



Evaluation of the Sensitivity of Inventory and Monitoring National Parks to Nutrient Enrichment Effects from Atmospheric Nitrogen Deposition

Southwest Alaska Network (SWAN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/333



ON THE COVER

Some ecosystems, such as arid shrublands, subalpine meadows, remote high elevation lakes, and wetlands, are sensitive to the effects of nutrient enrichment from atmospheric nitrogen deposition.

Photograph by: National Park Service

Evaluation of the Sensitivity of Inventory and Monitoring National Parks to Nutrient Enrichment Effects from Atmospheric Nitrogen Deposition

Southwest Alaska Network (SWAN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/333

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

February 2011

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Denver, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

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/n-sensitivity.cfm>) and the Natural Resource Publications Management website (<http://www.nature.nps.gov/publications/nrpm/>).

Please cite this publication as:

Sullivan, T. J., T. C. McDonnell, G. T. McPherson, S. D. Mackey, and D. Moore. 2011. Evaluation of the sensitivity of inventory and monitoring national parks to nutrient enrichment effects from atmospheric nitrogen deposition: Southwest Alaska Network (SWAN). Natural Resource Report NPS/NRPC/ARD/NRR—2011/333. National Park Service, Denver, Colorado.

Southwest Alaska Network (SWAN)

National maps of atmospheric N emissions and deposition are provided in Maps A and B as context for subsequent network data presentations. Map A shows county level emissions of total N for the year 2002. Map B shows total N deposition, again for the year 2002. Regional deposition data are not available for Alaska, but N deposition would be expected to be very low throughout most, but not necessarily all, of Alaska. 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 Katmai National Park, 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 CASTNET dry deposition measurements at DENA 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. The dry N deposition measurements by CASTNET have also been low, below about 0.25 kg N/ha/yr for each site and year measured. Thus, the sparse available atmospheric N deposition data for Alaska are consistent with the general understanding that atmospheric deposition tends to be very low at national park lands within Alaska. It can be assumed that N deposition in each of the Alaskan networks would be lower than 1 to 2 kg/ha/yr, on average, across each of those networks.

There are five park units 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 other smaller park is Alagnak Wild River (ALAG).

Total annual N emissions, by county, are shown in Map C for lands in and surrounding the Southwest Alaska Network. County-level emissions within the network were uniformly less than 1 ton per square mile. Map D showing point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH_3) N is not presented because there are no point sources of N emissions in this network. Urban centers within a 300-mile buffer around the network are shown in Map E. There are no human population centers within the network and only one in proximity to the network.

Map F of total N deposition in and around the network is not shown because there are no regional deposition data available. Given the absence of point sources and population centers, N deposition is expected to be low, below 1 to 2 kg N/ha/yr.

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

Map H shows the distribution within the parks that occur in this network of the five vegetation types thought to be most responsive to nutrient N enrichment effects (arctic herbaceous, alpine, grassland and meadow, wetland, and arid and semi-arid). There are several large parks in the eastern portion of this network. In general, the predominant sensitive vegetation types within these parks are arctic herbaceous, alpine, and wetland.

Park lands requiring special protection against potential adverse impacts associated with nutrient N enrichment from atmospheric N deposition are shown in Map I. Also shown on Map I are all federal lands designated as wilderness, both lands managed by NPS and also lands managed by

other federal agencies. The land designations used to identify this heightened protection included Class I designation under the CAAA 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) park units in this network (all except ANIA) are largely 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 ranks in the lowest quintile, among networks, in N pollutant Exposure (Figure A). Nitrogen emissions and expected N deposition within the network are both very low. The network Ecosystem Sensitivity ranking is also relatively low, at the bottom of the second lowest quintile among networks (Figure B). This is because there is limited vegetation coverage in the I&M parks that occur in this network that include vegetation types expected to be especially sensitive to nutrient enrichment effects from N deposition, and there are no high elevation lakes. This network ranks 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 yield an overall Network Risk ranking that is at the bottom of the second lowest quintile among all networks (Figure D). The overall level of concern for nutrient N enrichment effects on I&M parks within this network is considered 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 B. As for the network ranking figures, the park ranking figures 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 show Pollutant Exposure ranking in the lowest quintile among parks (Figure E, Table A). All of the parks have Ecosystem Sensitivity ranking in the middle (ALAG, ANIA, and KATM) or second lowest quintile (Figure F, Table A). Two (KATM, LACL) have Park Protection ranking in the highest quintile (Figure G). The three other parks have Park Protection ranking that is in the second highest (ALAG and KEFJ) or middle (ANIA) quintile among parks (Table A).

The Summary Park Risk ranking is Moderate (middle quintile) for one of these parks (KATM) and in the lowest or second lowest quintile for the remaining four parks (Figure G, Table A).

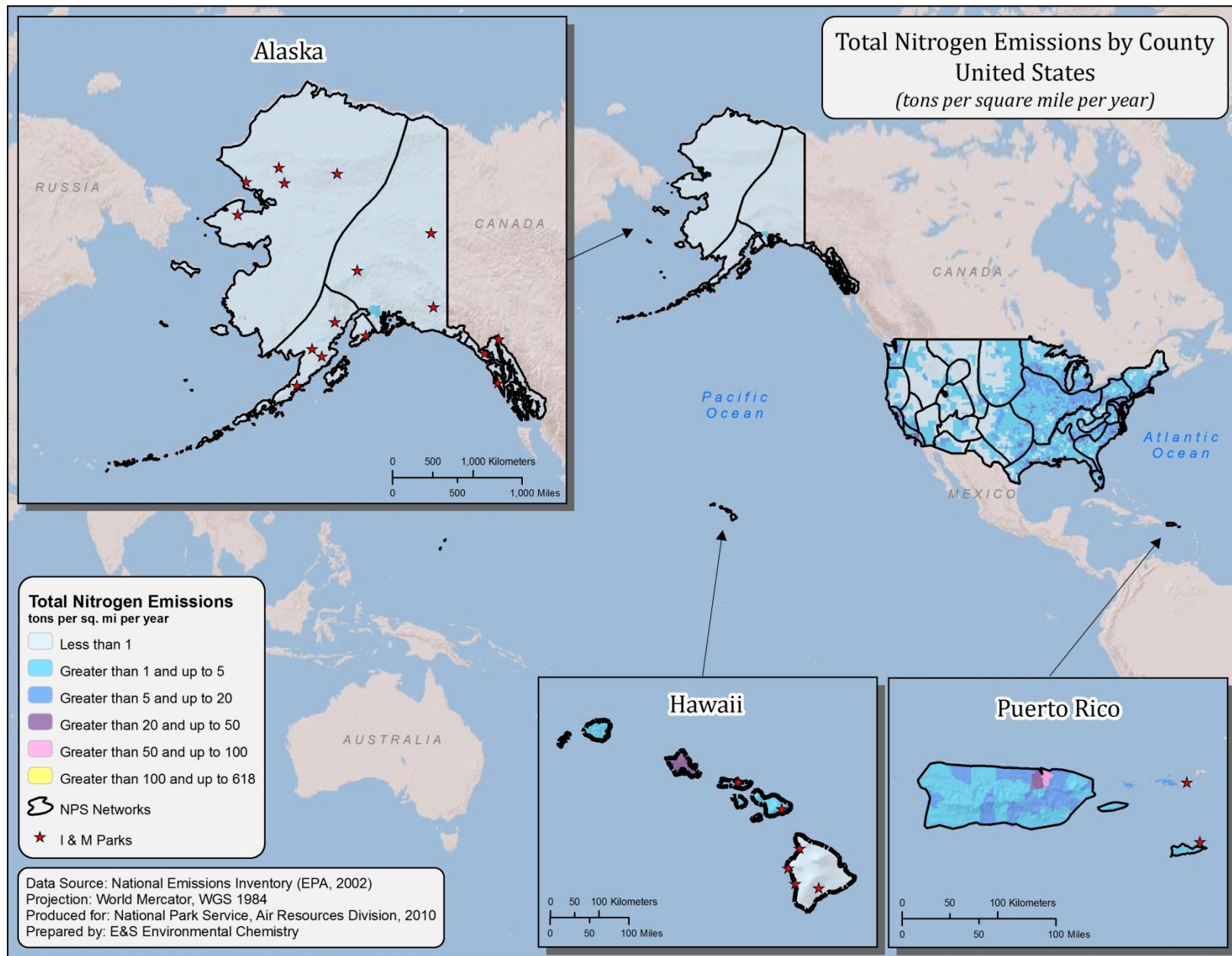
Table A. Relative rankings of individual I&M parks within the network for Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and Summary Risk from atmospheric nutrient N enrichment.

I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
	Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Alagnak	Very Low	Moderate	High	Low
Aniakchak	Very Low	Moderate	Moderate	Very Low
Katmai	Very Low	Moderate	Very High	Moderate
Kenai Fjords	Very Low	Low	High	Very Low
Lake Clark	Very Low	Low	Very High	Low

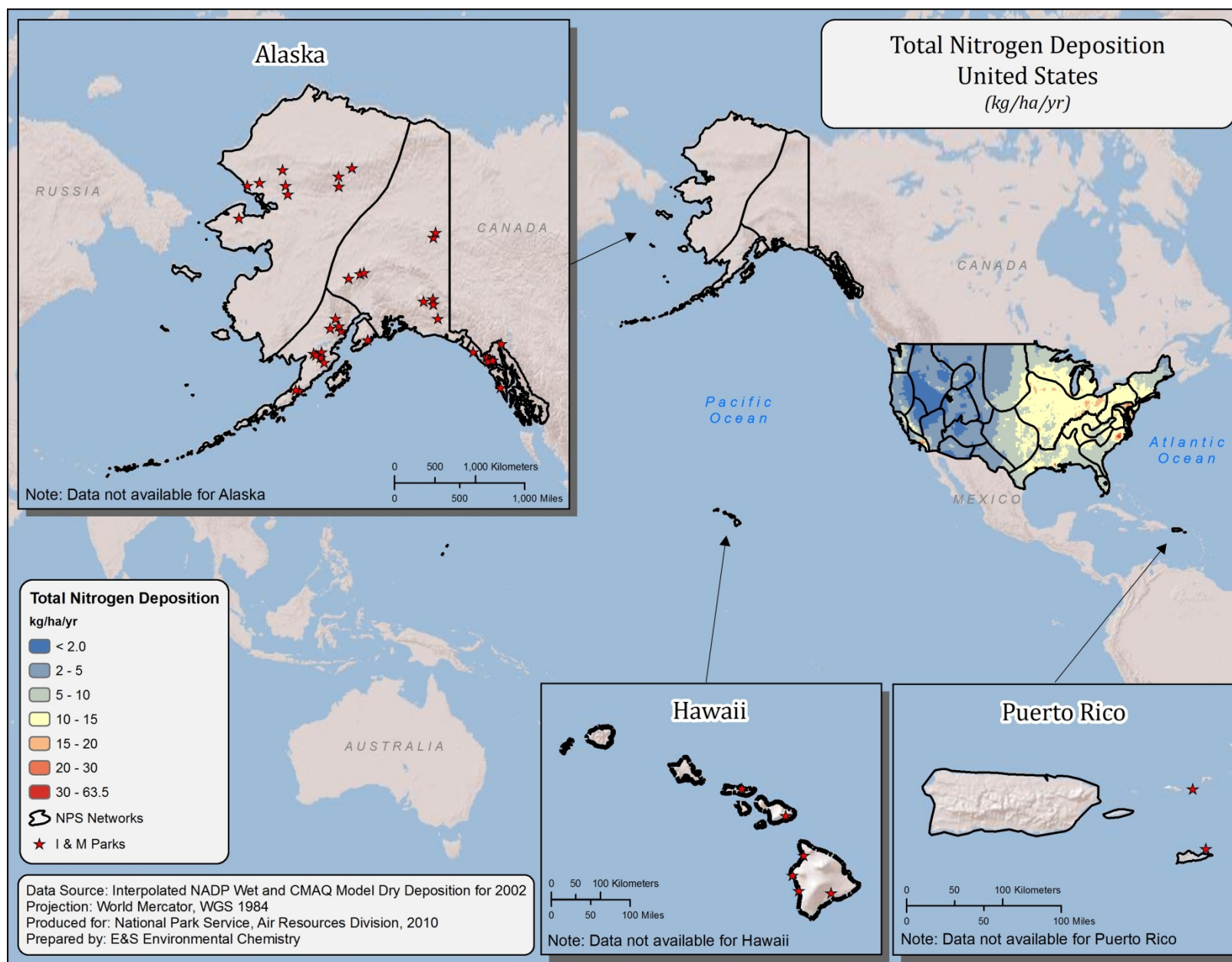
¹ Relative park rankings are designated according to quintile ranking, among all I&M Parks, from the lowest quintile (very low risk) to the highest quintile (very high risk).
² Park name is printed in bold italic for parks larger than 100 square miles.

- Map A. National map of total 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 B. Regional deposition data are not available for Alaska. Total N deposition throughout most areas in Alaska is expected to be low, below about 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 C. 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 E. 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)

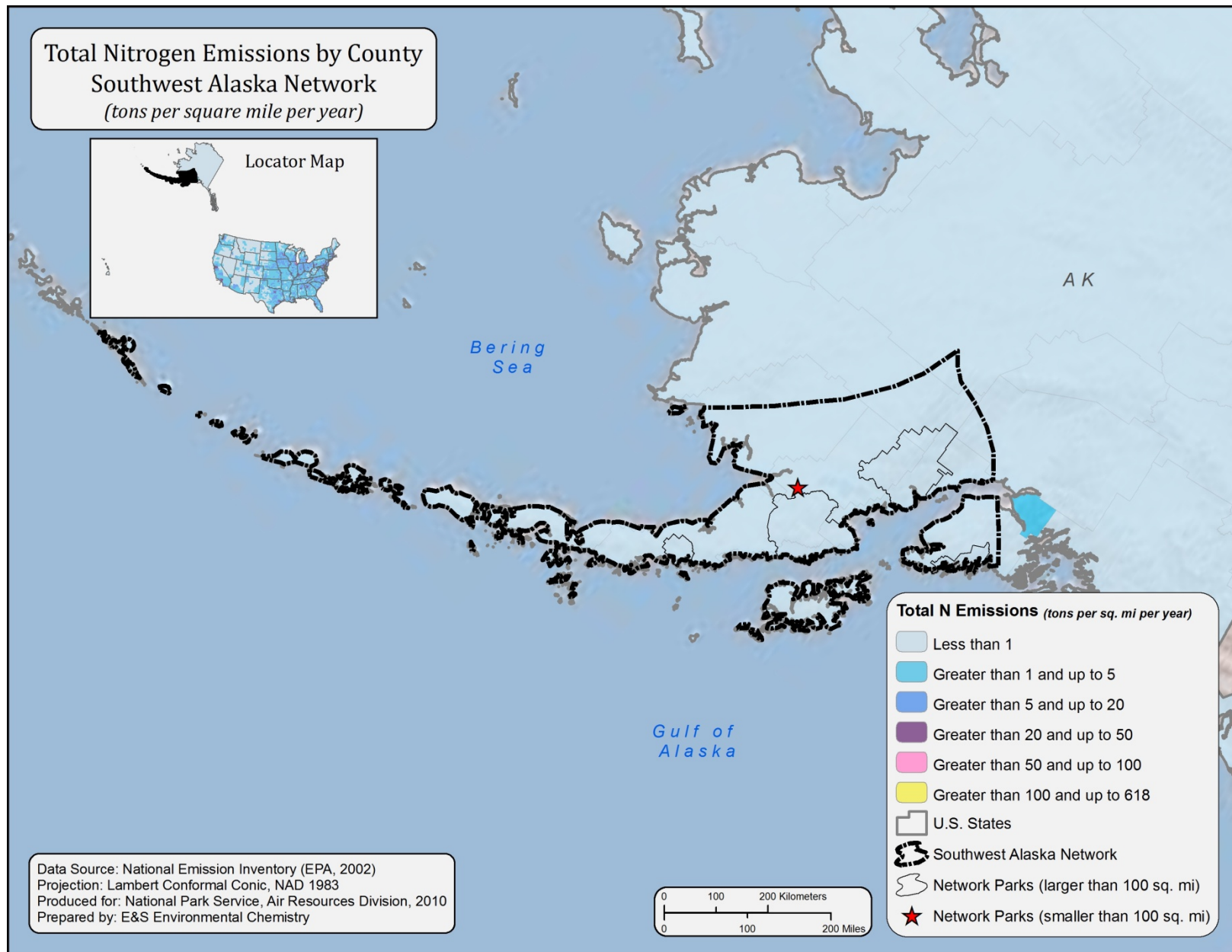
- Map G. Land cover types in and around the network, based on the National Land Cover dataset. (Source of data: National Land Cover Dataset, http://www.mrlc.gov/nlcd_multizone_map.php)
- Map H. Distribution within the larger (larger than 100 square miles) parks that occur in this network of the five terrestrial vegetation types thought to be most sensitive to N-nutrient enrichment effects: arctic, alpine, grassland and meadow, wetland, and arid and semi-arid. (Source of data: See Appendix A)
- Map I. 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 ranking, calculated as the sum of the averages of the scores for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection.
- 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 scores for all Summary Risk variables.



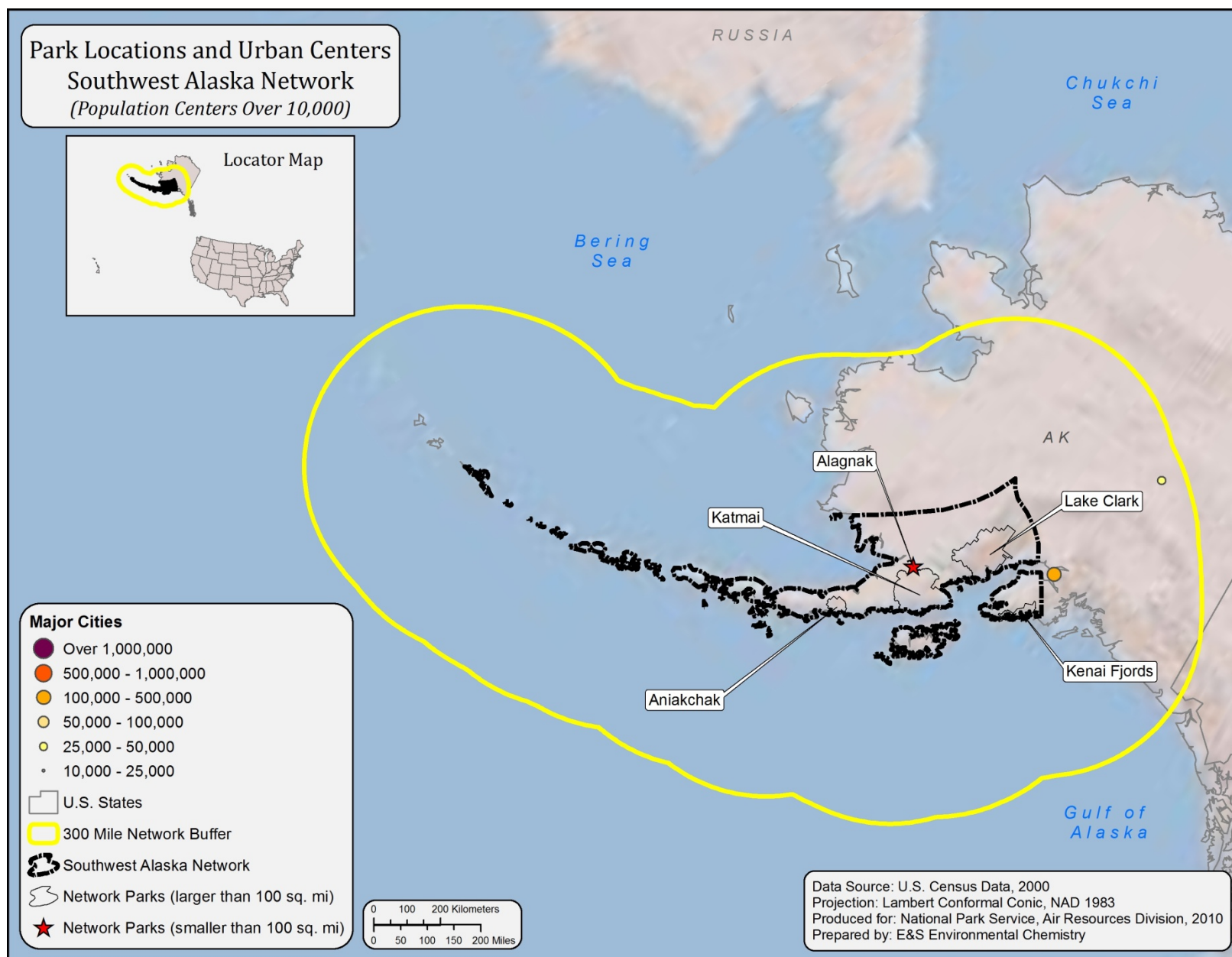
Map A



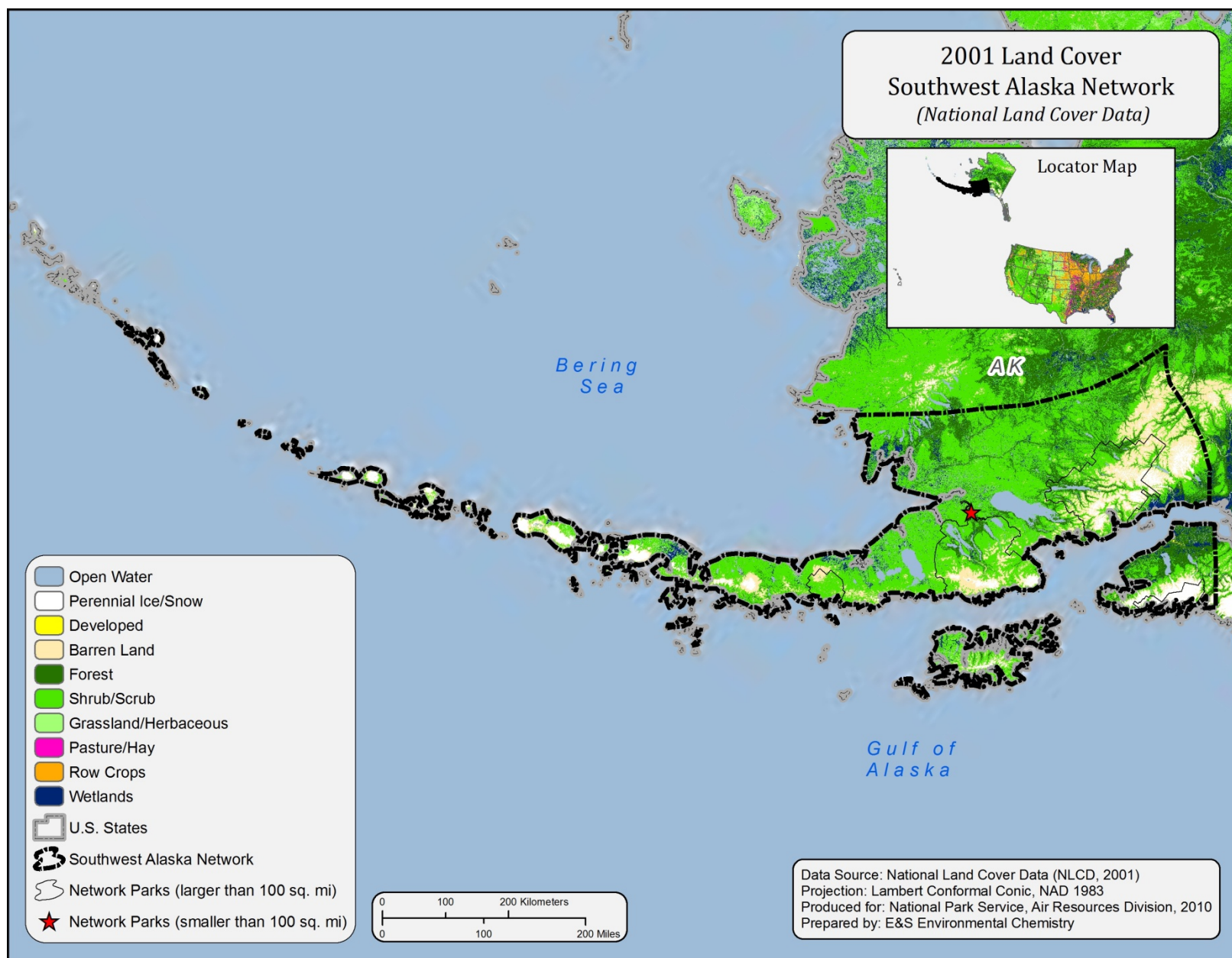
Map B



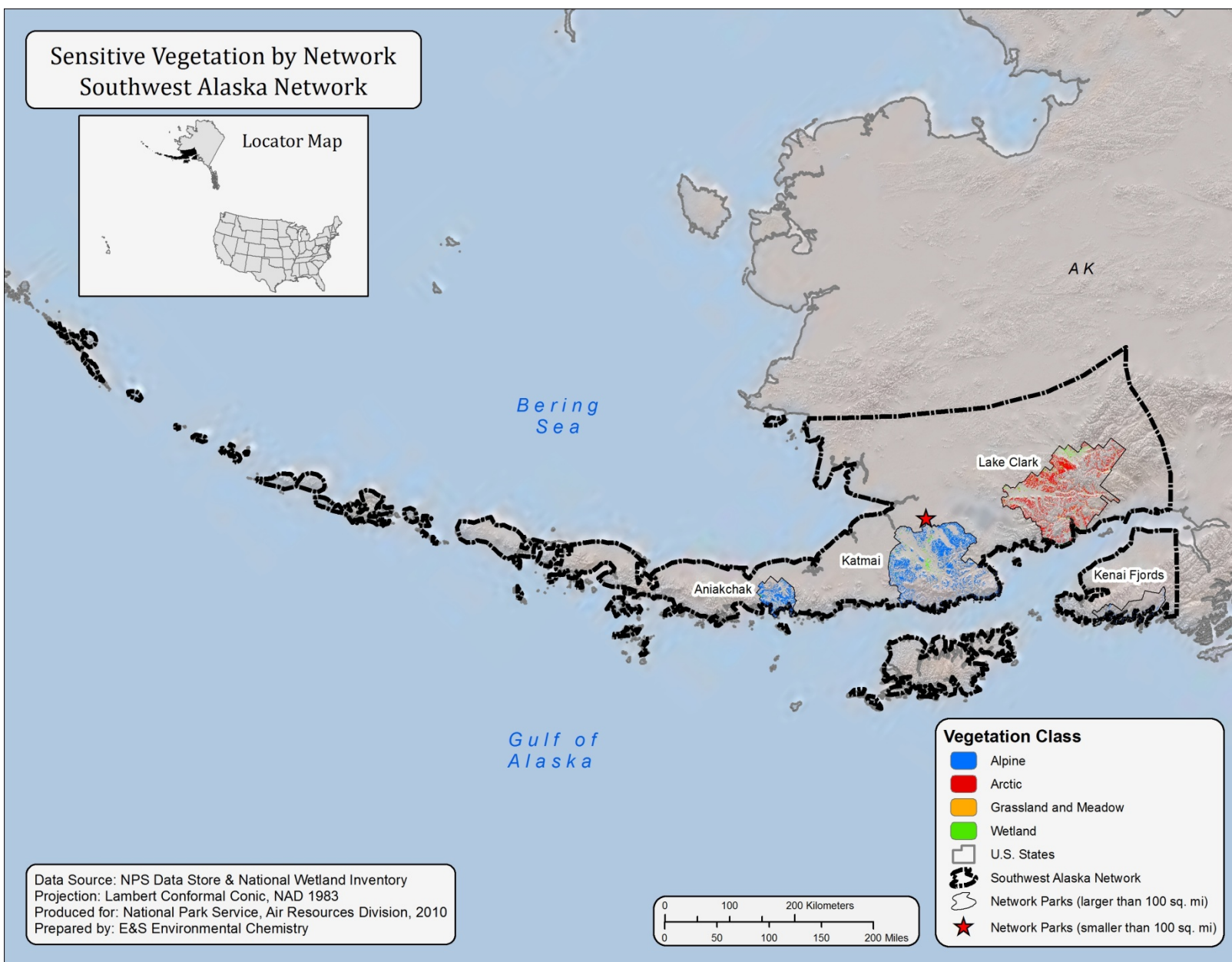
Map C



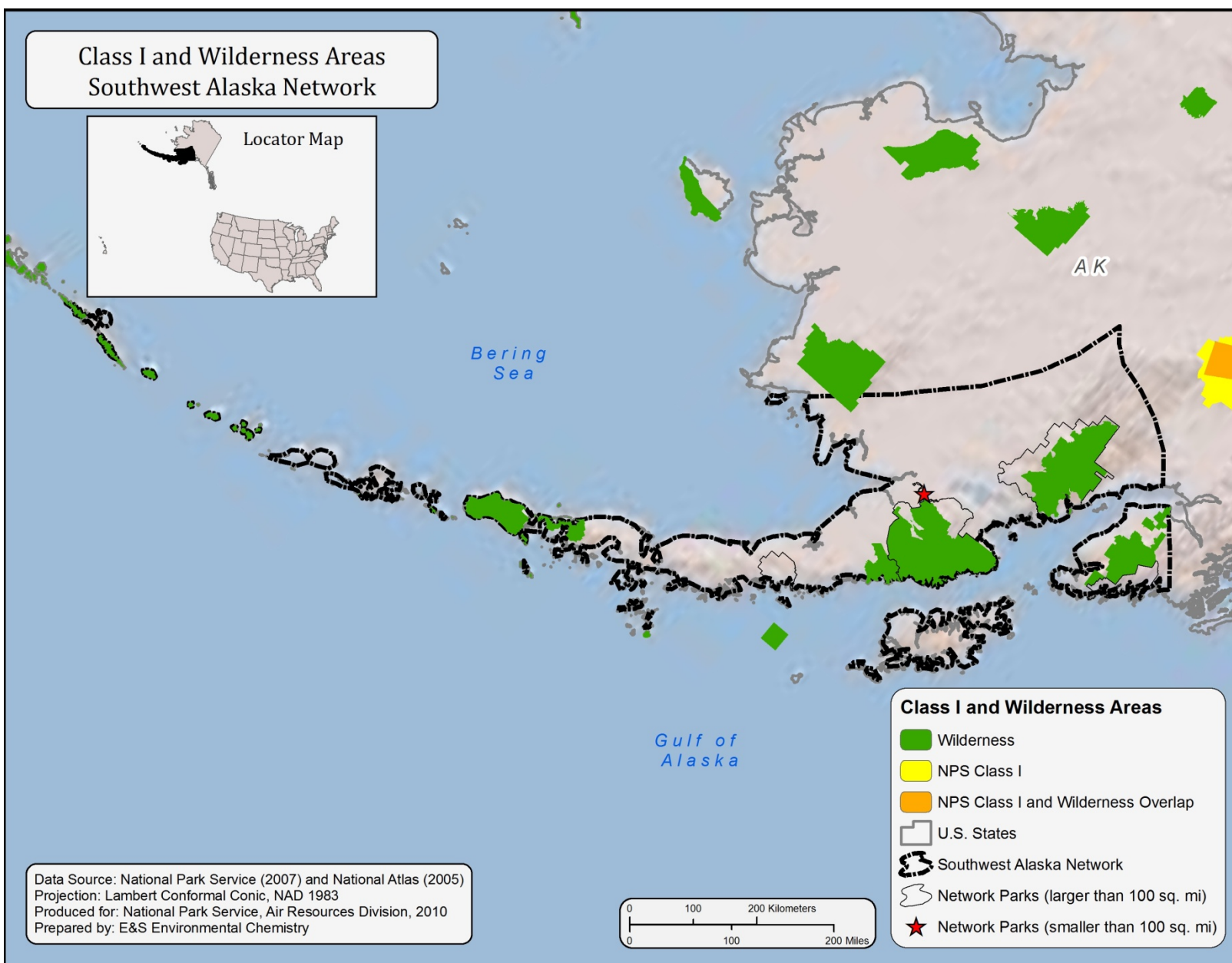
Map E



Map G



Map H



Map I

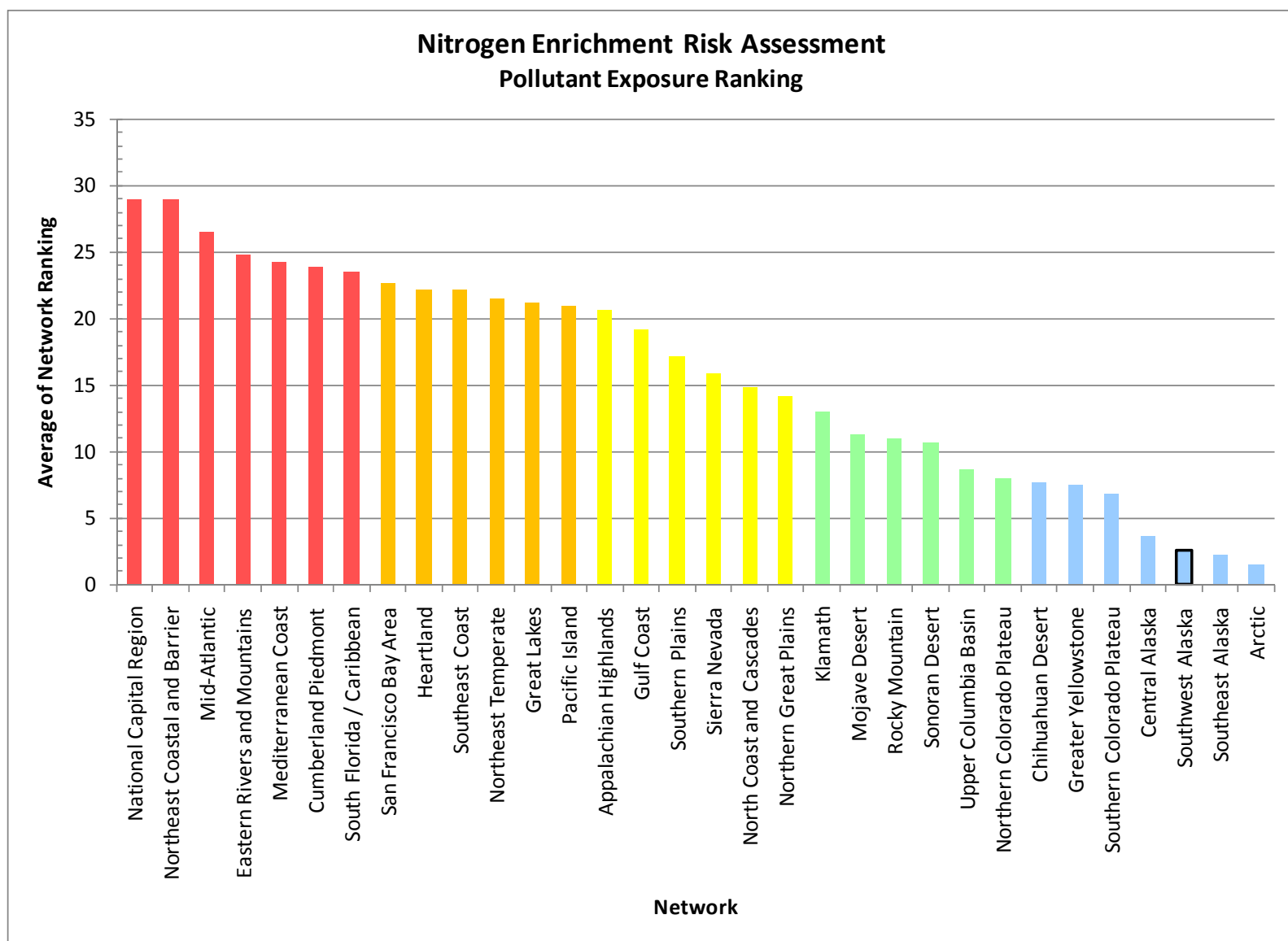


Figure A

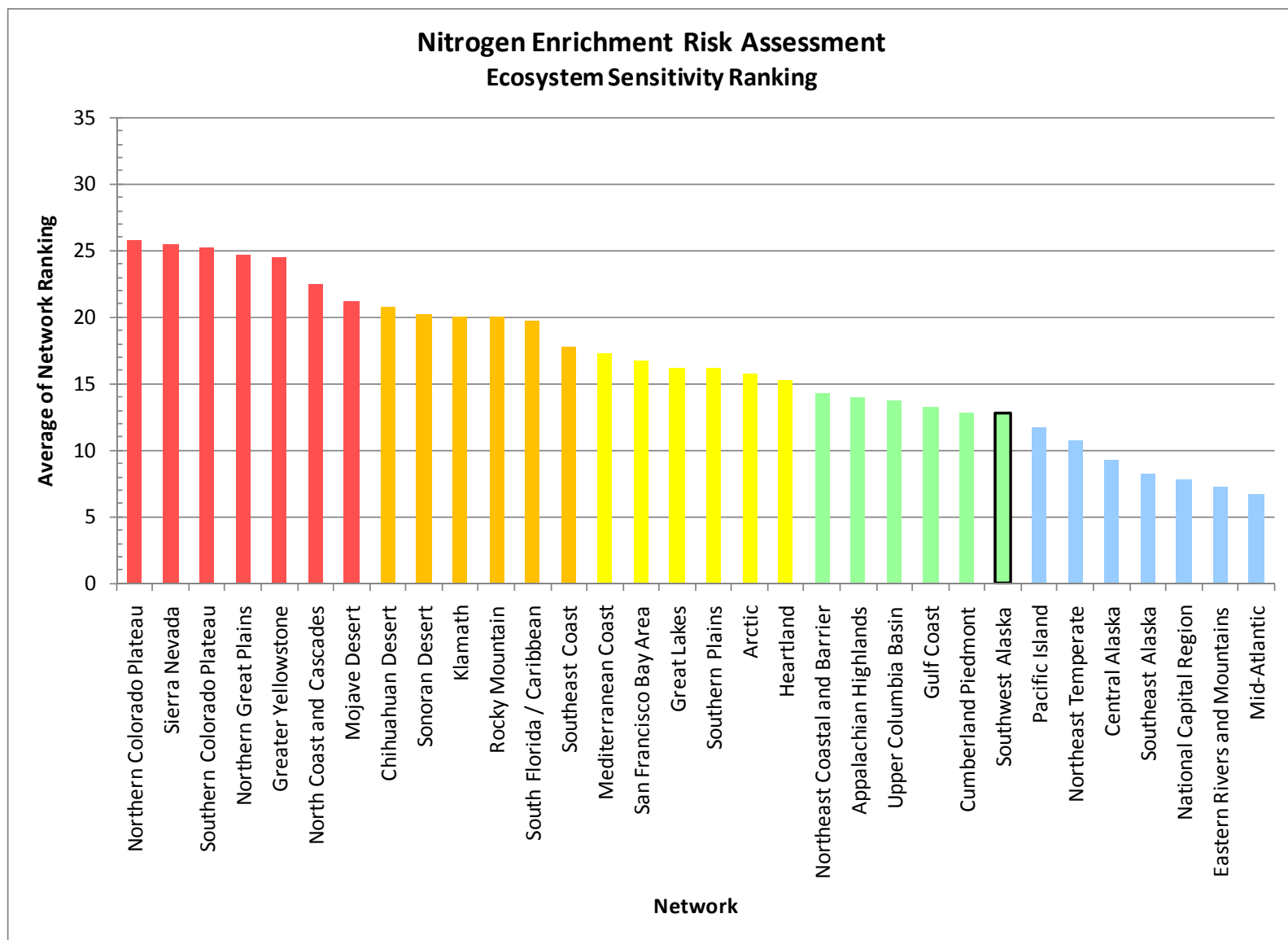


Figure B

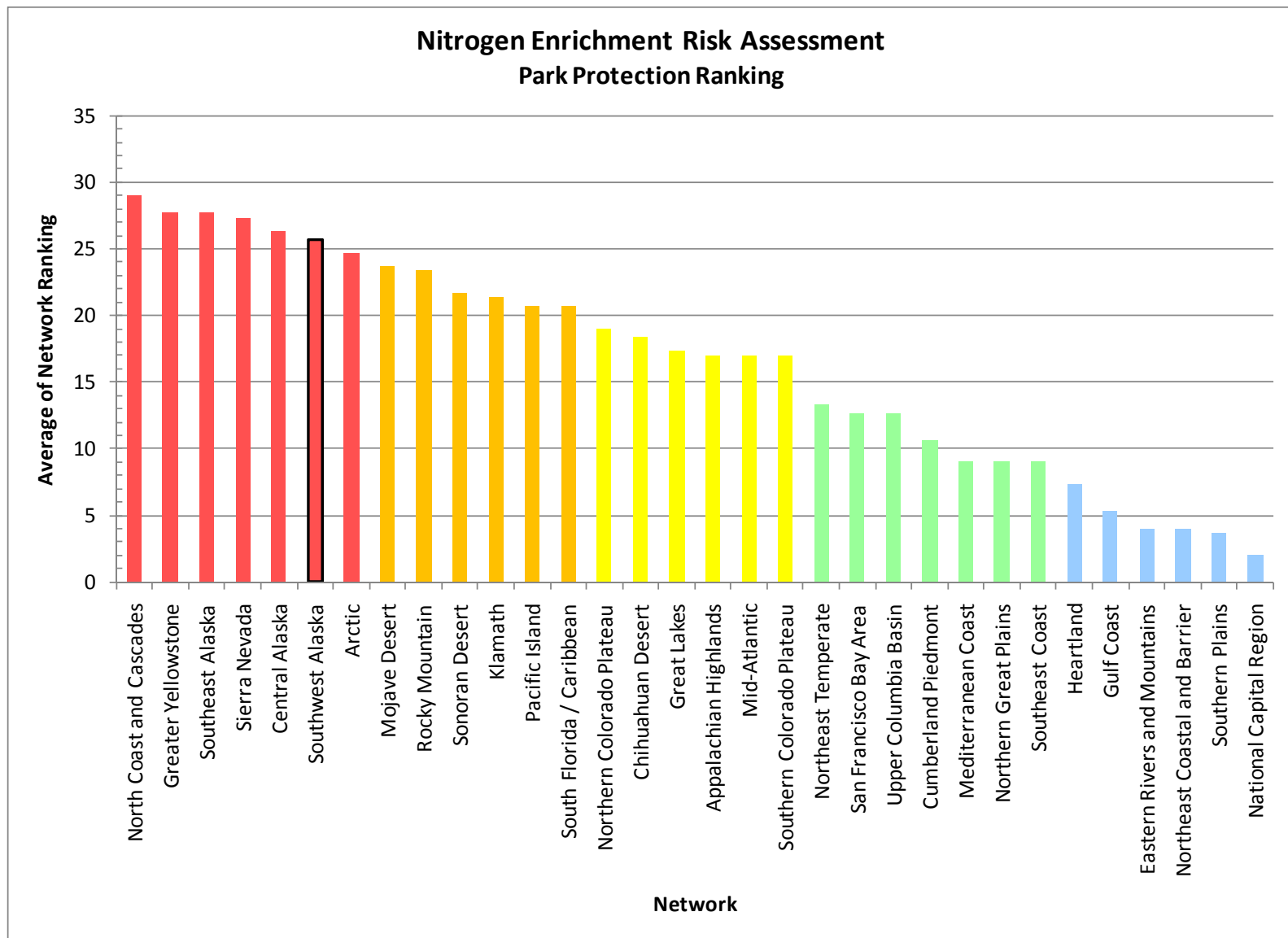


Figure C

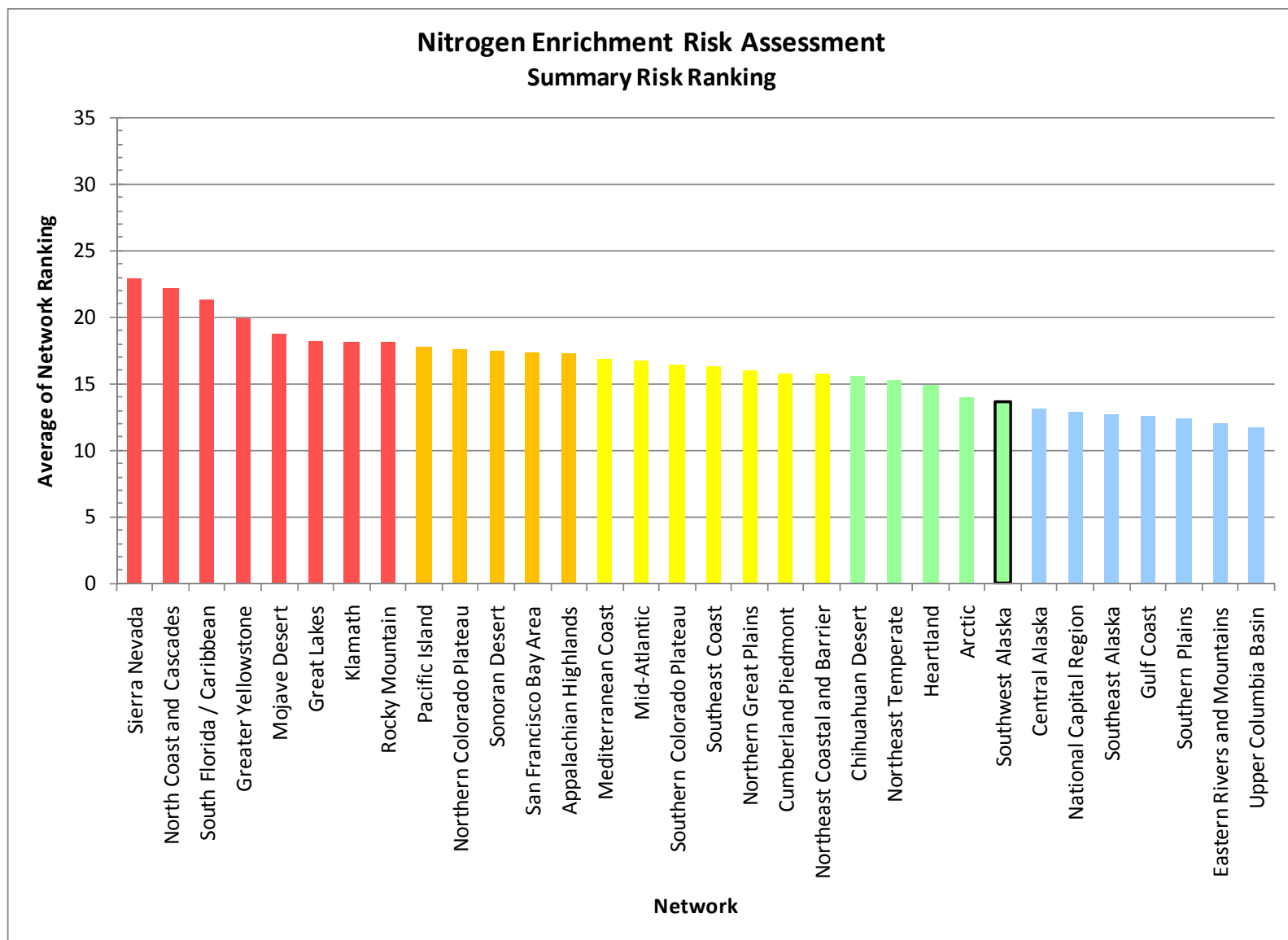


Figure D

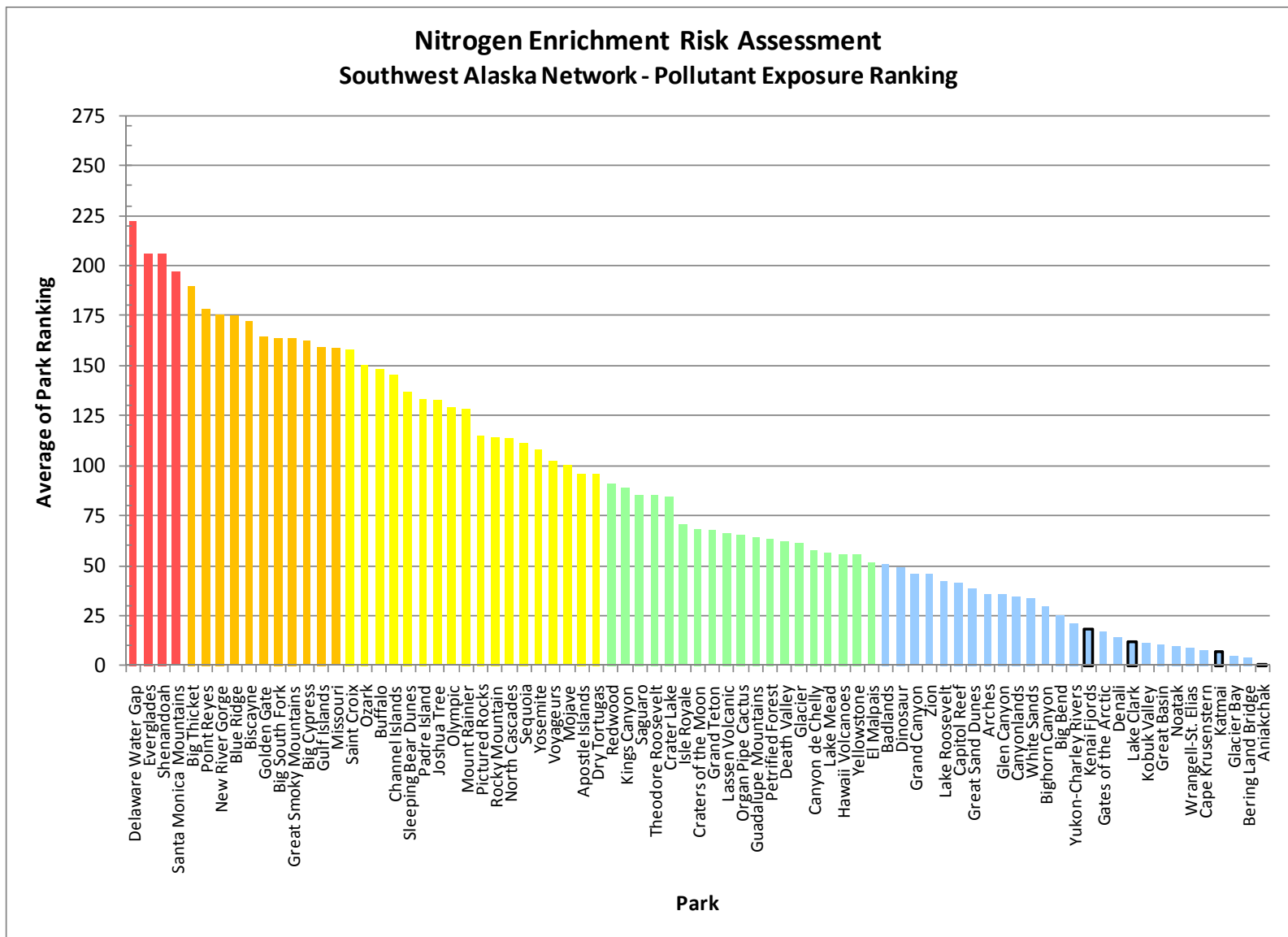


Figure E

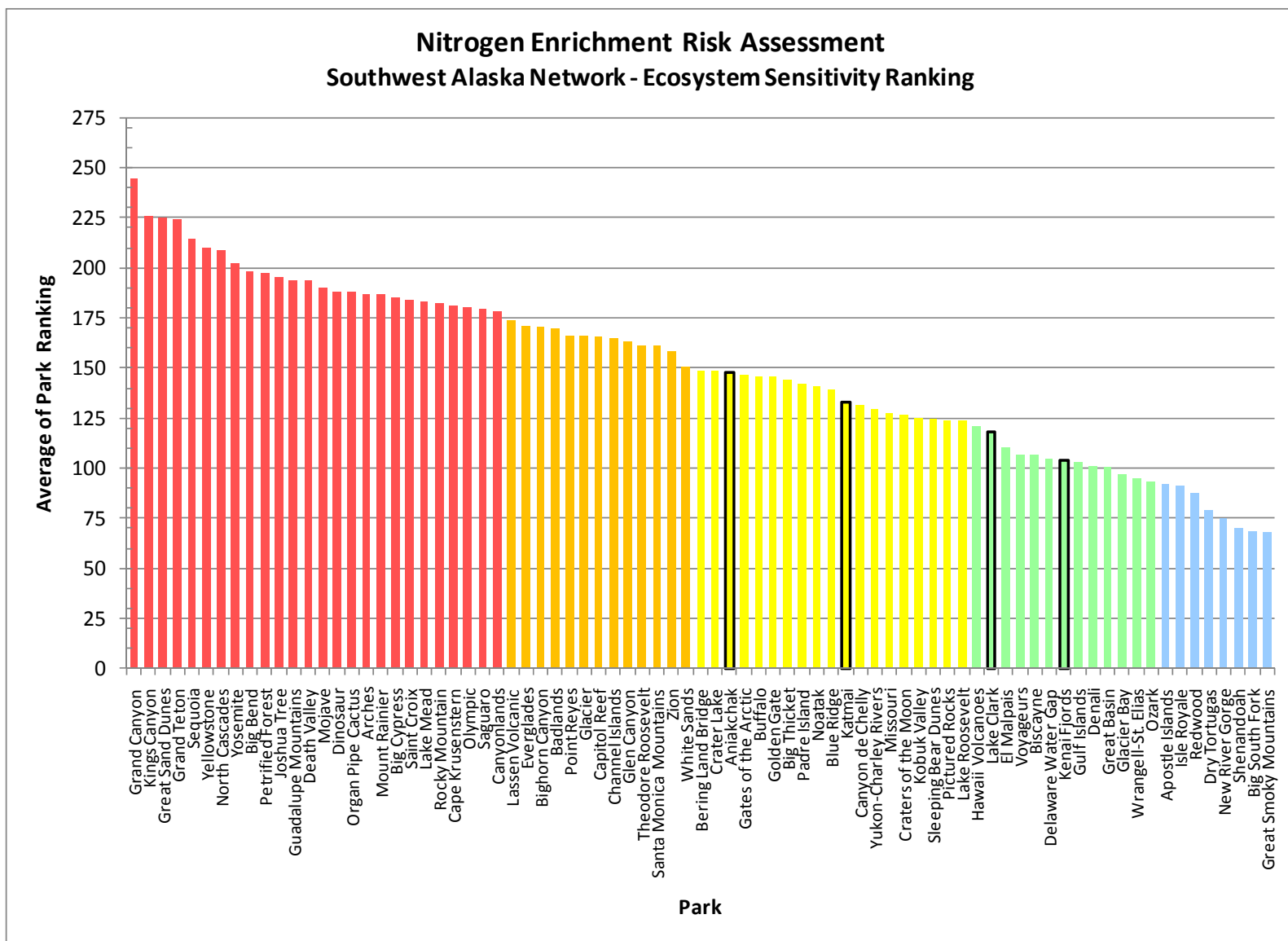


Figure F

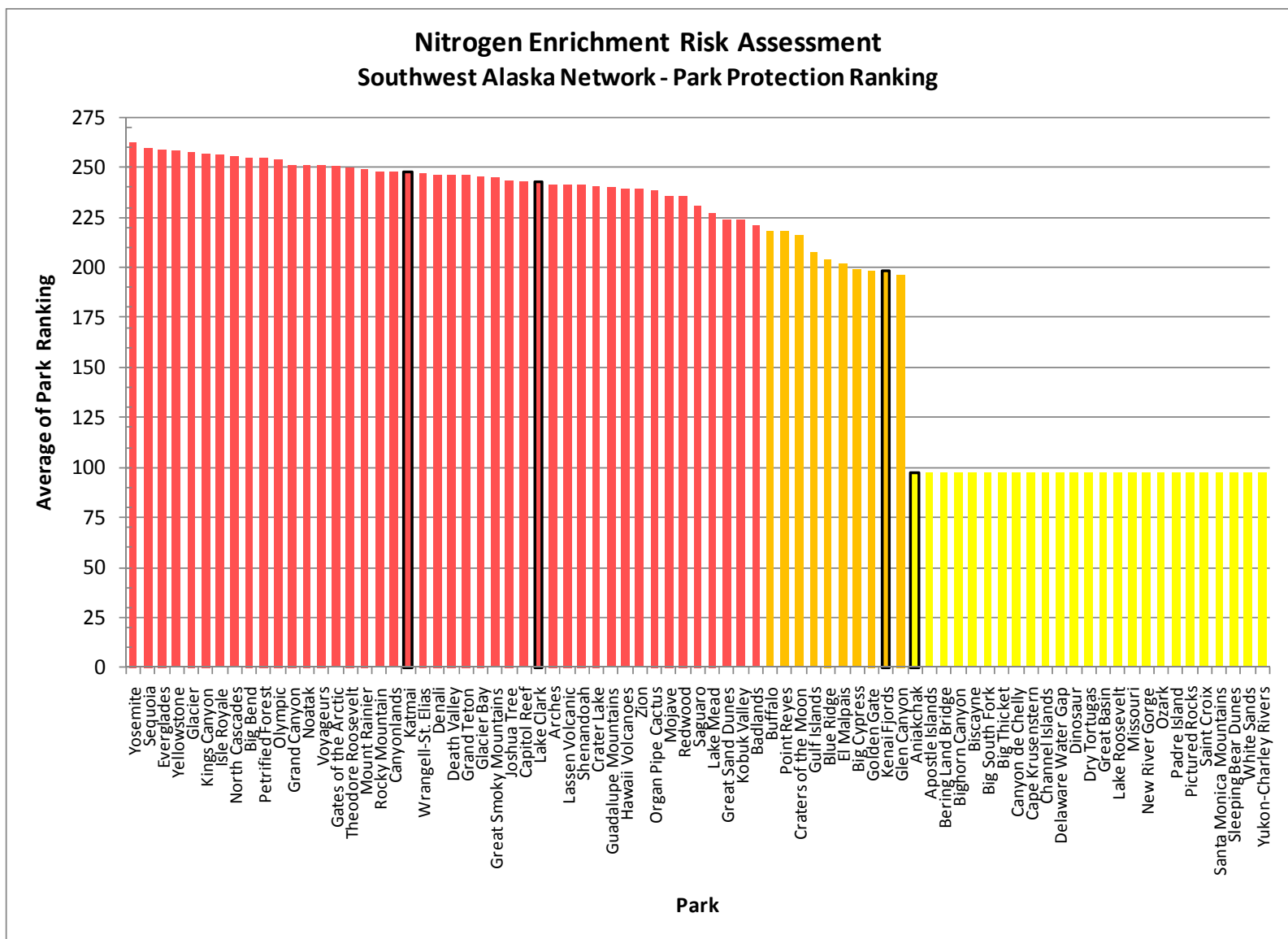


Figure G

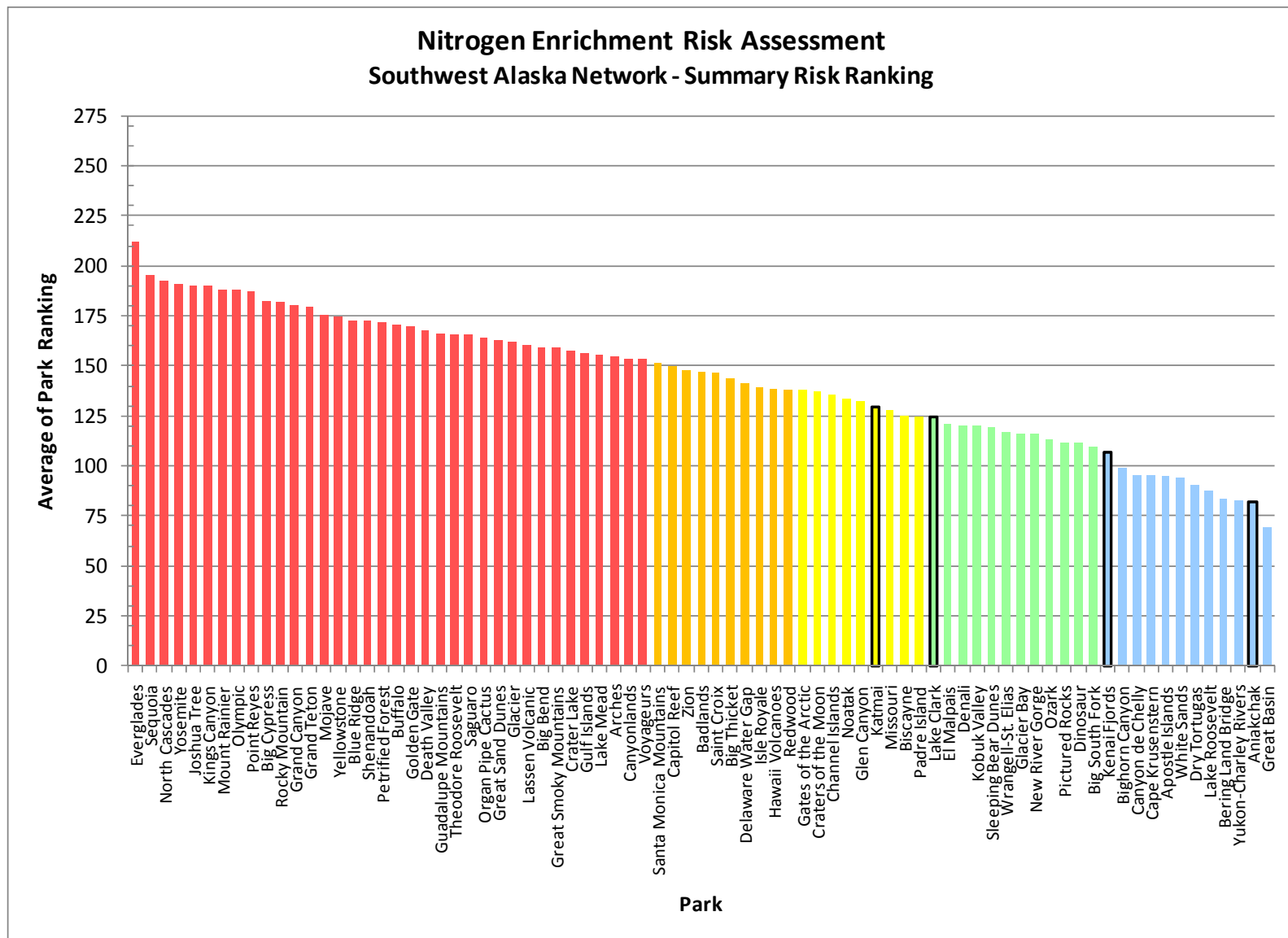


Figure H

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.

NPS 953/106715, February 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