



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

Northern Colorado Plateau Network (NCPN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/321



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

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Northern Colorado Plateau Network (NCPN)

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.

There are five parks in the Northern Colorado Plateau Network that are larger than 100 square miles: Arches (ARCH), Canyonlands (CANY), Capitol Reef (CARE), Dinosaur (DINO), and Zion (ZION). There are also 11 other smaller parks.

Total annual N emissions, by county, are shown in Map C for lands in and surrounding the Northern Colorado Plateau Network. County-level emissions within the network ranged from less than 1 ton per square mile to between 5 and 20 tons per square mile. In general, annual county N emissions were less than 5 tons per square mile. Point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH₃) N are shown in Map D. There are several relatively large (larger than about 4,000 tons per year) point sources of oxidized N in and around this network. Urban centers within the network and within a 300 mile buffer around the network are shown in Map E. All human population centers of any magnitude (larger than 25,000 people) are found near the Great Salt Lake.

Total N deposition in and around the network is shown in Map F. Included in this analysis are both wet and dry forms of N deposition and both the oxidized and reduced N species. Total N deposition within the network ranged from less than 2 kg N/ha/yr to as high as 5 to 10 kg N/ha/yr. Throughout most of the network, the estimated total N deposition was less than 5 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, forest, and grassland/herbaceous. There are also pasture/hay, developed areas, and row crops at scattered locations.

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, alpine, grassland and meadow, wetland, and arid and semi-arid). In general, the predominant sensitive vegetation type within these parks is arid and semi-arid vegetation.

Park lands requiring special protection against potential adverse impacts associated with nutrient N enrichment from atmospheric N deposition are shown on 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 include Class I designation under the CAAA and wilderness designation. There are numerous Class I and wilderness areas in this network, both in I&M parks and 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 Northern Colorado Plateau Network ranks in the second lowest quintile, among networks, in N Pollutant Exposure (Figure A). Nitrogen emissions and N deposition within the network are both low. However, the network Ecosystem Sensitivity ranking is Very High, the highest of all networks (Figure B). This is mainly because there are some vegetation types in the parks in this network that are among those expected to be especially sensitive to nutrient enrichment effects from N deposition. This network ranks at the top of the third quintile in Park Protection, having moderately high 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 in the second highest 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 High.

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.

The five I&M parks in the Northern Colorado Plateau Network that are larger than 100 square miles are all in the lowest quintile in Pollutant Exposure (Figure E). Among the smaller parks, Timpanogos Cave (TICA) is ranked in the middle quintile and three parks (Fossil Butte, FOBU; Golden Spike, GOSP; and Hovenweep, HOVE) are ranked in the second lowest quintile for Pollutant Exposure. Other small parks are ranked in the lowest quintile. Ecosystem Sensitivity is ranked in the highest (ARCH, CANY, DINO) or second highest (CARE, ZION) quintile for all of the large parks (Figure F). The smaller parks are ranked from the lowest quintile (TICA) to the highest quintile (Curecanti, CURE; FOBU; GOSP; HOVE) for this theme (Table A). Four of the five large parks (all except DINO) are ranked in the highest quintile for Park Protection (Figure G); most of the smaller parks are ranked in the middle quintile for this theme, but Bryce Canyon (BRCA) is ranked in the highest quintile, and three parks (Black Canyon of the Gunnison, BLCA; Cedar Breaks, CEBR; and TICA) are ranked in the second highest quintile.

Two of the five larger parks in this network (ARCH, CANY) show overall Summary Park Risk ranking in the highest quintile among parks, with CARE and ZION showing a High risk and DINO showing a Low Summary Risk (Figure H). Thus, the overall risk of nutrient N enrichment to the large parks in this network is generally High or Very High. The smaller parks exhibit a wide range in Summary Risk ranking, from Very Low (Colorado, COLM; CURE; Natural Bridges, NABR; Pipe Spring, PISP) to Moderate (BLCA, BRCA, GOSP, TICA).

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
<i>Arches</i>	Very Low	Very High	Very High	Very High
Black Canyon of the Gunnison	Very Low	Moderate	High	Moderate
Bryce Canyon	Very Low	Low	Very High	Moderate
<i>Canyonlands</i>	Very Low	Very High	Very High	Very High
<i>Capitol Reef</i>	Very Low	High	Very High	High
Cedar Breaks	Very Low	Low	High	Low
Colorado	Very Low	Low	Moderate	Very Low
Curecanti	Very Low	Very High	Moderate	Very Low
<i>Dinosaur</i>	Very Low	Very High	Moderate	Low
Fossil Butte	Low	Very High	Moderate	Low
Golden Spike	Low	Very High	Moderate	Moderate
Hovenweep	Low	Very High	Moderate	Low
Natural Bridges	Very Low	Low	Moderate	Very Low
Pipe Spring	Very Low	High	Moderate	Very Low
Timpanogos Cave	Moderate	Very Low	High	Moderate
<i>Zion</i>	Very Low	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.

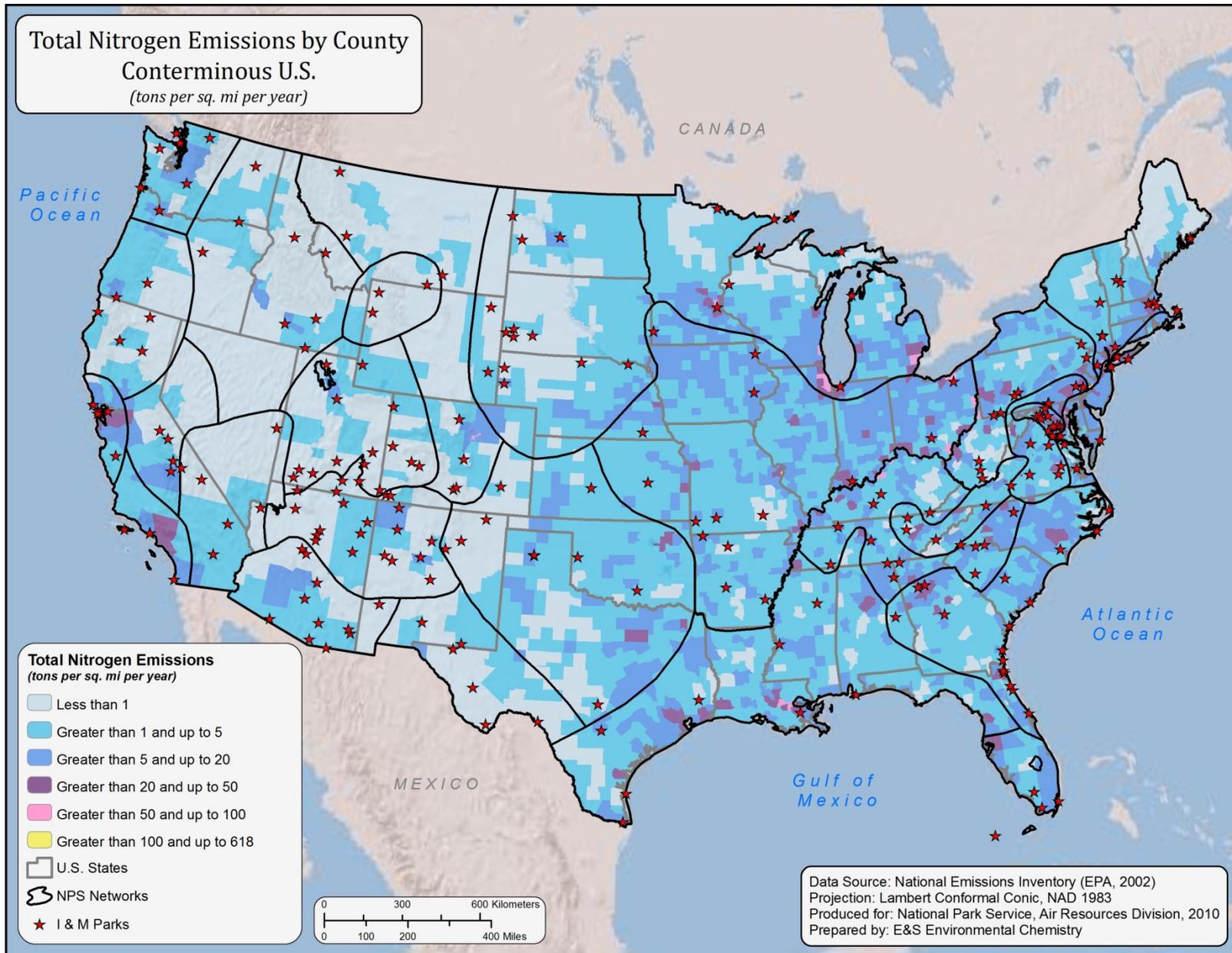
Map A. National map of total N emissions by county for the year 2002. Both oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH₃) forms of N are included. The total is expressed in tons per square mile per year. (Source of data: EPA National Emissions Inventory, <http://www.epa.gov/ttn/chief/net/2002inventory.html>)

Map B. 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 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 D. 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 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 F. 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: CMAQ Model wet and dry deposition data for 2002; see information for Map B above for details)
- 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 parks that occur in this network of the five terrestrial vegetation types thought to be most sensitive to N-nutrient enrichment effects: arctic, alpine, 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.

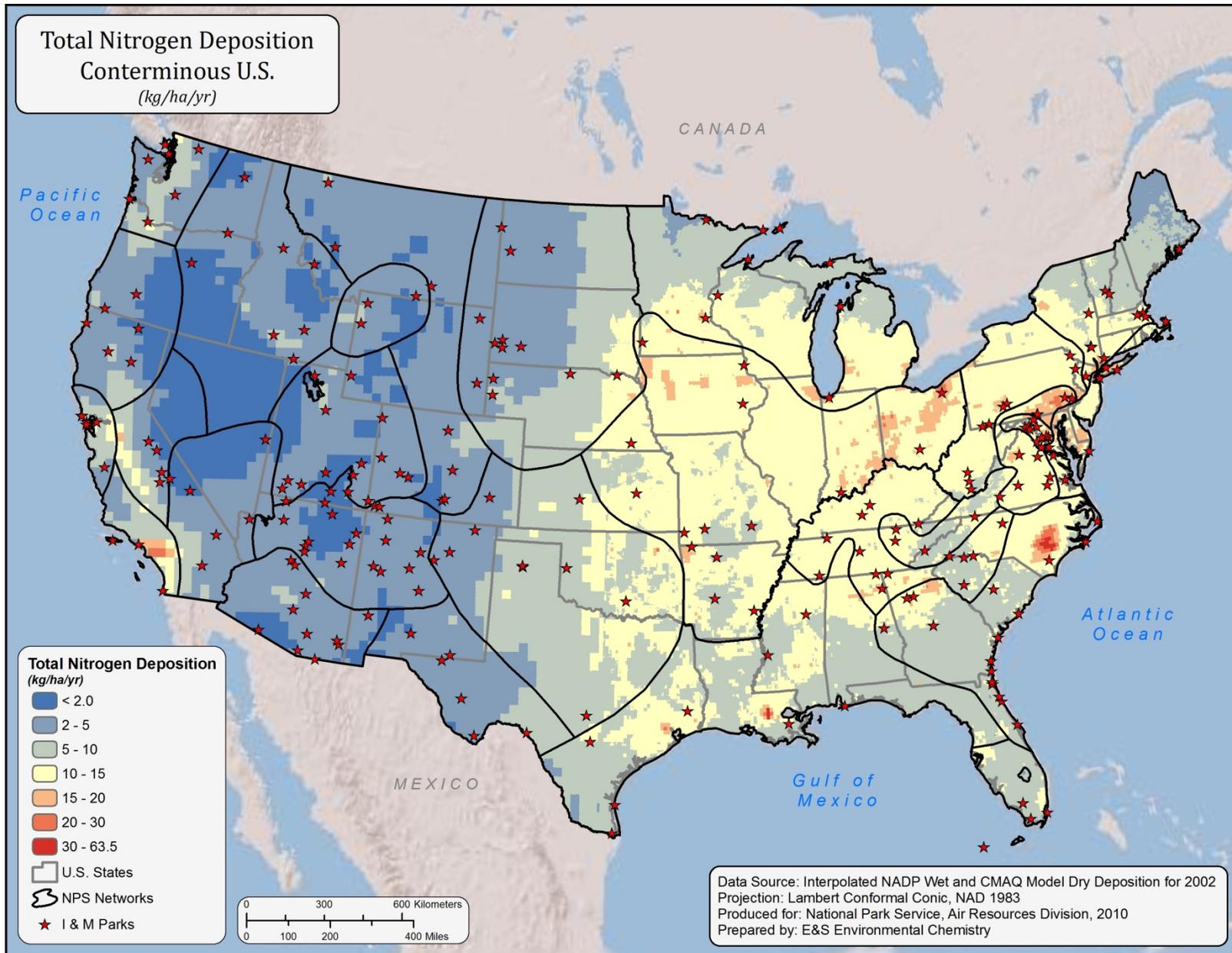
- Figure E. Park rankings for Pollutant Exposure for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Pollutant Exposure variables.
- Figure F. Park rankings for Ecosystem Sensitivity for all parks 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.

NCPN-6

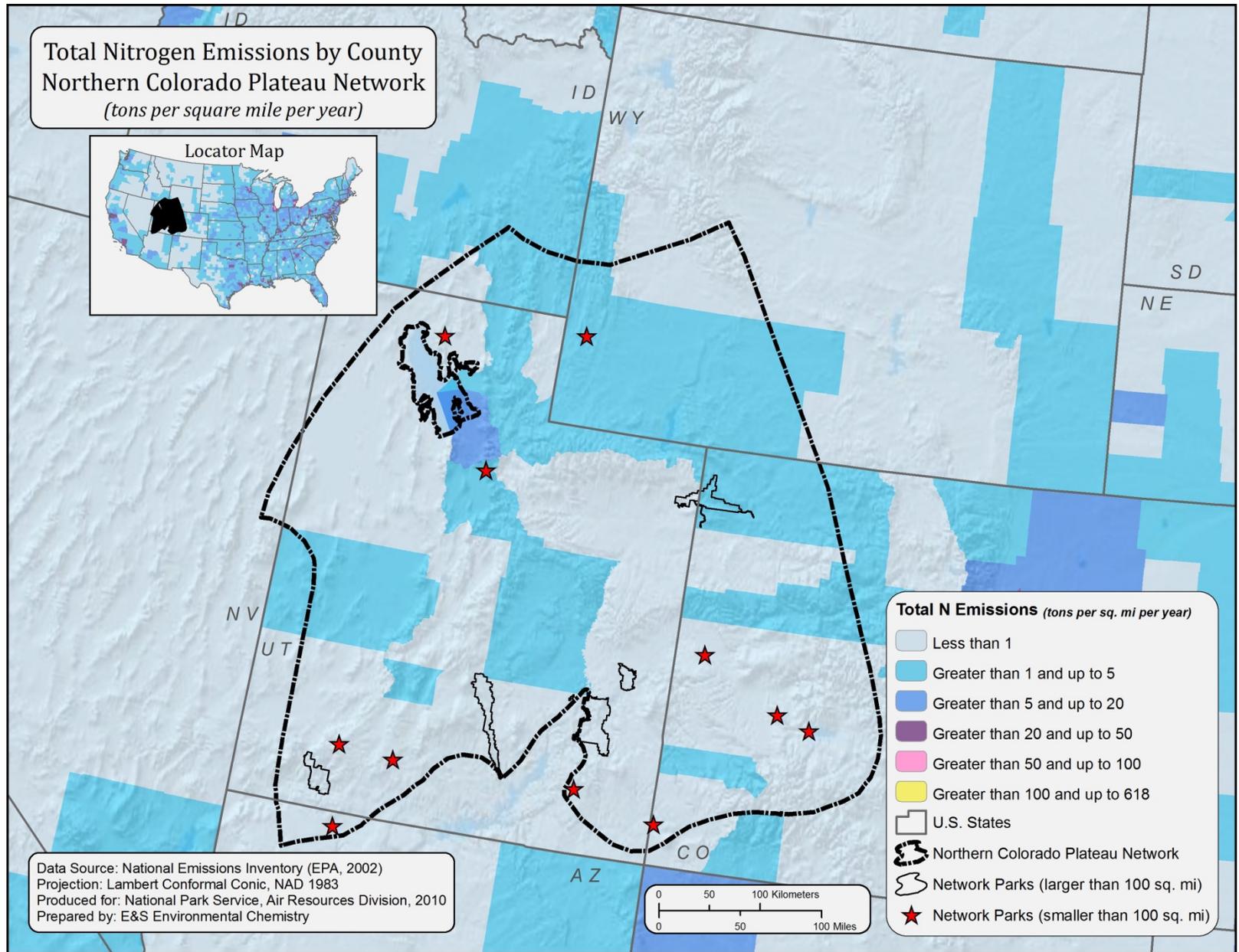


Map A

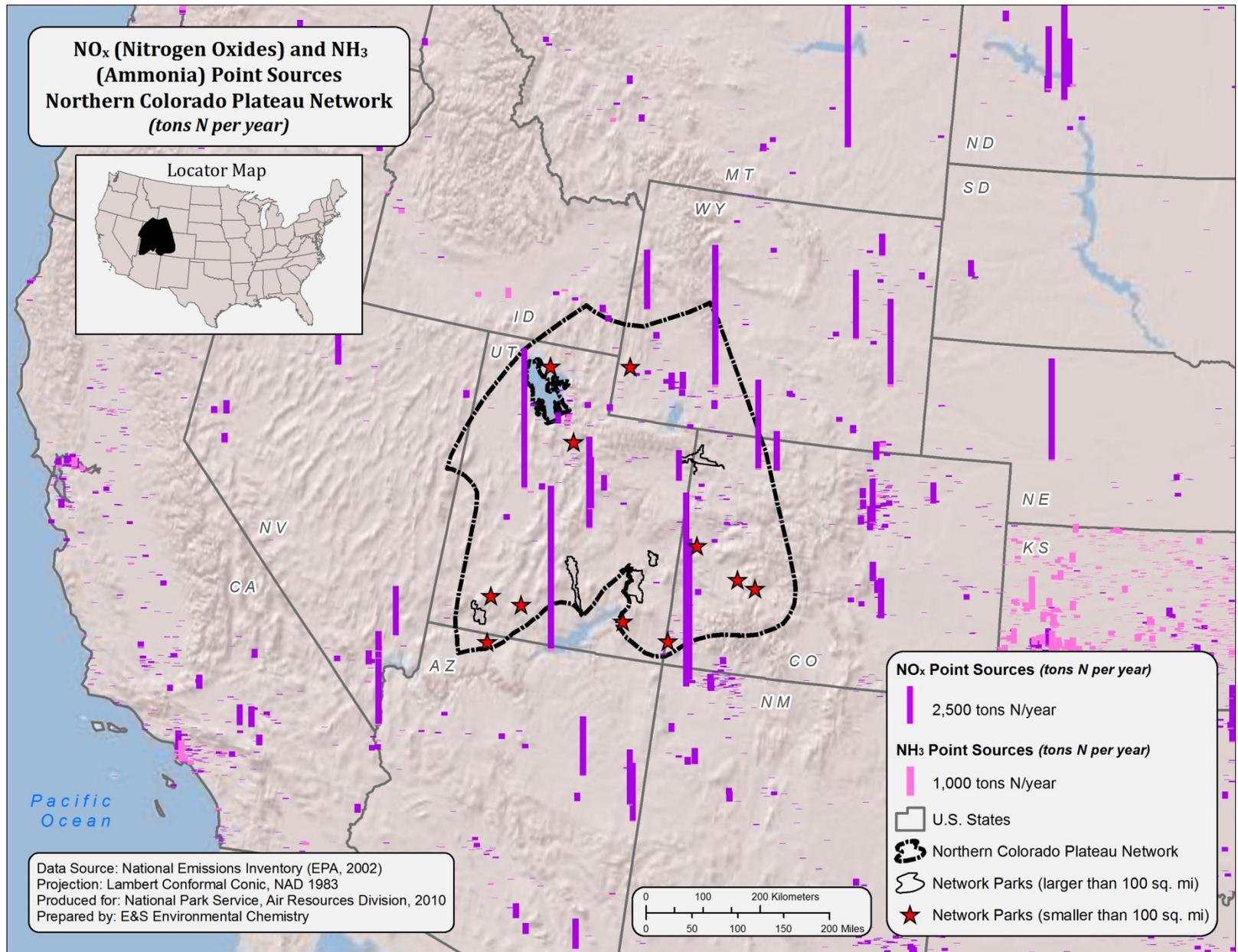
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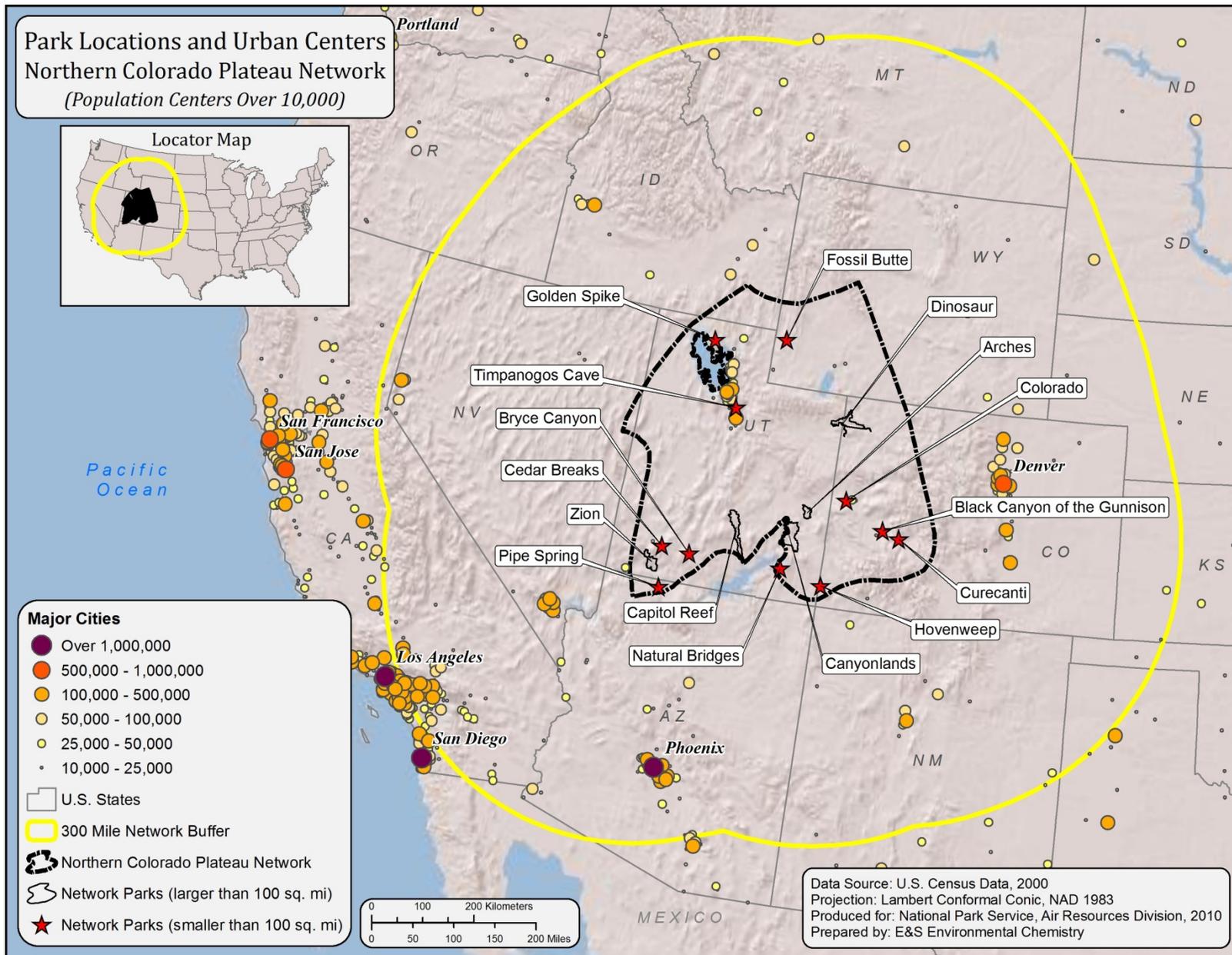
Map B



Map C

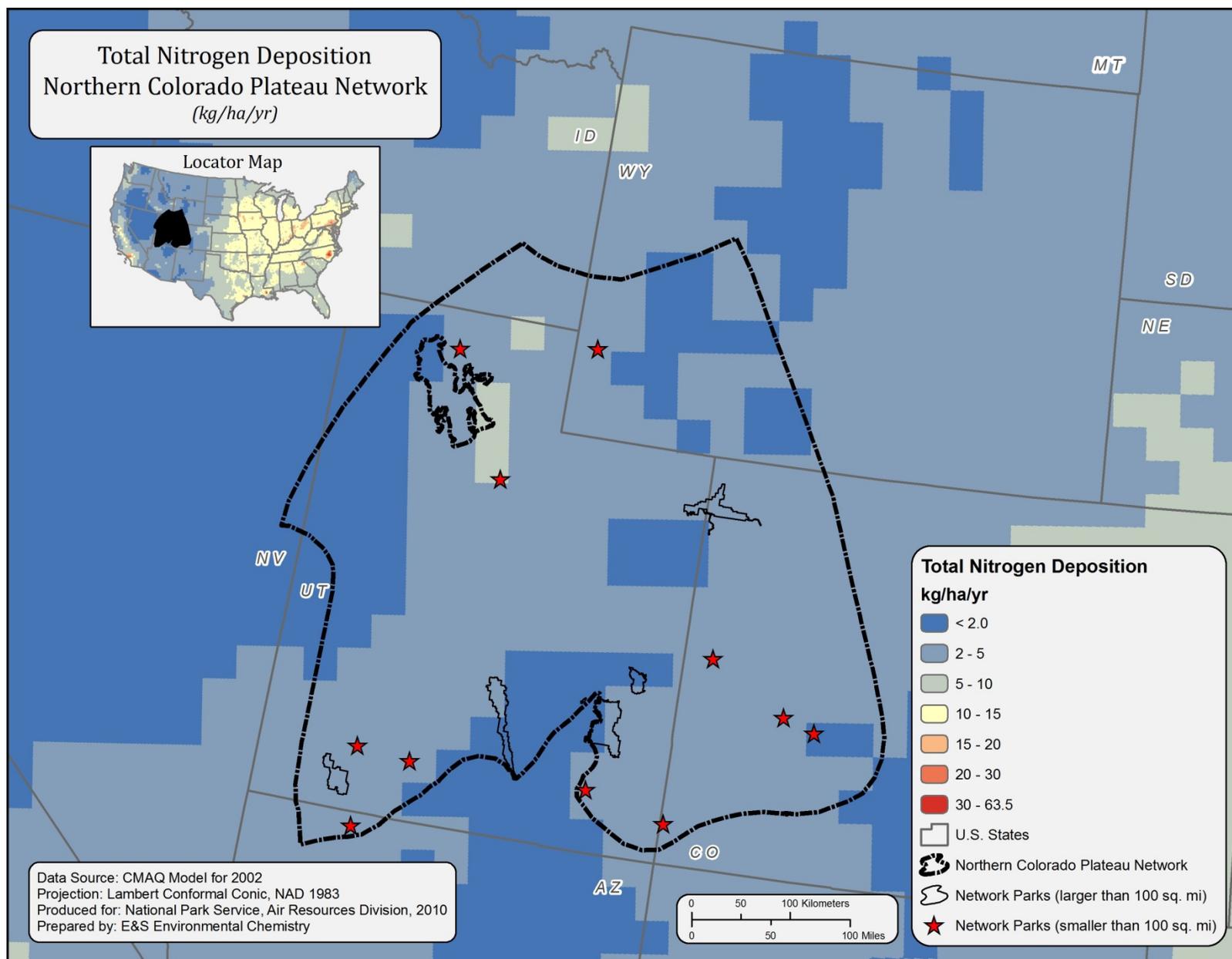


Map D

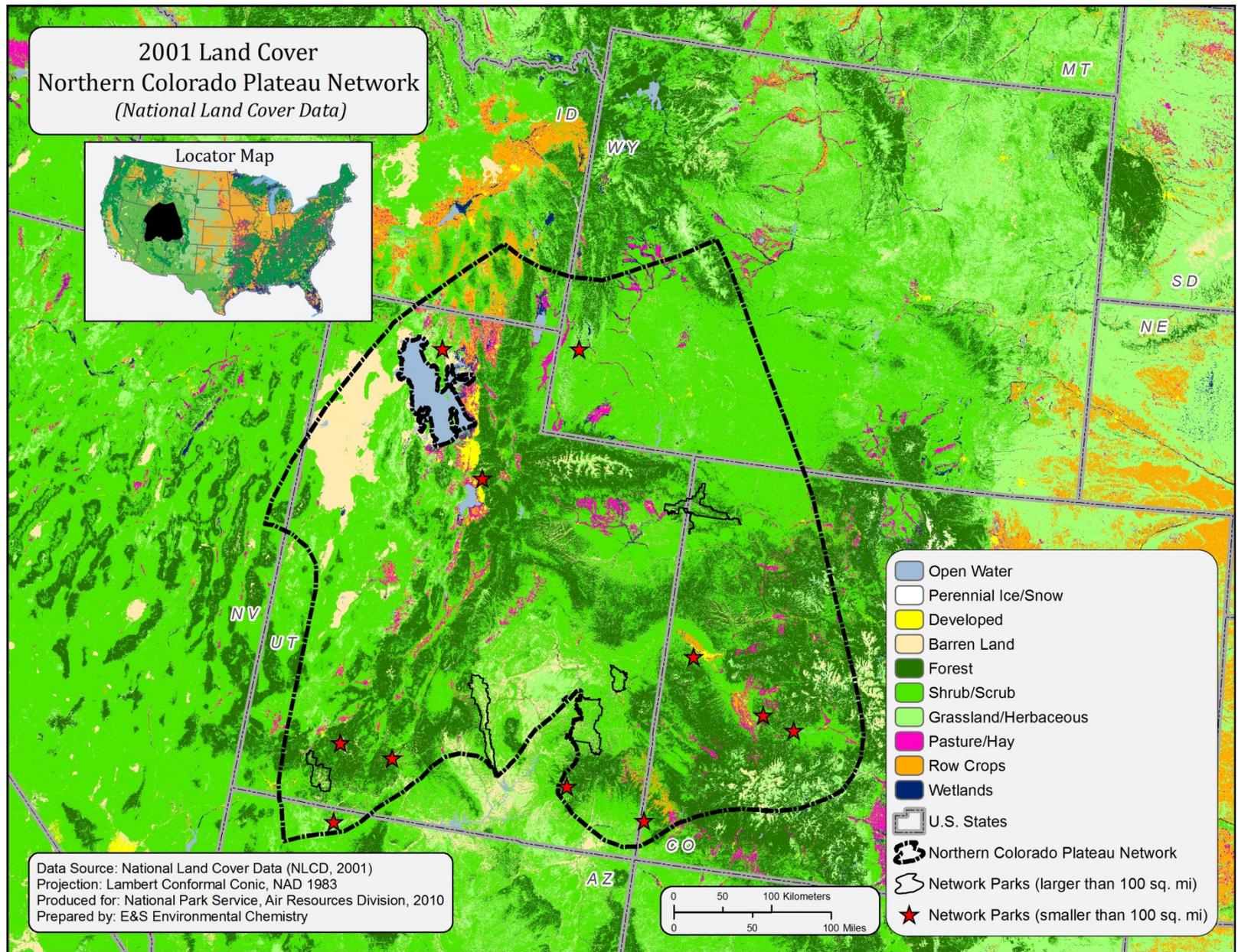


Map E

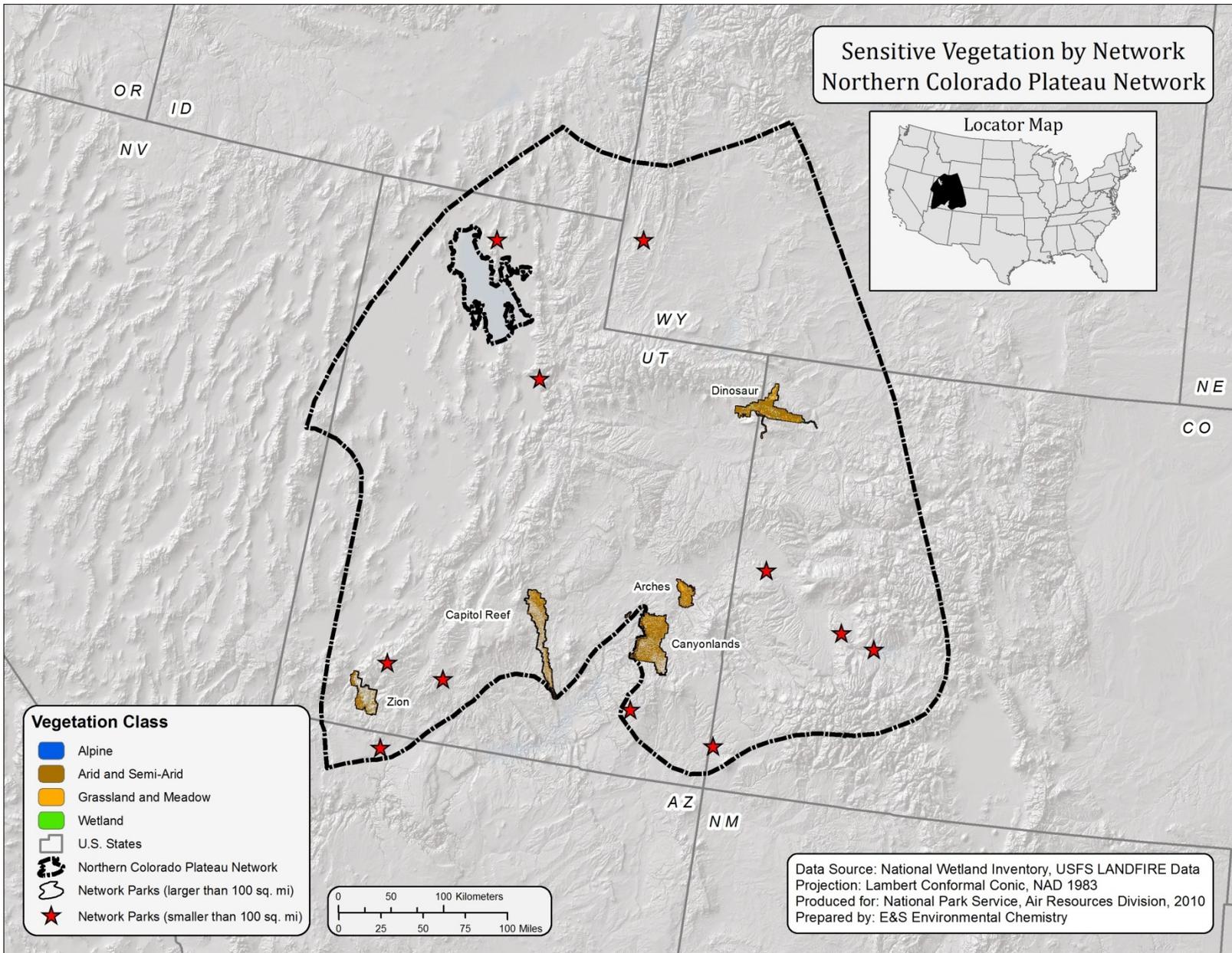
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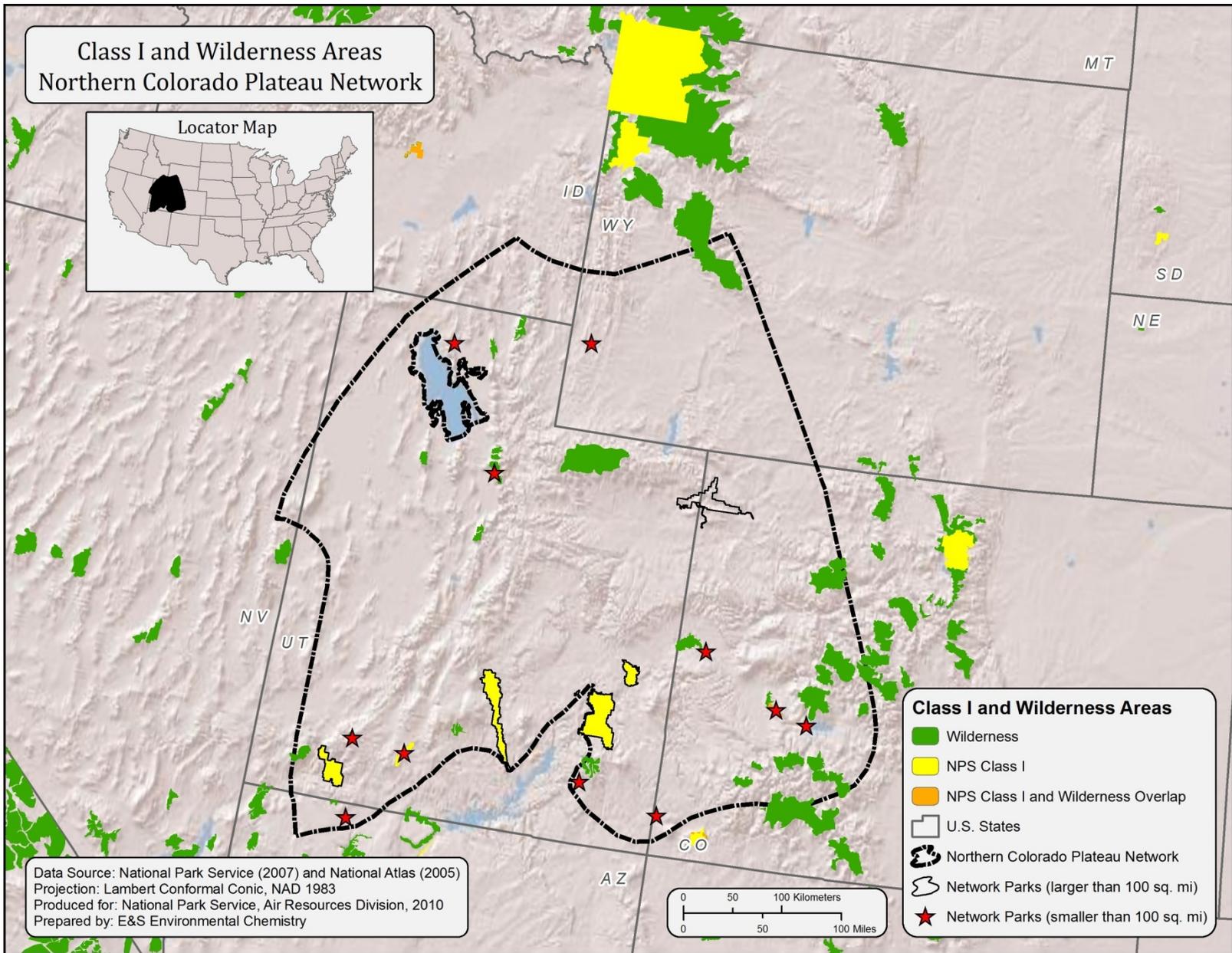
Map F



Map G



Map H



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Map I

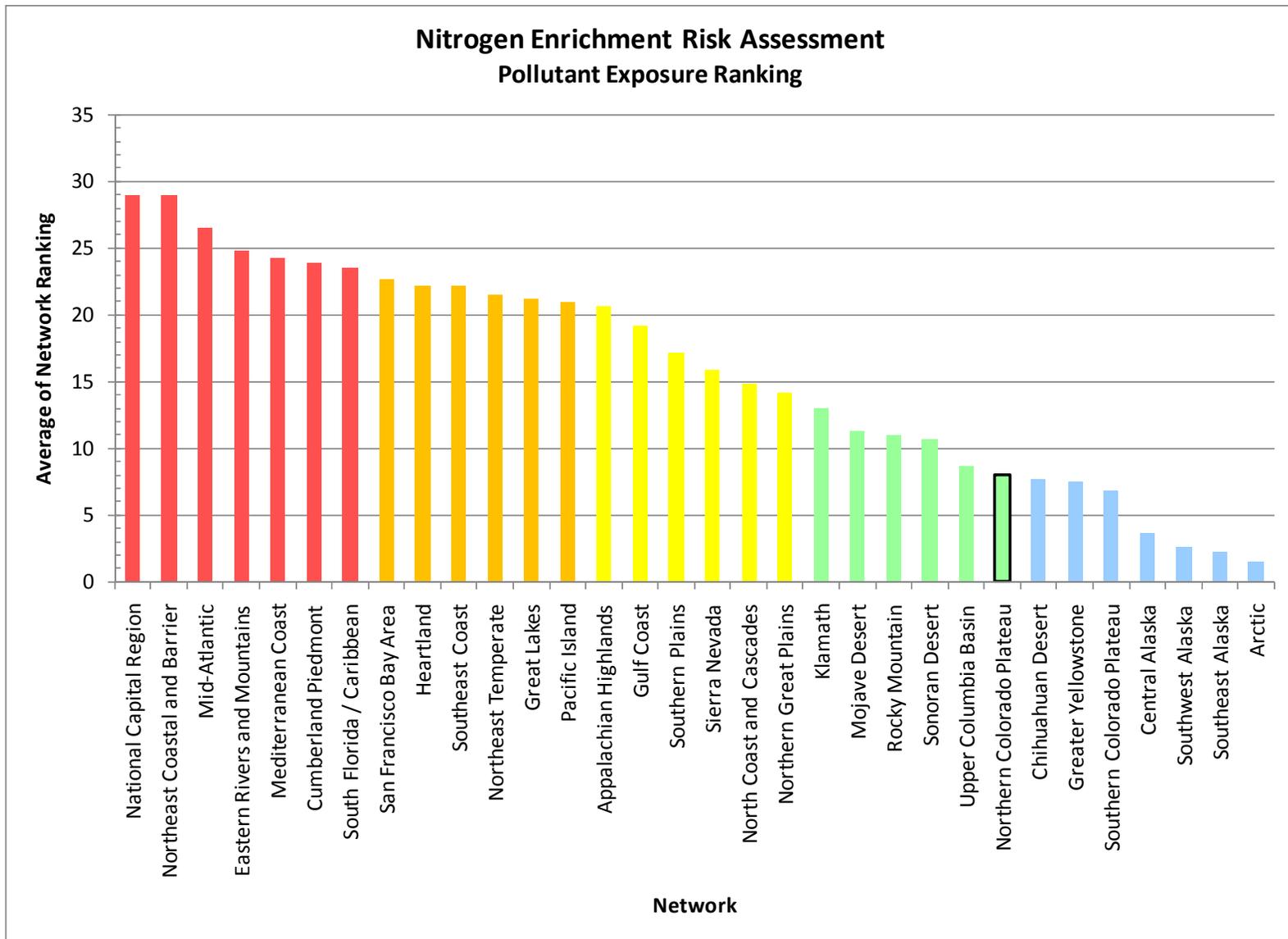


Figure A

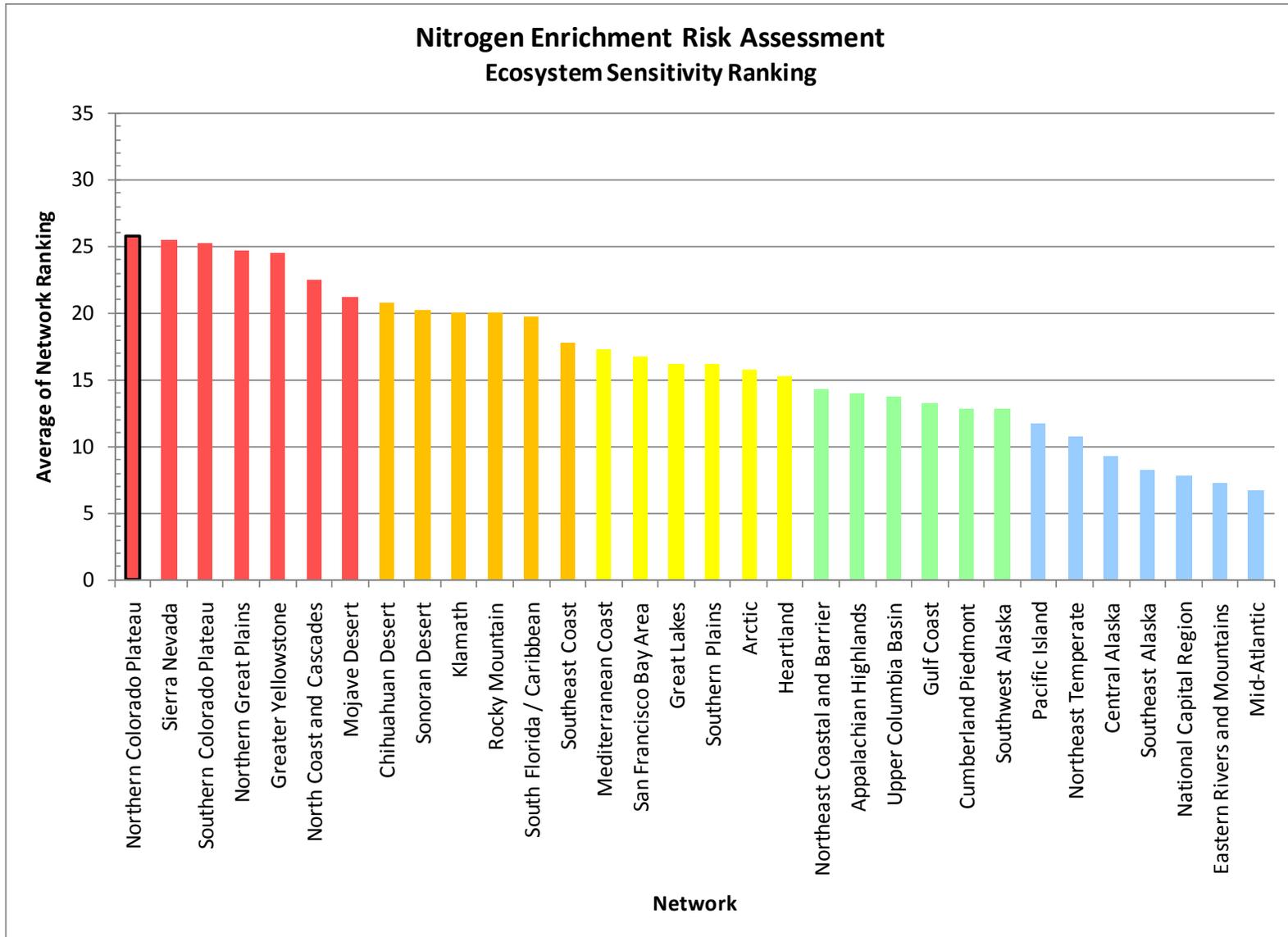


Figure B

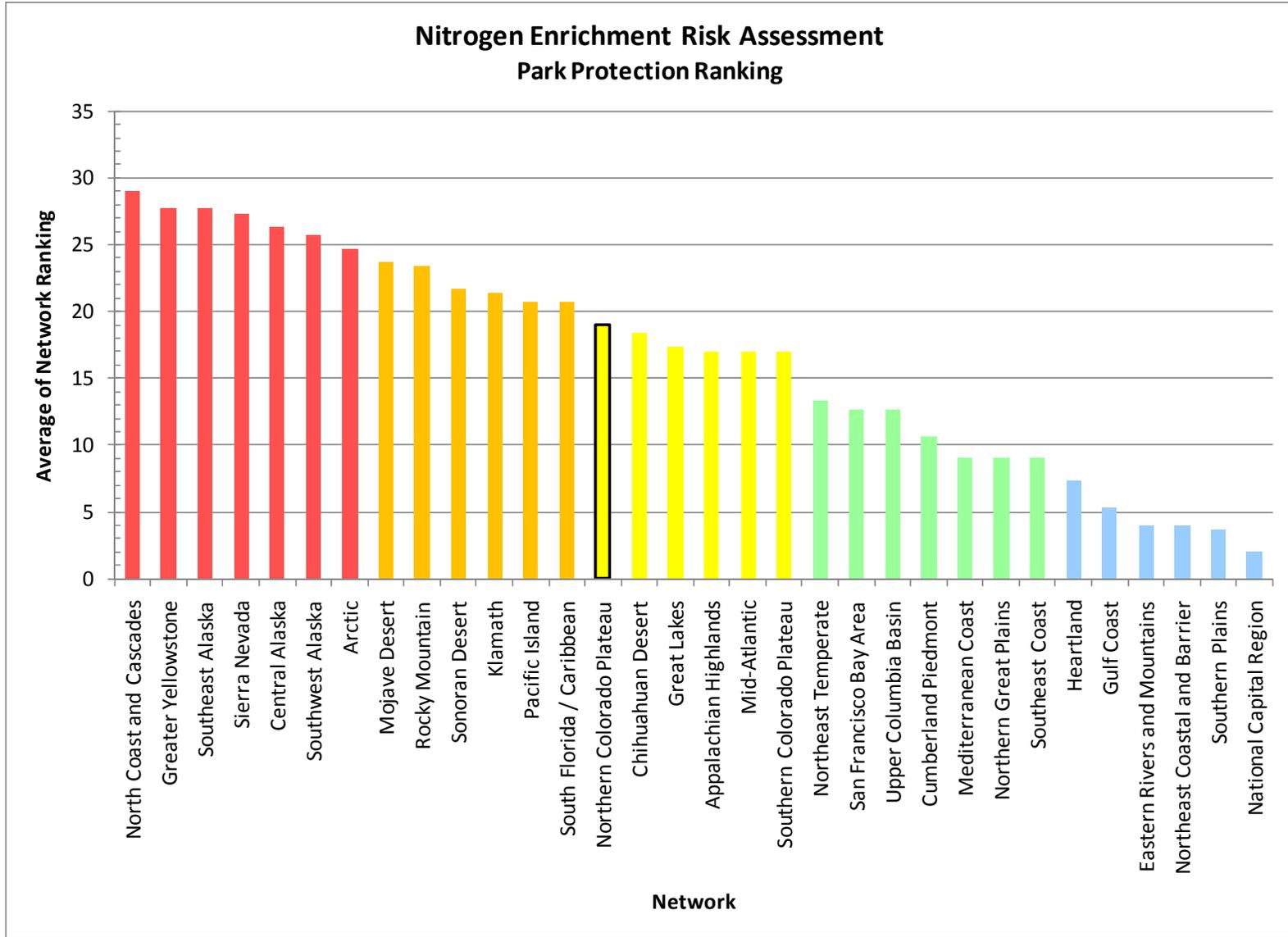


Figure C

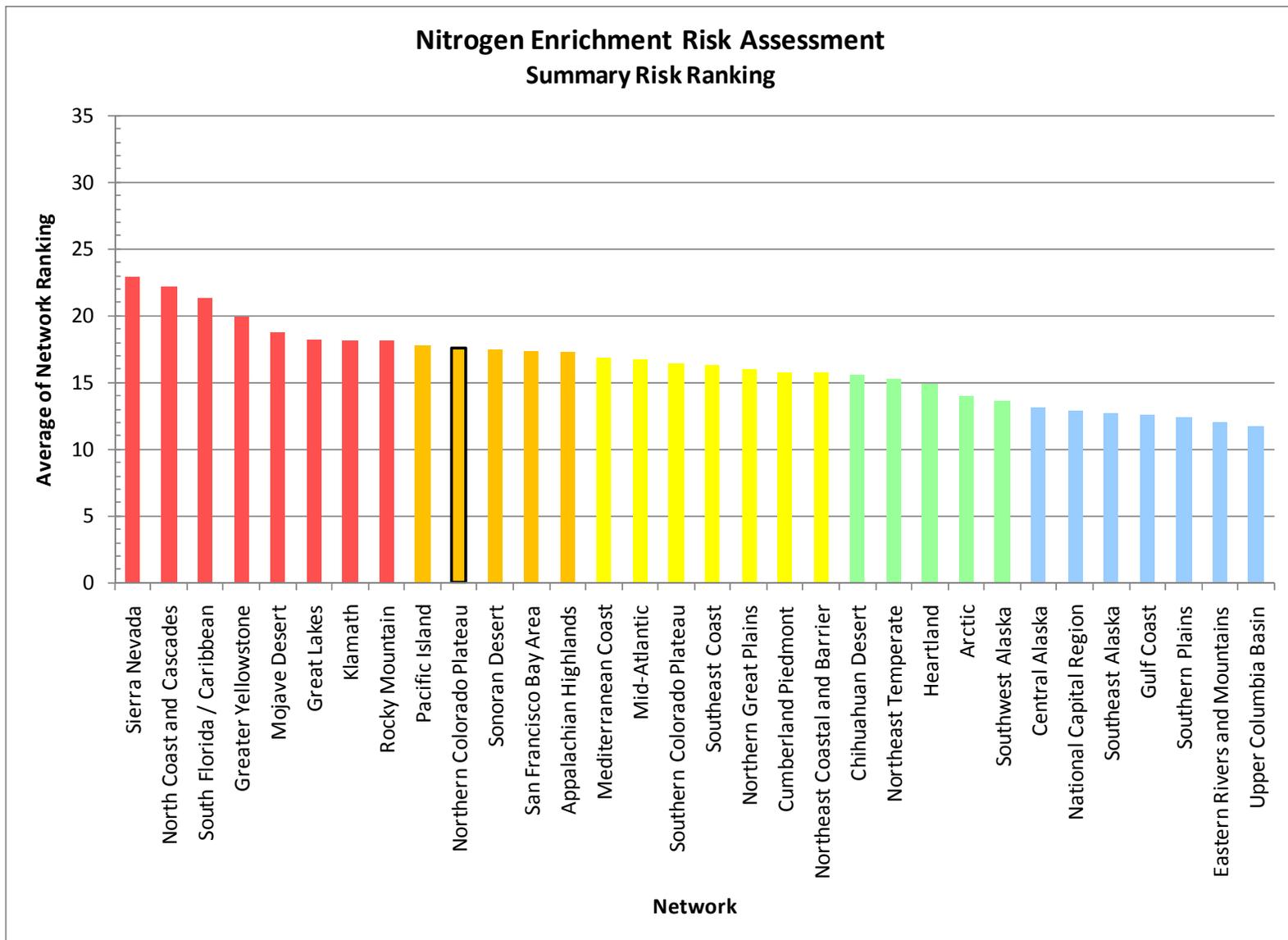


Figure D

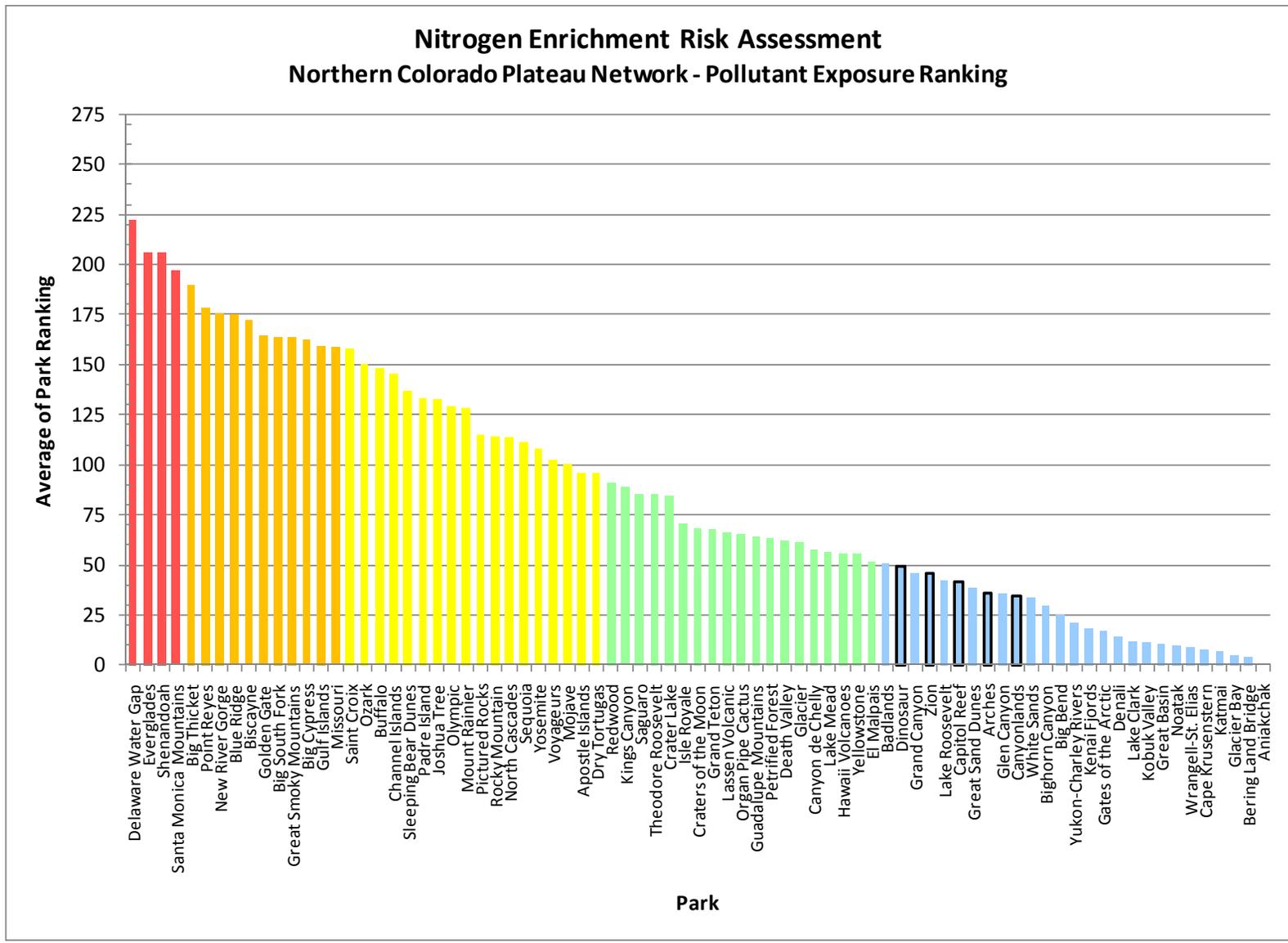


Figure E

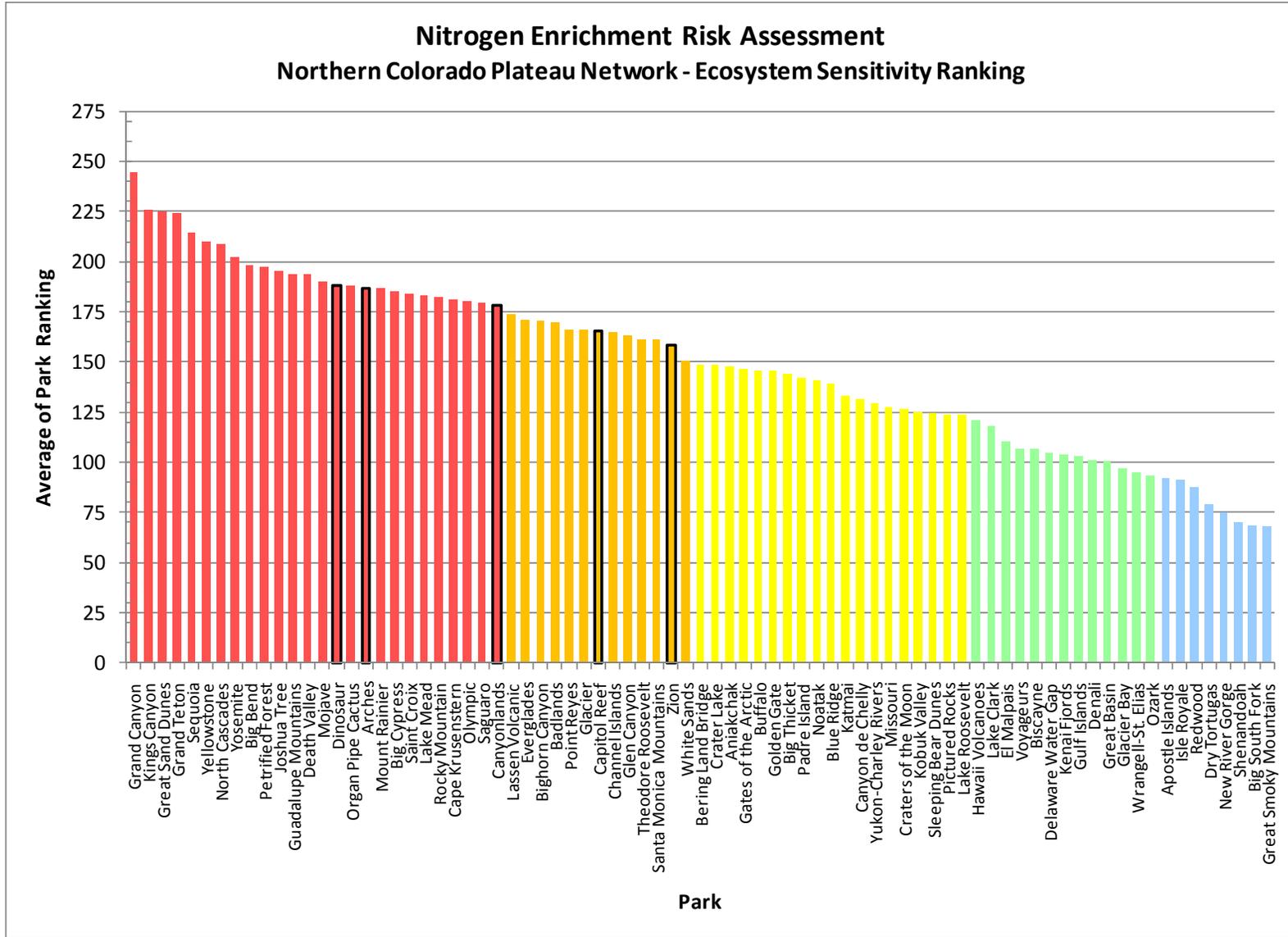


Figure F

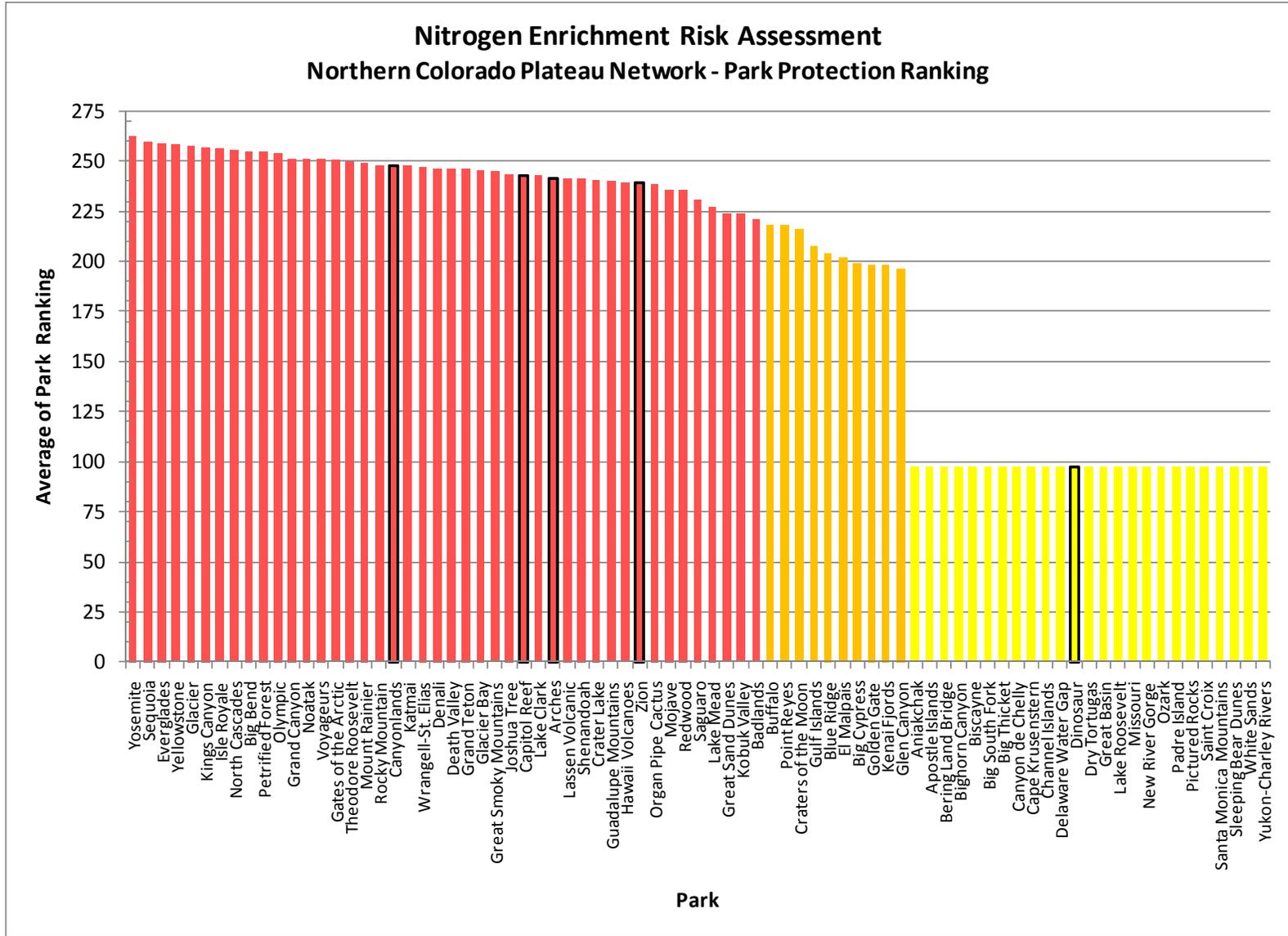


Figure G

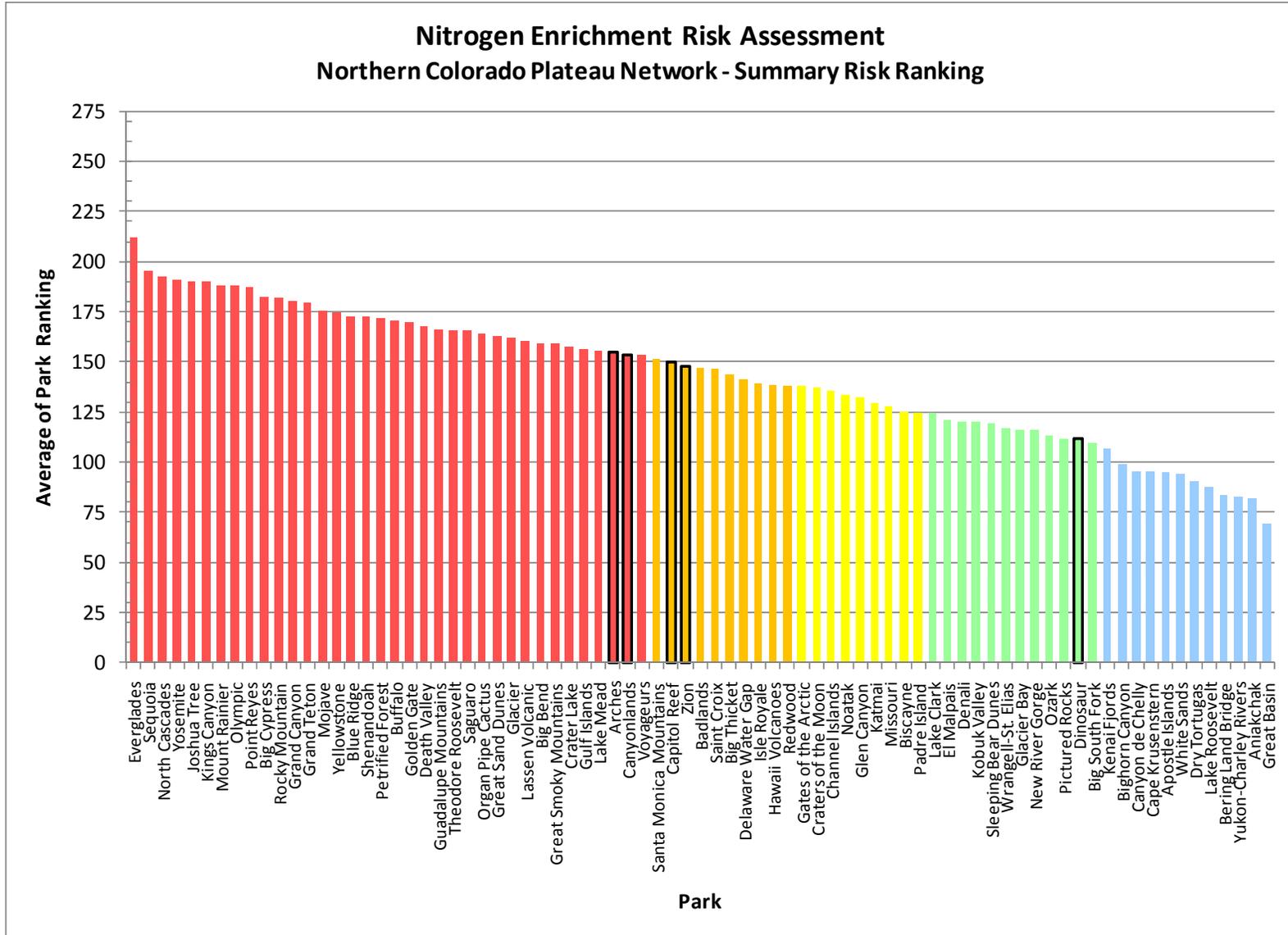


Figure H

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.

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