other monitoring sites. The dry deposition measurements by CASTNET have also been low. Thus, the sparse available atmospheric deposition data for Alaska are consistent with the general understanding that atmospheric deposition of both N and S tends to be very low at national park lands within Alaska. It can be assumed that both N and S deposition in each of the Alaskan networks would be lower than 1 to 2 kg/ha/yr, on average.

Land cover in and around the network is shown in Map L. The predominant cover types within this network are shrubland and perennial ice and snow.

Most of the land slope within the parks in this network is less than 20° (Map M). There is some steeper land (between 20° and 30°) in LACL.

Park lands requiring special protection against potential adverse impacts associated with acidic deposition are shown on Map N. Also shown on Map N are all federal lands designated as wilderness, both lands managed by NPS and lands managed by other federal agencies. The land designations used to identify this heightened protection included Class I designation under the Clean Air Act Amendments and wilderness designation. There are no Class I areas in this network, but there are a large number of wilderness areas. Three of the four large (larger than 100 square miles) parks in this network (all except ANIA) are mainly comprised of designated wilderness.

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 Southwest Alaska Network ranked in the lowest quintile among networks in Pollutant Exposure (Figure A). Emissions and expected S and N deposition within the network are very low. The network Ecosystem Sensitivity ranking was Moderate, within the middle quintile among networks (Figure B). There is no vegetation coverage in the I&M parks that occur in this network that includes red spruce or sugar maple, the primary tree species known to be sensitive to effects from acidic deposition, and there are no high-elevation lakes. Data are not available at this time for designating stream order in Alaska, so this variable was not included in the Ecosystem Sensitivity ranking. This network ranked in the top quintile in Park Protection, having substantial 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 in the middle of the distribution among networks (Figure D). The overall level of concern for acidification effects on I&M parks within this network is considered Moderate.

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.

All of the parks in the Southwest Alaska Network showed Pollutant Exposure ranking in the lowest quintile among parks (Figure E, Table A). Ecosystem Sensitivity ranking varied: one park (ALAG) was ranked Low, two parks were ranked High (ANAI and KEFJ), and two parks were ranked Very High (KATM and LACL; Figure F, Table A). Two parks (KATM, LACL) had Park Protection ranking in the highest quintile (Figure G). The three other parks had Park Protection ranking that was in the second highest (ALAG and KEFJ) or middle (ANIA) quintile among parks (Table A).

The park Summary Risk ranking was High for two of the large parks (KATM and LACL) and Moderate for the other two large parks (ANIA and KEFJ; Figure H, Table A). The one small park was ranked Low (Table A).

Table A. Relative rankings of individual I&M parks within the network for Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and overall Summary Risk from acidic deposition.				
I&M Parks² in Network	Relative Ranking of Individual Parks¹			
	Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Alagnak	Very Low	Low	High	Low
Aniakchak	Very Low	High	Moderate	Moderate
Katmai	Very Low	Very High	Very High	High
Kenai Fjords	Very Low	High	High	Moderate
Lake Clark	Very Low	Very High	Very High	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, 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. Regional S deposition data are not available for Alaska. Total S deposition throughout most areas in Alaska is expected to be low, below about 1 to 2 kilograms of S per hectare per year. Total S deposition for the continental United States is presented for context here for the year 2002, expressed in units of kilograms of S deposited from the atmosphere to the earth surface per hectare per year. Wet and dry forms of deposition 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 D. Regional N deposition data are not available for Alaska. Total N deposition throughout most areas in Alaska is expected to be low, below about 1 to 2 kilograms of N per hectare per year. Total N deposition for the continental United States is presented for context here 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)

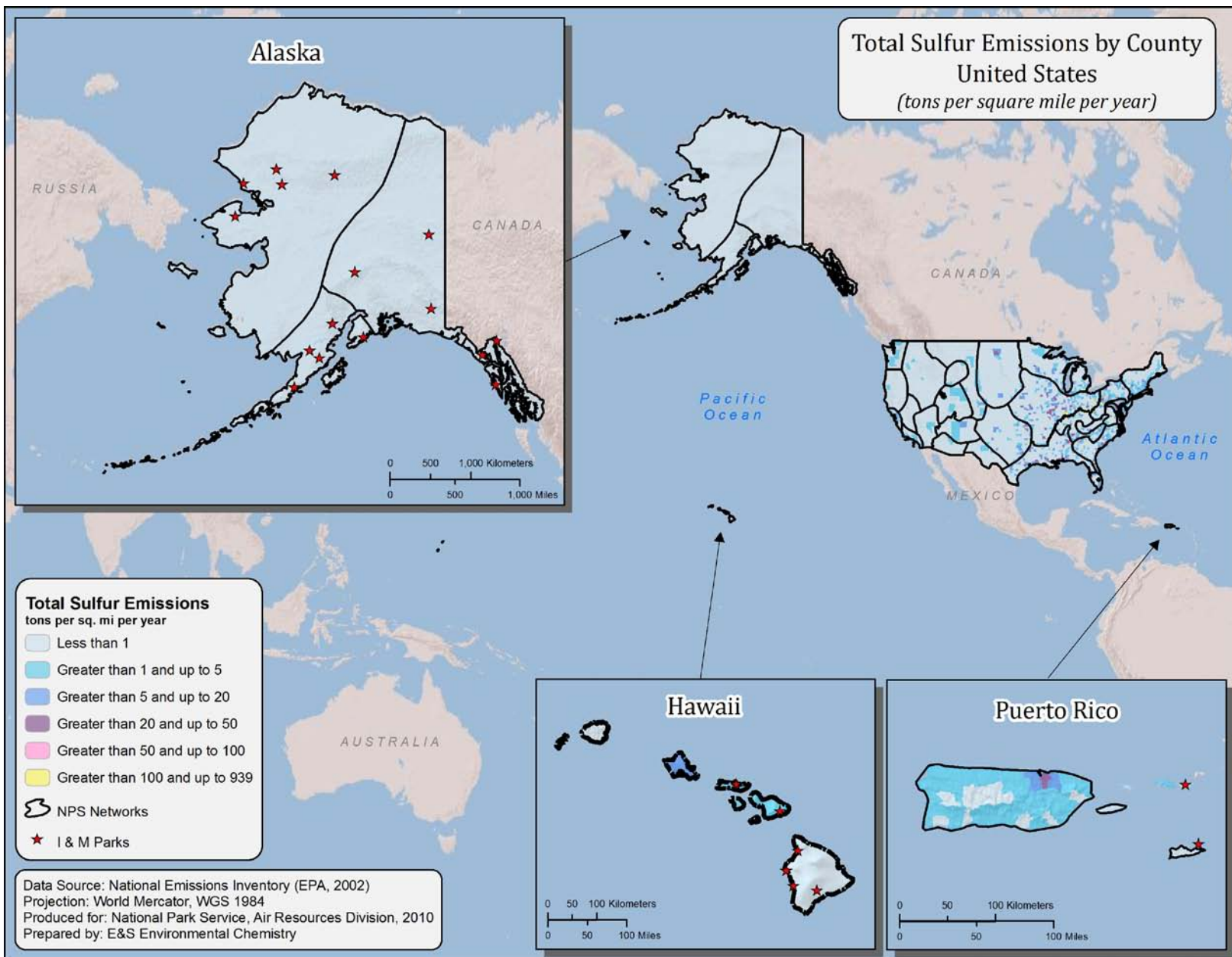
- Map L. Land cover types in and around the network, based on the National Land Cover dataset. (Source of data: National Land Cover Dataset, http://www.mrlc.gov/nlcd_multizone_map.php)

- 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/>])

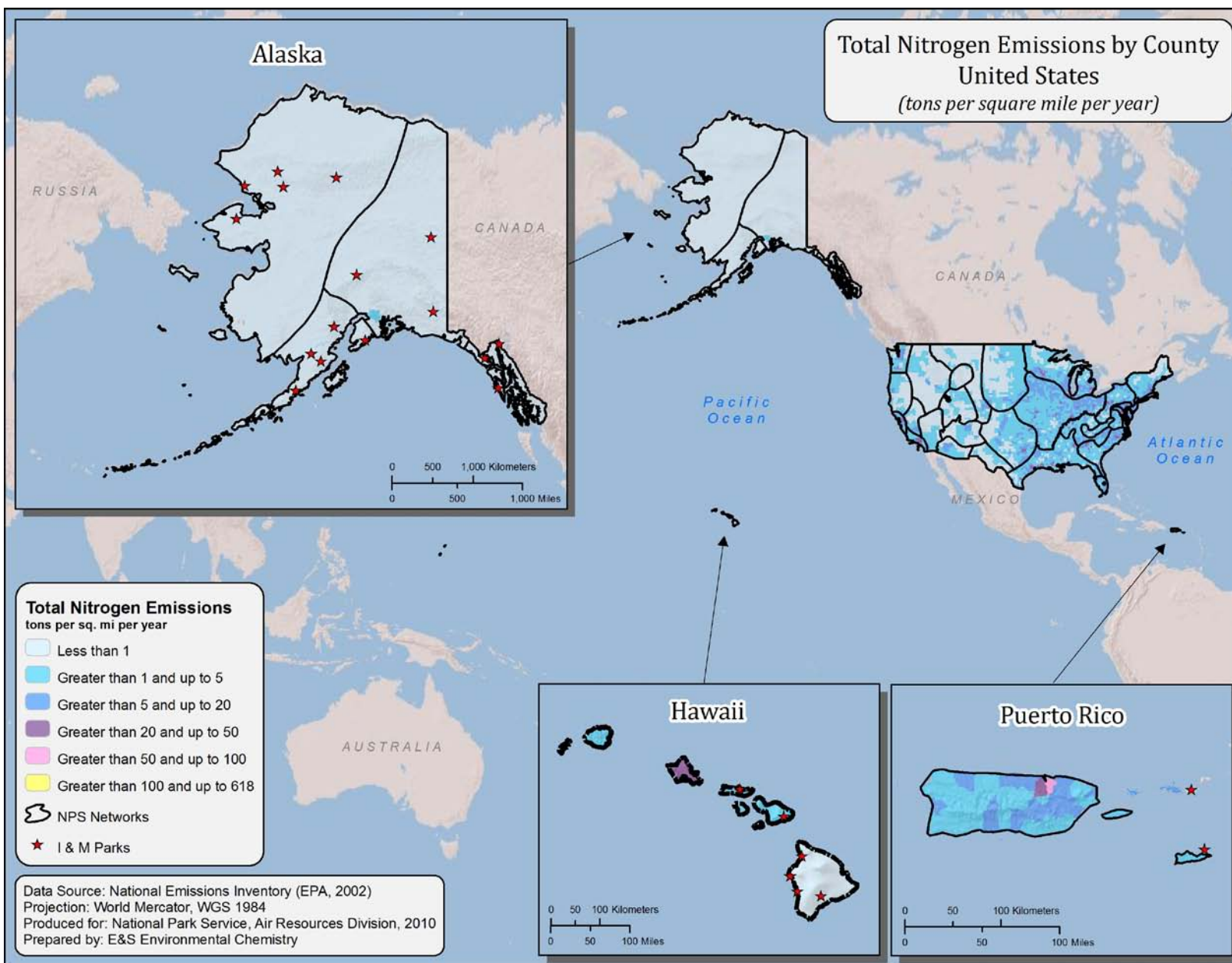
- Map N. Lands within the network that are classified as Class I or wilderness area. (Source of data: USGS 2005 [National Atlas; <http://nationalatlas.gov>] and NPS)

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

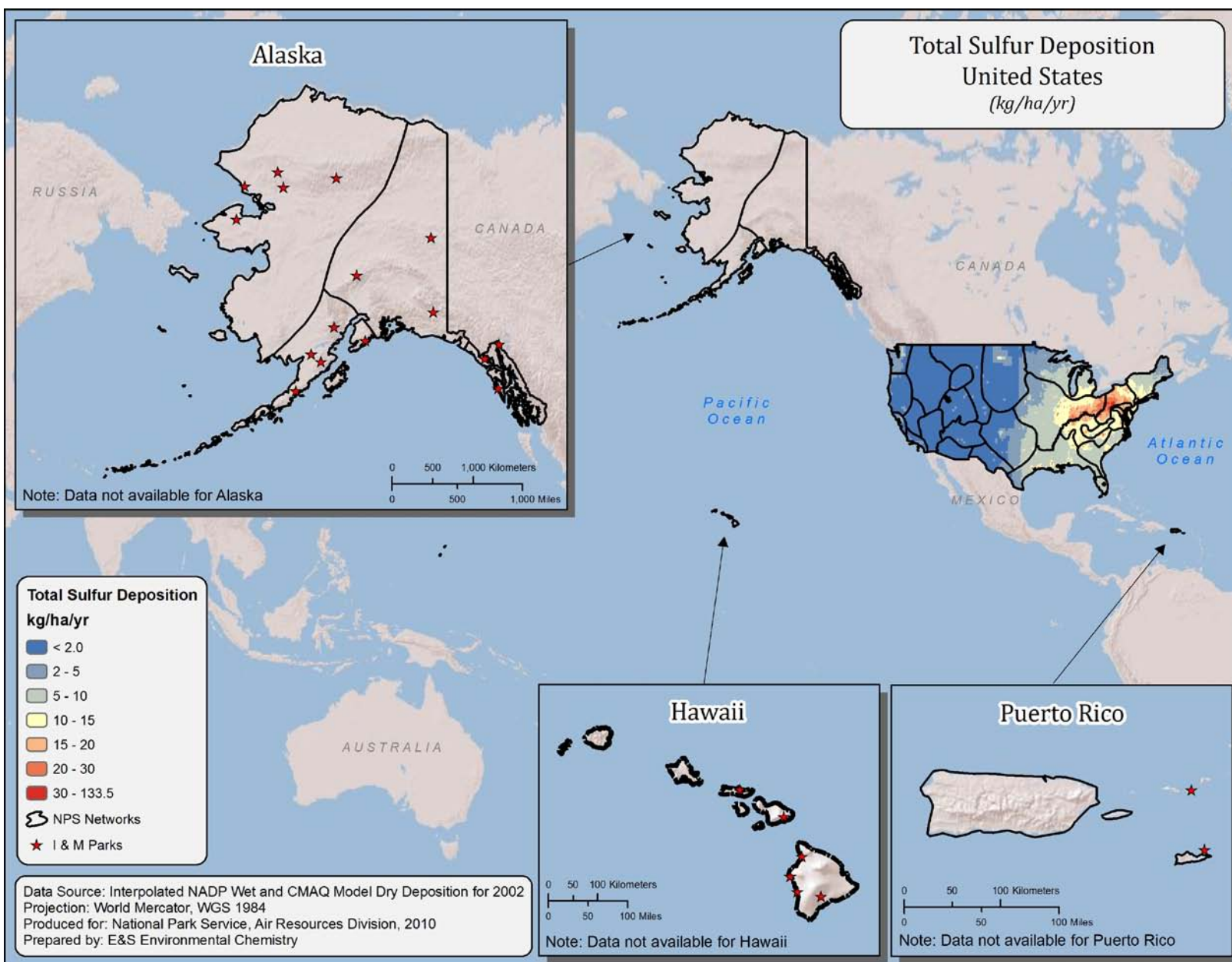
- Figure B. Network rankings for Ecosystem Sensitivity, calculated as the average of scores for all Ecosystem Sensitivity variables.
- Figure C. Network rankings for Park Protection, calculated as the average of scores for all Park Protection variables.
- Figure D. Network Summary Risk rankings, calculated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



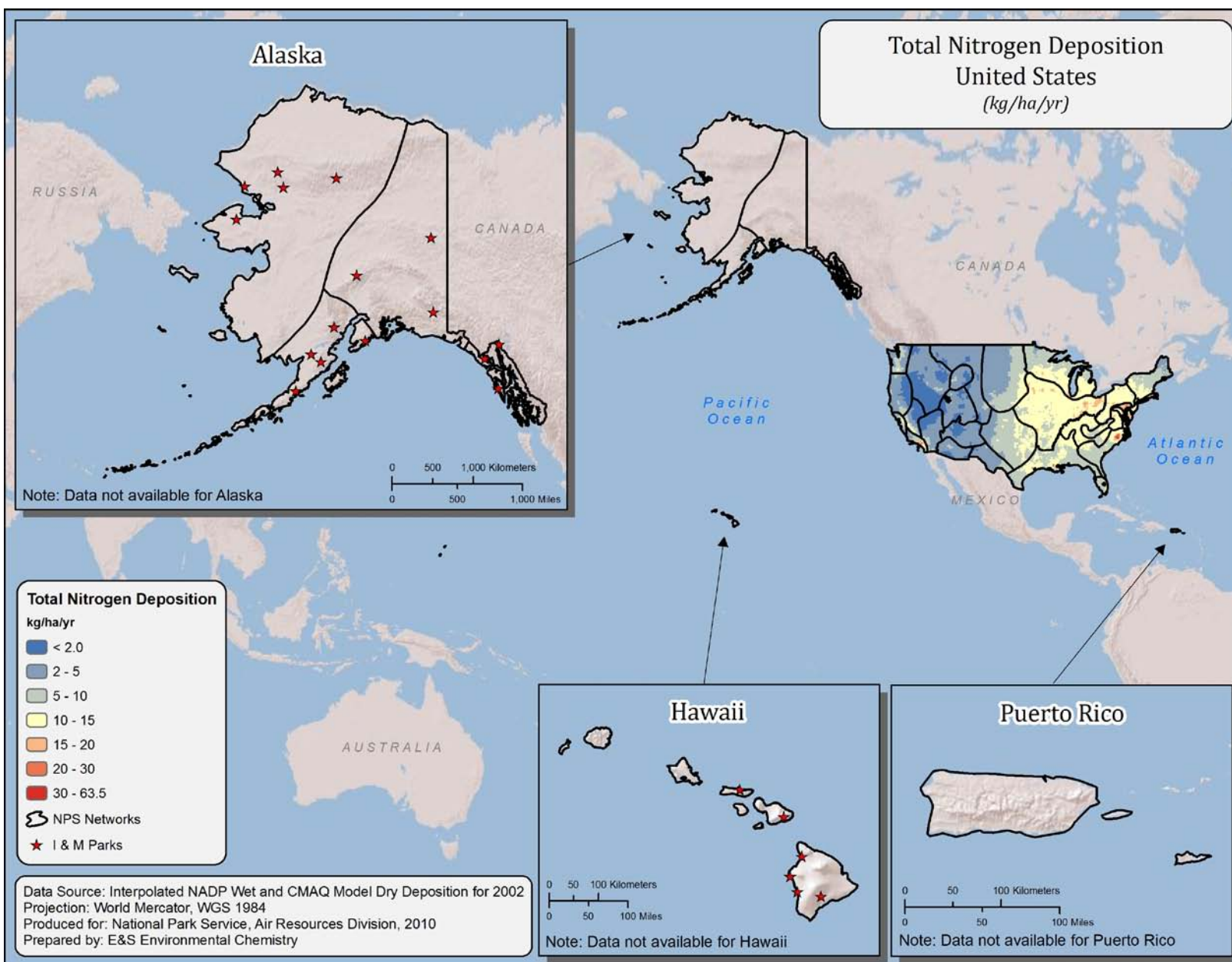
Map A



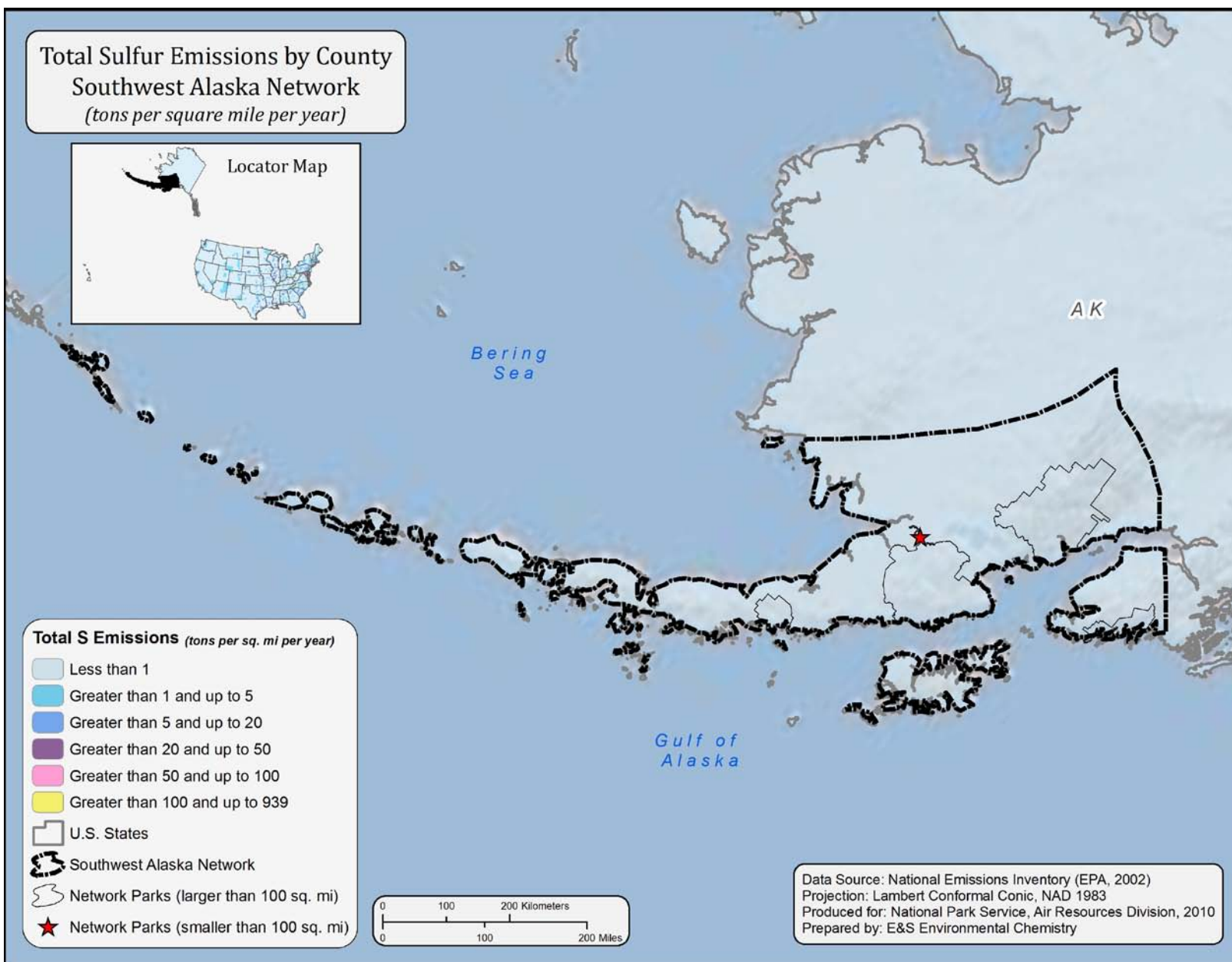
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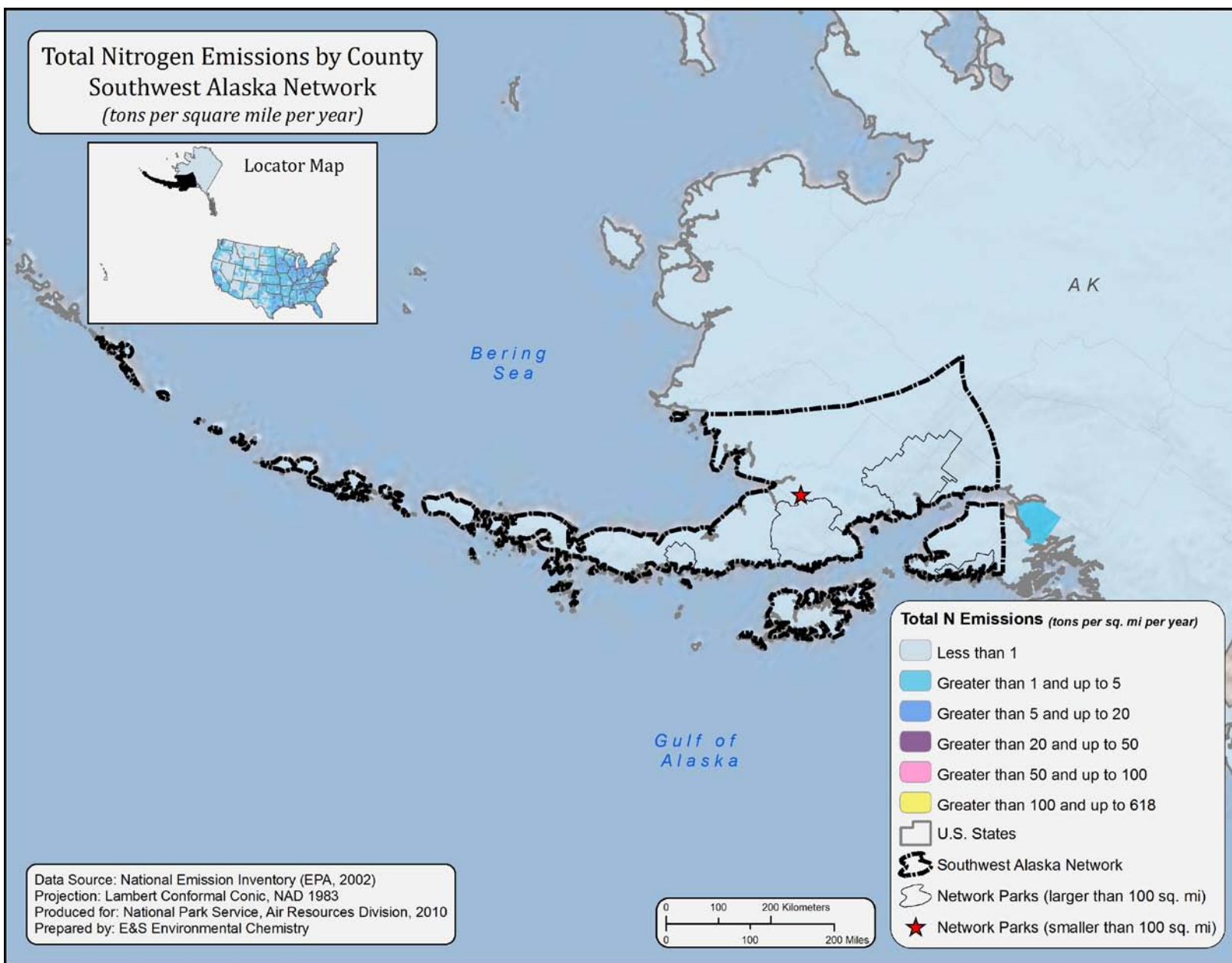
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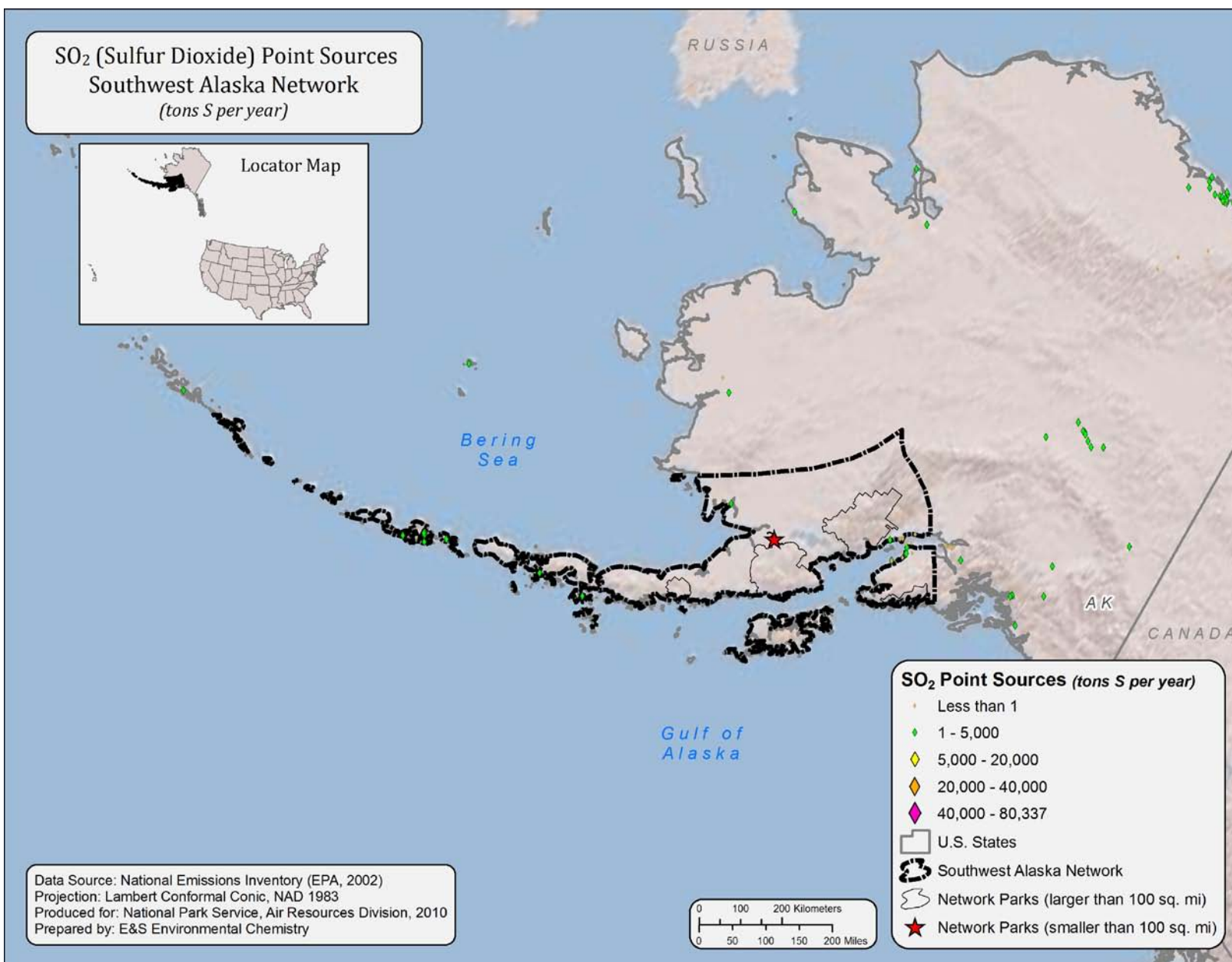
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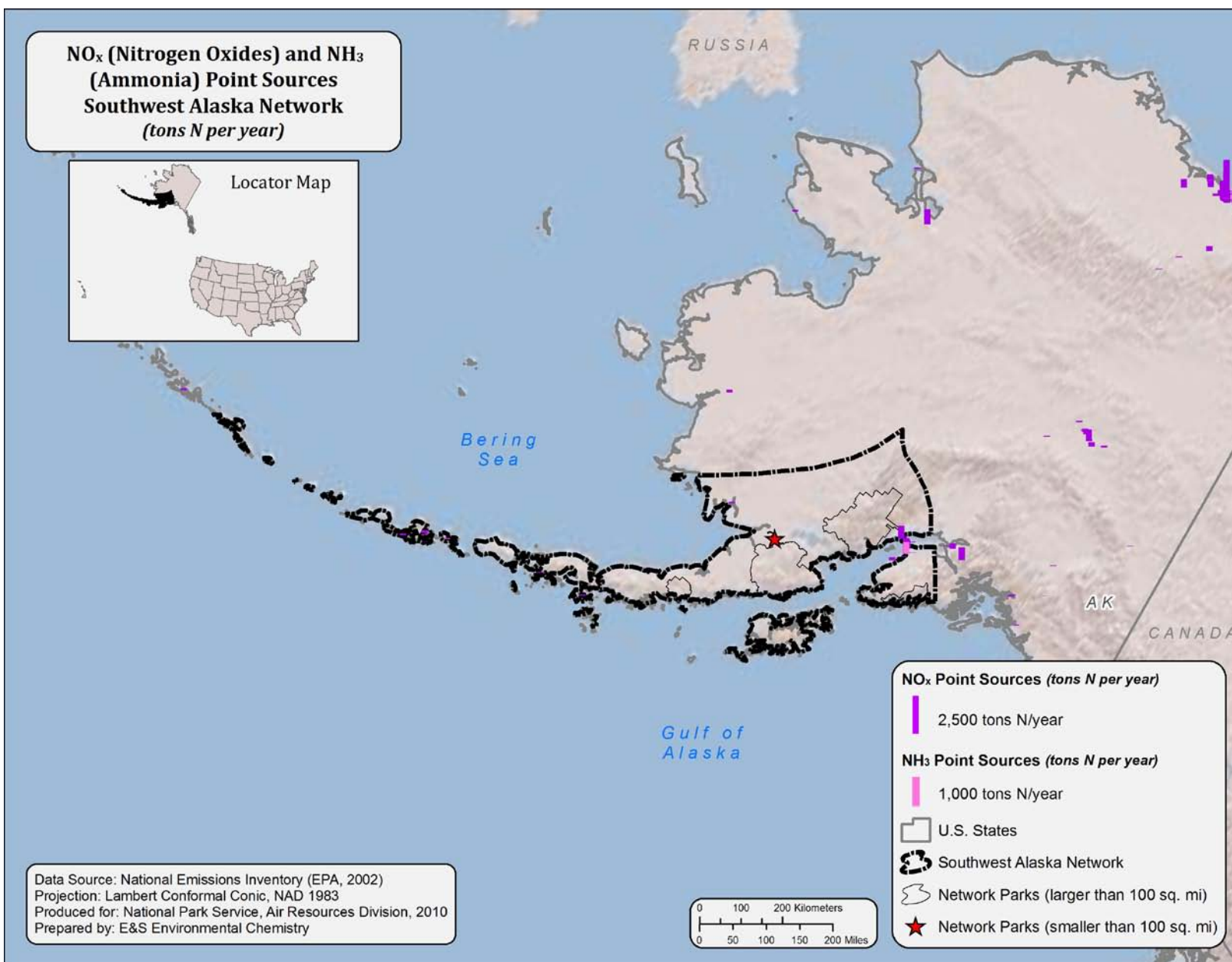
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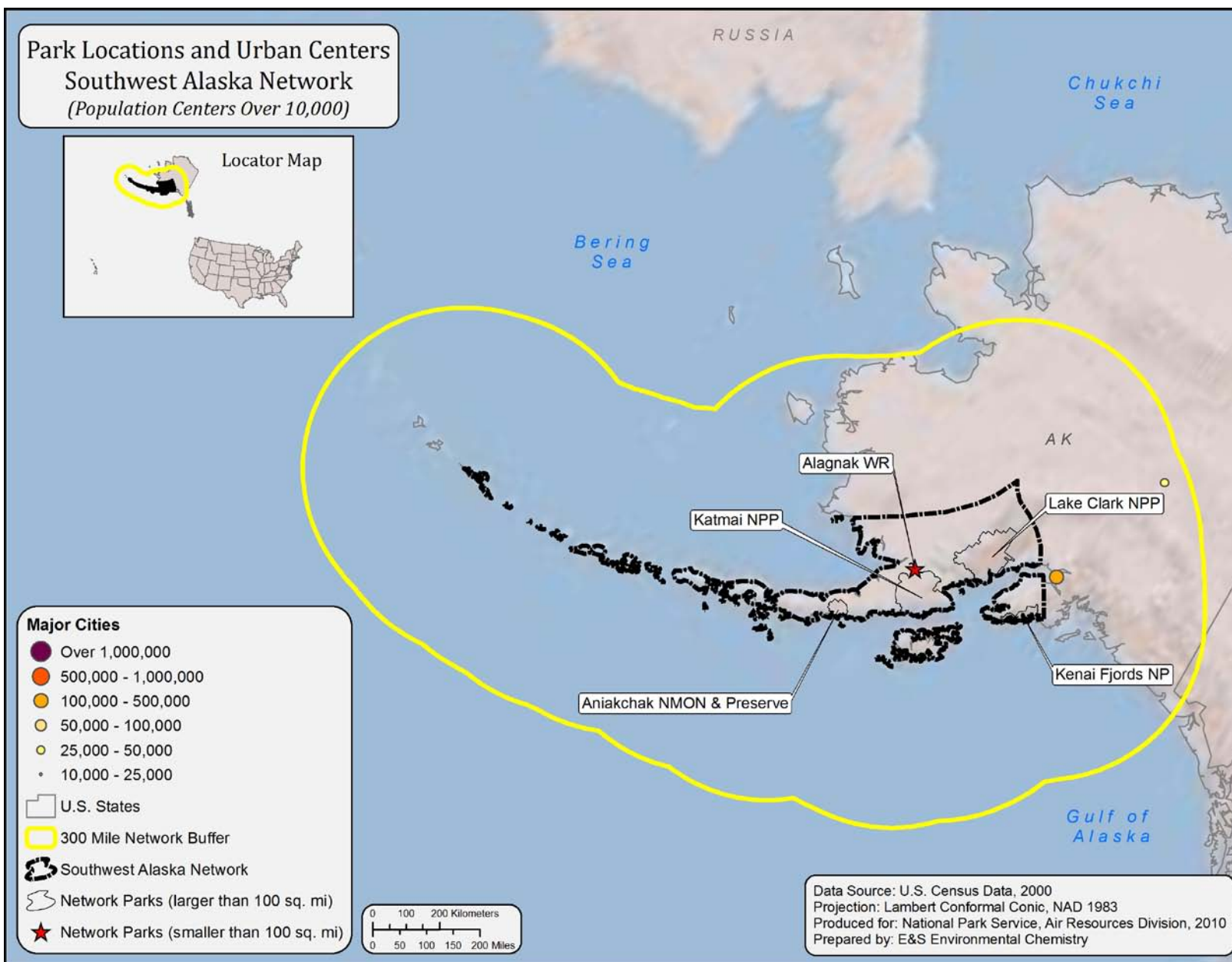
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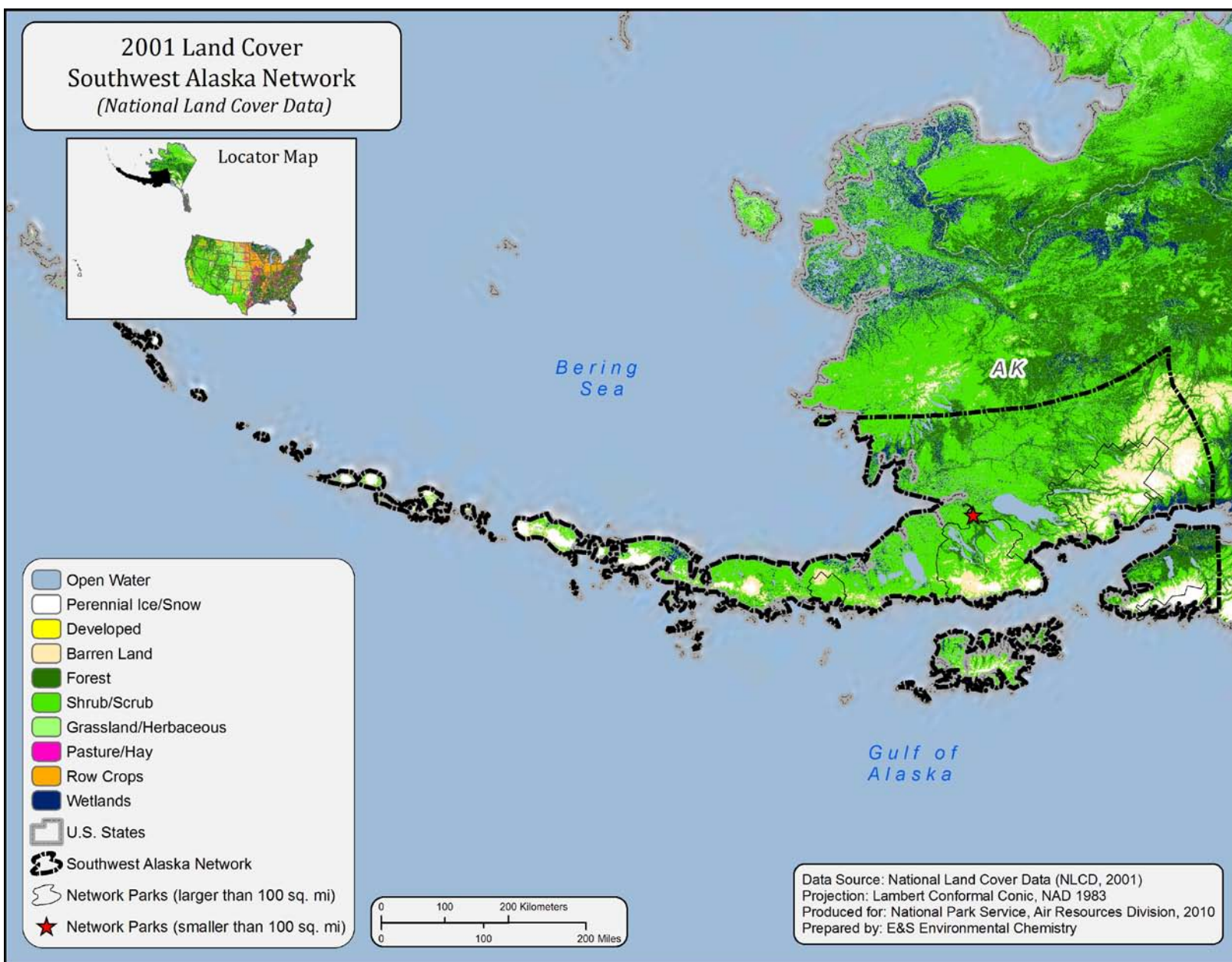
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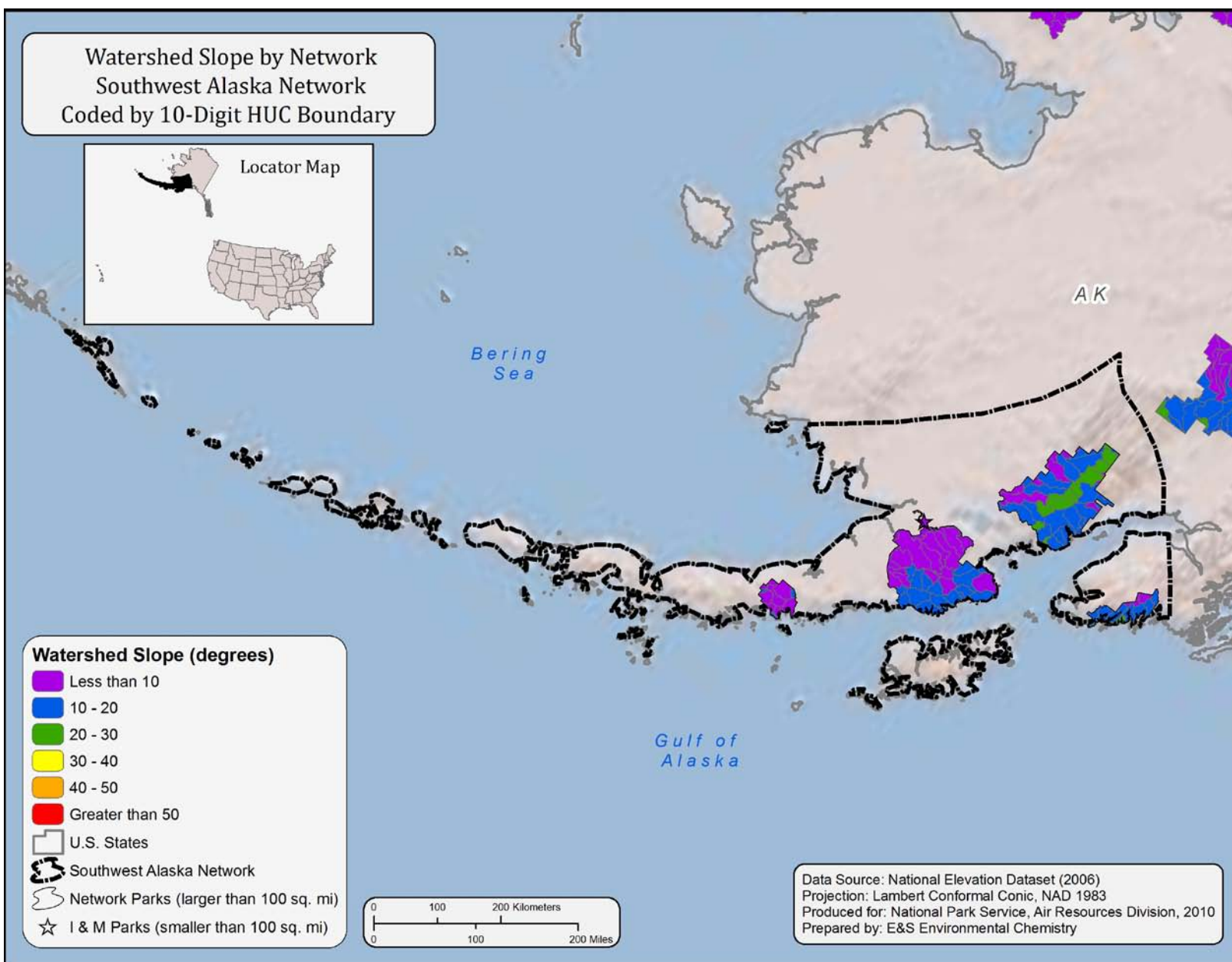
Map H



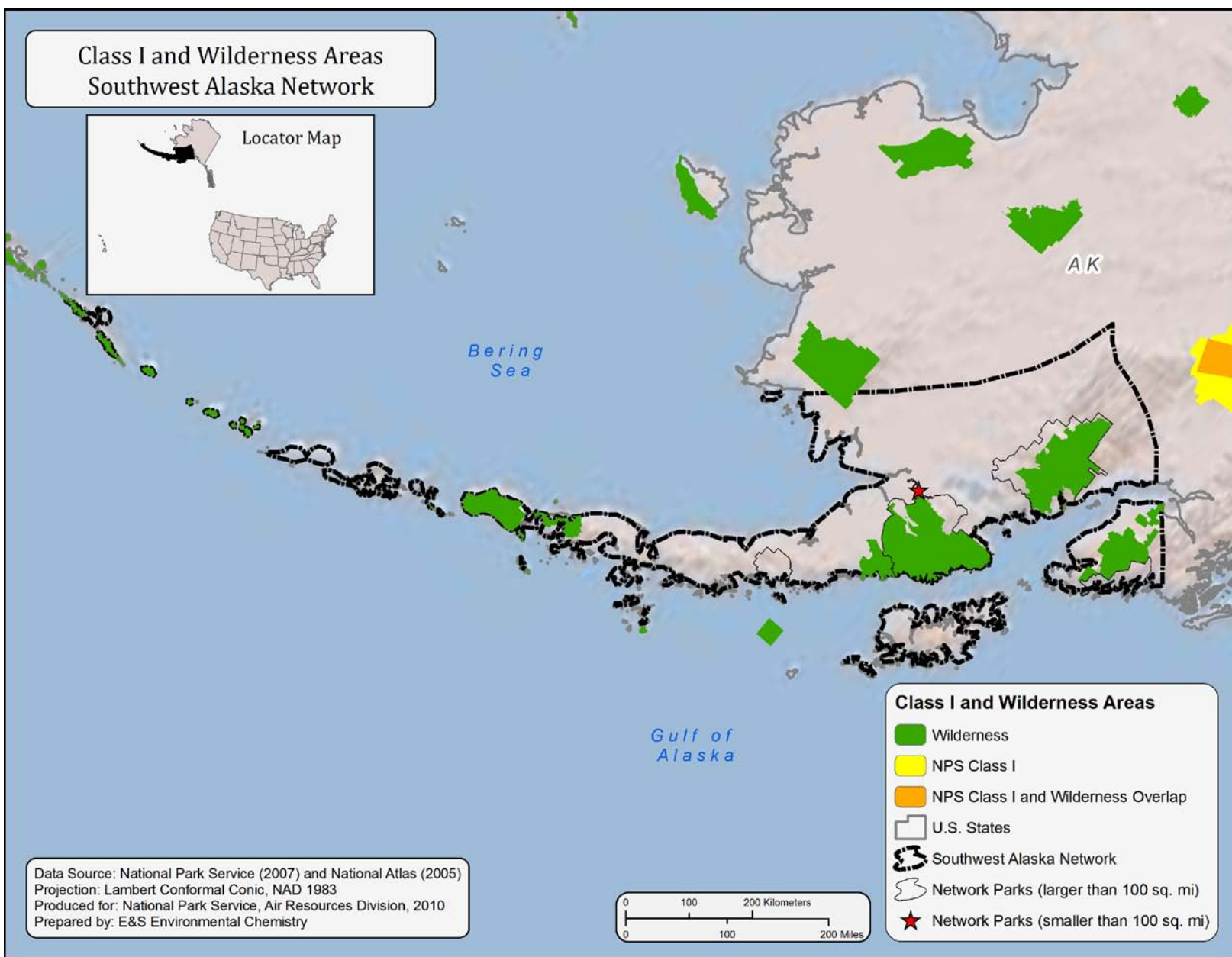
Map I



Map L



Map M



Map N

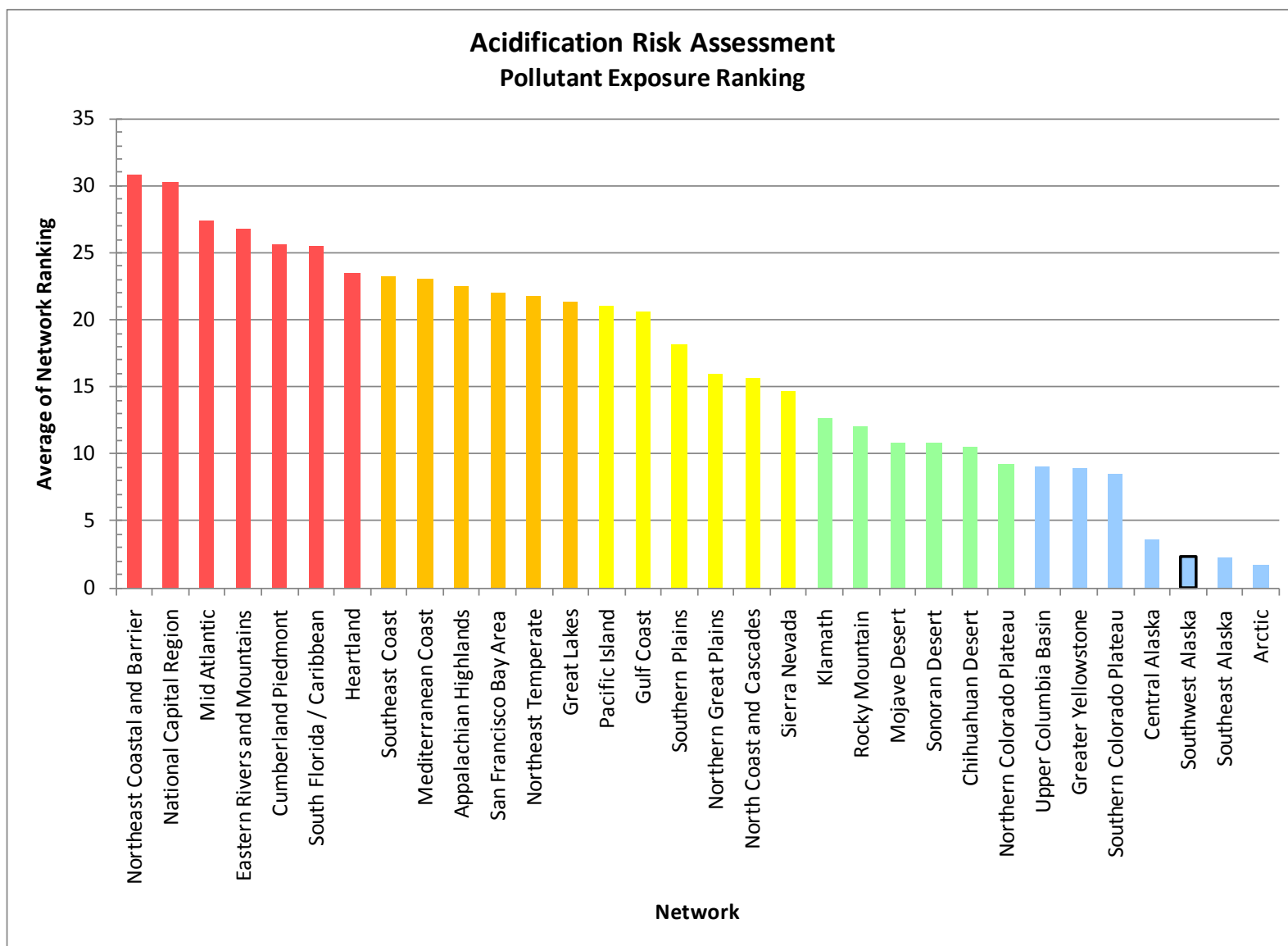


Figure A

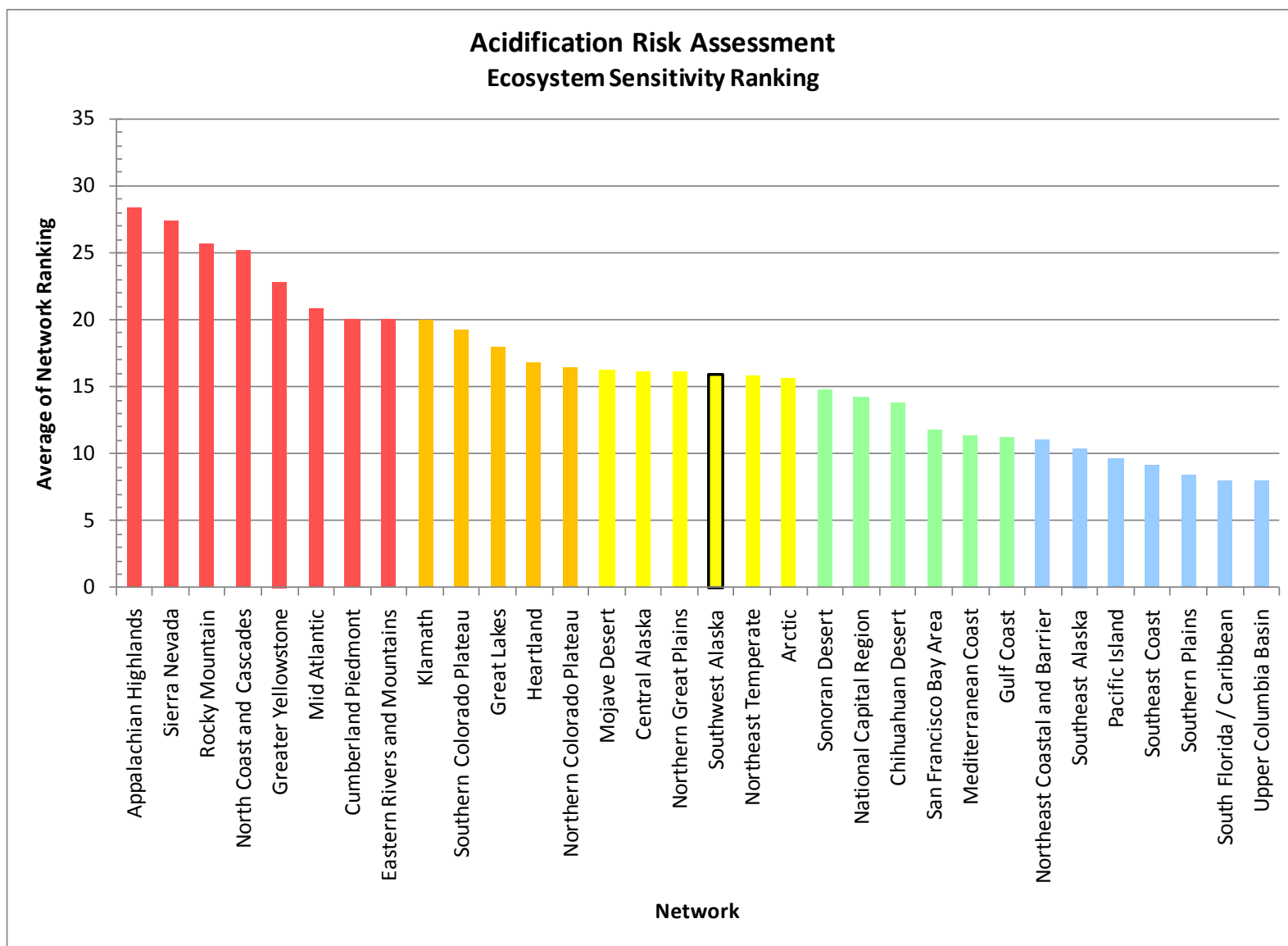


Figure B

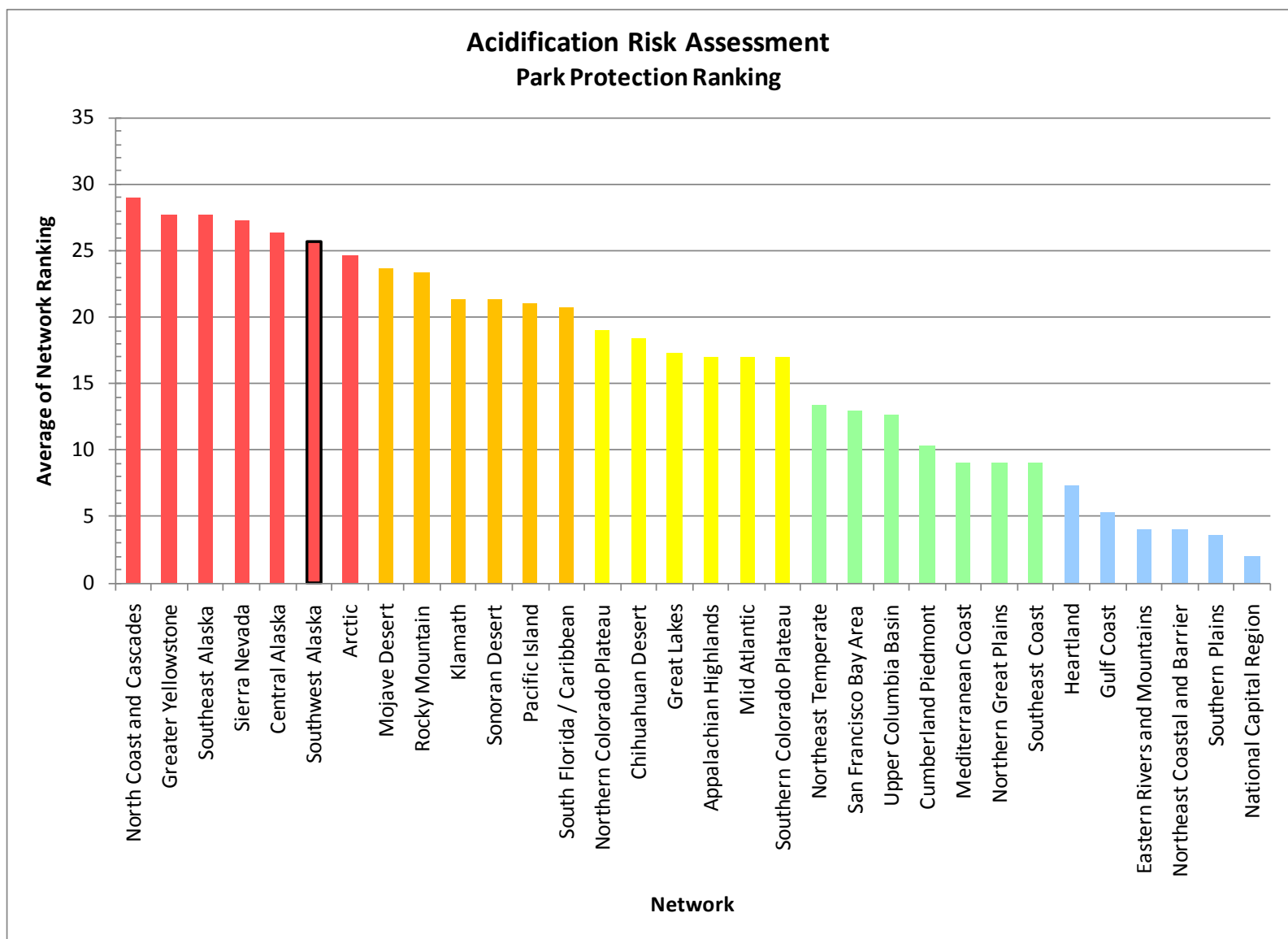


Figure C

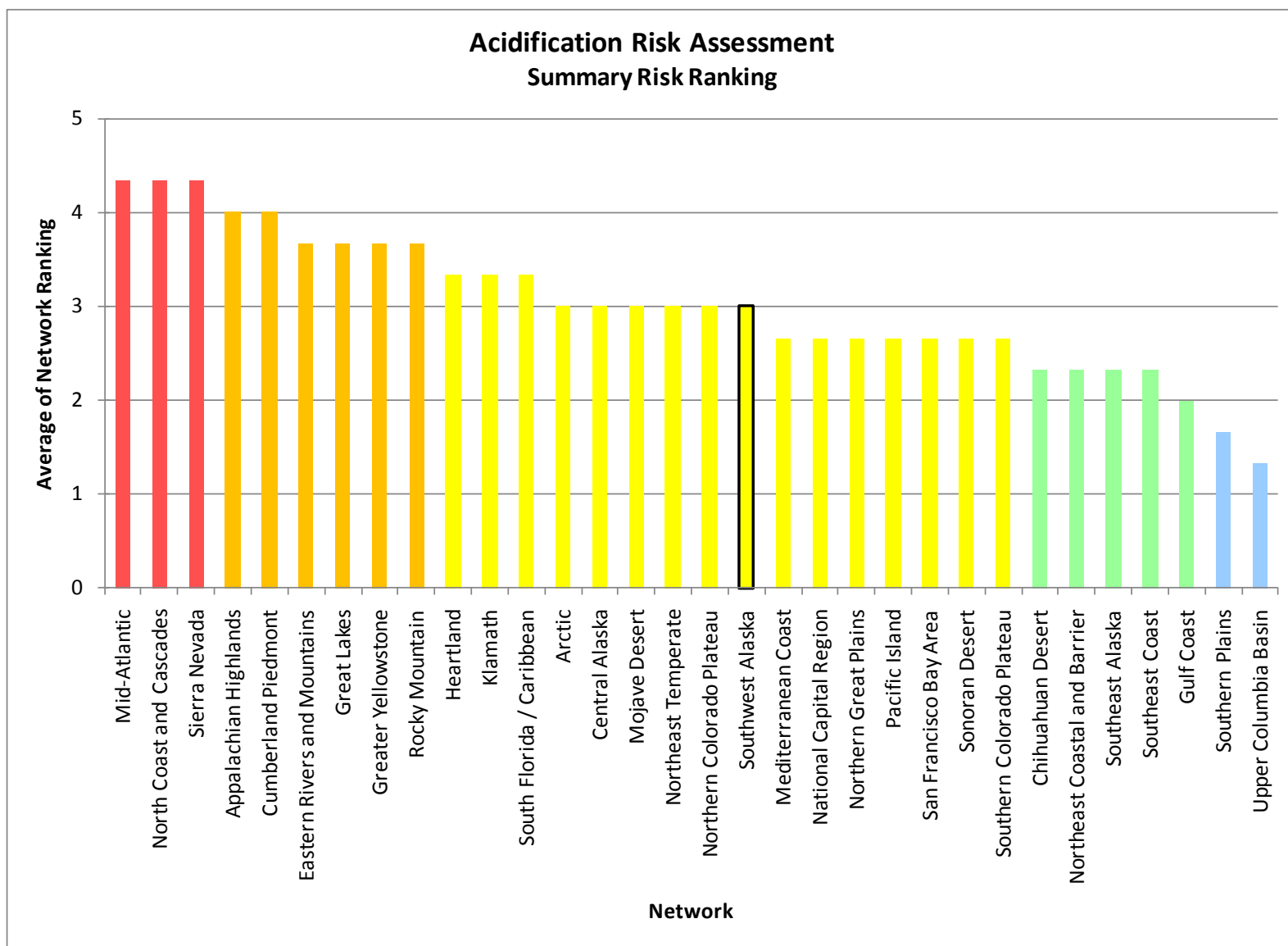


Figure D

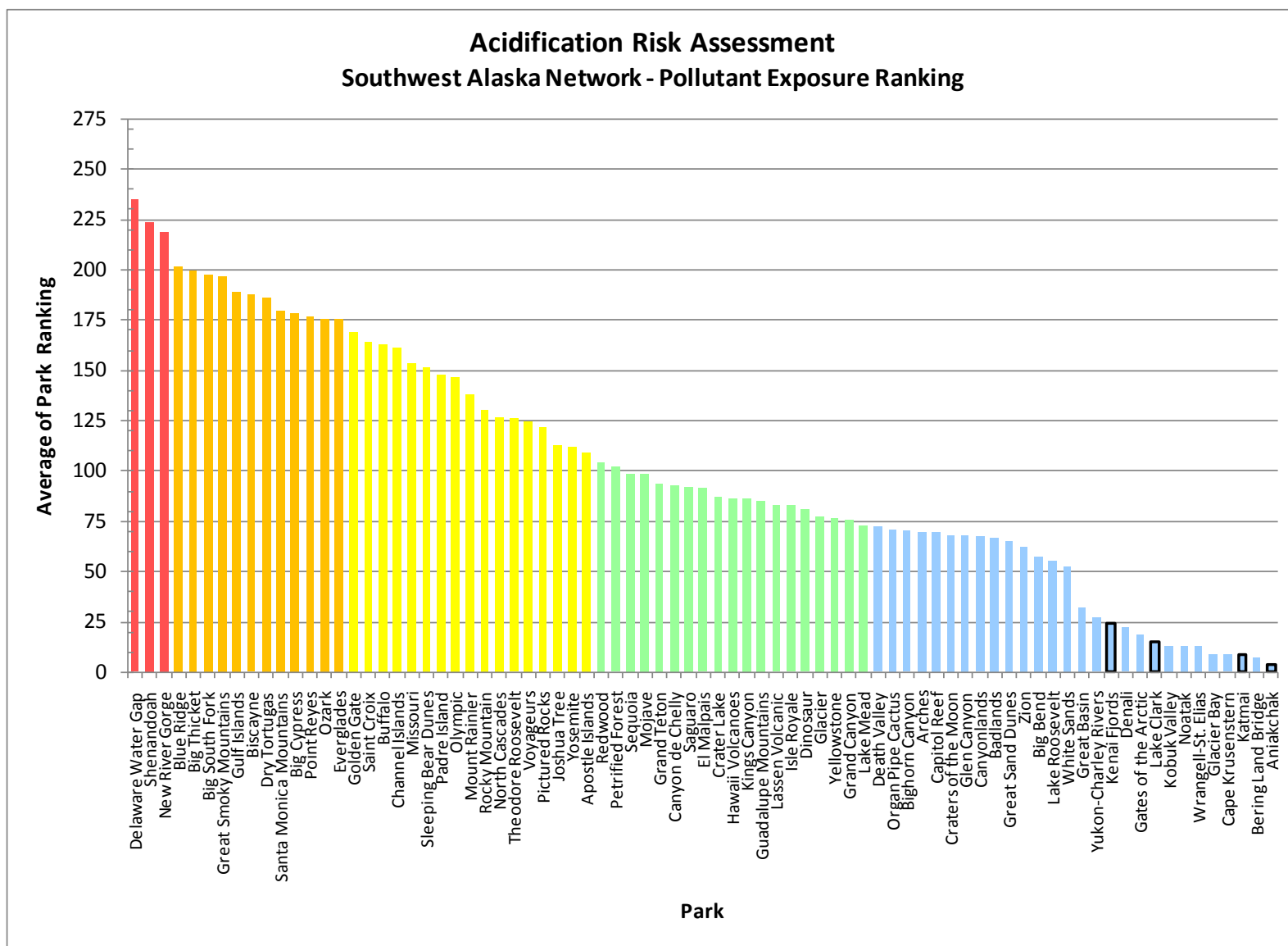


Figure E

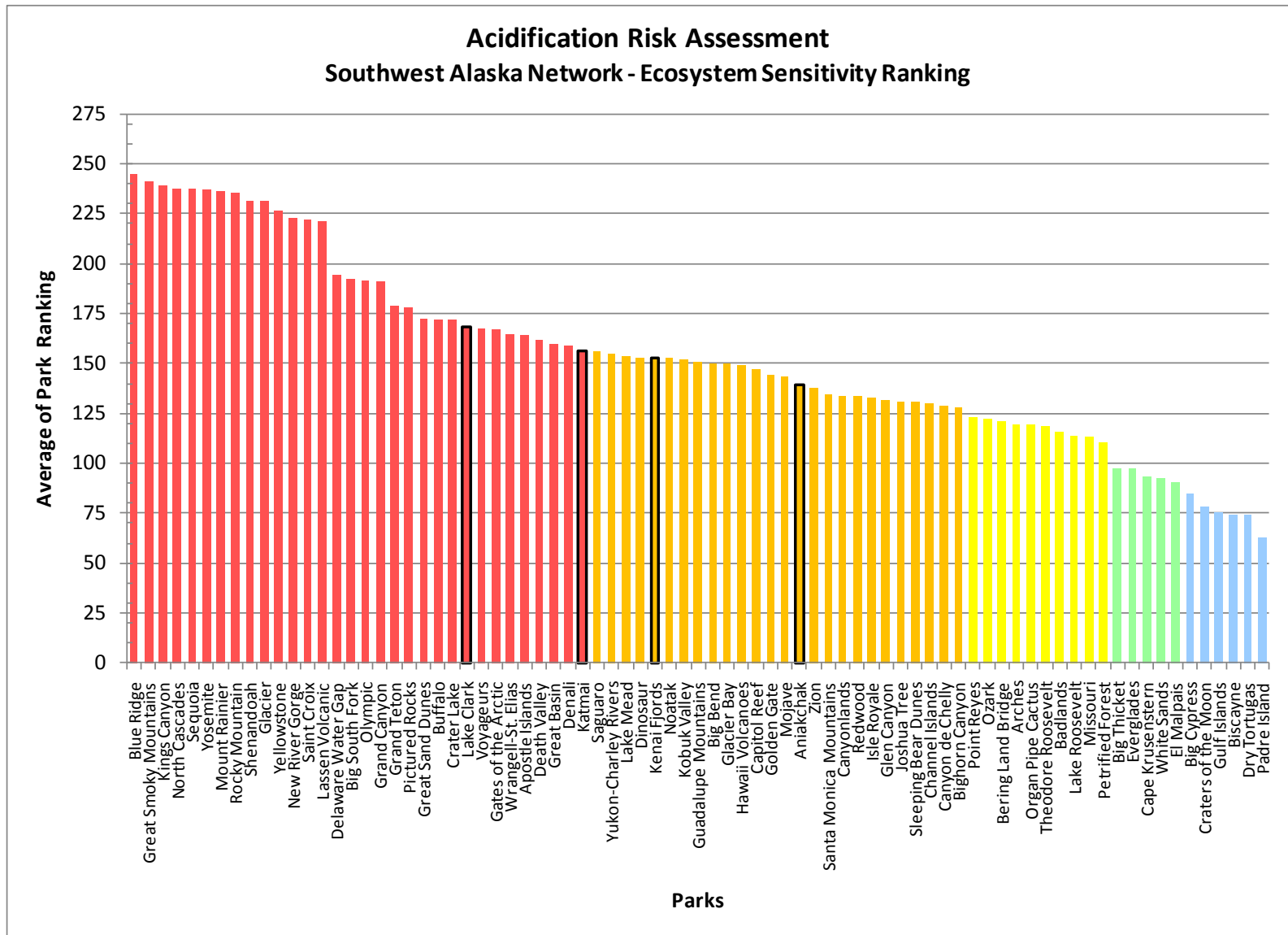


Figure F

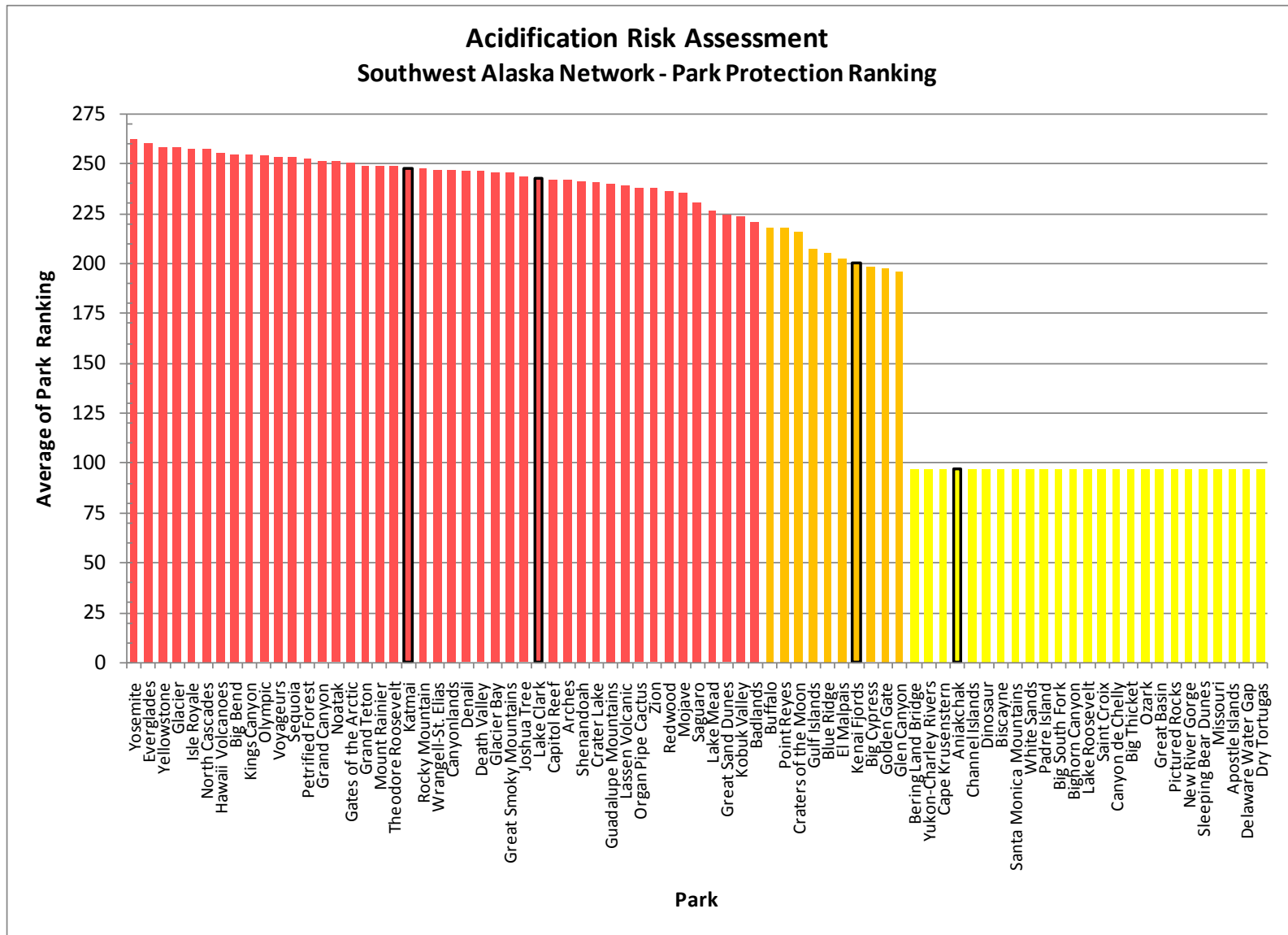


Figure G

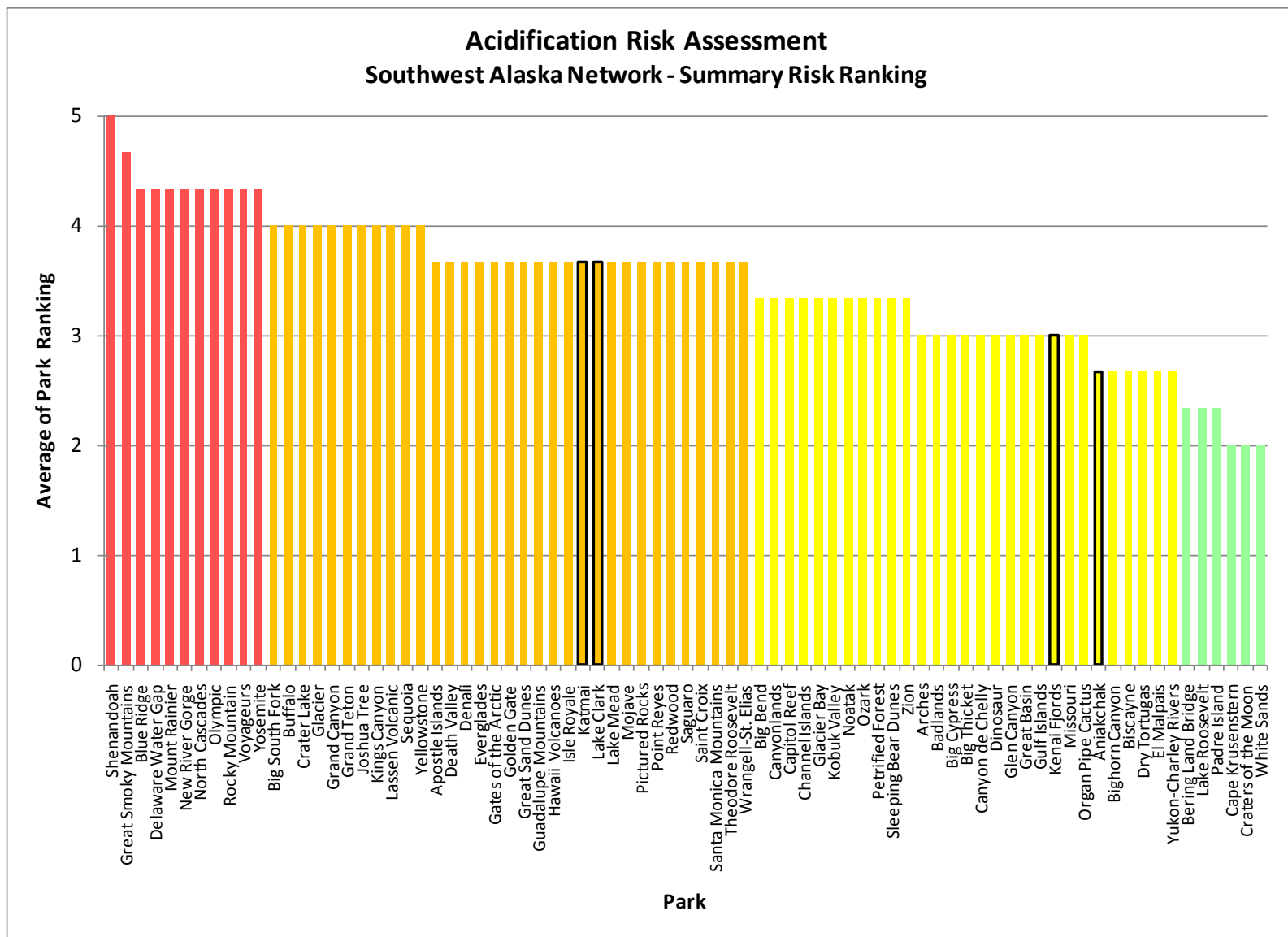


Figure H

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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