National Park Service
U.S. Department of the Interior

Natural Resource Program Center

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

Pacific Island Network (PACN)

Natural Resource Report NPS/NRPC/ARD/NRR—2011/323

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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February 2011

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

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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.

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: Pacific Island Network (PACN). Natural Resource Report NPS/NRPC/ARD/NRR—2011/323. National Park Service, Denver, Colorado.

NPS 963/106687, February 2011

Pacific Island Network (PACN)

The Pacific Island Network includes islands at diverse locations in the Pacific Ocean (Map PACN-1). It includes the Hawaiian Islands, northern Mariana Islands, Guam, and American Samoa. There are nine parks in the Pacific Island Network. Only one is larger than 100 square miles: Hawaii Volcanoes (HAVO), which is located on the island of Hawaii.

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. Deposition data are not available for the Pacific Islands Network, but deposition would be expected to be relatively high on some of the Hawaiian Islands, especially Oahu, and lower elsewhere.

Total annual N emissions, by county, are shown in Map C for lands in and surrounding the Pacific Island Network. County-level emissions within the network ranged from less than 1 ton per square mile on the big island of Hawaii to between 20 and 50 tons per square mile on Oahu. Annual emissions of N from the other Hawaiian Islands were intermediate, between 1 and 5 tons per square mile. Point source emissions of oxidized (nitrogen oxides, NO_x) and reduced (ammonia, NH_3) N are shown in Map D. There are relatively few N point sources in Hawaii. Most are located on Oahu and emit oxidized N. Urban centers within the network and within a 300 mile buffer around the network are shown in Map E-1. The only population center of any magnitude (more than 100,000 people) is Honolulu on Oahu. There are no large population centers in the American Affiliated Islands (Map E-2).

Map F of total N deposition in the Pacific Island network is not shown. There are no available data for atmospheric N deposition in the Pacific Islands Network. Deposition of N is expected to be low on the American Affiliated Islands, but not necessarily on all of the Hawaiian islands, especially Oahu.

Land cover in and around the network is shown in Maps G-1 and G-2. The predominant cover types within this network are mixed and include substantial forest, row crop, shrubland, and grassland/herbaceous cover types.

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). The only park large enough to see the vegetation pattern at the scale of the network is HAVO. The predominant sensitive vegetation type in this park is grassland and meadow.

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 some wilderness and Class I areas in the Hawaiian Islands, mostly limited to HAVO in the southern portion of the island of Hawaii.

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 Pacific Island Network ranks at the bottom of the second highest quintile, among networks in N Pollutant Exposure (Figure A). However, the network Ecosystem Sensitivity ranking is relatively low, within the lowest quintile among networks (Figure B). This is because there is limited vegetation coverage in the I&M parks in this network that includes vegetation types that are among those expected to be especially sensitive to nutrient enrichment effects from N deposition, and there are no high elevation lakes. This network ranks in the second highest 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 at the top of 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 one I&M park (HAVO) in the Pacific Island Network that is larger than 100 square miles ranks in the second lowest quintile in Pollutant Exposure (Figure E). This may be because HAVO is located on the southern side of the Island of Hawaii, some distance from the areas of concentrated N pollution emissions sources on the islands of Oahu and Maui. The smaller parks in the network also rank Low, in the second lowest quintile, in Pollutant Exposure, except for Kalaupapa (KALA), which ranks Very High. HAVO is in the second lowest quintile in Ecosystem Sensitivity (Figure F) and in the highest quintile in Park Protection (Figure G). Most of the smaller parks in the network are ranked in the lowest or second lowest quintile for Ecosystem Sensitivity. The exceptions are American Memorial Park (AMME) and Haleakala (HALE), which are ranked in the middle quintile for this theme and Kaloko-Honokohau (KAHO) which is ranked High. Like HAVO, HALE is ranked in the highest quintile in Park Protection, whereas other parks in the network are ranked in the middle quintile.

HAVO scores in the second highest quintile in the Summary Park Risk ranking (Figure H). Its overall risk of damage from nutrient N enrichment is considered High. HALE and KALA are also ranked in the second highest quintile for Summary Risk, whereas other small parks in the network are ranked in the lowest or second lowest quintile. Thus, the overall risk from nutrient N deposition to parks in this network is High for HALE, HAVO, and KALA, but Low to Very Low for the other parks in the Pacific Island Network.

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
American Memorial Park	ND[3]	Moderate	Moderate	Low
Haleakala	Low	Moderate	Very High	High
Hawaii Volcanoes	Low	Low	Very High	High
Kalaupapa	Very High	Low	Moderate	High
Kaloko-Honokohau	Low	High	Moderate	Very Low
National Park of American Samoa	ND[3]	Low	Moderate	Very Low
Pu'uhonua o Honaunau	Low	Low	Moderate	Very Low
Puukohola Heiau	Low	Very Low	Moderate	Very Low
War in the Pacific	ND[3]	Very Low	Moderate	Very 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.

[3] ND indicates no data.

Map PACN-1. Location of the islands that comprise the Pacific Island Network.

Map A. 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 B. Deposition data are not available for the Pacific Island Network. Total N deposition throughout most areas 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, 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 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, NH_3) 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, 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.

Map E-1. Urban centers having more than 10,000 people within the Hawaiian portion of the network and within a 300-mile buffer around the perimeter of the network. (Source of data: U.S. Census 2000)

Map E-2. Urban centers having more than 10,000 people within the American Affiliated Islands portion of the network and within a 300-mile buffer around the perimeter of the network. (Source of data: U.S. Census 2000)

Map G-1. Land cover types in and around the Hawaiian portion of 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 G-2. Land cover types in and around the American Affiliated Islands portion of the network, based on the National Land Cover dataset. (Source of data: National Land Cover Dataset, http://www.mrlc.gov/nlcd_multizone_map.php; Liu, Z. and L. Fischer. 2006a. Commonwealth of the Northern Mariana Islands vegetation mapping using very high spatial respolution imagery, USDA Forest Service - Pacific Southwest Region, Forest Health Protection; Liu, Z., and Fischer, L. 2006b. Guam Vegetation Mapping Using Very High Spatial Resolution Imagery – Methodology. USDA Forest Service, Pacific Southwest Region, Forest Health Protection; Liu, Z. and L. Fischer (2007). American Samoa vegetation mapping using very high spatial resolution imagery, USDA Forest Service, Pacific Southwest Region, Forest Health Protection)

Map H. Distribution within the larger (larger than 100 square miles) parks in the Hawaiian portion of the 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.

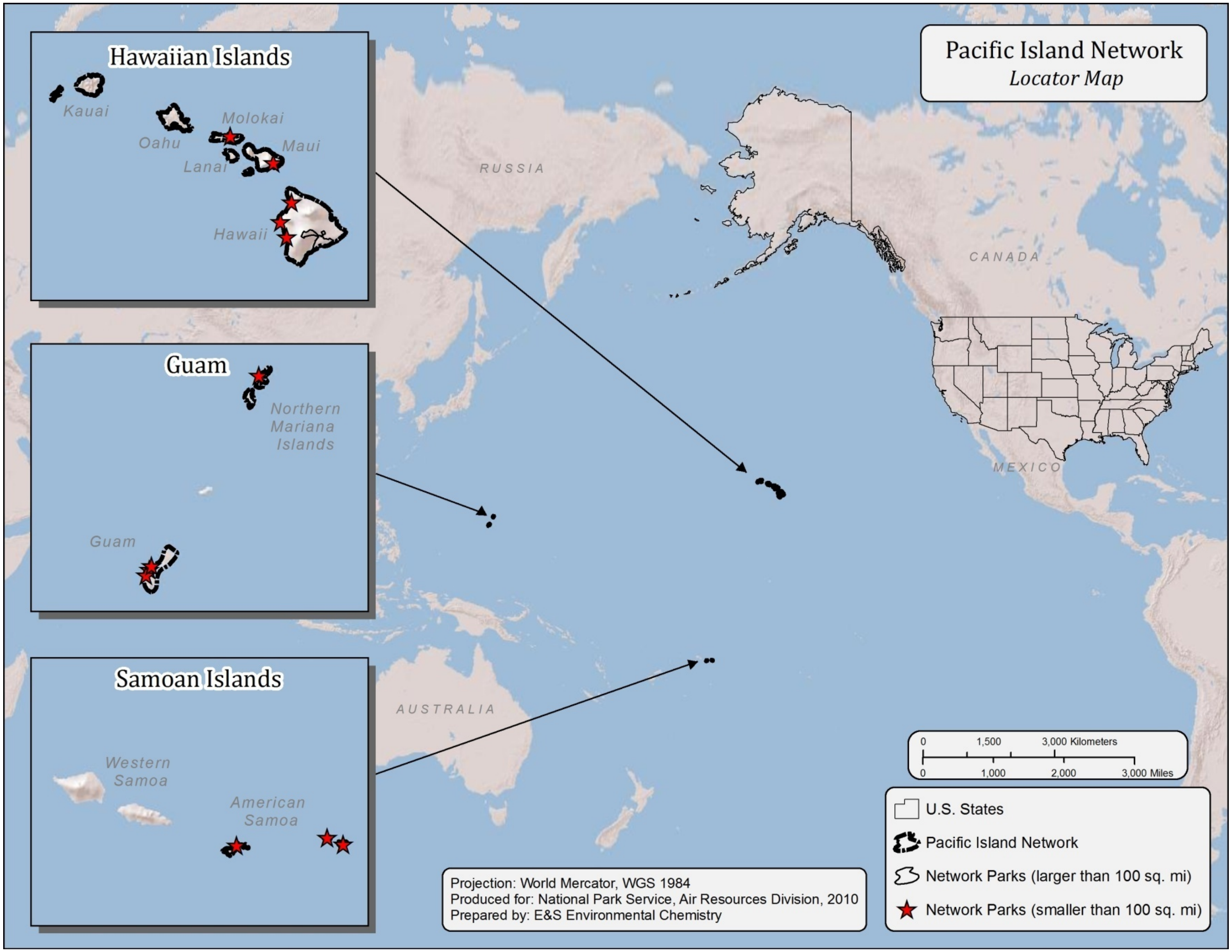
Figure D. Network Summary Risk ranking, calculated as the sum of the averages of the scores for Pollutant Exposure, Ecosystem Sensitivity, and Park Protection.

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.

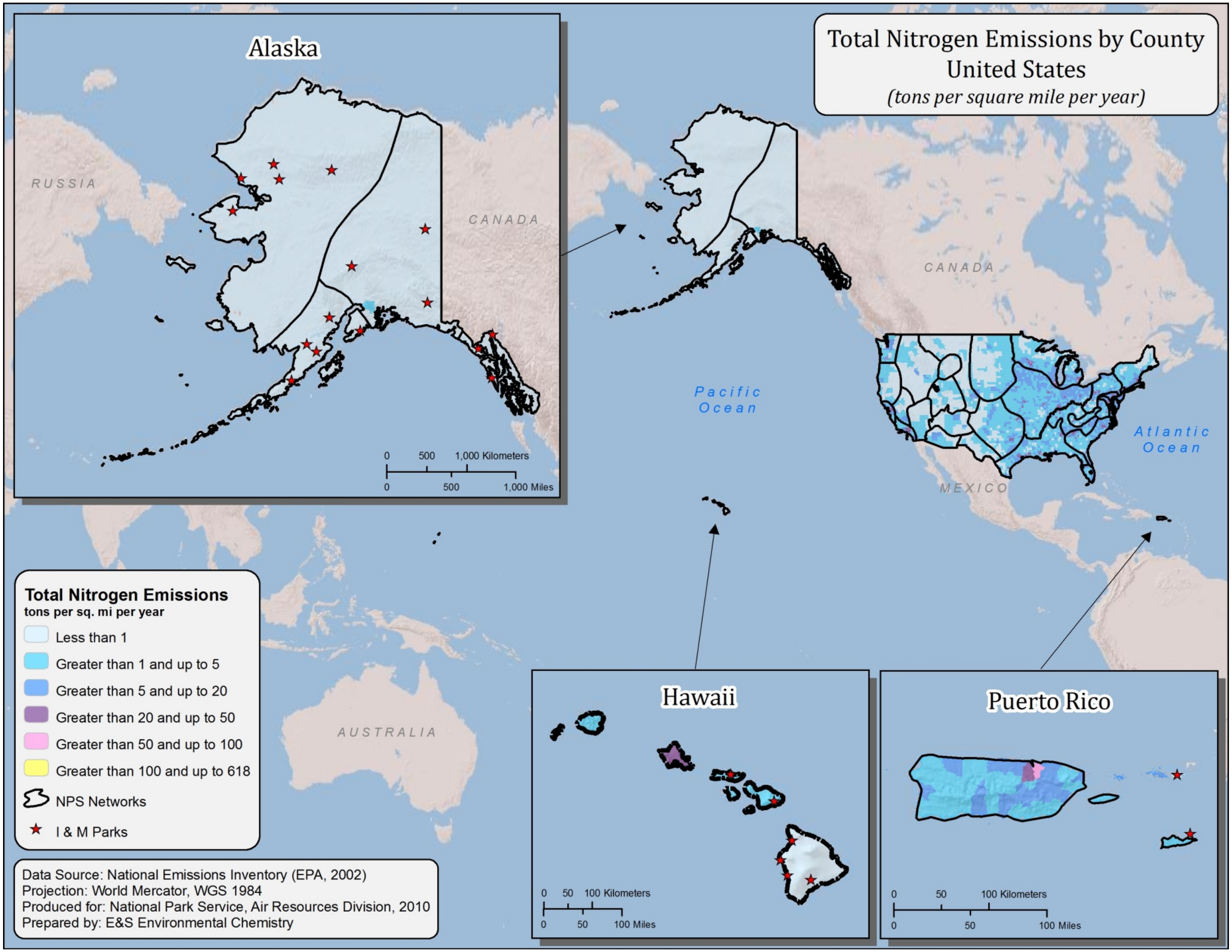
Figure G. Park rankings for Park Protection for all parks larger than 100 square miles. Ranks for each park were calculated relative to all parks, regardless of size, as the average of scores for all Park Protection variables.

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.

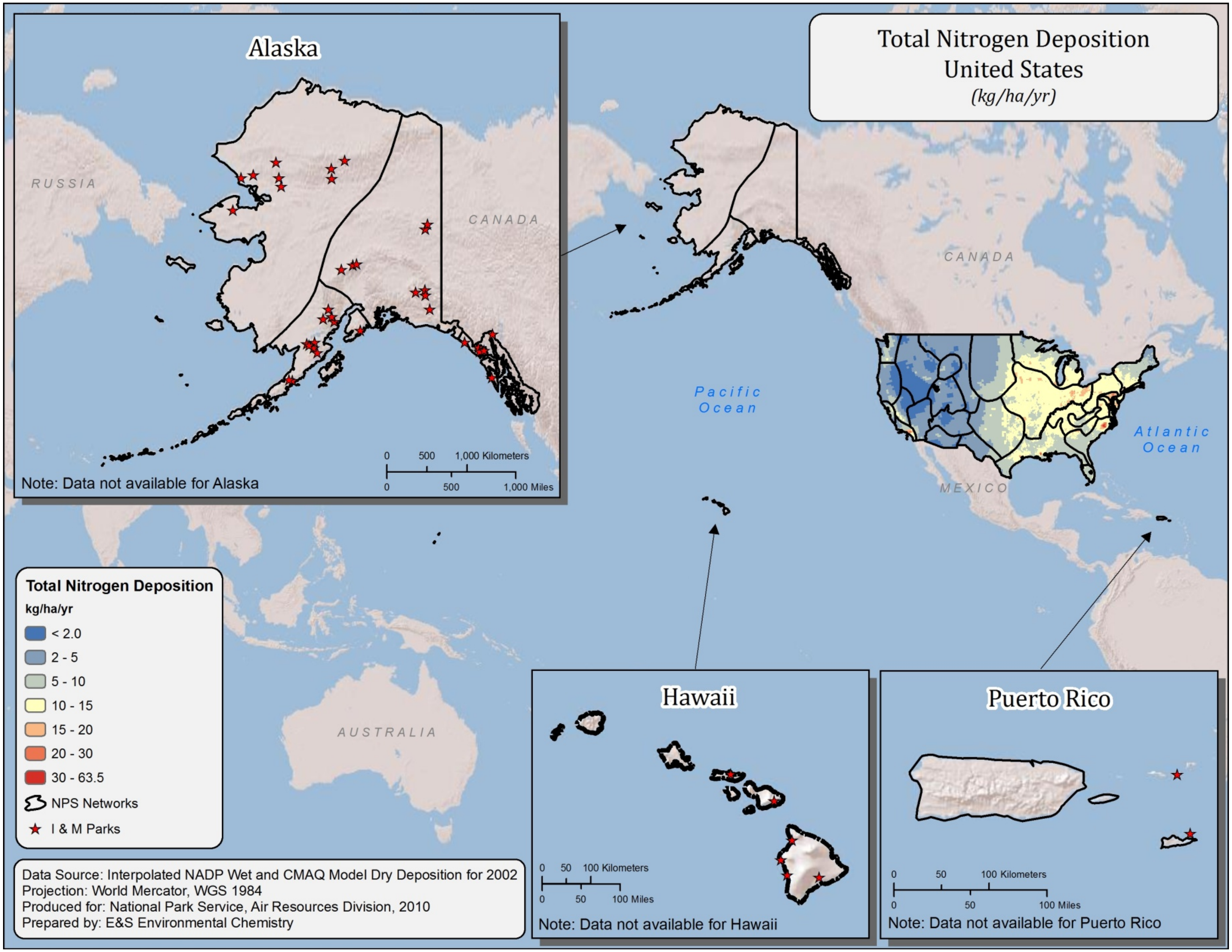

Pacific Island Network
Locator Map
Hawaiian Islands
Kauai
Oahu
Molokai
Maui
Lanai
Hawaii
Guam
Northern Mariana Islands
Guam
Samoan Islands
Western Samoa
American Samoa
RUSSIA
CANADA
MEXICO
AUSTRALIA
0
1,500
3,000 Kilometers
0
1,000
2,000
3,000 Miles
U.S. States
Pacific Island Network
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
Projection: World Mercator, WGS 1984
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry

Map PACN-1

PACN-7

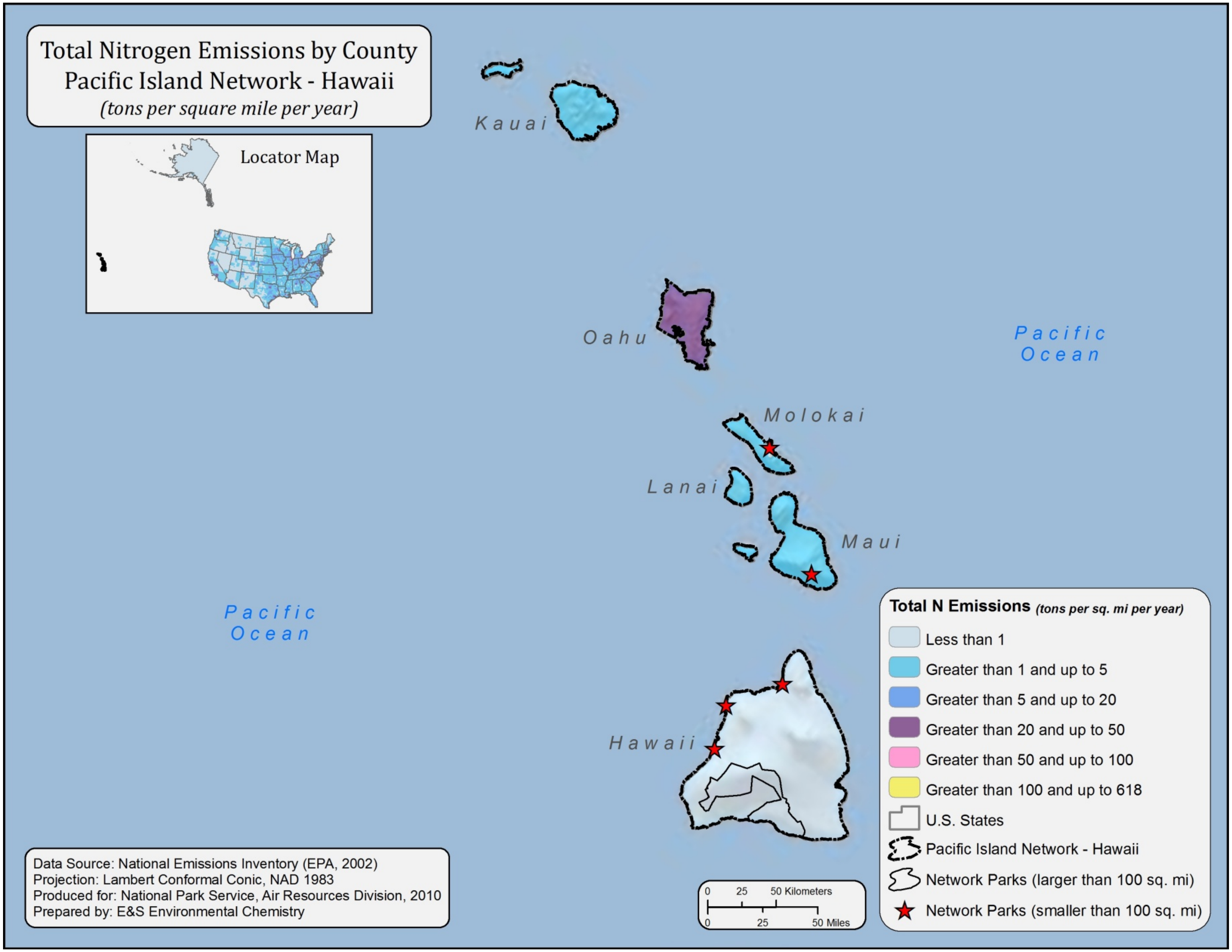

Total Nitrogen Emissions by County
United States
(tons per square mile per year)
Alaska
RUSSIA
CANADA
0 500 1,000 Kilometers
0 500 1,000 Miles
CANADA
Pacific Ocean
Atlantic Ocean
MEXICO
AUSTRALIA
Total Nitrogen Emissions
tons per sq. mi per year
Less than 1
Greater than 1 and up to 5
Greater than 5 and up to 20
Greater than 20 and up to 50
Greater than 50 and up to 100
Greater than 100 and up to 618
NPS Networks
I & M Parks
Data Source: National Emissions Inventory (EPA, 2002)
Projection: World Mercator, WGS 1984
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
Hawaii
0 50 100 Kilometers
0 50 100 Miles
Puerto Rico
0 50 100 Kilometers
0 50 100 Miles

Map A



Total Nitrogen Deposition
United States
(kg/ha/yr)
Alaska
RUSSIA
CANADA
Note: Data not available for Alaska
0 500 1,000 Kilometers
0 500 1,000 Miles
Pacific Ocean
Atlantic Ocean
MEXICO
AUSTRALIA
Total Nitrogen Deposition
kg/ha/yr
< 2.0
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 63.5
NPS Networks
I & M Parks
Data Source: Interpolated NADP Wet and CMAQ Model Dry Deposition for 2002
Projection: World Mercator, WGS 1984
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
Hawaii
0 50 100 Kilometers
0 50 100 Miles
Note: Data not available for Hawaii
Puerto Rico
0 50 100 Kilometers
0 50 100 Miles
Note: Data not available for Puerto Rico

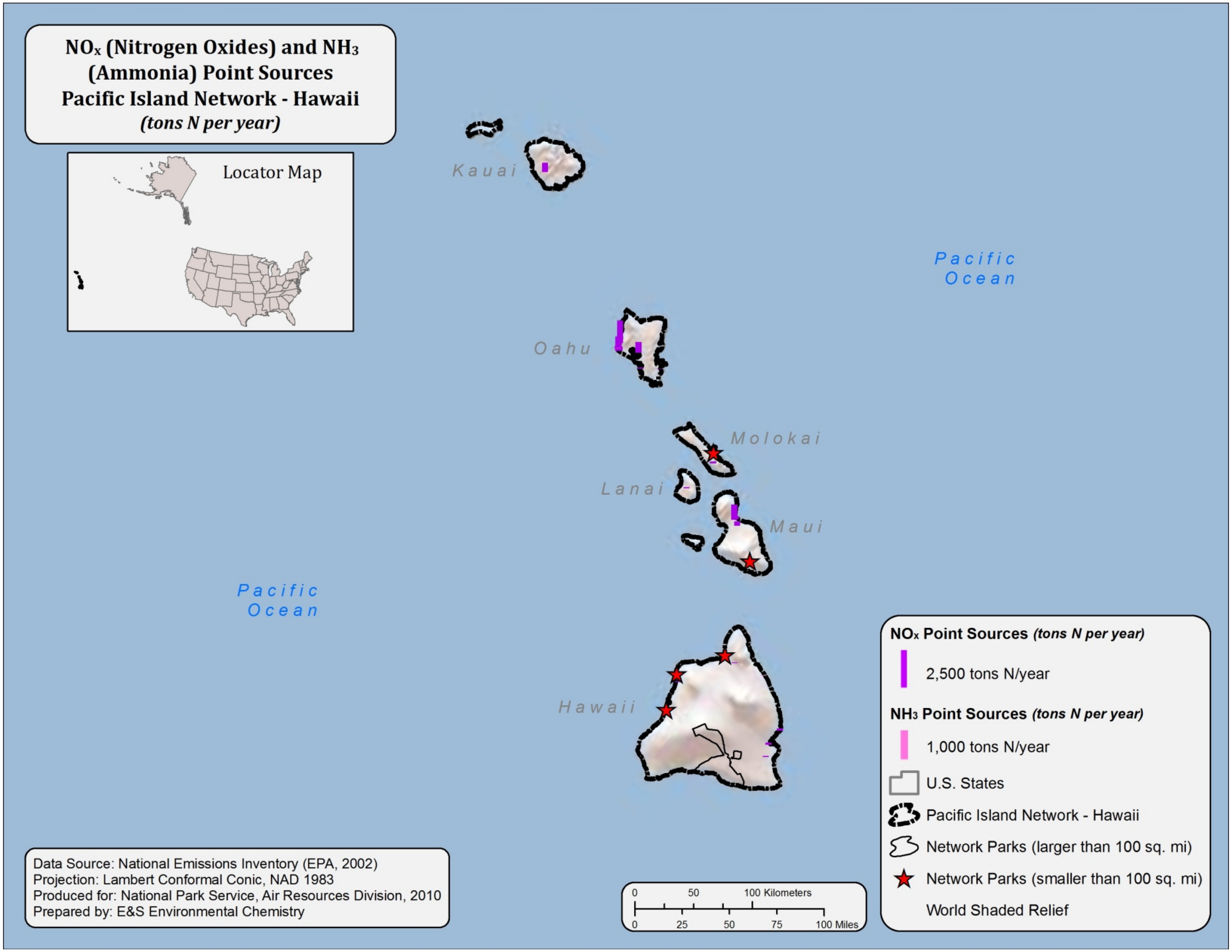
Map B



Total Nitrogen Emissions by County
Pacific Island Network - Hawaii
(tons per square mile per year)
Locator Map
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
Pacific Ocean
Pacific 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
Pacific Island Network - Hawaii
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

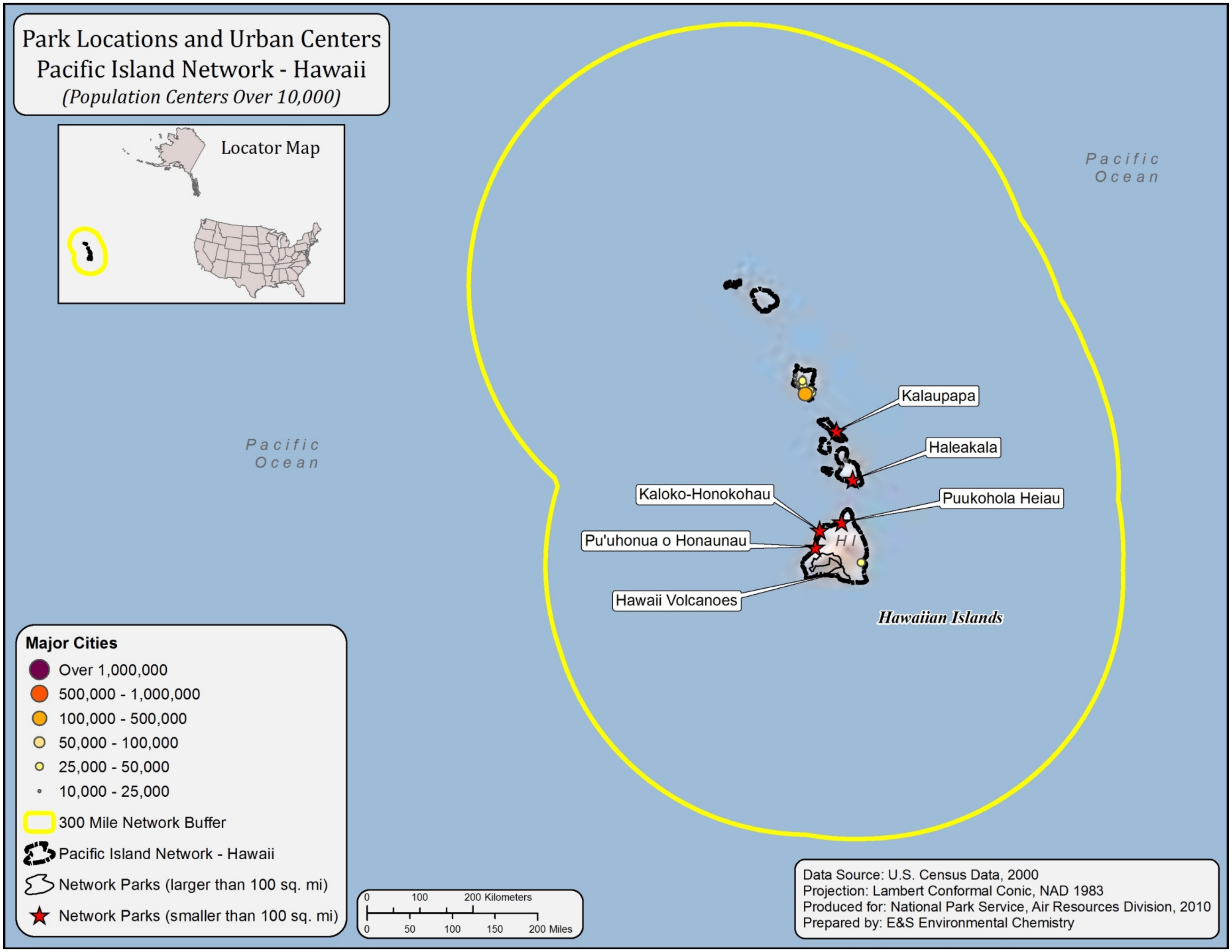
Map C

PACN-9



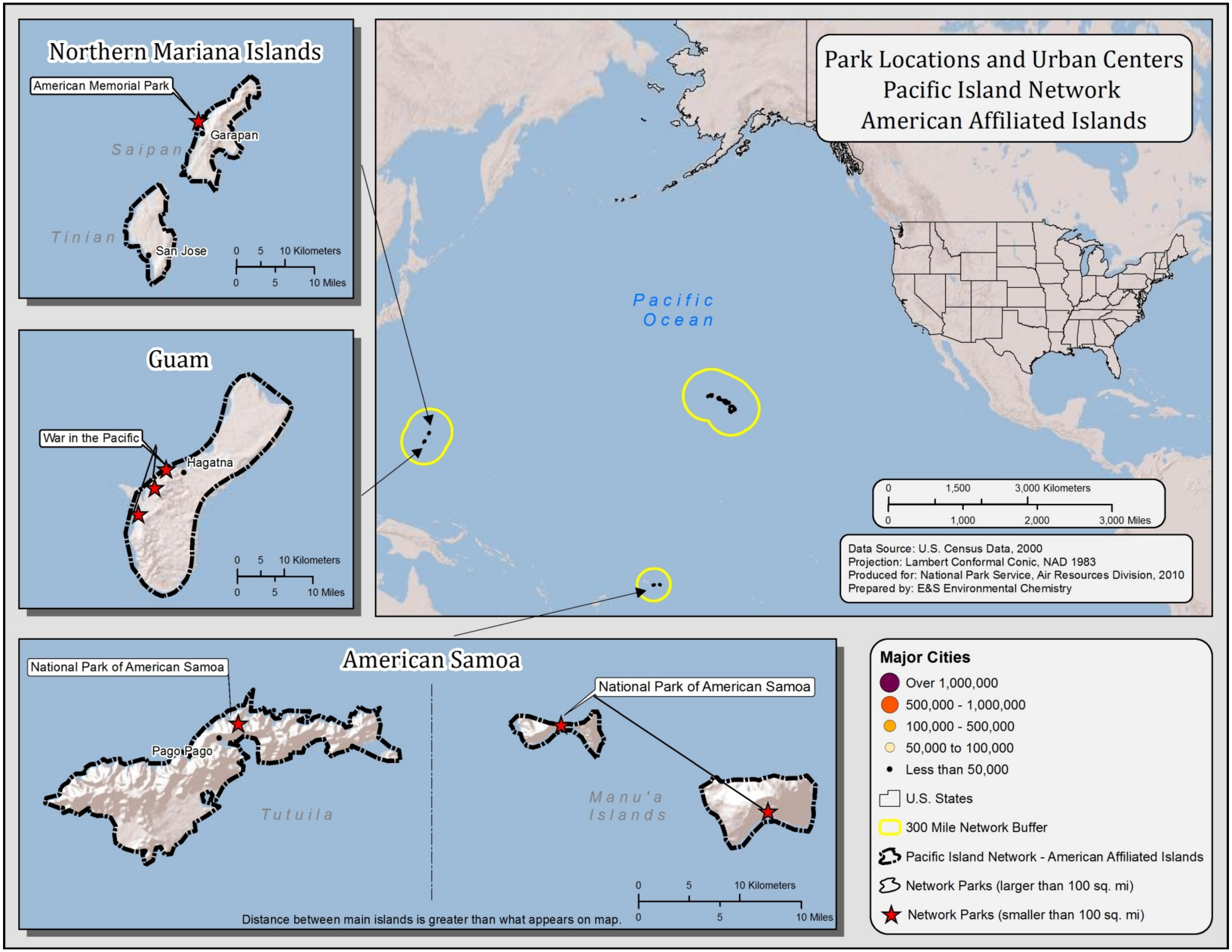
NOx (Nitrogen Oxides) and NH3 (Ammonia) Point Sources
Pacific Island Network - Hawaii
(tons N per year)
Locator Map
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
Pacific Ocean
Pacific Ocean
NOx Point Sources (tons N per year)
2,500 tons N/year
NH3 Point Sources (tons N per year)
1,000 tons N/year
U.S. States
Pacific Island Network - Hawaii
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)
World Shaded Relief
0 50 100 Kilometers
0 25 50 75 100 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 D



Park Locations and Urban Centers
Pacific Island Network - Hawaii
(Population Centers Over 10,000)
Locator Map
Pacific Ocean
Pacific Ocean
Kalaupapa
Haleakala
Kaloko-Honokohau
Puukohola Heiau
Pu'uhonua o Honaunau
HI
Hawaii Volcanoes
Hawaiian Islands
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
300 Mile Network Buffer
Pacific Island Network - Hawaii
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

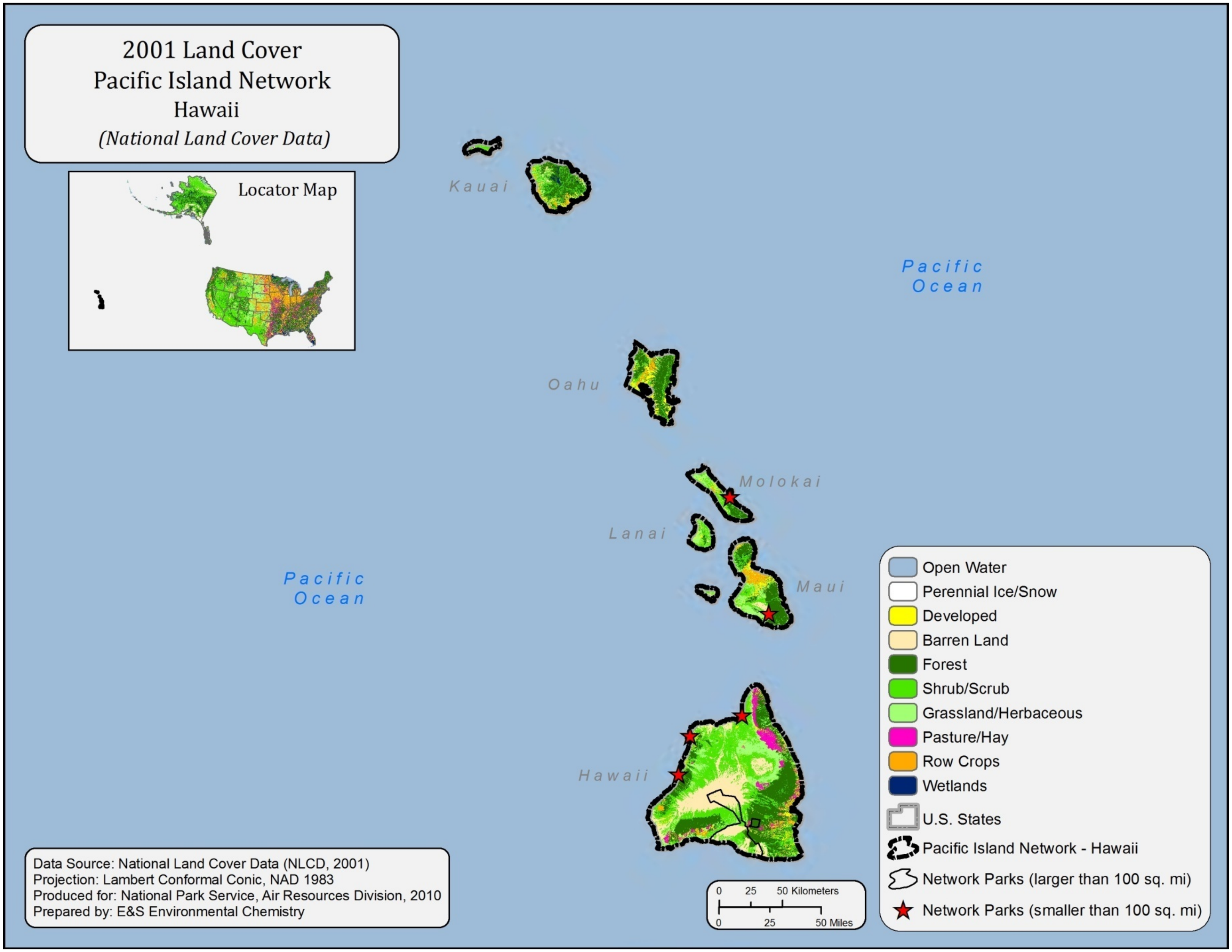
Map E-1



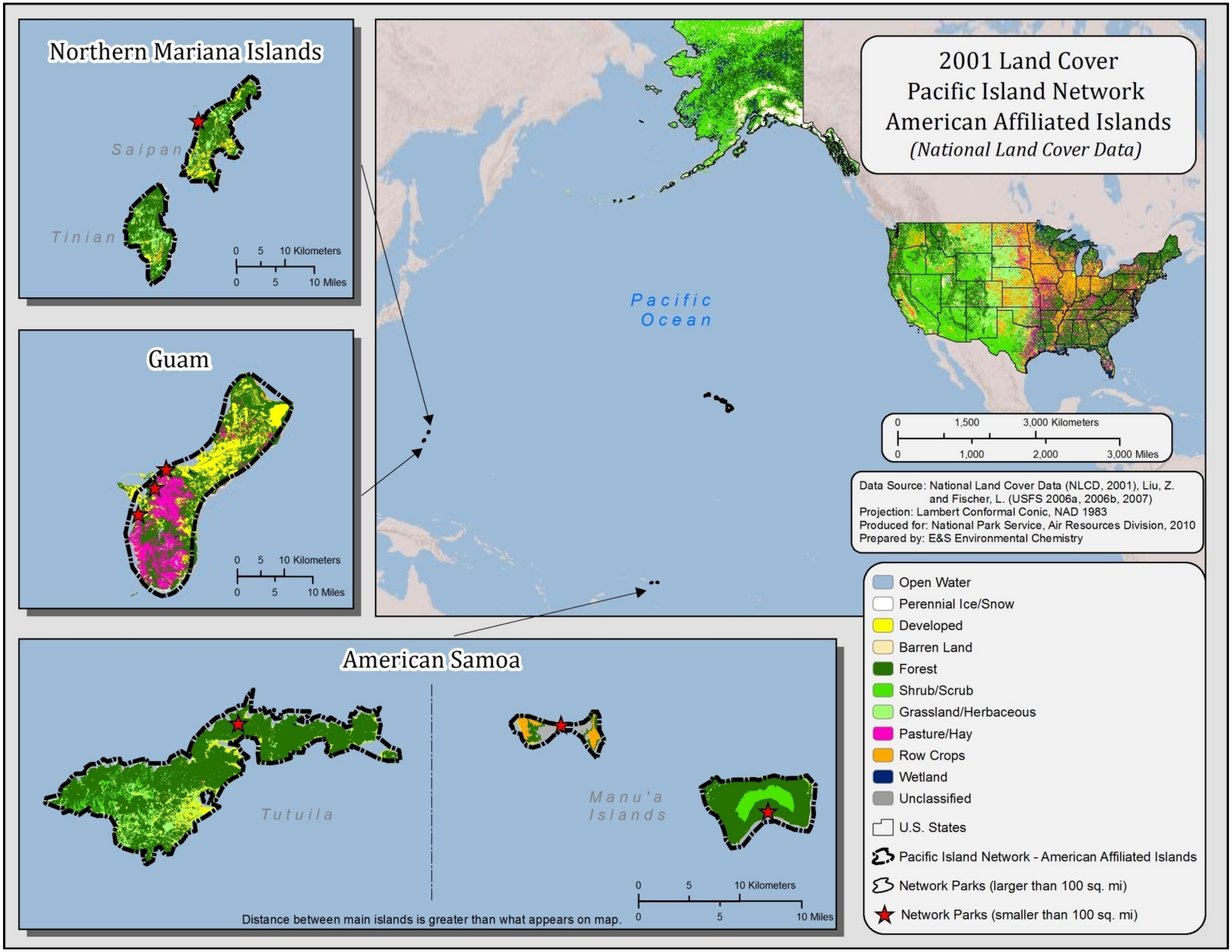
PACN-12

Map E-2

PACN-13

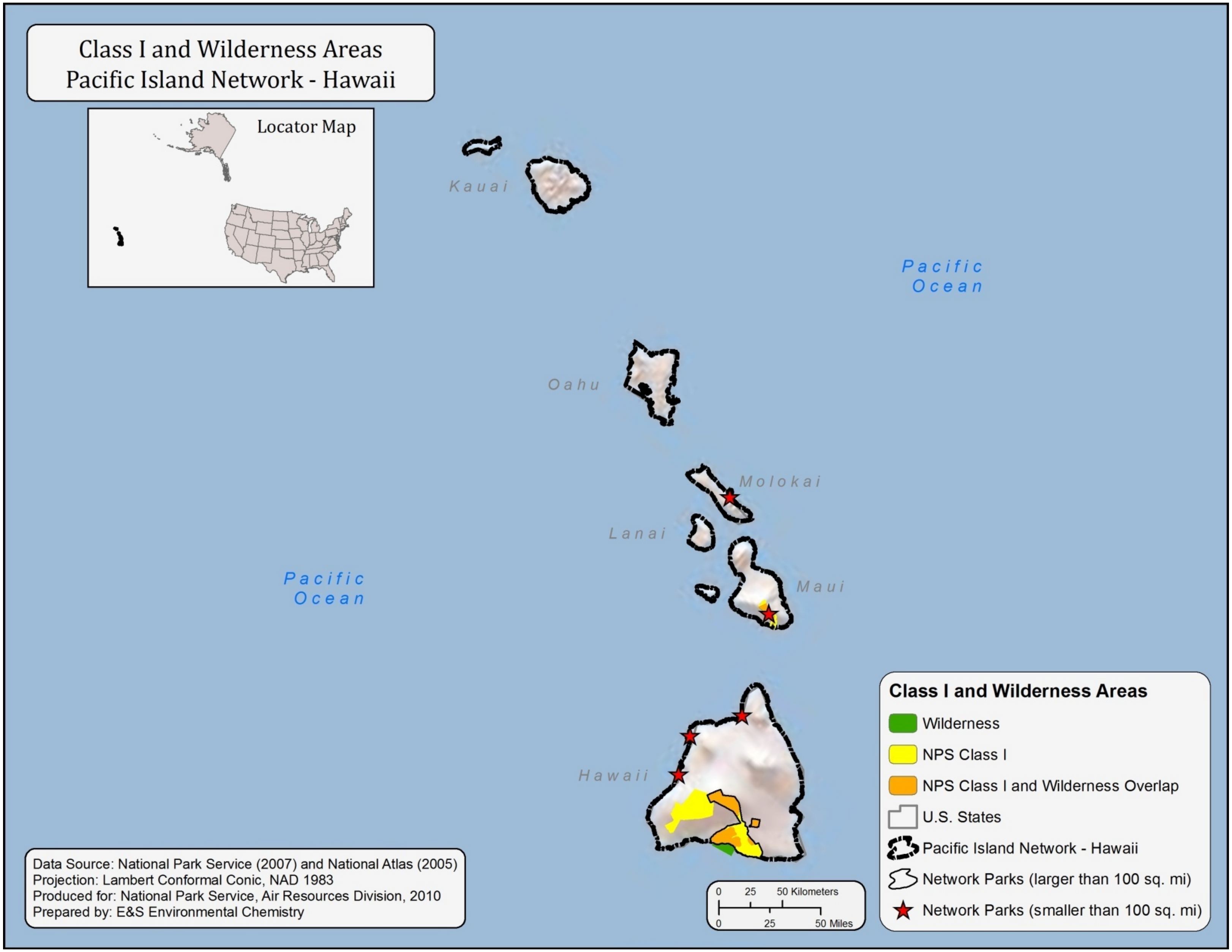


Map G-1



2001 Land Cover
Pacific Island Network
American Affiliated Islands
(National Land Cover Data)
Northern Mariana Islands
Saipan
Tinian
0 5 10 Kilometers
0 5 10 Miles
Guam
0 5 10 Kilometers
0 5 10 Miles
American Samoa
Tutuila
Manu'a Islands
0 5 10 Kilometers
0 5 10 Miles
Distance between main islands is greater than what appears on map.
Pacific Ocean
0 1,500 3,000 Kilometers
0 1,000 2,000 3,000 Miles
Data Source: National Land Cover Data (NLCD, 2001), Liu, Z. and Fischer, L. (USFS 2006a, 2006b, 2007)
Projection: Lambert Conformal Conic, NAD 1983
Produced for: National Park Service, Air Resources Division, 2010
Prepared by: E&S Environmental Chemistry
Open Water
Perennial Ice/Snow
Developed
Barren Land
Forest
Shrub/Scrub
Grassland/Herbaceous
Pasture/Hay
Row Crops
Wetland
Unclassified
U.S. States
Pacific Island Network - American Affiliated Islands
Network Parks (larger than 100 sq. mi)
Network Parks (smaller than 100 sq. mi)

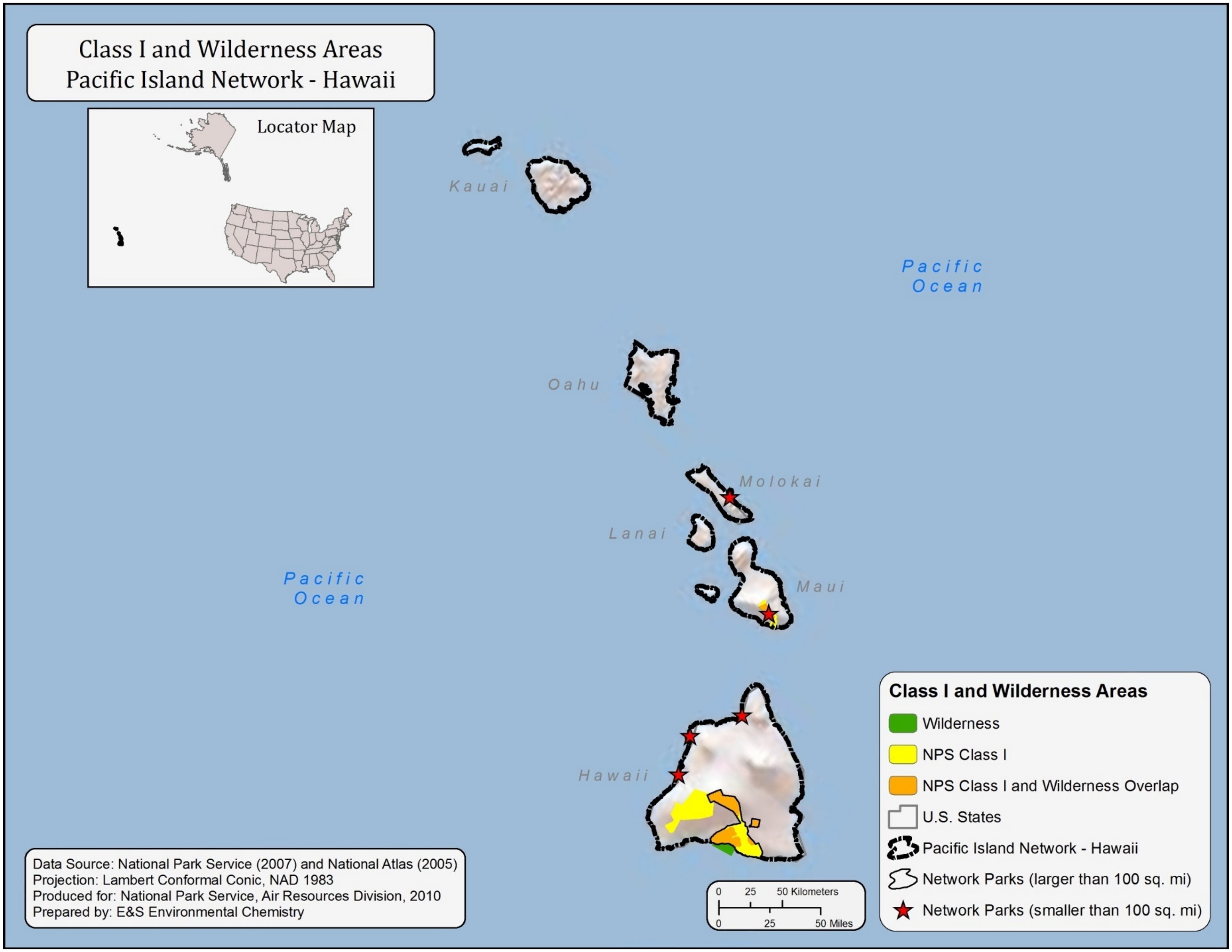
Map G-2



Class I and Wilderness Areas
Pacific Island Network - Hawaii
Locator Map
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
Pacific Ocean
Pacific Ocean
Class I and Wilderness Areas
Wilderness
NPS Class I
NPS Class I and Wilderness Overlap
U.S. States
Pacific Island Network - Hawaii
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 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

Map H

PACN-16



Class I and Wilderness Areas
Pacific Island Network - Hawaii
Locator Map
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
Pacific Ocean
Pacific Ocean
Class I and Wilderness Areas
Wilderness
NPS Class I
NPS Class I and Wilderness Overlap
U.S. States
Pacific Island Network - Hawaii
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 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

Map I

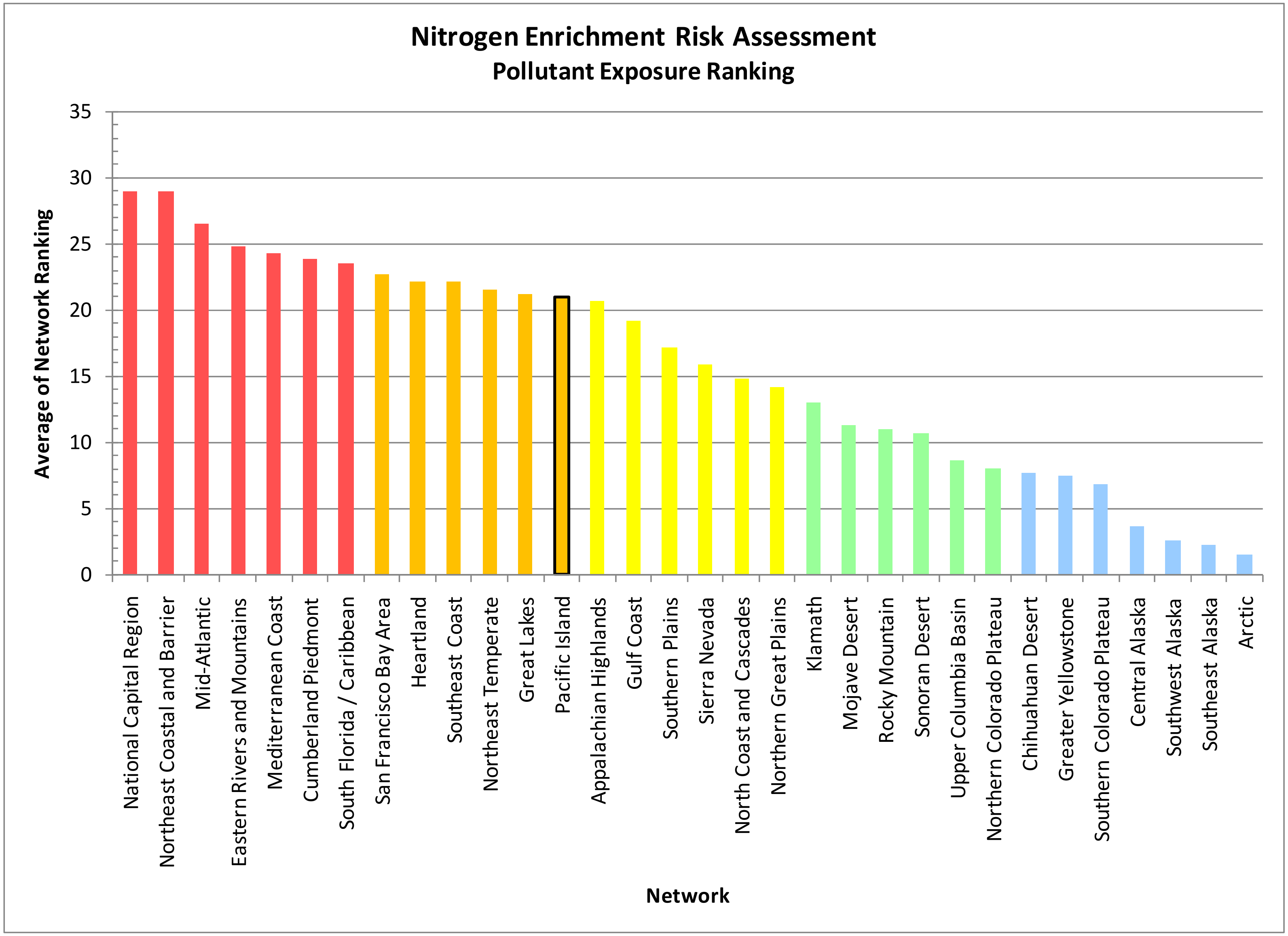


Figure A

PACN-17

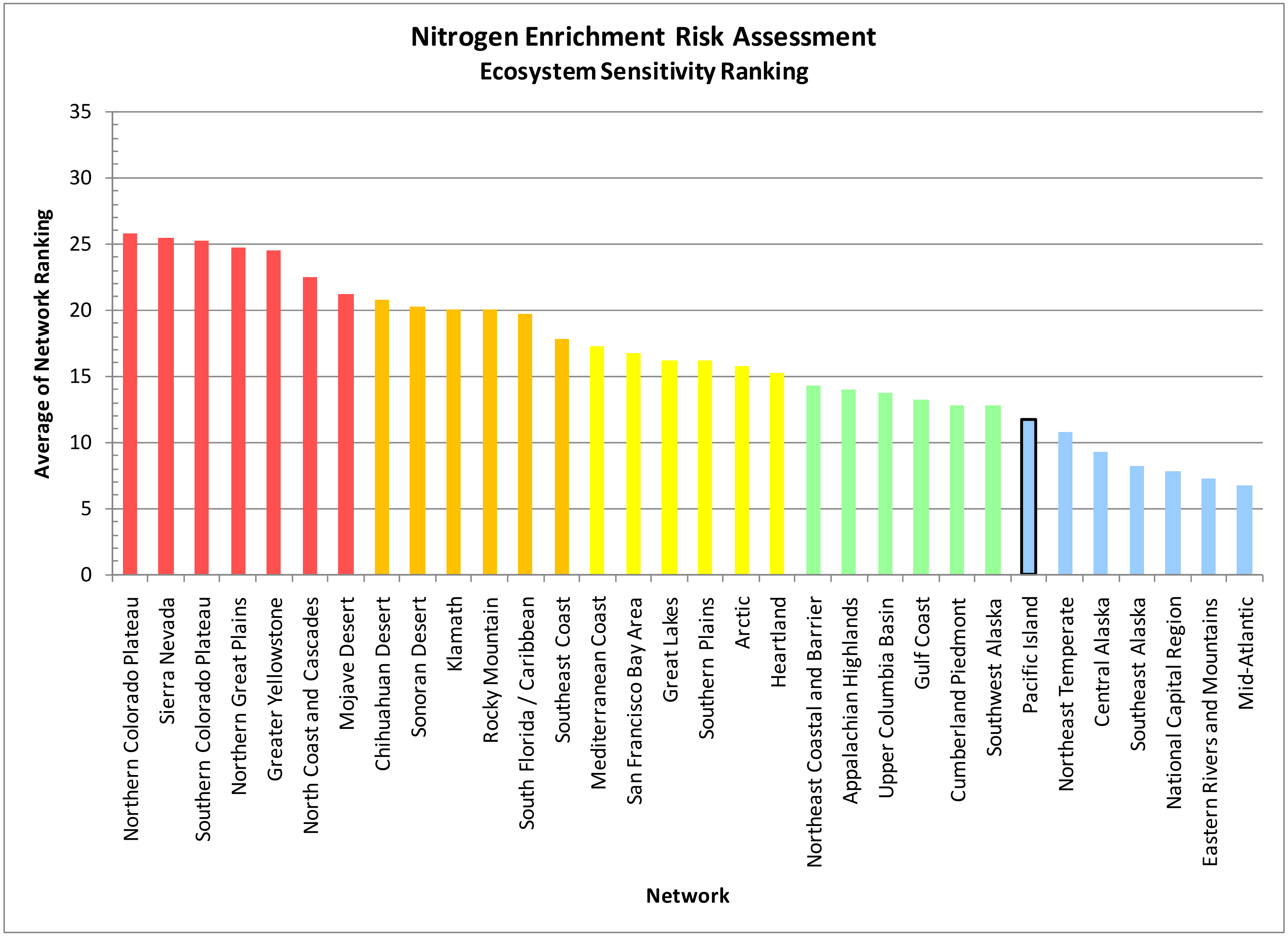
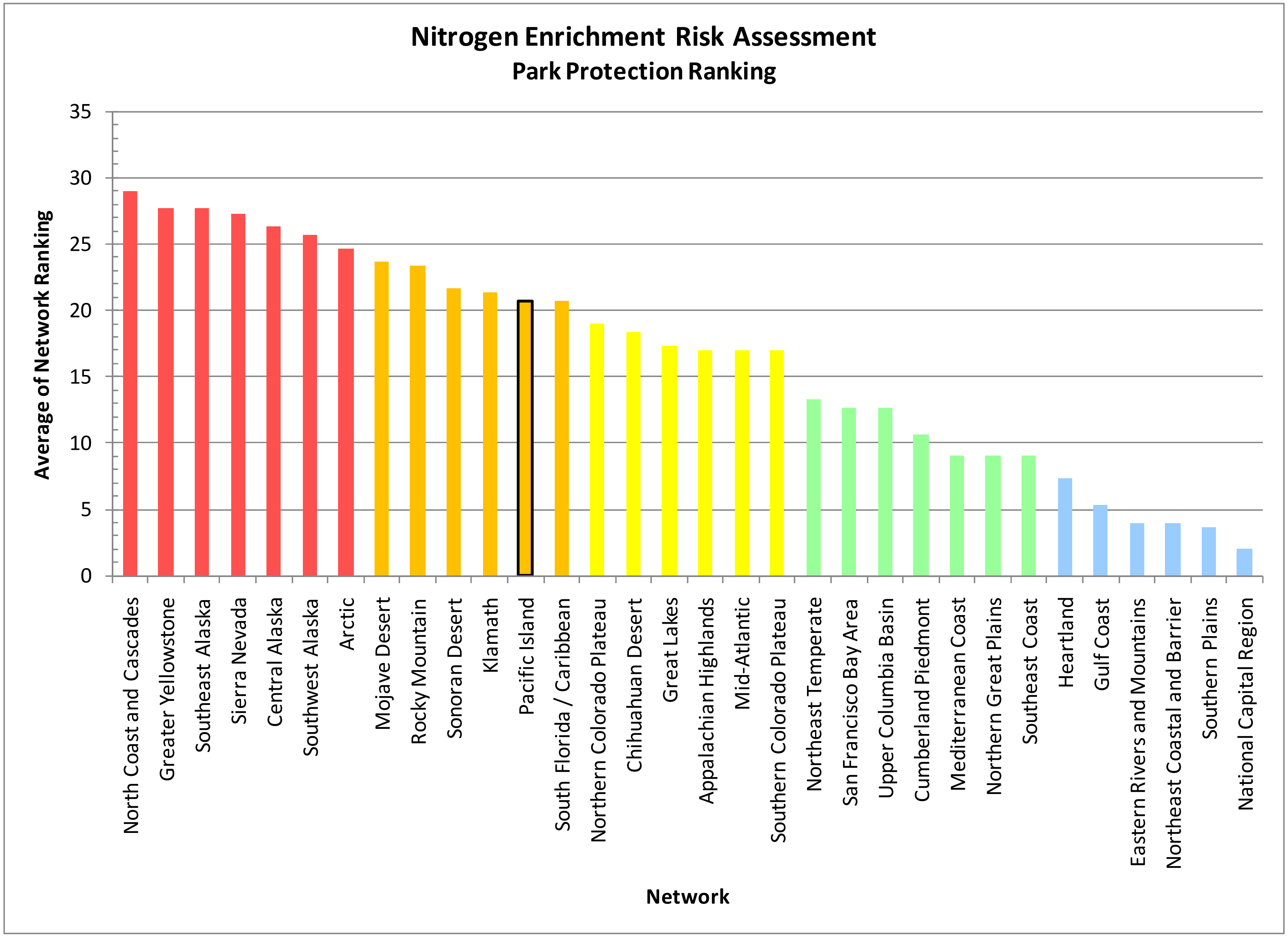

Nitrogen Enrichment Risk Assessment
Ecosystem Sensitivity Ranking
Average of Network Ranking
0
5
10
15
20
25
30
35
Northern Colorado Plateau
Sierra Nevada
Southern Colorado Plateau
Northern Great Plains
Greater Yellowstone
North Coast and Cascades
Mojave Desert
Chihuahuan Desert
Sonoran Desert
Klamath
Rocky Mountain
South Florida / Caribbean
Southeast Coast
Mediterranean Coast
San Francisco Bay Area
Great Lakes
Southern Plains
Arctic
Heartland
Northeast Coastal and Barrier
Appalachian Highlands
Upper Columbia Basin
Gulf Coast
Cumberland Piedmont
Southwest Alaska
Pacific Island
Northeast Temperate
Central Alaska
Southeast Alaska
National Capital Region
Eastern Rivers and Mountains
Mid-Atlantic
Network

Figure B



Nitrogen Enrichment 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
Sonoran Desert
Klamath
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

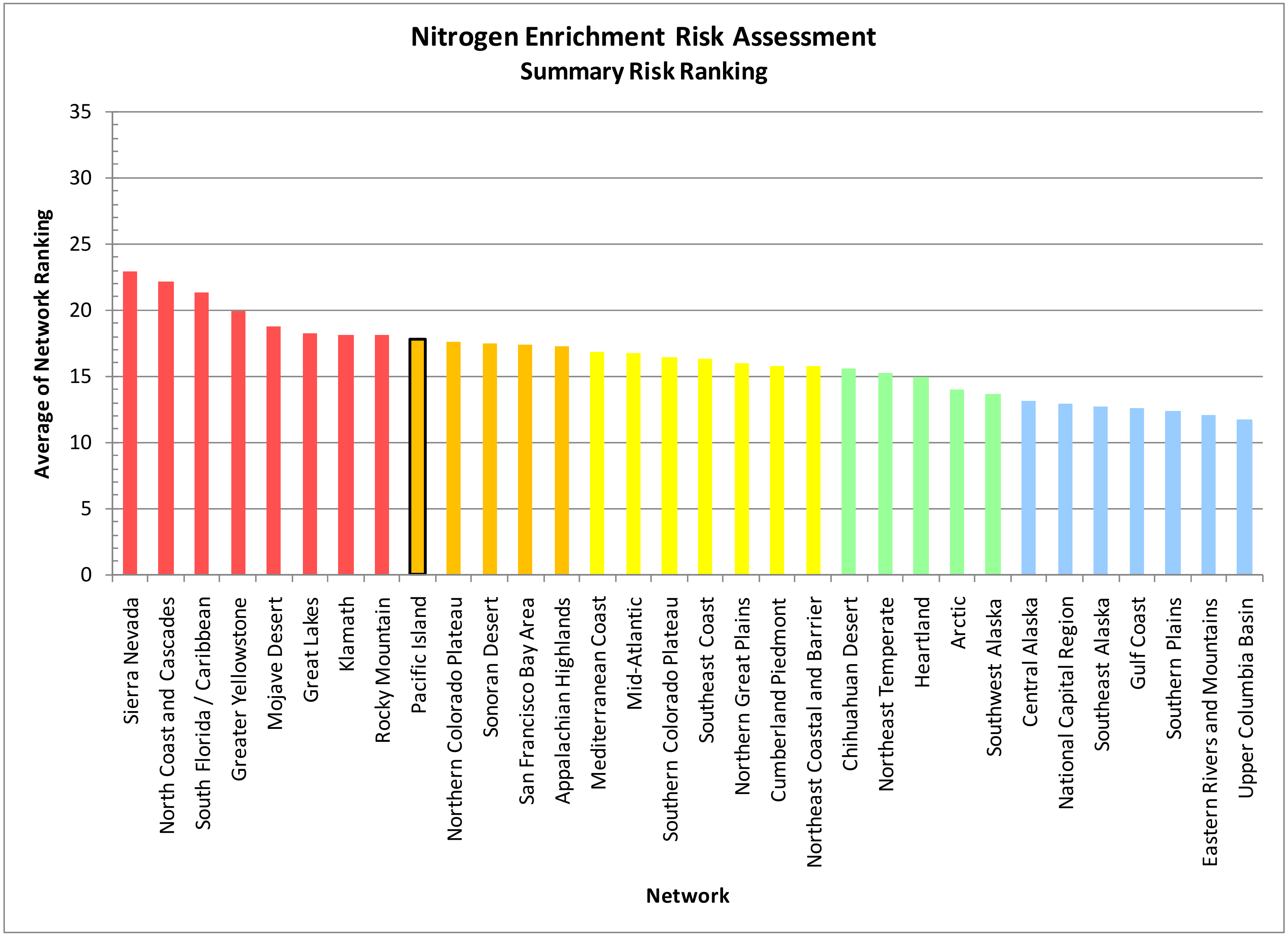

Nitrogen Enrichment Risk Assessment
Summary Risk Ranking
Average of Network Ranking
35
30
25
20
15
10
5
0
Sierra Nevada
North Coast and Cascades
South Florida / Caribbean
Greater Yellowstone
Mojave Desert
Great Lakes
Klamath
Rocky Mountain
Pacific Island
Northern Colorado Plateau
Sonoran Desert
San Francisco Bay Area
Appalachian Highlands
Mediterranean Coast
Mid-Atlantic
Southern Colorado Plateau
Southeast Coast
Northern Great Plains
Cumberland Piedmont
Northeast Coastal and Barrier
Chihuahuan Desert
Northeast Temperate
Heartland
Arctic
Southwest Alaska
Central Alaska
National Capital Region
Southeast Alaska
Gulf Coast
Southern Plains
Eastern Rivers and Mountains
Upper Columbia Basin
Network

Figure D

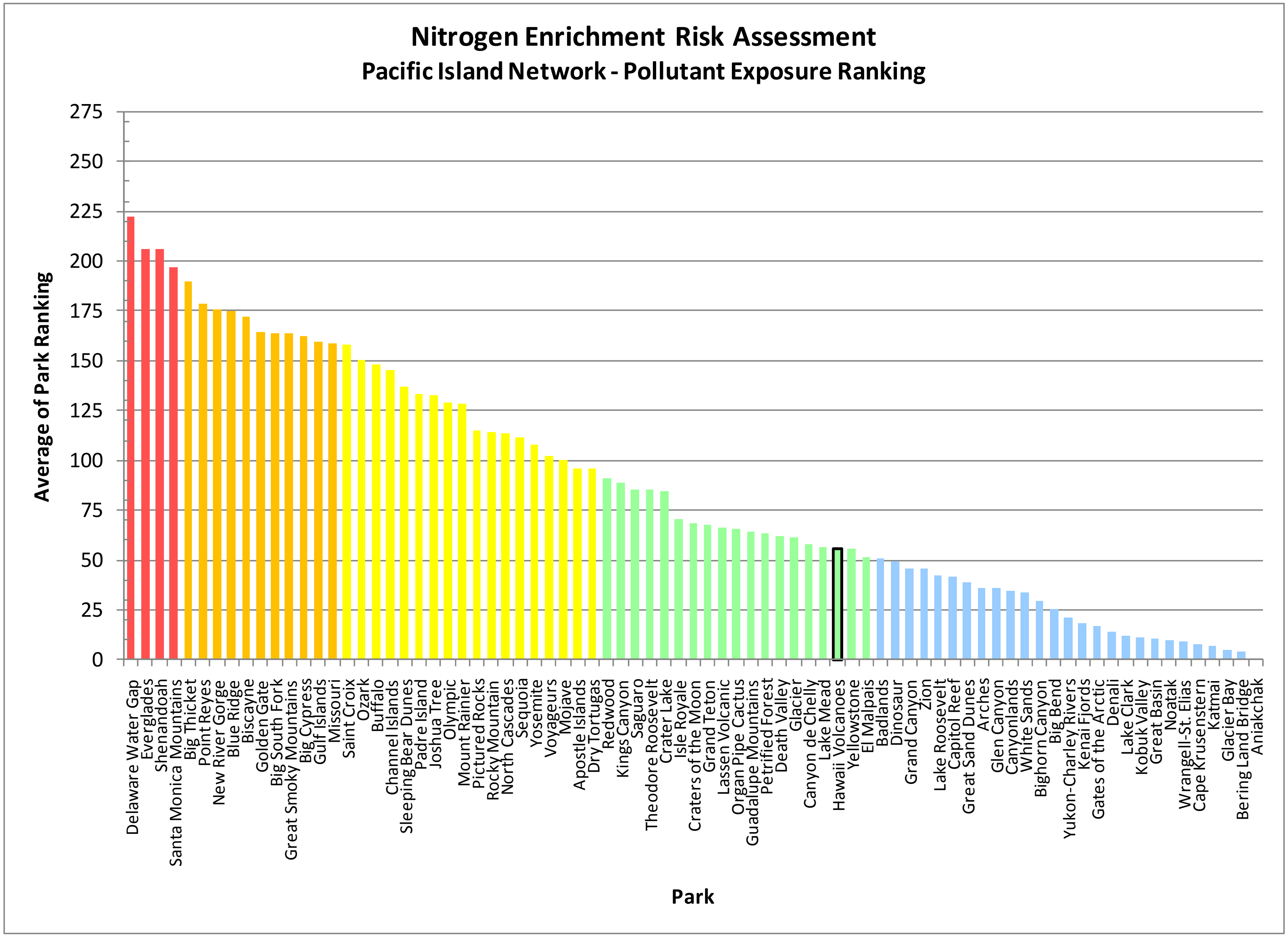


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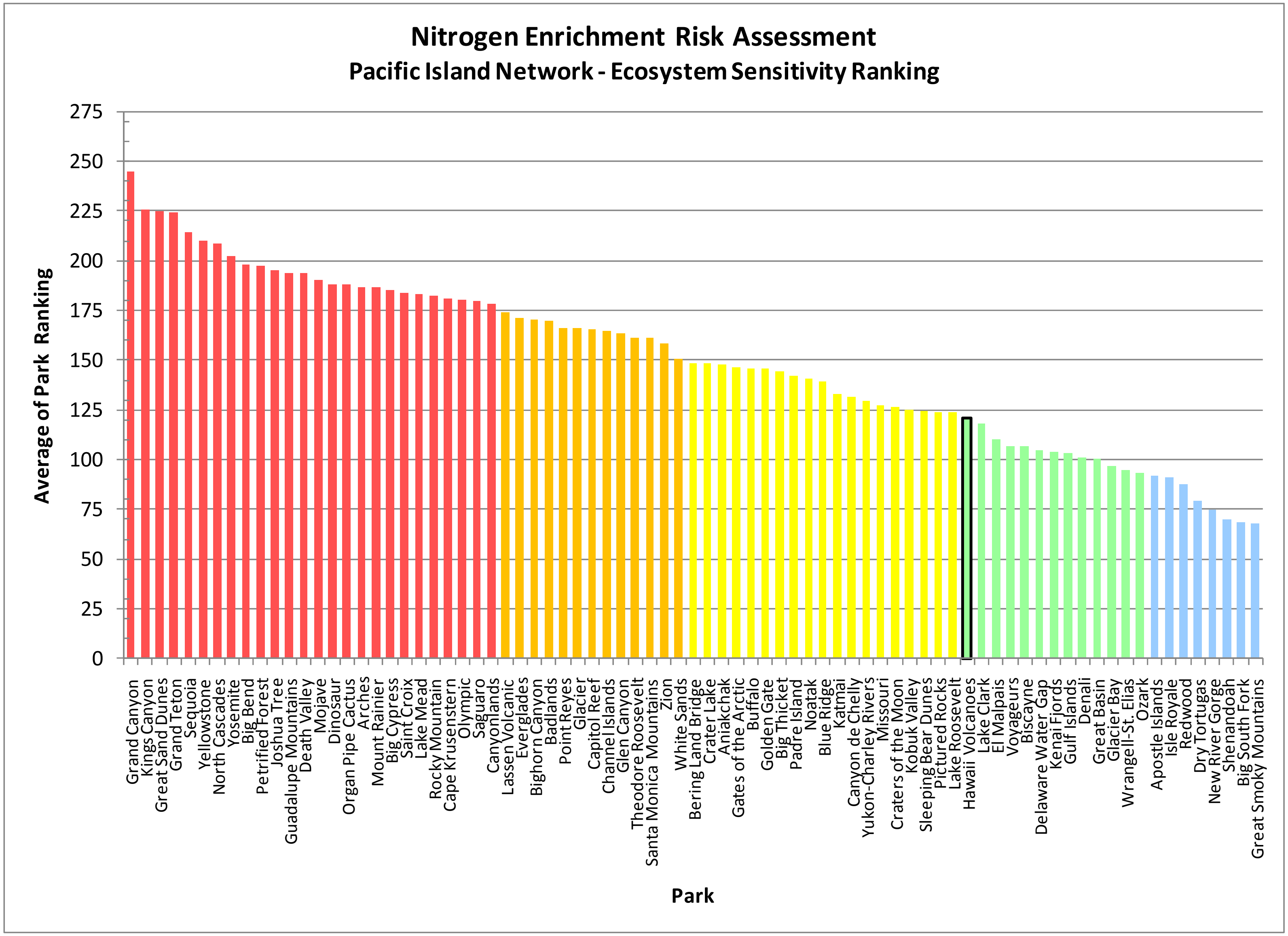
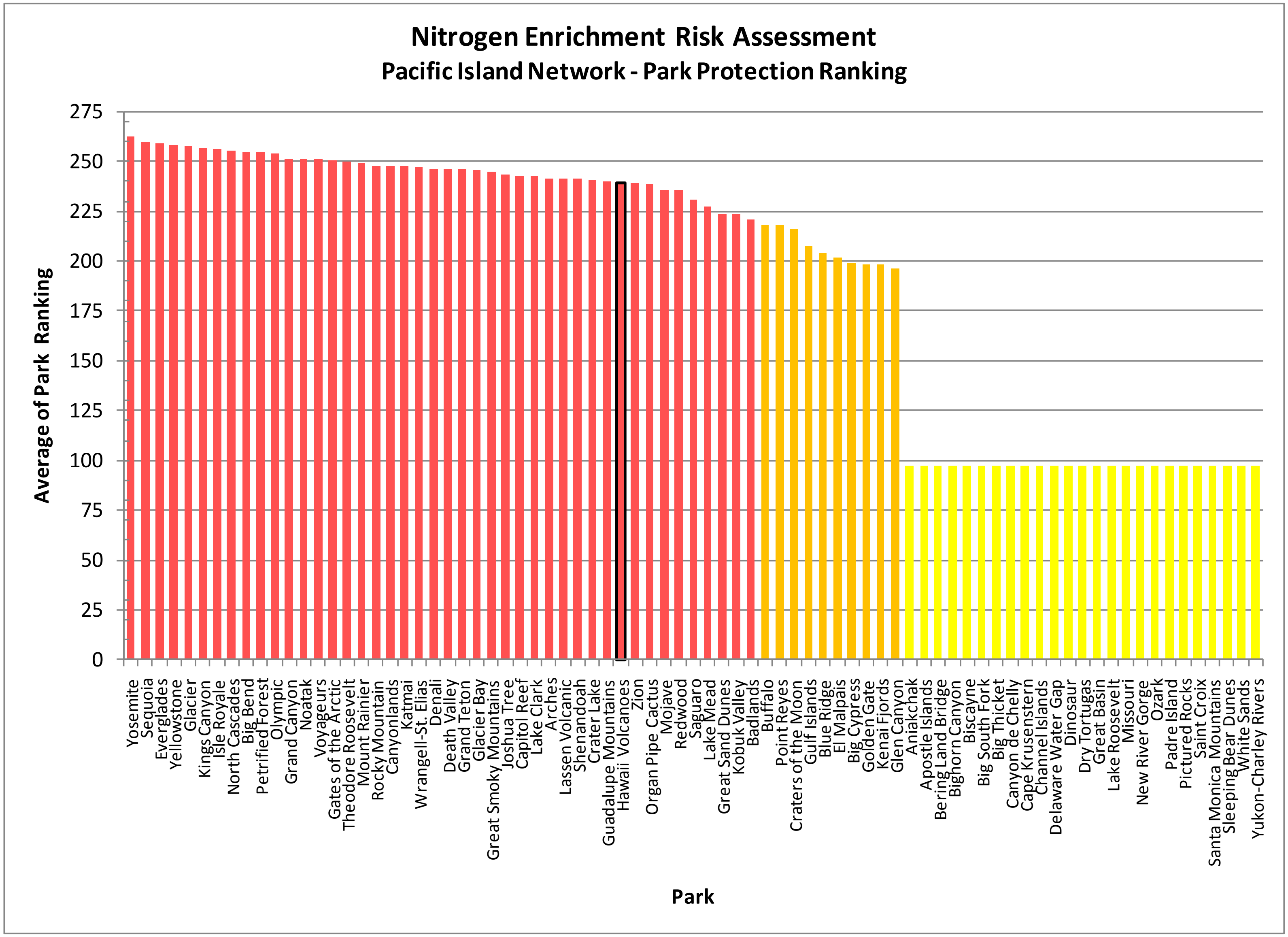
Figure E



Nitrogen Enrichment Risk Assessment
Pacific Island Network - Ecosystem Sensitivity Ranking
Average of Park Ranking
275
250
225
200
175
150
125
100
75
50
25
0
Grand Canyon
Kings Canyon
Great Sand Dunes
Grand Teton
Sequoia
Yellowstone
North Cascades
Yosemite
Big Bend
Petrified Forest
Joshua Tree
Guadalupe Mountains
Death Valley
Mojave
Dinosaur
Organ Pipe Cactus
Arches
Mount Rainier
Big Cypress
Saint Croix
Lake Mead
Rocky Mountain
Cape Krusenstern
Olympic
Saguaro
Canyonlands
Lassen Volcanic
Everglades
Bighorn Canyon
Badlands
Point Reyes
Glacier
Capitol Reef
Channel Islands
Glen Canyon
Theodore Roosevelt
Santa Monica Mountains
Zion
White Sands
Bering Land Bridge
Crater Lake
Aniakchak
Gates of the Arctic
Buffalo
Golden Gate
Big Thicket
Padre Island
Noatak
Blue Ridge
Katmai
Canyon de Chelly
Yukon-Charley Rivers
Missouri
Craters of the Moon
Kobuk Valley
Sleeping Bear Dunes
Pictured Rocks
Lake Roosevelt
Hawaii Volcanoes
Lake Clark
El Malpais
Voyageurs
Biscayne
Delaware Water Gap
Kenai Fjords
Gulf Islands
Denali
Great Basin
Glacier Bay
Wrangell-St. Elias
Ozark
Apostle Islands
Isle Royale
Redwood
Dry Tortugas
New River Gorge
Shenandoah
Big South Fork
Great Smoky Mountains
Park

Figure F


Nitrogen Enrichment Risk Assessment
Pacific Island Network - Park Protection Ranking
Average of Park Ranking
275
250
225
200
175
150
125
100
75
50
25
0
Yosemite
Sequoia
Everglades
Yellowstone
Glacier
Kings Canyon
Isle Royale
North Cascades
Big Bend
Petrified Forest
Olympic
Grand Canyon
Noatak
Voyageurs
Gates of the Arctic
Theodore Roosevelt
Mount Rainier
Rocky Mountain
Canyonlands
Katmai
Wrangell-St. Elias
Denali
Death Valley
Grand Teton
Glacier Bay
Great Smoky Mountains
Joshua Tree
Capitol Reef
Lake Clark
Arches
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Shenandoah
Crater Lake
Guadalupe Mountains
Hawaii Volcanoes
Zion
Organ Pipe Cactus
Mojave
Redwood
Saguaro
Lake Mead
Great Sand Dunes
Kobuk Valley
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Buffalo
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Big South Fork
Big Thicket
Canyon de Chelly
Cape Krusenstern
Channel Islands
Delaware Water Gap
Dinosaur
Dry Tortugas
Great Basin
Lake Roosevelt
Missouri
New River Gorge
Ozark
Padre Island
Pictured Rocks
Saint Croix
Santa Monica Mountains
Sleeping Bear Dunes
White Sands
Yukon-Charley Rivers
Park

Figure G

PACN-24

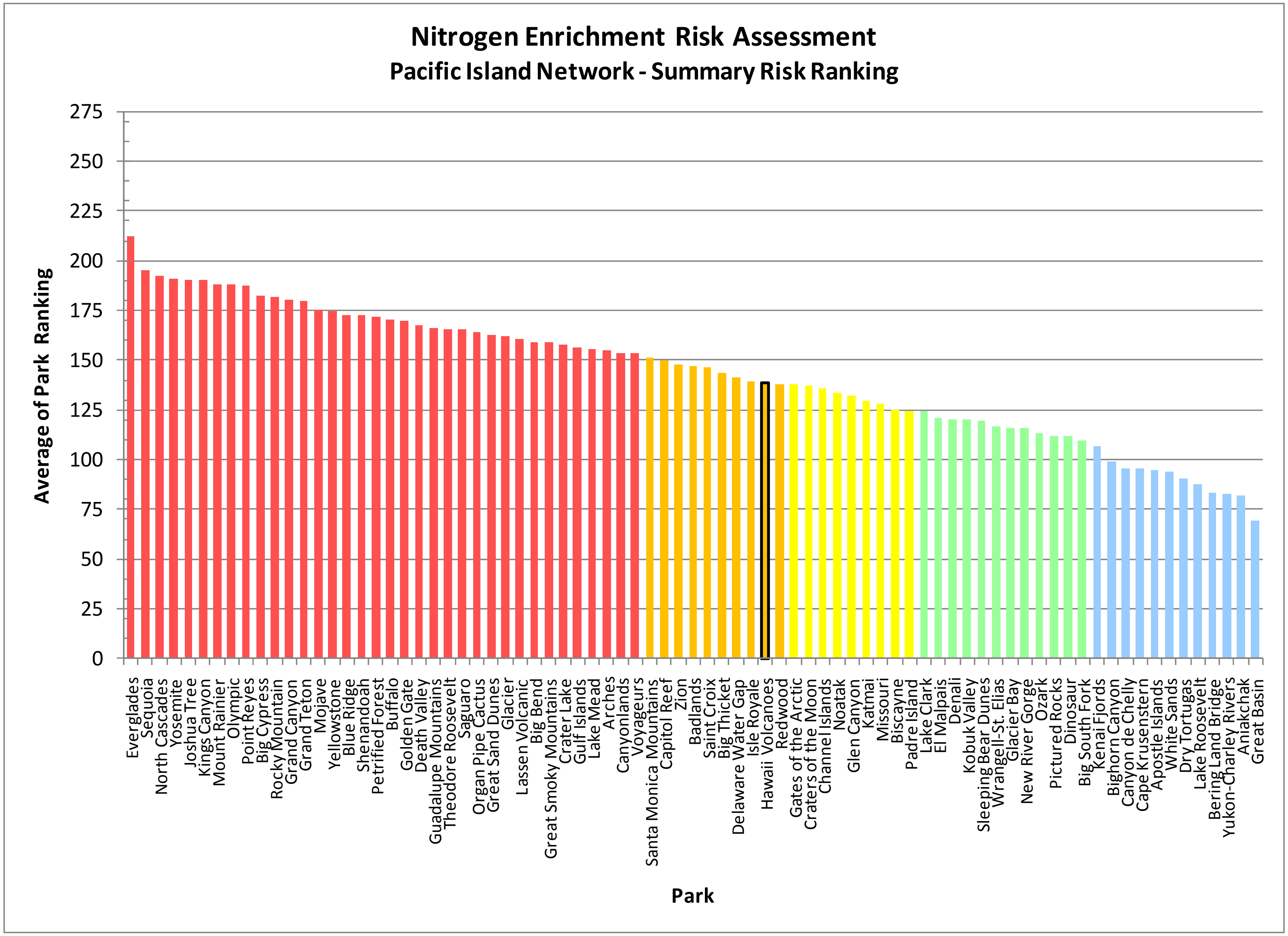

Figure H

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 963/106687, February 2011

National Park Service
U.S. Department of the Interior

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