



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

Main Report

Natural Resource Report NPS/NRPC/ARD/NRR—2011/313



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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Executive Summary

This document was prepared for the National Park Service (NPS), Air Resources Division, to assist the Inventory and Monitoring (I&M) national park units in the United States to evaluate their relative sensitivity to potential nutrient enrichment effects caused by atmospheric N deposition. Such effects can be caused by the addition of oxidized N (NO_x) and/or reduced N (NH_x) to natural ecosystems. Nutrient N enrichment can occur in both terrestrial and aquatic ecosystems. The addition of N from air pollution sources to national park ecosystems can alter plant and algal communities and influence the mix of species that thrive in sensitive ecosystems.

The goal of this effort was to construct a preliminary overall risk assessment to estimate the relative risk to I&M parks, and to I&M networks, of nutrient enrichment impacts from atmospheric N deposition. This assessment includes consideration of three factors that influence nutrient enrichment risk to park resources from atmospheric N deposition: N Pollutant Exposure, inherent Ecosystem Sensitivity, and Park Protection mandates. National parks and networks are ranked according to each of these factors (themes), as discussed in the three sections that follow. An overall risk ranking is then calculated based on averages of the three theme rankings.

Nitrogen Pollutant Exposure

Nitrogen Pollutant Exposure is reflected in multiple variables that indicate N emissions and N deposition. The amounts of NO_x and NH_x emitted into the atmosphere vary across the United States, generally with highest emissions in and around major population centers and centers of energy, agricultural, and industrial development. The direction of atmospheric transport and distance traveled vary with chemical and meteorological conditions encountered along the path from emissions source to the location at which pollutants are deposited from the air to the ground surface. Nitrogen deposition also varies dramatically across the United States. This variability applies to the mechanism of deposition (wet, dry, cloud, fog), relative contribution of oxidized versus reduced forms of N, and total quantity deposited.

Emissions inventories are available from the U.S. Environmental Protection Agency (EPA). However, they are only approximations of actual atmospheric emissions and are less certain for NH_x , as compared with NO_x . Deposition estimates are uncertain, especially for the dry component of deposition. Estimates of wet plus dry N deposition constructed for this project are relatively coarse (12-km grid cells in the East; 36-km grid cells in the West) and do not fully capture spatial variation in deposition that are especially pronounced in areas of complex terrain. Nevertheless, they do provide a reasonable approximation of patterns in N deposition that potentially impact the ecosystems on which this deposition falls.

Ecosystem Effects

The addition of relatively small amounts of a key nutrient (nitrogen) from atmospheric deposition can contribute to changes in the species mix of the terrestrial plant and aquatic algal communities. Nutrient enrichment can cause some species to thrive, and others to decline. Thus, the mix of species present in an ecosystem can change as a consequence of nutrient addition.

We summarize here the extent and distribution of the fresh water aquatic and terrestrial ecosystems within the national parks that are thought to be most sensitive to the effects of nutrient enrichment from atmospheric N deposition. These include remote lakes at high elevation, and also alpine, arctic, meadow, arid and semi-arid terrestrial ecosystems, and wetlands which are transitional between terrestrial and aquatic ecosystems.

In many terrestrial ecosystems and some aquatic ecosystems, N is the most important nutrient limiting the growth of plants and/or algae. If an appreciable amount of N is added to such an ecosystem from atmospheric deposition, growth rates can increase. Because some species are better able to take advantage of added N than others, the end result can be an increase in the growth of some species at the expense of others. The species that benefit are often non-native opportunistic species; those that are suppressed are sometimes rare native species.

Certain plants and plant communities appear to be more sensitive to nutrient effects than others. Some lichens are especially sensitive, with documented effects occurring in the N deposition range of only about 3 kilograms per hectare per year (kg N/ha/yr; one hectare equals 2.47 acres). In general, plant communities that are dominated by herbaceous plants appear to be more sensitive to N enrichment than plant communities dominated by trees. This may be partly due to lifetime cycle differences, because it takes a long time for scientists to document effects on trees which can grow for decades or centuries, and/or because the understory plants in a forest may be affected at lower levels of N input than the trees themselves. Regardless, nutrient enrichment effects on plant communities in the United States have been most convincingly demonstrated for arctic and alpine herbaceous communities, meadows, wetlands, and arid or semi-arid lands (U.S. EPA 2009). The latter include plant communities in arid and semi-arid settings that might be dominated by shrubs, grasses and forbs, or cacti. These are the plant community types that we discuss here. This does not mean, however, that some of these same effects may not also be occurring in forest or mesic shrub communities.

Park Protection

The NPS 1916 Organic Act directs the NPS to manage parks in such a way as to leave them unimpaired for the enjoyment of future generations. NPS Management Policies (NPS 2006; available at <http://www.nps.gov/policy/mp2006.pdf>) state that NPS will preserve the best possible air quality in all parks to preserve natural resources and ecosystems, and protect sensitive resources from air pollution damage. In addition, there are two types of public land designation that confer special protection against air pollution degradation: Wilderness and Class I. These designations were specified by the Wilderness Act and the Clean Air Act (CAA), respectively. Lands are identified for this N effects assessment that receive special Wilderness and/or Class I protection. These are the lands that are intended to receive the highest level of protection against adverse impacts caused by atmospheric deposition associated with air pollution. These more highly protected lands are assigned higher risk designations in this analysis than lands not designated as Class I or Wilderness.

Network and Park Rankings

Parks and networks are ranked by perceived risk. The risk rankings are determined by combining the three themes or layers of variables that represent N Pollutant Exposure, inherent Ecosystem Sensitivity, and the extent of existing special Park Protection. Each of these themes is quantified

using variables that are available spatially, generally for the entire United States, and that provide insight into the relative differences among parks in these three aspects of overall risk.

Networks were ranked for each emissions or deposition variable that was available spatially, from the network showing the lowest N Pollutant Exposure (lowest rank) to the network showing the highest N Pollutant Exposure (highest rank). These variable-specific rankings were then averaged to yield an overall N Pollutant Exposure ranking for each of the 32 networks, where lower numbers (near 1) reflect lower N Pollutant Exposure and higher numbers (near 32) reflect higher N Pollutant Exposure. Results of this summary statistic are graphed for each network.

Network designations were calculated in the same manner for the other two nutrient N enrichment themes: Ecosystem Sensitivity and level of Park Protection. Ecosystem Sensitivity is represented by the percent coverage of vegetative types expected to be most sensitive to nutrient N enrichment and the abundance of high-elevation lakes that might be prone to N-limitation. Park Protection is represented by designation as wilderness and Class I area. Finally, an overall risk of nutrient N enrichment effects was calculated as the average of the rankings for the three themes discussed above.

As for the network rankings, park rankings were calculated individually for N pollutant Exposure, Ecosystem Sensitivity, and Park Protection metrics. Results of those rankings are summarized by quintile for all parks regardless of size in each of the individual network sections of the report. Average scores for each metric and results of the overall park-specific risk assessment for the 79 larger I&M parks (those larger than 100 square miles) are graphed and mapped.

Differences among ranks were most pronounced for the approximately 20% of the networks that showed highest calculated risk. These included four western mountain networks (Sierra Nevada, North Coast and Cascades, Greater Yellowstone, and Klamath), one wetland dominated network (South Florida/Caribbean), one desert network (Mojave Desert), and the Great Lakes Network.

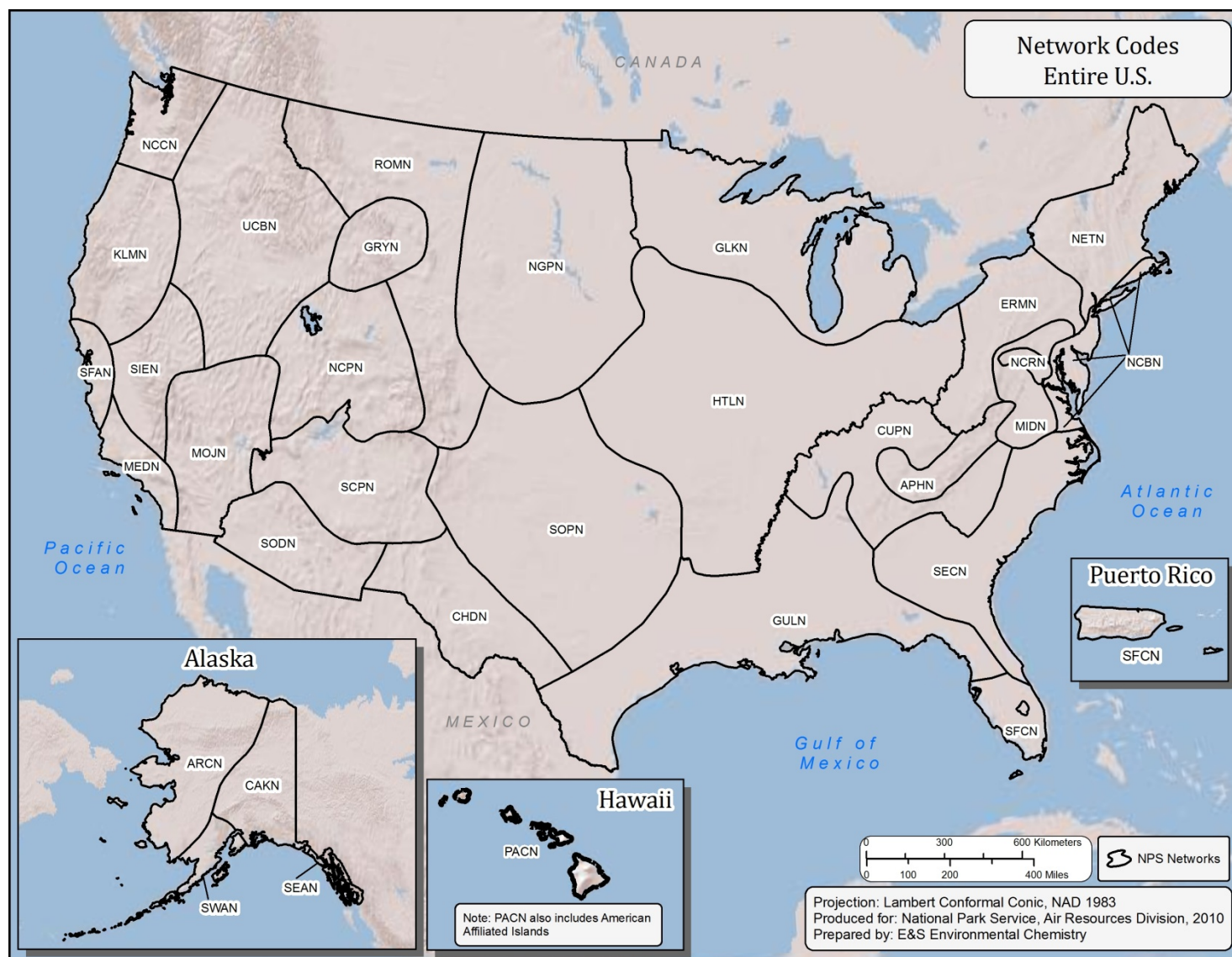
1. Background

1.1 Overall Project Approach

This project evaluates the sensitivity of all Inventory and Monitoring (I&M) national parks in the United States to nutrient enrichment effects caused by atmospheric nitrogen (N) deposition. Such effects can be caused by the addition of oxidized N (NO_x) and/or reduced N (NH_x) to natural ecosystems. Nutrient N enrichment can occur in both terrestrial and aquatic ecosystems and to wetlands that are transitional between the two. The addition of N from air pollution sources to national park ecosystems can alter plant and algal communities and influence the mix of species that occur or thrive in those ecosystems. Atmospheric deposition of N can also contribute to soil and drainage water acidification; acidification topics are addressed in a companion report.

This assessment includes consideration of several factors that influence risk to park resources: N Pollutant Exposure, inherent Ecosystem Sensitivity, and Park Protection mandates. Sensitivity varies with plant and algal community type. Some vegetation and algal community types have been found to be more susceptible to nutrient enrichment impacts from low to moderate levels of N addition than others. Such differences in response may be associated with such factors as differences in growth rates, nutrient assimilative capacity, and interspecific competitive interactions. The extent of N Pollutant Exposure is reflected in available data on the magnitude of emission sources and location relative to the I&M parks. Atmospheric wet and dry deposition estimates and proximity to human population centers and agricultural source areas also reflect N Pollutant Exposure. All parks receive protection under the Organic Act. Nevertheless, some parks, especially those designated as Class I or Wilderness, receive special protection from air pollution caused degradation. The degree of special protection conferred by these regulations is evaluated by computing the percent of park lands that are designated Class I and/or Wilderness.

The boundaries of the I&M networks are shown in Map 1; Table 1 lists the networks, along with the four-letter codes used to identify them. These codes are used throughout the individual network sections of this document for network identification.



Map 1. Locations of I&M networks. The network names associated with the four-letter identification codes are given in Table 1.

Table 1. List of Inventory and Monitoring networks and associated network codes.

Network Name	Network Code
Appalachian Highlands	APHN
Arctic	ARCN
Central Alaska	CAKN
Chihuahuan Desert	CHDN
Cumberland Piedmont	CUPN
Eastern Rivers and Mountains	ERMN
Great Lakes	GLKN
Greater Yellowstone	GRYN
Gulf Coast	GULN
Heartland	HTLN
Klamath	KLMN
Mediterranean Coast	MEDN
Mid Atlantic	MIDN
Mojave Desert	MOJN
National Capital Region	NCRN
North Coast and Cascades	NCCN
Northeast Coastal and Barrier	NCBN
Northeast Temperate	NETN
Northern Colorado Plateau	NCPN
Northern Great Plains	NGPN
Pacific Island	PACN
Rocky Mountain	ROMN
San Francisco Bay Area	SFAN
Sierra Nevada	SIEN
Sonoran Desert	SODN
South Florida Caribbean	SFCN
Southeast Alaska	SEAN
Southeast Coast	SECN
Southern Colorado Plateau	SCPN
Southern Plains	SOPN
Southwest Alaska	SWAN
Upper Columbia Basin	UCBN

1.2 Nitrogen Pollutant Exposure

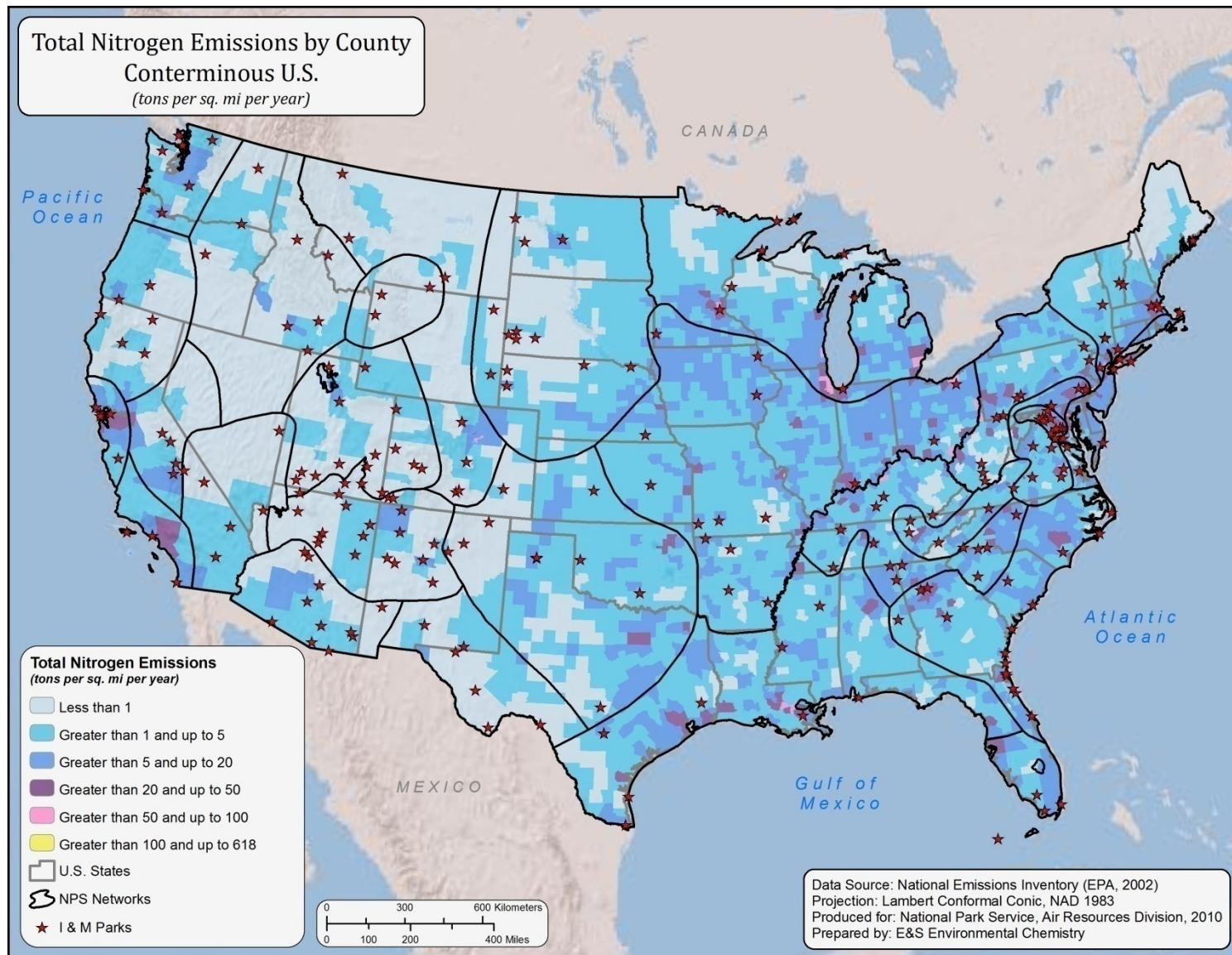
1.2.1 Emissions into the Atmosphere

There are two major kinds of human-caused emissions of N into the atmosphere in the United States: NO_x and NH_x. The oxidized forms (primarily nitrogen dioxide) derive mainly from motor vehicles, power plants, and industrial facilities. The reduced forms (primarily ammonia) derive mainly from agriculture, via volatilization of N contained in animal manures and fertilizers.

The amounts of NO_x and NH_x emitted into the atmosphere vary across the United States, generally with highest emissions in and around major population centers and centers of energy, agricultural, and industrial development. Total N emissions sources are mapped by county in Map 2, based on U.S. EPA emissions estimates for the United States (<http://www.epa.gov/ttn/chief/net/2002inventory.html#inventorydata>). These N emissions are dispersed through the atmosphere and transported with the prevailing winds. Some emissions are preferentially deposited to the ground in proximity to the source. When the emitted N is transported vertically upward by convection to the middle and upper troposphere, however, it can be transported long distances from the source areas. The direction of atmospheric transport and distance traveled vary with chemical and meteorological conditions encountered along the path from emissions source to the location at which pollutants are deposited from the air to the ground surface.

1.2.2 Atmospheric Deposition

Emissions of sulfur (S) and N from point and nonpoint air pollution sources eventually fall out of the atmosphere and land somewhere on the Earth's surface. In order for atmospheric N emitted from human-caused sources to contribute to environmental impacts (for example to plants, algae, or aquatic animals), the N must first be deposited from the air to the surface. Although this transfer is commonly called "acid rain" in the popular vernacular, rain only accounts for part of the transfer. Atmospheric pollutants move to the ground in rain, snow, clouds, and as dry particles and gases. The overall transfer process is called atmospheric deposition, which can be broken down into wet, dry, and cloud or fog components. This deposition can fall on multiple surfaces (e.g., plant foliage, ground, water, snow). Wet deposition has been monitored for about 20 to 30 years at many locations around the country by continuously collecting and analyzing samples of rain and snow. Dry and cloud deposition are more difficult to measure. Dry deposition can be estimated from measurements or model projections of pollutant concentrations in the air, assuming a rate of transfer from the air to the earth surface. Cloud deposition has been measured at only a few locations; measurements are generally prohibitively time-intensive and expensive. From plant surfaces, N can be transported to the interior of plant leaves through the leaf stomata. It can also be washed from plant surfaces into the soil with rainfall. Once N makes its way into plant tissues or into soil it can cause several kinds of ecological effects. These effects can be broadly characterized as nutrient enrichment effects and acidification effects. This report addresses nutrient enrichment effects. A companion report addresses acidification effects and associated processes called N saturation.



Map 2. Total annual N emissions by county for the year 2002 throughout the conterminous United States. Also shown are the locations of I&M parks and the I&M network boundaries.

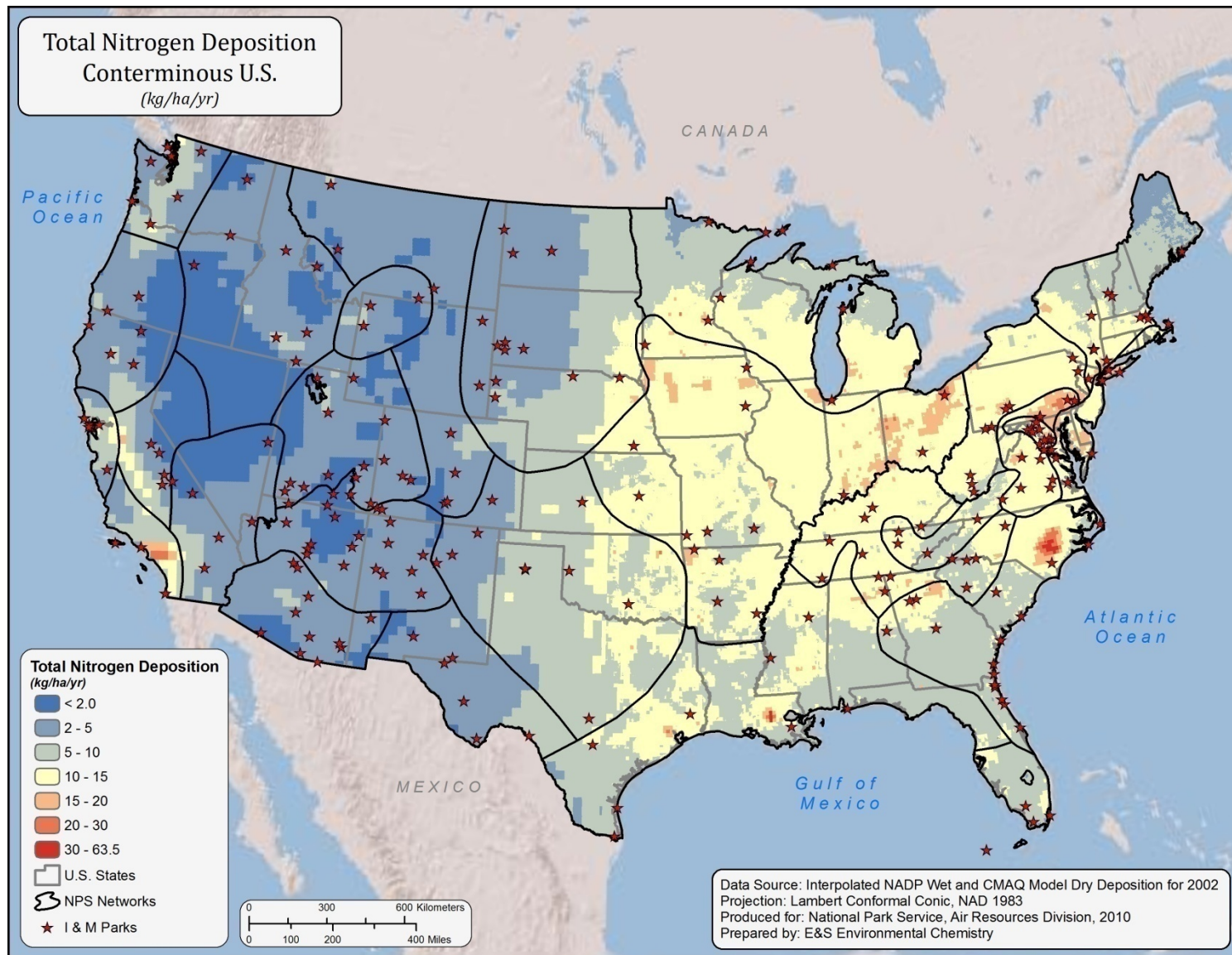
Nitrogen can take many forms in the atmosphere, soil, water, and living tissue. It depends on the identity and amount of the other things (mainly oxygen, hydrogen, and/or carbon) to which the N is attached. Atmospheric N is emitted from motor vehicles mostly as oxidized N (one N atom attached to one or more oxygen atoms). Atmospheric N from agricultural croplands or livestock is mostly emitted as reduced N (ammonia, containing one N atom and three hydrogen atoms). Within the soil, there are many conversions and transformations that take place, often facilitated by bacteria and fungi. The N form can change rather rapidly. Different plants and different kinds of algae vary in their needs for N nutrition. Some prefer oxidized forms; some prefer reduced forms; some can use small organic N molecules that also contain carbon atoms. When N leaches from the soil into drainage water, and eventually to a stream or lake, it is mostly in the nitrate (NO_3^-) form. When N deposition and its effects are discussed, all these different forms of N, and others, are included. Because so many of the forms are interconvertible in the environment, it is possible to ignore the complexities and discuss N as one entity, rather than many.

Nitrogen deposition varies dramatically across the United States. This variability applies to the mechanism of deposition (wet, dry, cloud, fog), relative contribution of oxidized versus reduced forms, and total quantity deposited. Dry deposition is much higher than wet deposition at some locations, mostly notably in and around the Los Angeles basin and near large sources of NO_x or NH_x . Cloud deposition can constitute as much as half of the total deposition in high mountain areas such as portions of Great Smoky Mountains National Park and other areas in the eastern United States that lie above about 1,500 m elevation. Coniferous trees have greater leaf surface area than do deciduous trees, shrubs, grasses, or forbs; therefore, dry deposition to conifer needles is generally higher than dry deposition to other vegetative surfaces. Reduced N deposition can be especially high near and downwind of confined animal feeding operations.

In general, atmospheric N deposition is relatively high throughout much of the eastern United States and at various hot-spots in the West, including downwind of the Los Angeles area. In some places, total N deposition has likely increased nearly 10-fold over the past century due to energy, agricultural, industrial, and transportation development. Patterns of deposition are highly complex due to the influence of such variables as meteorology, atmospheric transport, atmospheric chemistry, precipitation patterns, and vegetative cover. In some places, the total amount of deposition can vary several fold over relatively short distances, especially in complex mountainous terrain.

Wet deposition of N is monitored on a continuous basis at sites throughout the United States by the National Atmospheric Deposition Program, National Trends Network (NADP/NTN). These data were mapped for the eastern United States using the approach of Grimm and Lynch (1997) applying a statistical interpolation procedure that corrects for the effects of changing elevation on precipitation amount (data provided by J. Grimm). For the western United States, wet deposition monitoring sites are sparsely located. We therefore estimated spatial patterns in wet deposition throughout the western United States using output from the Community Multiscale Air Quality (CMAQ) atmospheric transport model (data provided by R. Dennis, EPA). Estimates of dry deposition from CMAQ for both the East and the West were added to wet deposition estimates for the analysis presented here. The resulting estimates of total wet plus dry N deposition, including both oxidized and reduced forms of N, are shown in Map 3. There may be additional cloud deposition at the highest elevation areas in some regions and fog deposition at coastal locations. Neither of these forms of deposition are well quantified. In addition, the estimates of

wet plus dry N deposition used in this analysis are relatively coarse (12-km CMAQ grid cells in the East; 36-km CMAQ grid cells in the West) and do not fully capture spatial variation in areas of complex terrain. Nevertheless, they do provide a reasonable approximation of patterns in N deposition that potentially impact the ecosystems on which this deposition falls. Finer-scale CMAQ estimates may be available in the foreseeable future from EPA at a 12-km resolution in the West and a 4-km resolution in the East.



Map 3. 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.

1.3 Ecosystems Effects

Nutrient enrichment is a term used to describe a host of environmental changes that can occur when the availability of a key nutrient is increased as a consequence of air or water pollution. Nutrient enrichment effects can occur in terrestrial, wetland, and aquatic environments. In all cases, the mechanism is essentially the same. The addition of relatively small amounts of a key nutrient (N) from atmospheric deposition can contribute to changes in the species mix of the plant and algal communities. Nutrient enrichment can cause some species to thrive, at the expense of others. Thus, the mix of species present in an ecosystem can change as a consequence of nutrient addition.

We summarize here the extent and distribution of the fresh water aquatic, wetland, and terrestrial ecosystems within the national parks that are thought to be most sensitive to the effects of nutrient enrichment from atmospheric N deposition. These include remote lakes at high elevation, and also alpine, arctic, meadow, arid, and semi-arid terrestrial ecosystems, and wetland ecosystems. Some national parks have extensive coverage of one or more of these presumed sensitive vegetation types. Other national parks are dominated by forest vegetation or some other cover type thought to be less sensitive to such effects at N deposition levels that are commonly found in the United States. Although nutrient enrichment effects in the United States are expected to be most pronounced in these plant communities that lack trees, the same kinds of effects of modest N loading can also occur in forest cover types. It is known that N fertilization can increase tree growth, at least to a point, and cause changes to forest understory vegetation, but long-term effects on forest understory plants and/or differential growth effects on different tree species are poorly known in this country. Estuaries and near-coastal marine waters can also be sensitive to nutrient enrichment effects from anthropogenic N. In addition to atmospheric N inputs, however, a wide variety of point and nonpoint pollution sources often contribute N to these waters. Such contributions from non-atmospheric sources are generally not quantified. Therefore, this report does not attempt to assess the relative importance to near-coastal waters of atmospheric N versus other sources of N in this regard.

1.3.1 *Terrestrial Effects*

In many terrestrial ecosystems, N is the most important nutrient limiting the growth of plants. If an appreciable amount of N is added to such ecosystems from atmospheric deposition, plant growth rates can increase. Because some species are better able to take advantage of added N than others, the end result can be an increase in the growth of some plant species at the expense of others. The species that benefit are often non-native opportunistic species; those that are suppressed are sometimes rare native species.

Terrestrial ecosystems throughout much of the United States are exposed to a continuous supply of N from the atmosphere. The extent to which these ecosystems respond to nutrient addition depends in part on the extent to which the growth of plants and algae is limited by N availability, versus the availability of phosphorous (P), light, water, or some other nutrient. Most north temperate terrestrial ecosystems are at least partially N-limited. This means that if the availability of N is increased, many of the plants will grow faster. Because some plant species are better able to take advantage of this addition of the key limiting nutrient than are other plant species, the end result is a shift in the competitive advantage to favor those plants. One of our Scandinavian research colleagues, Dr. Harald Sverdrup, likens the plant community to ill-mannered passengers

on a bus. They are not friends. They are continually pushing and jockeying to capture the limited number of available seats. Some stake out a position and manage to get a seat. Others are pushed off the bus. Thus, continuous N deposition, at sufficiently high levels, pushes some plant species off the bus (out of the ecosystem). This can decrease species diversity, alter the species make-up of the plant community, and can eliminate some of the rare, or otherwise valued, species.

Some kinds of plants and plant communities appear to be more sensitive to nutrient effects than others. Some lichens are especially sensitive, with documented effects occurring in the N deposition range of only about 3 kg N/ha/yr. In general, plant communities that are dominated by herbaceous plants appear to be more sensitive to N enrichment than plant communities dominated by woody plants. This may be partly because it takes a long time for scientists to document effects on trees, which can grow for decades or centuries. Regardless, nutrient enrichment effects on plant communities in the United States have been most convincingly demonstrated for herbaceous arctic and alpine plant communities, meadows, wetlands, and arid or semi-arid lands (U.S. EPA 2009). These are the plant community types that we discuss here. This does not mean that some of these same effects may not also be occurring in forest communities.

Growth stimulation from added N can alter competitive interactions among species and cause nutrient imbalances, which can reduce biodiversity. The level of atmospheric N deposition at which such effects are triggered is variable and is known only in general terms. A variety of factors influence these relationships, including the extent of plant community N-limitation, total N deposition amounts, mix of the forms of deposited N, climatic conditions, history of past land use, and capacity of the soil to retain N.

Alpine plant communities are known for their high diversity of vascular plant species (Bobbink et al. 2010), and have been shown to be especially sensitive to N enrichment. Some studies suggest that sedges benefit more from N addition to alpine grassland than do grasses or forbs (Bowman et al. 2006, Bobbink et al. 2010). Changes to a species of alpine sedge (*Carex rupestris*) have been demonstrated at N deposition levels near 4 kg N/ha/yr. More dramatic effects on alpine vascular plant community composition within a relatively short time period (a few years) probably require higher levels of N deposition, perhaps near 10 kg N/ha/yr (Bowman et al. 2006). There are a number of plant community characteristics in the alpine zone that appear to govern sensitivity to N input. These include low temperature, restricted growing season, low levels of primary production, and wide variation in moisture regimes from boggy meadows to the desiccating conditions of wind-swept ridges (Bowman et al. 1993, Bowman 1994, Bowman and Fisk 2001). Another contributing factor is the fact that soil formation is a slow process in the harsh alpine environment. Therefore, alpine plants have evolved under conditions of low nutrient supply (U.S. EPA 2008). In some alpine scrub habitats, ground layer bryophytes and lichens are thought to be most sensitive to N addition (Fremstad et al. 2005, Britton and Fisher 2007).

Arctic plants have not been well studied with regards to their sensitivity to modest levels of N enrichment that might correspond with potential future levels of atmospheric N deposition. Nevertheless, some arctic plant communities share many commonalities with alpine vegetation and are therefore thought to be highly sensitive. Arctic environmental conditions also contribute to slow soil development and low nutrient availability, thereby enhancing sensitivity to N deposition impacts.

Increased N input has been shown to reduce plant biodiversity in grasslands in both Europe and North America (Bobbink et al. 2003, Stevens et al. 2004, Clark and Tillman 2008). Such effects have been shown across a range of soil conditions. Changes in species composition have been reported at N deposition levels as low as about 10 kg N/ha/yr (Bobbink et al. 2003). In the San Francisco Bay area, which receives total N deposition of about 10-15 kg N/ha/yr, non-native nitrophilous (N-loving) grasses have displaced native plant species. This effect has been attributed to greater N supply from the atmosphere combined with cessation of livestock grazing, which had previously removed some of the excess N from the ecosystem (Fenn et al. 2003, U.S. EPA 2008). A survey across acidic grasslands in the United Kingdom by Stevens et al. (2004) estimated a decrease of one plant species for every 2.5 kg N/ha/yr of deposition.

Experimental N-fertilization studies have been conducted in arid and semi-arid plant communities in southern California and the Colorado Plateau. Such vegetation communities are commonly dominated by shrubs, but can also be dominated by grasses, forbs, and/or cacti. Results of the fertilization studies suggested increased biomass of some non-native plant species and reduced biomass of some native species with increased N. There also appears to be an increased fire risk where grasses replaced shrub cover. There are apparently multiple interactions involving N-stimulation of non-native grass species, competitive abilities of native forb and shrub species, and the incidence of fire (cf., Eliason and Allen 1997, Yoshida and Allen 2001). The coastal sage scrub plant community in California, in particular, has been declining for many decades. Current scientific understanding suggests that atmospheric N deposition plays a role in this decline, and causes shrub replacement by Mediterranean annual grasses, which promote increased fire cycles (Padgett and Allen 1999, Padgett et al. 1999, Fenn et al. 2003, D'Antonio and Vitousek 1992, Minnich and Dezanni 1998).

Additional studies have been conducted in desert plant communities, suggesting that N additions in the range of 10 kg N/ha/yr or higher can cause invasion of exotic plant species, including grasses (U.S. EPA 2008). Effects appear to be more pronounced at higher elevations, perhaps because the increased precipitation that occurs at higher elevation can contribute to increased grass production. Increased grass biomass in desert plant communities is associated with increased fire frequency (Brooks 1999, Brooks and Esque 2002, Brooks et al. 2004). Effects of N deposition on arid and semiarid plant communities may vary with moisture levels. In some cases, N may be limiting during wet seasons or years, whereas water may be limiting during dry seasons or years.

An undisturbed, unpolluted mature forest typically uses and stores, mostly in the soil, almost all of the small amount of N that it receives from atmospheric deposition. This N is cycled between soil and vegetation. However, forests have a maximum capacity to store N that they receive from outside the watershed. This capacity is determined by the plant species present on the site and the history of logging and other disturbances that previously removed some of the N that was stored in the soil and trees. When N inputs exceed this storage capacity, the site becomes N saturated, and more of the incoming N leaches (or leaks) as NO_3^- to soil water and eventually to streams and lakes. This leaching of NO_3^- can contribute to acidification of soil and water, with harmful consequences to plants, fish, and other life. In the early stages of N saturation, the trees may actually grow faster because they are being fertilized by N, which is the most-important growth-limiting nutrient in many forests. During the latter stages of N saturation, tree health deteriorates and the forest may release to drainage water more N than is coming into the watershed from

atmospheric deposition (Aber et al. 2002). Under conditions of advanced N saturation, tree growth declines and sensitive tree species die.

The tree species that appear to be most susceptible to damage from air pollution are sugar maple and red spruce. These effects of air pollution on both sugar maple and red spruce are related to acidification, rather than nutrient enrichment, aspects of atmospheric deposition. They are addressed in the companion report on acidification effects.

In general, lichens tend to be the most sensitive terrestrial receptors indicating the effects of nutrient N additions. Lichens are types of fungi that grow in association with algae or cyanobacteria. The algae or cyanobacteria provide photosynthetic capability to augment the moisture-holding and attachment capabilities of the fungus. This symbiotic association of two different kinds of life forms is important to nutrient cycling processes in the ecosystems in which these lichens are found.

Epiphytic lichens vary in their N requirements. Montane species tend to be adapted to low N availability and are classified as oligotrophic. They are commonly found on coniferous trees. Valley species tend to be adapted to more mesotrophic conditions, and often occur on hardwood trees. Eutrophic species are adapted to high N supply, often in association with animal nesting or roosting sites. Atmospheric N deposition results in a shift from more oligotrophic towards more eutrophic conditions; this shift is typically accompanied by a change in the lichen community to favor the mesotrophic and eutrophic forms, with a decrease in the oligotrophic species. This change in lichen species in response to a change in N supply can have broader ecosystem-level effects because of the importance of various oligotrophic lichen species as forage, for nutrient cycling, and as nesting materials for other organisms.

Many lichen species that are prevalent in the western United States have relatively well known N requirements, rated low to high (Table 2; McCune and Geiser 2009). Also included in Table 2 is the atmospheric N deposition level at which each species is most commonly found. These indicator species and associated classes can be applied throughout the western United States, although they may be somewhat less applicable in the southwestern extremes of the region (L. Geiser, U.S. Forest Service, Pers. Comm., April, 2010). Despite the available information regarding the N requirements of many lichen species, it is not possible at this time to use this information in classifying or ranking the I&M parks according to nutrient N enrichment sensitivity. This is because data on the occurrence, distribution, and abundance of lichen species in the national parks are not widely available.

Table 2. List of lichen species with known N requirements for the western United States (McCune and Geiser 2009).

Species	N Rating Class ¹	N Requirement	Peak N Deposition Frequency (kg N/ha/yr)
<i>Ahtiana sphaerosporella</i>	O	Low-Mod	2.0
<i>Alectoria imshaugii</i>	O	Low-Mod	1.9
<i>Alectoria sarmentosa</i>	O	Low-Mod	2.4
<i>Alectoria vancouverensis</i>	O	Low-Mod	2.3
<i>Bryoria bicolor</i>	O	Low	1.1
<i>Bryoria capillaris</i>	M	Mod	2.7
<i>Bryoria fremontii</i>	O	Low-Mod	1.9
<i>Bryoria friabilis</i>	M	Mod	2.6
<i>Bryoria furcellata</i>	O	Low	1.1
<i>Bryoria fuscescens</i>	O	Low-Mod	2.3
<i>Bryoria glabra</i>	O	Low-Mod	2.4
<i>Bryoria pseudocapillaris</i>	O	Low	1.1
<i>Bryoria pseudofuscescens</i>	O	Low-Mod	2.1
<i>Bryoria spiralifera</i>	O	Low	1.1
<i>Bryoria subcana</i>	M	Mod	3.4
<i>Bryoria trichodes</i>	M	Mod	2.7
<i>Candelaria concolor</i>	E	Hi	6.1
<i>Cavernularia hultenii</i>	O	Low	1.1
<i>Cavernularia lophyrea</i>	O	Low	1.1
<i>Cetraria californica</i>	O	Low	1.1
<i>Cetraria chlorophylla</i>	M	Mod	2.7
<i>Cetraria merrillii</i>	O	Low-Mod	1.9
<i>Cetraria orbata</i>	O	Low-Mod	2.4
<i>Cetraria pallidula</i>	O	Low-Mod	1.9
<i>Cetraria platyphylla</i>	O	Low-Mod	2.3
<i>Cetraria subalpina</i>	M	Mod	3.6
<i>Cladonia bellidiflora</i>	O	Low	1.1
<i>Cladonia carneola</i>	O	Low-Mod	2.0
<i>Cladonia chlorophaea</i>	E	Broad	4.7
<i>Cladonia furcata</i>	O	Low-Mod	2.1
<i>Cladonia macilenta</i>	E	Hi	6.1
<i>Cladonia norvegica</i>	O	Low	1.1
<i>Cladonia ochrochlora</i>	M	Mod	2.7
<i>Cladonia pyxidata</i>	M	Mod	3.4
<i>Cladonia squamosa</i>	E	Broad	4.6
<i>Cladonia transcendens</i>	O	Broad	2.3
<i>Cladonia umbricola</i>	M	Mod	3.7
<i>Cladonia verruculosa</i>	O	Low-Mod	1.9
<i>Collema nigrescens</i>	E	Broad	6.1
<i>Erioderma solediatum</i>	O	Low	1.1
<i>Esslingeriana idahoensis</i>	O	Low-Mod	2.0
<i>Evernia prunastri</i>	E	Hi	6.1
<i>Fuscopannaria leucostictoides</i>	M	Mod	3.6
<i>Fuscopannaria mediterranea</i>	M	Broad	3.2
<i>Fuscopannaria pacifica</i>	O	Low	1.1

Species	N Rating Class ¹	N Requirement	Peak N Deposition Frequency (kg N/ha/yr)
<i>Heterodermia leucomela</i>	O	Low	1.1
<i>Hypogymnia apinnata</i>	O	Low-Mod	2.3
<i>Hypogymnia duplicata</i>	O	Low	1.1
<i>Hypogymnia enteromorpha</i>	O	Low-Mod	2.3
<i>Hypogymnia heterophylla</i>	O	Low	1.1
<i>Hypogymnia imshaugii</i>	O	Low-Mod	2.4
<i>Hypogymnia inactiva</i>	M	Mod	3.8
<i>Hypogymnia metaphysodes</i>	O	Low-Mod	2.4
<i>Hypogymnia occidentalis</i>	M	Mod	2.6
<i>Hypogymnia oceanica</i>	M	Mod	2.7
<i>Hypogymnia physodes</i>	E	Broad	4.9
<i>Hypogymnia rugosa</i>	M	Mod	3.6
<i>Hypogymnia tubulosa</i>	M	Mod-Hi	4.3
<i>Hypotrachyna sinuosa</i>	O	Low	1.1
<i>Leioderma soledatum</i>	O	Low	1.1
<i>Leptogium brebissonii</i>	O	Low	1.1
<i>Leptogium furfuraceum</i>	M	Mod-Hi	3.2
<i>Leptogium gelatinosum</i>	E	Hi	6.1
<i>Leptogium lichenoides</i>	O	Low	1.1
<i>Leptogium palmatum</i>	O	Low	1.1
<i>Leptogium polycarpum</i>	M	Mod	2.8
<i>Leptogium saturninum</i>	E	Mod-Hi	4.7
<i>Letharia columbiana</i>	M	Mod	3.2
<i>Letharia vulpina</i>	O	Low-Mod	2.0
<i>Lichinodium canadense</i>	O	Low-Mod	2.2
<i>Lobaria hallii</i>	M	Mod	3.0
<i>Lobaria oregana</i>	O	Low	1.1
<i>Lobaria pulmonaria</i>	O	Low-Mod	2.2
<i>Lobaria scrobiculata</i>	M	Mod	3.2
<i>Melanelixia fuliginosa</i>	E	Hi	6.1
<i>Melanelixia glabra</i>	M	Mod-Hi	3.3
<i>Melanelixia subaurifera</i>	E	Hi	6.1
<i>Melanohalea elegantula</i>	E	Mod-Hi	5.0
<i>Melanohalea exasperatula</i>	M	Mod-Hi	3.2
<i>Melanohalea subelegantula</i>	E	Hi	6.1
<i>Melanohalea subolivacea</i>	M	Mod	3.3
<i>Menegazzia terebrata</i>	O	Low	1.1
<i>Nephroma bellum</i>	O	Low	1.1
<i>Nephroma helveticum</i>	O	Low-Mod	2.4
<i>Nephroma laevigatum</i>	O	Low	1.1
<i>Nephroma occultum</i>	M	Mod	2.7
<i>Nephroma parile</i>	M	Mod	2.6
<i>Nephroma resupinatum</i>	O	Low	1.1
<i>Niebla cephalota</i>	O	Low	1.1
<i>Nodobryoria abbreviata</i>	M	Mod	3.1
<i>Nodobryoria oregana</i>	M	Mod	2.6
<i>Parmelia hygrophila</i>	M	Low-Mod	2.5
<i>Parmelia pseudosulcata</i>	O	Low	1.1

Species	N Rating Class ¹	N Requirement	Peak N Deposition Frequency (kg N/ha/yr)
<i>Parmelia saxatilis</i>	E	Broad	4.7
<i>Parmelia squarrosa</i>	O	Low	1.1
<i>Parmelia sulcata</i>	E	Broad	6.1
<i>Parmeliopsis ambigua</i>	O	Low-Mod	2.1
<i>Parmeliopsis hyperopta</i>	M	Mod	2.6
<i>Parmotrema arnoldii</i>	O	Low	1.1
<i>Parmotrema chinense</i>	O	Low	1.1
<i>Parmotrema crinitum</i>	O	Low	1.1
<i>Peltigera britannica</i>	O	Low	1.1
<i>Peltigera collina</i>	M	Broad	3.3
<i>Peltigera membranacea</i>	O	Low	1.1
<i>Peltigera neopolydactyla</i>	O	Low	1.1
<i>Physcia adscendens</i>	E	Hi	6.1
<i>Physcia aipolia</i>	E	Hi	6.1
<i>Physcia stellaris</i>	M	Mod	3.0
<i>Physcia tenella</i>	E	Hi	6.1
<i>Physconia americana</i>	M	Mod	3.3
<i>Physconia enteroxantha</i>	E	Hi	6.1
<i>Physconia isidiigera</i>	M	Mod-Hi	3.2
<i>Physconia perisidiosa</i>	E	Hi	6.1
<i>Platismatia glauca</i>	M	Broad	3.1
<i>Platismatia herrei</i>	M	Mod	2.6
<i>Platismatia lacunosa</i>	O	Low	1.1
<i>Platismatia stenophylla</i>	M	Mod	3.7
<i>Polychidium contortum</i>	O	Low	1.1
<i>Pseudocyphellaria anomala</i>	O	Low-Mod	2.3
<i>Pseudocyphellaria anthraspis</i>	O	Low	1.4
<i>Pseudocyphellaria crocata</i>	O	Low	1.1
<i>Pseudocyphellaria rainierensis</i>	M	Mod	2.7
<i>Punctelia subrudecta</i>	E	Hi	6.1
<i>Ramalina dilacerata</i>	E	Mod-Hi	4.8
<i>Ramalina farinacea</i>	E	Broad	5.7
<i>Ramalina menziesii</i>	O	Low	1.1
<i>Ramalina pollinaria</i>	O	Low	1.1
<i>Ramalina roesleri</i>	O	Low	1.1
<i>Ramalina subleptocarpha</i>	E	Hi	6.1
<i>Ramalina thrausta</i>	O	Low	1.1
<i>Sphaerophorus globosus</i>	O	Low	1.1
<i>Sticta fuliginosa</i>	O	Broad	1.1
<i>Sticta limbata</i>	O	Low	1.1
<i>Sticta weigeli</i>	O	Low	1.1
<i>Sulcaria badia</i>	M	Mod	3.4
<i>Usnea cavernosa</i>	M	Mod	3.2
<i>Usnea cornuta</i>	O	Low	1.1
<i>Usnea filipendula</i>	O	Low-Mod	2.1
<i>Usnea glabrescens</i>	M	Mod	3.6
<i>Usnea hirta</i>	O	Low	1.1
<i>Usnea lapponica</i>	M	Mod	3.2

Species	N Rating Class ¹	N Requirement	Peak N Deposition Frequency (kg N/ha/yr)
<i>Usnea longissima</i>	O	Low	1.1
<i>Usnea rubicunda</i>	O	Low	1.1
<i>Usnea scabrata</i>	O	Low-Mod	2.3
<i>Usnea schadenbergiana</i>	O	Low	1.1
<i>Usnea subfloridana</i>	E	Hi	6.1
<i>Usnea wirthii</i>	O	Low	1.1
<i>Vulpicida canadensis</i>	O	Low-Mod	2.0
<i>Xanthomendoza fallax</i>	E	Hi	6.1
<i>Xanthoria candelaria</i>	E	Hi	6.1
<i>Xanthoria parietina</i>	E	Hi	6.1
<i>Xanthoria polycarpa</i>	E	Hi	6.1

¹ E = eutrophic; M = mesotrophic; O = oligotrophic

1.3.2 Aquatic Effects

Estuaries and coastal marine waters, which are not considered for this analysis, are generally susceptible to nutrient enrichment effects from atmospheric N deposition because N tends to be the main growth-limiting nutrient in such environments. Growth of plants and algae in fresh waters, in contrast, is often limited by the availability of phosphorus (P), which is typically not an important component of air pollution and atmospheric deposition at most locations. There are some fresh waters, however, that are limited in their algal growth by N or by a combination of both N and P. Recent research (cf., Elser et al. 2009a,b) suggests that atmospheric inputs of N in some high elevation areas have altered the relative availability of N and P to phytoplankton. These changes in nutrient availability may have shifted lakes from N limitation towards P limitation, with consequent alterations to plankton community structure, species diversity, and trophic interactions (Elser et al. 2009b).

The same general kinds of effects that occur when N is added to terrestrial ecosystems can also occur when N is added to aquatic ecosystems. Again, the ecosystem response is largely governed by the nutrient limitation status. Many lakes and streams are P-limited. Adding N to such a water body would not be expected to result in a change in primary productivity. Many other surface waters, especially lakes at high elevation in remote areas, are N-limited or N and P co-limited, and therefore may be more responsive to small additions of N. Stream segments that are not N- or P-limited are often light-limited.

It appears that sensitivity to nutrient enrichment effects on fresh waters in the United States most commonly occurs in remote, high-elevation lakes. In high-elevation areas that have received relatively high levels of atmospheric N deposition, past deposition may have shifted the nutrient supply from a relatively balanced but primarily N-deficient condition to a more P-limited condition (Elser et al. 2009b). For high-elevation lakes in the Rocky Mountains, rather small N additions (less than 2 kg N/ha/yr) have been shown to alter lake diatom communities. Diatoms are microscopic algae that constitute an important part of the food web of lake ecosystems. Musselman and Slausen (2004) showed that biota in lakes in the Front Range of Colorado take up rather substantial amounts of N, as revealed through lake chemistry comparisons between early and late growing season and through comparisons between inlet and outlet chemistry.

High-elevation lakes are of particular concern, among aquatic ecosystems, with respect to potential impacts attributable to atmospheric nutrient N enrichment for several reasons. Many high-elevation lakes tend to be dilute to ultra-dilute and nutrient poor, contributing to increased risk of biological change from nutrient addition, even in relatively low quantities. Many high-elevation lakes have been shown to be N limited. Diatom communities in several high-elevation lakes in Colorado and Wyoming have been shown to have been impacted by relatively low levels of atmospheric N deposition (Wolfe et al. 2001, Saros et al. 2003). Because soils in the watersheds of high-elevation lakes are often poorly developed, with much exposed bedrock, the supply of N from soils to lake water can be low. Furthermore, because there is typically little to no human development in the watersheds of high-elevation lakes, the atmosphere generally constitutes the dominant source of N to the watersheds of these lakes.

1.3.3 Wetland Ecosystem Effects

Nitrogen deposition to wetlands can alter competitive relationships among species, sometimes increasing the establishment of non-native species at the expense of the rare species. Such changes are thought to occur in Europe at N deposition levels in the range of 5 to 10 kg N/ha/yr for raised and blanket bogs, 10 to 20 kg N/ha/yr for poor fens, and at higher deposition levels for rich fens and salt marshes (Achermann and Bobbink 2003). Some wetland plants appear to be adapted to low-N environments. These include some species in the genera *Sphagnum* and *Isoetes* and some insectivorous plants, such as the green pitcher (*Sarracenia oreophila*) and the roundleaf sundew (*Drosera rotundifolia*). The pitcher plant *Sarracenia purpurea*, which is native to nutrient-poor peatlands in the eastern United States, has been proposed as an indicator of atmospheric N supply (Ellison and Gotelli 2002).

1.4 Park Protection

All parks are equally deserving of protection, as per the NPS 1916 Organic Act, which states that the NPS will:

promote and regulate the use of...national parks...by such means and measures as conform to the fundamental purpose of the said parks...which purpose is to conserve the scenery and the natural and historic objects and wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (16 U.S.C. 1).

The Organic Act and its 1970 and 1978 amendments do not directly address air pollution effects. However, they do specify what resources should be protected in the National Park system.

The 1978 amendments clarify the importance Congress placed on protecting park resources:

The authorization of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by the Congress (16 U.S.C. 1a-1).

There are two types of public land designation that confer special protection against air pollution degradation: wilderness and Class I. These designations were specified by the Wilderness Act and the Clean Air Act (CAA), respectively. Therefore, lands are identified for this N effects assessment that receive special Wilderness and/or Class I protection. These are the lands that are intended to receive the highest level of protection against adverse impacts caused by air pollution.

The Wilderness Act sets aside a subset of the public lands where natural processes are allowed to dominate.

Wilderness areas... shall be administered for the use of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness (16 U.S.C. Sec. §1131)

The CAA designates some national park lands as Class I areas, based on size and the year in which the park was established. The Act grants the federal land managers an affirmative responsibility to protect these areas from adverse impacts caused by air pollution. The CAA provides the legal framework for federal land managers to preserve and protect air quality related values from pollution sources both within and outside park boundaries.

The Prevention of Significant Deterioration section of the CAA establishes ceilings on allowable additional amounts of air pollution over baseline levels in clean air areas. It requires EPA or the States to provide to the federal land managers notice of any proposed major emitting facility whose emissions may affect a Class I area (42 U.S.C. §7475(d)(2)(A)).

Class I areas include national parks larger than 6,000 acres and national wilderness areas and national memorial parks which exceed 5,000 acres, and which were in existence on August 7, 1977. Additions to the boundaries of previously existing Class I areas are also designated as Class I areas. Currently, 48 areas in the National Park system are designated as Class I.

2. Methods

The goal of this effort is to construct an overall risk assessment to estimate the relative risk to I&M parks, and to I&M networks, of nutrient enrichment impacts from atmospheric N deposition. Parks and networks are ranked by perceived risk. The risk rankings are determined by combining three layers of variables that represent 1) N Pollutant Exposure, 2) inherent Ecosystem Sensitivity, and 3) the extent of existing special Park Protection. Each of these layers is quantified using variables that are in most cases available spatially for the entire United States and that provide insight into the relative differences among parks in these three aspects (or themes) of overall risk.

Thus, an assessment is conducted here of all I&M parks and the networks in which they reside to determine their relative rankings with respect to N Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and Overall Summary Risk. Results are organized by network, and rankings are provided of all parks and of all networks.

Many of the variables that feed into this risk assessment are uncertain. They are constrained to a large degree by the need to cover the entire country. National-scale data that reflect various aspects of risk are scarce. In general, point source emissions data are more certain than nonpoint source data. Emissions and deposition data for NO_x are more certain than for NH_x . Wet deposition is more certain than dry or occult (cloud and fog) deposition. The relative sensitivities of various ecosystem types are not completely understood. Thus, the risk rankings developed for this project should be considered as coarse first approximations of true risk. Confidence in the rankings will increase as scientific knowledge regarding N Pollutant Exposure and inherent Ecosystem Sensitivity improve, and also as national-scale datasets that shed light on these issues become available and are depicted at finer scales. This document should be considered only a first step in that process.

2.1 National Mapping Approach

The extent to which resources within a given national park are exposed to atmospheric N pollution is difficult to precisely quantify. Atmospheric deposition patterns are related to regional emissions, especially emissions from the areas that are generally upwind of the sensitive resources. Thus, the pattern in local to regional emissions can serve as a coarse surrogate for deposition exposure. Wet deposition is measured at many locations throughout the lower 48 states, but only at a handful of locations in Alaska and not at all in the Pacific Islands. The suite of wet deposition monitors is relatively dense, with good spatial coverage, in the East but sparse in the West. Dry deposition is monitored at fewer locations and modeled spatially for this project using an atmospheric transport model.

Two maps are presented in each network section, labeled Maps A and B, to illustrate the broad regional to national patterns observed for N emissions and deposition. These national maps provide context for network and park-specific maps and data found in subsequent sections of this report. Map A illustrates patterns in total N emissions, expressed by county, in units of tons of N emitted into the atmosphere per square mile per year ($\text{tons}/\text{mi}^2/\text{yr}$). Total N emissions are comprised of point (generally large and discrete sources such as a power plant or industrial facility), non-point (generally smaller and widely distributed sources such as agricultural

fertilizer application), and mobile (e.g., motor vehicle) N emission sources. This information is based on National Emissions Inventory (NEI) data from EPA for the year 2002 (<http://www.epa.gov/ttnchie1/net/2002inventory.html>). In general, total N emissions tend to be relatively low (less than about 5 tons/mi²/yr) throughout much of the western United States, but above that level throughout much of the eastern United States. Relatively high N emissions levels (greater than 20 tons/mi²/yr) occur at scattered locations throughout the eastern United States and at a few locations in the West, primarily in and around Los Angeles and San Francisco. Counties that have in excess of 50 tons/mi²/yr of N emissions are relatively rare.

Map B illustrates patterns in total N deposition in units of kilograms of N deposited to the earth surface per hectare per year. This information was derived by adding estimates of wet and dry deposition. Wet deposition was interpolated for the eastern United States from NADP measurements by J. Grimm (unpublished data provided to B. Jackson), with elevation correction to account for orographic effects (Grimm and Lynch 1997). Wet deposition was modeled for the western United States using the CMAQ model (Robin Dennis, U.S. EPA, pers. comm., 2009) at 36-km resolution. Dry deposition was modeled using CMAQ for the western United States at 36-km resolution and for the eastern United States at 12-km resolution. Again, the CMAQ dry deposition datasets were also provided by Robin Dennis. NADP measurements were constructed as three-year averages centered on the year 2002. CMAQ simulations in all cases were for the year 2002.

Generally speaking, based on these estimates of wet plus dry N deposition, broad patterns in N deposition match the broad patterns in N emissions shown in Map A. Most of the western United States receives less than 5 kg N deposition per hectare per year, although higher values are seen in some areas, most particularly in parts of California, Washington, and the Front Range of Colorado. Broad areas in the eastern United States are estimated to receive more than 10 kg N/ha/yr, and some locations appear to receive considerably more than that.

2.2 Network Mapping Approach

For each of the 32 I&M networks, a series of maps is presented at the network scale to depict three themes, or aspects of: 1) N Pollutant Exposure, 2) inherent Ecosystem Sensitivity to N enrichment effects, and 3) the degree of special protection against potential air pollution effects afforded to lands within that network. Each is described below.

The maps that are presented in this document to shed light on spatial patterns in N Pollutant Exposure represent various aspects of probable N Pollutant Exposure, recently and in the future. There are six N Pollutant Exposure variables, listed in Table 3. They provide information regarding N emissions, human population, relative amounts of developed and agricultural land, and atmospheric N deposition. Each of the six N Pollutant Exposure variables, and its associated data source(s), has uncertainty associated with it. In combination, these data provide an indication of relative levels of N emissions and deposition in and around the parks that occur within that network. The map labeling is consistent from network to network. For example, Map C in each network depicts county-level emissions data, Map D in each network depicts point sources, and so on. If there are no data available, the map is not included; subsequent maps are not relettered, but rather maintain the same letter designation for all networks.

Table 3. Variables used to determine network rankings.

Variable		Method of Calculation
Nitrogen Pollutant Exposure Variables		
I.	N emissions by county	Total county-level annual N emissions, as areally weighted average of lands within network, per unit area
II.	Human population within network	Total human population per unit area within network
III.	Human population within buffers	Total human population per unit area within 100-mile buffer around network
IV.	Percent developed land within network	Percent of land within network classified as developed area
V.	Percent agricultural within network	Percent of land within network classified as agricultural
VI.	Average N deposition within parks	Average total annual N deposition for all park lands that occur within the network
Ecosystem Sensitivity Variables		
VII.	Percent sensitive vegetation types within parks	Percent of land within parks that occur within the network occupied by arctic, alpine, meadow, wetland, arid, and/or semi-arid vegetation
VIII.	Number of high-elevation lakes within parks	Number of high-elevation lakes found in or partially within parks that occur within the network
Park Protection Variables		
IX.	Amount of lands in the park receiving special protection	Area of park lands within network designated as wilderness and/or Class I
X.	Percent of lands in the park receiving special protection	Percent of park lands within network designated as wilderness and/or Class I
XI.	Percent of network in designated wilderness	Percent of all lands within network designated as wilderness
Summary Statistics		
XII.	Pollutant exposure	Average of rankings for variables I through VI
XIII.	Ecosystem sensitivity	Average of rankings for variables VII and VIII
XIV.	Park protection	Average of rankings for variables IX through XI
XV.	Overall risk of nutrient N enrichment effects	Average of rankings for variables XII through XIV

Total N emissions are mapped by county in each network for the year 2002 and depicted in Map C. These are the same emissions data that are shown for the nation in Map A. The locations of individual point sources of both oxidized and reduced N compounds are shown, for all point sources included in the 2002 NEI database, in Map D. Urban centers having populations greater than 10,000 people are shown in Map E. Urban populations are based on U.S. Census data for the year 2000. Urban centers constitute probable locations of both point and nonpoint pollutant sources, including motor vehicles, industry, equipment, and other stationary and mobile sources of N emissions. Total N deposition in and around the network is depicted in Map F, using the same sources of wet and dry deposition as depicted for the national coverage shown in Map B. Finally, land cover data from the National Land Cover (NLCD) Dataset (http://www.mrlc.gov/nlcd_multizone_map.php) were mapped for each network to provide an indication of where agricultural and developed lands (both probable sources of N emissions) are located within and in proximity to each network.

For all of these N Pollutant Exposure maps, data are shown for the network itself, plus surrounding areas. These data are important from the perspective of emissions and deposition within the network. They are also important from the perspective of emissions that occur outside the network, but that might be transported to the network, and more specifically to the national parks, by the prevailing winds. Weather systems in the continental United States generally trend from west to east. Nevertheless, wind patterns are not fixed and national parks can receive N Pollutant Exposure from emissions sources that occur in any direction from the park.

Inherent terrestrial Ecosystem Sensitivity to nutrient N enrichment effects is represented using maps of the presence of certain terrestrial vegetation types (Map H). Nutrient enrichment effects from N deposition to terrestrial ecosystems can occur in any vegetative community. There will always be a range of plant species sensitivity to N addition. Some species will benefit from added N; other species will lose competitive advantage in response to N enrichment. This response pattern is expected in all plant community types. Similarly, it is possible, but not likely, that a lake in virtually any setting could be N-limited and sensitive to N input. However, recent research suggests that some plant community types and the algae in some lakes in the United States are more susceptible to such effects than others. Research indicates that the most sensitive terrestrial vegetation types include herbaceous arctic, alpine, meadow, and arid or semi-arid plant communities. Wetland plant communities have also been found to be relatively sensitive, based largely on research conducted in Europe. Therefore, these are the vegetation types mapped and analyzed here.

Vegetation data were collected from a variety of sources. The primary source was the NPS Vegetation Mapping Inventory/ USGS Vegetation Characterization Program (<http://biology.usgs.gov/npsveg/>). This inventory of the 272 I&M parks is on-going and not all parks have been completed. Secondarily, vegetation data generated through the U.S. Forest Service (USFS) LANDFIRE program were used for the remainder of the parks within the lower 48 states. The National Wetland Inventory (NWI) dataset was also used as a secondary source for wetland data. For parks in Alaska, Pacific Islands, and Puerto Rico, sensitive vegetation types were identified from previous NPS surveys, USFS surveys, and NLCD data. The source of the vegetation coverage data used for each I&M park is given in Appendix A. Some tree species, especially red spruce and sugar maple, are known to be highly sensitive to N and S deposition

because of acidification, rather than nutrient enrichment, effects. These sensitivities are addressed in a separate report.

In general, high-elevation lakes are not mapped at the network scale. This is because the high-elevation lakes tend to be too small to be seen at that scale. Rather, where high-elevation lakes are numerous in an I&M park, they are typically mapped at the park scale (discussed below in the Park Mapping Approach section).

The degree of special protection afforded to national parks was evaluated on the basis of land classification as Class I areas and as designated wilderness. Class I and wilderness areas receive the highest levels of protection under the CAA and the Wilderness Act, respectively. The 1977 Clean Air Act Amendments (CAAA) outlined special protections for Class I areas relative to adverse impacts on Air Quality Related Values (AQRVs). The latter include flora and bodies of water that could potentially be damaged by air pollution and atmospheric deposition. Congress also delegated to federal land managers an affirmative responsibility to protect AQRVs in Class I areas. The 1990 CAAA further strengthened this responsibility and special protections. The Wilderness Act of 1964 established the National Wilderness Preservation System and requires protection of the earth and its community of life at a level of natural conditions. Both NPS Class I and Wilderness areas (all jurisdictions) are mapped for each network, and depicted on Map I.

2.3 Park Mapping Approach

For networks that include some of the larger national parks and some of the parks that have been more thoroughly studied with respect to effects from atmospheric N deposition, one or more park-specific maps is also provided. These maps show the locations of vegetation types thought to be most responsive to nutrient N enrichment effects and/or the locations of high-elevation lakes that may be more likely to be N-sensitive than many lower-elevation lakes. Neither of these data layers is consistently readily apparent on the network maps because of problems of scale. Each is more visible on the park maps, which show only a small fraction of the overall land area within the network. Particularly sensitive vegetation types often occur as small patches, which can be difficult to see at the scale of the network. Nitrogen-sensitive high-elevation lakes are often, but not always, small (i.e., less than about 100 hectares in area).

Many lakes and streams are expected to be limited in their primary production by the availability of P or something else other than N, such as, for example, light in the case of many small streams. Addition of atmospheric N deposition to such a water body or its watershed would not be expected to result in increased productivity, with consequent ecological impacts. However, some fresh waters are known to be N-limited, and those appear to be prevalent at high elevation in remote locations. Only a small number of parks contain high-elevation lakes.

It is not possible, based on existing data, to specify a range of elevation above which N-sensitive lakes would be expected to occur. This range likely varies regionally and perhaps locally. Nevertheless, there is value in quantifying the numbers of lakes in parks or networks that are located at high elevation relative to the surrounding terrain. For high-elevation lake mapping in this study, areas were identified as high elevation using the following criterion. For each network, the elevation above which 15% of the network area exists was determined. Any lake that occurs above this elevation was considered a “high elevation” lake. Lake polygon data were obtained from the National Hydrography Dataset (NHD) at medium resolution (approximately

1:100K scale) for all parks except those in Alaska, where only high resolution (approximately 1:24K scale) NHD data were available. The number of lakes that occur at high elevation within each park was extracted and tabulated for each network.

2.4 Calculation of Network and Park Rankings

Six variables were calculated to represent various aspects of N Pollutant Exposure within the 32 park networks. They are listed in Table 3. Each N Pollutant Exposure variable reflects one or more aspects of atmospheric N emissions in and/or near the network or the best available estimate of the general patterns of N deposition in and around the parks that occur in that network. Each of the listed variables was calculated for each network. Networks were then ranked for each variable, from the network showing the lowest N Pollutant Exposure (lowest rank) to the network showing the highest N Pollutant Exposure (highest rank). For cases where networks received the same rank (tie) the average of the tied rankings was reported for each of those park networks. For example, if there were two networks, in rank positions 10 and 11, that were tied in terms of their N Pollutant Exposure variable rankings, each of those networks was assigned a rank of 10.5. These variable-specific rankings were then averaged to yield an overall N Pollutant Exposure ranking for each of the 32 networks, where lower numbers (near 1) reflect lower N Pollutant Exposure and higher numbers (near 32) reflect higher N Pollutant Exposure. Results of this summary statistic are graphed for each network. Results are ordered from left to right on the graph to reflect decreasing N Pollutant Exposure ranking, and are color coded according to quintile from the lowest quintile (the 20% of networks that received the lowest N Pollutant Exposure ranking) to the highest quintile (highest 20% of network rankings). Warm colors (red, orange) reflect higher risk; cool colors (green, blue) reflect lower risk. For cases where networks received the same ranking across a quintile boundary, the higher quintile (higher risk) was reported.

Network designations were calculated in generally the same manner for the other two nutrient N enrichment themes: Ecosystem Sensitivity and level of Park Protection. Ecosystem Sensitivity is represented by two variables, and Park Protection is represented by three variables, which are given in Table 3. The former is based on the relative coverage of vegetative types expected to be most sensitive to nutrient N enrichment and the existence of high-elevation lakes that might be prone to N-enrichment impacts. The latter is based on designation as wilderness and Class I areas. Finally, an overall Summary Risk of nutrient N enrichment effects was calculated as the average of the rankings for the three themes discussed above. Results of this network overall Summary Risk assessment are graphed, with networks having highest risk shown on the left, and park networks having lowest risk shown on the right.

Rankings for the 271 individual I&M parks (plus the Appalachian Trail corridor, which is addressed within the section on the Appalachian Highlands Network) were calculated using the variables given in Table 4. Tied park rankings were treated as described for tied network rankings. As for the network rankings, park rankings were calculated individually for N Pollutant Exposure, Ecosystem Sensitivity, and Park Protection metrics. Results of those rankings, summarized by quintile, are listed in Appendix B and are summarized in tabular form in each of the individual network sections of the report. Average scores for each metric and results of the overall park-specific Summary Risk assessment for the 79 larger I&M parks (those larger than 100 square miles) are graphed and mapped in the Results section below.

Table 4. Variables to determine I&M park rankings.

Variable		Method of Calculation
Nitrogen Pollutant Exposure Variables		
I.	Average N deposition	Average total annual N deposition for all lands within the park
II.	N emissions by county	Total county-level annual N emissions, as areally weighted average of all counties bordering on the park and within 100 miles of the park boundary, per unit area
Ecosystem Sensitivity Variables		
III.	Percent sensitive vegetation types	Percent of land within the park occupied by arctic, alpine, meadow, wetland, and arid and semi-arid vegetation
IV.	Number of high elevation lakes	Number of high-elevation lakes within the park
Park Protection Variables		
V.	Amount of lands in the park receiving special protection	Area of park designated as wilderness and/or Class I
VI.	Percent of lands in the park receiving special protection	Percent of park designated as wilderness and/or Class I
Summary Statistics		
VII.	Pollutant exposure	Average of rankings for variables I and II
VIII.	Ecosystem sensitivity	Average of rankings for variables III and IV
IX.	Park protection	Average of rankings for variables V and VI
X.	Overall risk of nutrient N enrichment	Average of rankings for variables VII through IX

The vegetation data available and the approach used to identify vegetation communities that might be expected to be most sensitive to nutrient enrichment effects of atmospheric N deposition may have inadvertently deemphasized the Ecosystem Sensitivity rankings of some of the parks within high-latitude networks in Alaska. The potential sensitivity of high-latitude plant species to low to moderate levels of N enrichment is expected to correlate with woodiness, stature, and relative growth rate (Chapin et al. 1996), but is poorly known. Rapidly growing plant species that are most efficiently able to take advantage of added N may out-compete neighboring plants that are less responsive to fertilization. Such effects should be more pronounced in vegetation communities dominated by small, non-woody plants as compared with taller trees and shrubs. Functional vegetation types, based on classes such as deciduous shrubs, evergreen shrubs, forbs, graminoids, mosses, and lichens, have been widely used to describe patterns of plant species response to changes in environmental conditions in high-latitude ecosystems (cf., Walker et al. 1989, Chapin et al. 1996). Nevertheless, the effects of N fertilization at the modest levels of N input that might conceivably be associated with atmospheric N deposition on high-latitude woody plant communities have not been well studied. In addition, the widespread

distribution of non-vascular plants and lichens in many vegetative communities that occur within these areas may confer heightened sensitivity to N enrichment effects. Unfortunately, available data on the distribution and relative abundance of non-vascular plants and lichens in park lands throughout the United States are insufficient as the basis for Ecosystem Sensitivity assessment across the I&M parks at the present time.

3. Results

3.1 Ranking of Networks and Parks

3.1.1 Networks

The calculated values of the rankings for the N Pollutant Exposure metrics across the 32 networks, shown for each variable individually in Table 5, are depicted for the N Pollutant Exposure theme in Figure 1. The two networks having the highest average values for the six N Pollutant Exposure variables (National Capital Region and Northeast Coastal and Barrier) are shown on the left side of the graph as the tallest bars. These networks had average values for the six N Pollutant Exposure variables equal to 29. In other words, these networks had high rankings for the six variables that were used to indicate N Pollutant Exposure. Thus, the average ranking among all six N Pollutant Exposure variables was 29 (out of a maximum possible 32) for these two networks. The four networks on the far right side of the graph (shortest bars) all showed an average N Pollutant Exposure ranking that was less than about 3. This means that each of these four networks was ranked low for the N Pollutant Exposure variables. Not surprisingly, these are the four networks in Alaska, where atmospheric emissions of N are very low at most locations. Note that regional deposition data are not available for Alaska. Thus, the average of the N Pollutant Exposure rankings for networks in Alaska is calculated for only five, rather than all six, variables listed in Table 3. Also, note that these low rankings for the Alaskan networks do not necessarily indicate that N emissions are universally low throughout Alaska.

Rather, they indicate that emissions (and associated deposition) are generally low throughout the networks in this region. There may, in fact, be isolated “hot spots” of relatively high deposition.

Rankings for network-specific Ecosystem Sensitivity and Park Protection metrics are presented in the same manner as the N Pollutant Exposure metrics. In the case of Ecosystem Sensitivity, the average is calculated for two variables: 1) presence of terrestrial vegetation types expected to be most sensitive to N enrichment effects, and 2) presence of high-elevation lakes. For Park Protection, the average is calculated for three variables: 1) area of parkland classified as Class I and/or wilderness, 2) percent of parkland classified as Class I and/or wilderness, and 3) percent of network designated as wilderness. The calculated averages for the rankings of Ecosystem Sensitivity and Park Protection are given in Figures 2 and 3, respectively.

Six of the seven networks that scored highest (on left side of the graphic) for Ecosystem Sensitivity were western networks: Sierra Nevada, Northern and Southern Colorado Plateau, Greater Yellowstone, North Coast and Cascades, and Mojave Desert. The western networks were somewhat more likely to contain presumed sensitive alpine, arid, semi-arid, and meadow vegetation and high-elevation lakes as compared with networks in other parts of the country that are often more densely forested. The networks that scored highest for Park Protection were mainly western mountain and Alaskan networks. Two desert networks (Mojave Desert, Sonoran Desert) were also ranked fairly high for the Park Protection metric.

Table 5. Rankings for quantitative variables calculated for each of the 32 I&M park networks.

Network Name	Variable Ranking ¹										
	Nitrogen Pollutant Exposure Variables						Ecosystem Sensitivity Variables		Park Protection Variables		
	I	II	III	IV	V	VI ²	VII	VIII	IX	X	XI
Appalachian Highlands	20	19	23	20	20	22	1	27	18	20	13
Arctic	3	1	1	1	1.5	0	21	10.5	31	17	26
Central Alaska	4	4	2	4	4	0	8	10.5	32	18	29
Chihuahuan Desert	7	9	11	7	6	6	31	10.5	21	24	10
Cumberland Piedmont	25	20	19	27	27	25	2	23.5	12	12	8
Eastern Rivers and Mountains	26	24	29	25	22	23	4	10.5	2.5	2.5	7
Great Lakes	22	22	15	23	30	15	9	23.5	19	19	14
Greater Yellowstone	5	6	5	6	13	10	20	29	27	29	27
Gulf Coast	21	18	17	17	23	19	16	10.5	6	6	4
Heartland	24	17	18	18	32	24	7	23.5	8	9	5
Klamath	12	12	20	14	12	8	12	28	17	27	20
Mediterranean Coast	29	30	25	31	14	17	24	10.5	2.5	2.5	22
Mid Atlantic	27	26	30	22	28	26	3	10.5	14	26	11
Mojave Desert	11	14	21	8	7	7	32	10.5	29	14	28
National Capital Region	31	31	26	30	29	27	5	10.5	2.5	2.5	1
North Coast and Cascades	19	21	8	19	11	11	14	31	26	31	30
Northeast Coastal and Barrier	32	32	31	32	26	21	18	10.5	5	5	2
Northeast Temperate	18	27	32	21	15	16	11	10.5	9	22	9
Northern Colorado Plateau	9	10	7	9	9	4	28	23.5	20	21	16
Northern Great Plains	14	5	9	13	31	13	26	23.5	13	11	3
Pacific Island	16	25	28	26	10	0	13	10.5	15	28	19
Rocky Mountain	8	11	6	11	18	12	10	30	22	30	18
San Francisco Bay Area	30	29	16	28	19	14	23	10.5	11	10	17
Sierra Nevada	15	15	24	15	17	9	19	32	25	32	25
Sonoran Desert	13	16	13	12	8	2	30	10.5	16	25	24
South Florida Caribbean	28	28	27	29	24	5	29	10.5	24	15	23
Southeast Alaska	1	3	3	3	1.5	0	6	10.5	28	23	32
Southeast Coast	23	23	22	24	21	20	25	10.5	7	8	12
Southern Colorado Plateau	10	8	10	5	5	3	27	23.5	23	13	15
Southern Plains	17	13	14	16	25	18	22	10.5	2.5	2.5	6
Southwest Alaska	2	2	4	2	3	0	15	10.5	30	16	31
Upper Columbia Basin	6	7	12	10	16	1	17	10.5	10	7	21

¹ The rankings range from the lowest network to the highest network. Thus, a low value reflects low risk. Variable Roman numbers given at the top of the columns are described in Table 2. Tied ranks are averaged.

² Deposition data are not available for Alaska on a regional basis. However, based on limited deposition monitoring data, existing emissions data, and probable sources, N deposition in these networks is expected to be very low.

ND = No data

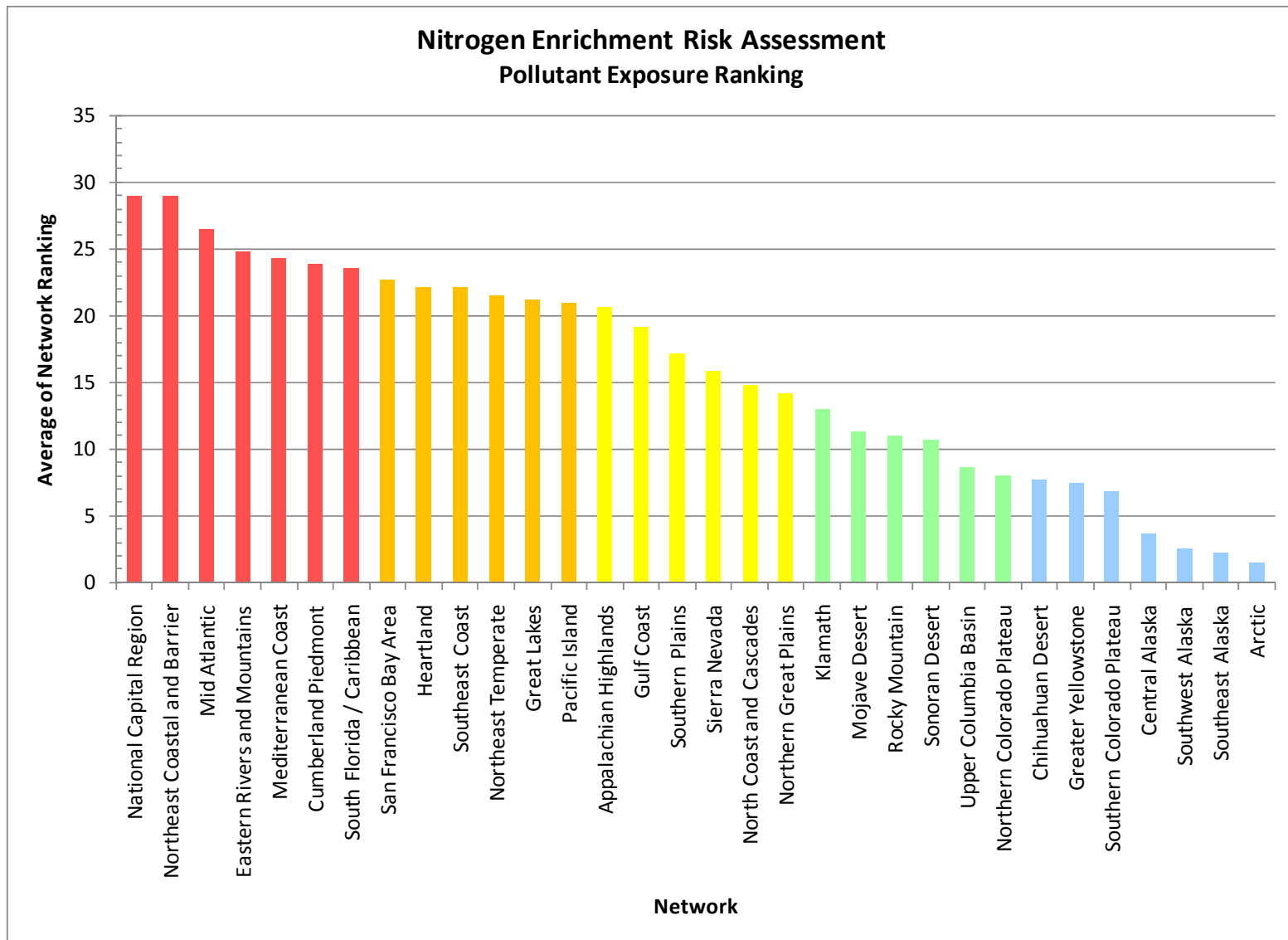


Figure 1. Calculated N Pollutant Exposure ranking for each of the 32 I&M networks. Networks are color coded by quintile.

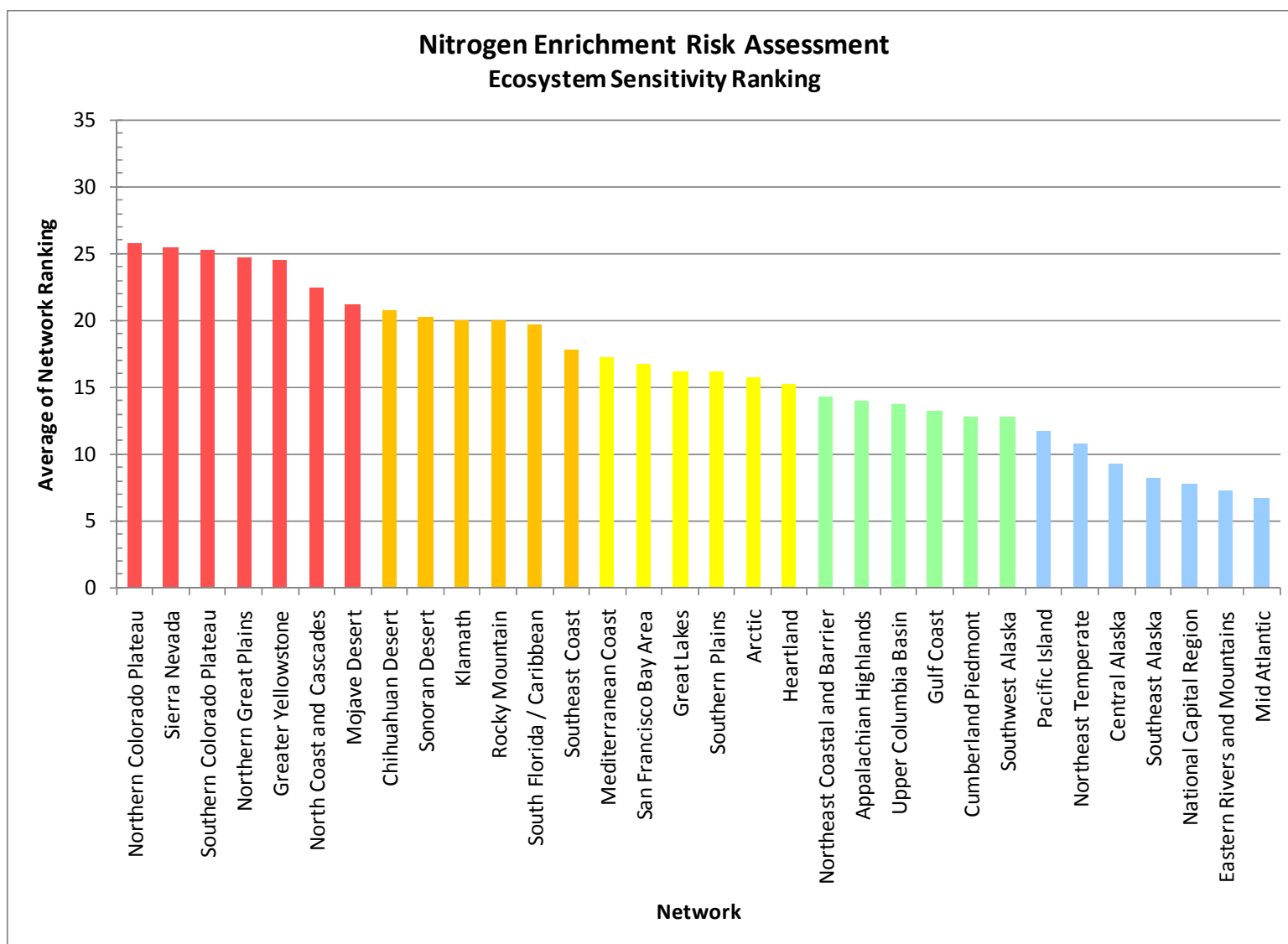


Figure 2. Calculated Ecosystem Sensitivity ranking for each of the 32 I&M networks. Networks are color coded by quintile.

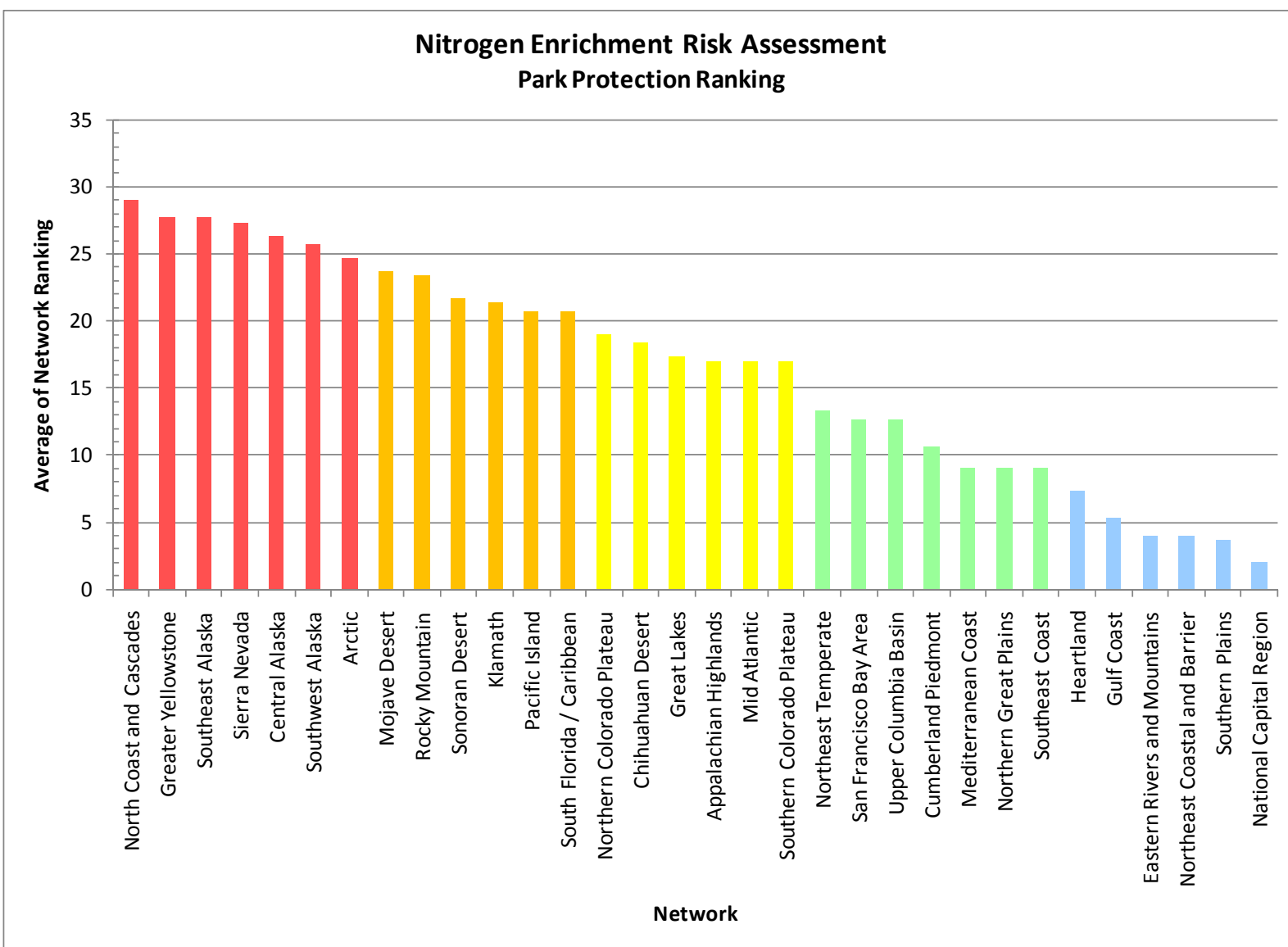


Figure 3. Calculated Park Protection ranking for each of the 32 I&M networks. Networks are color coded by quintile.

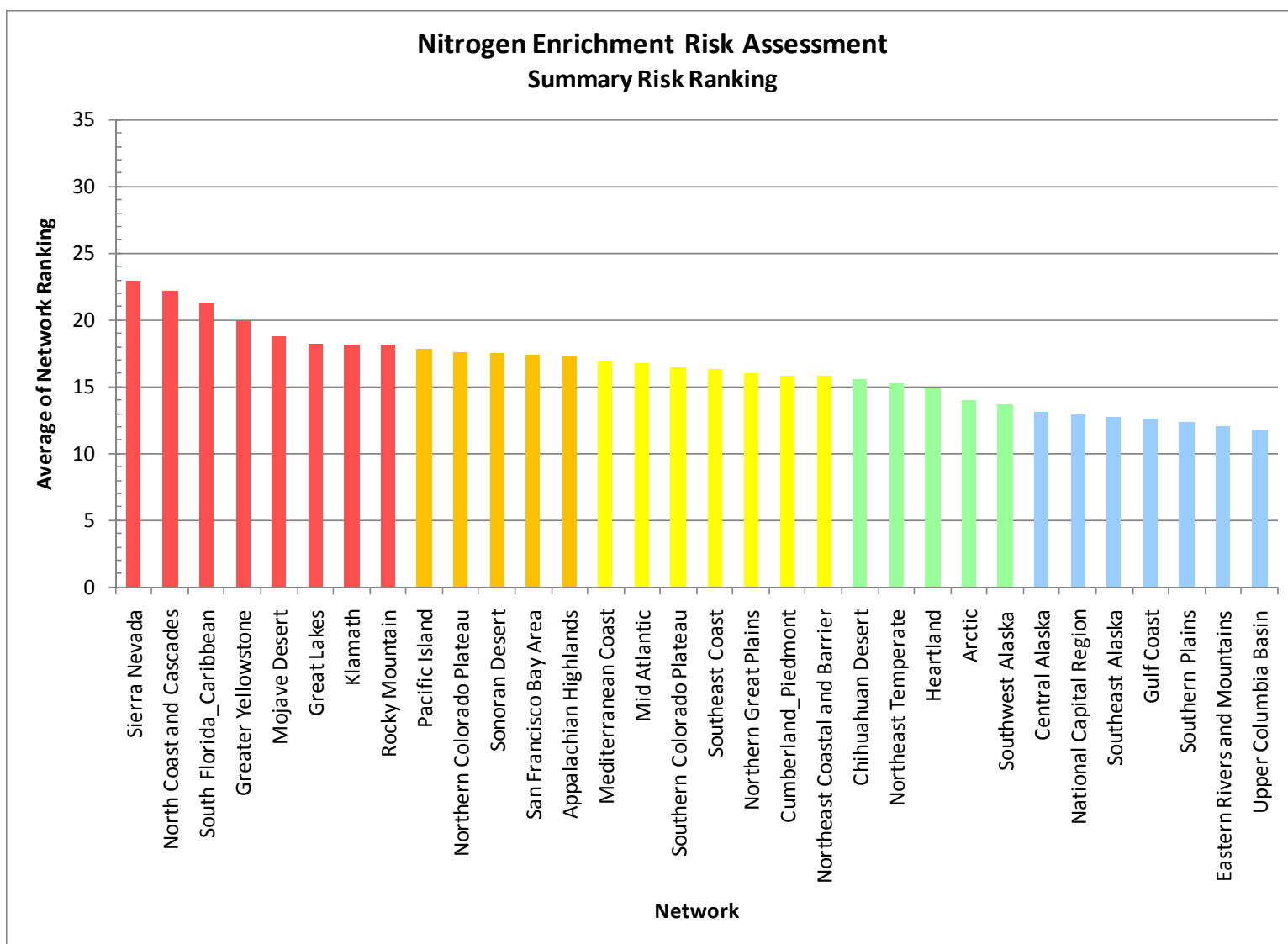
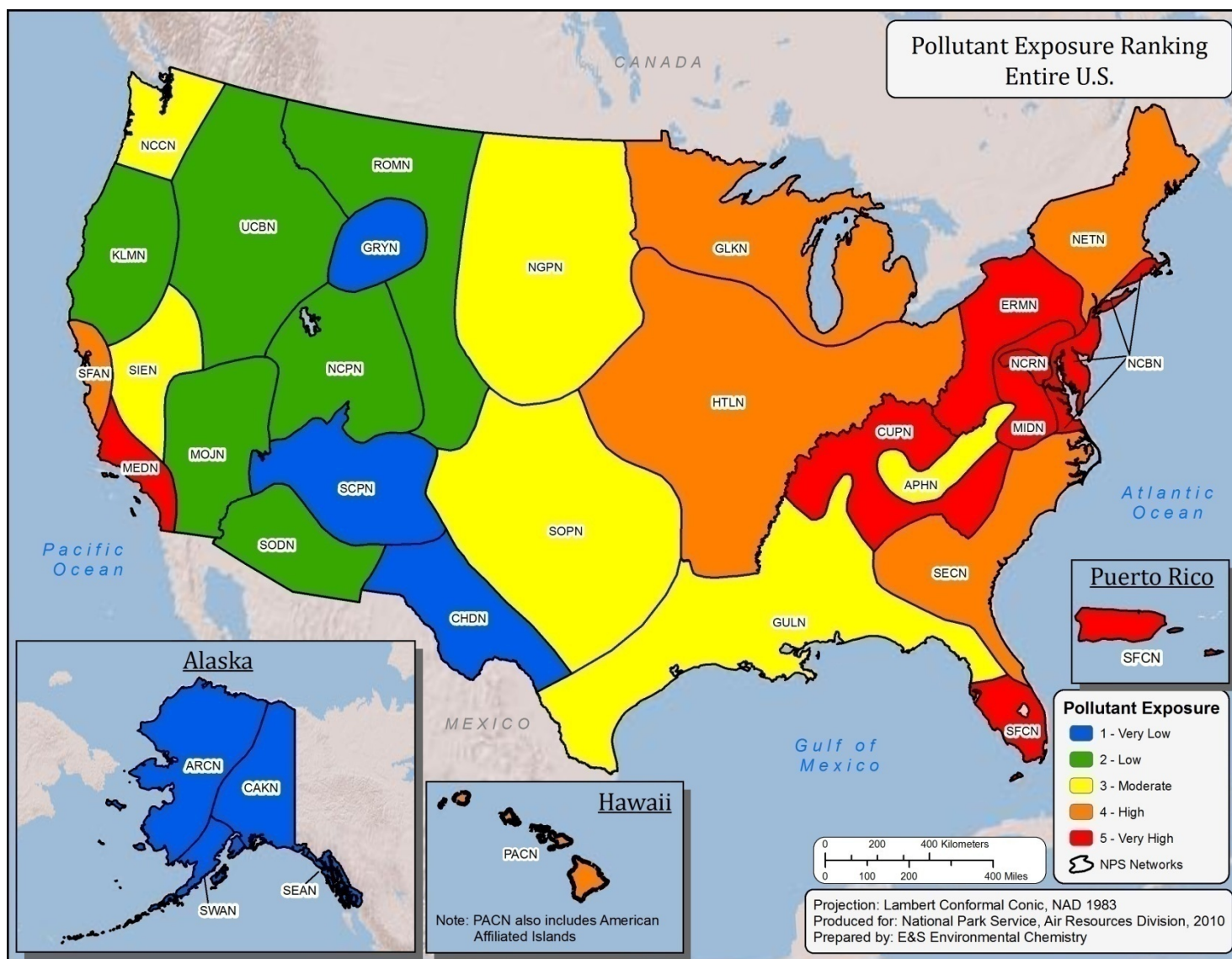
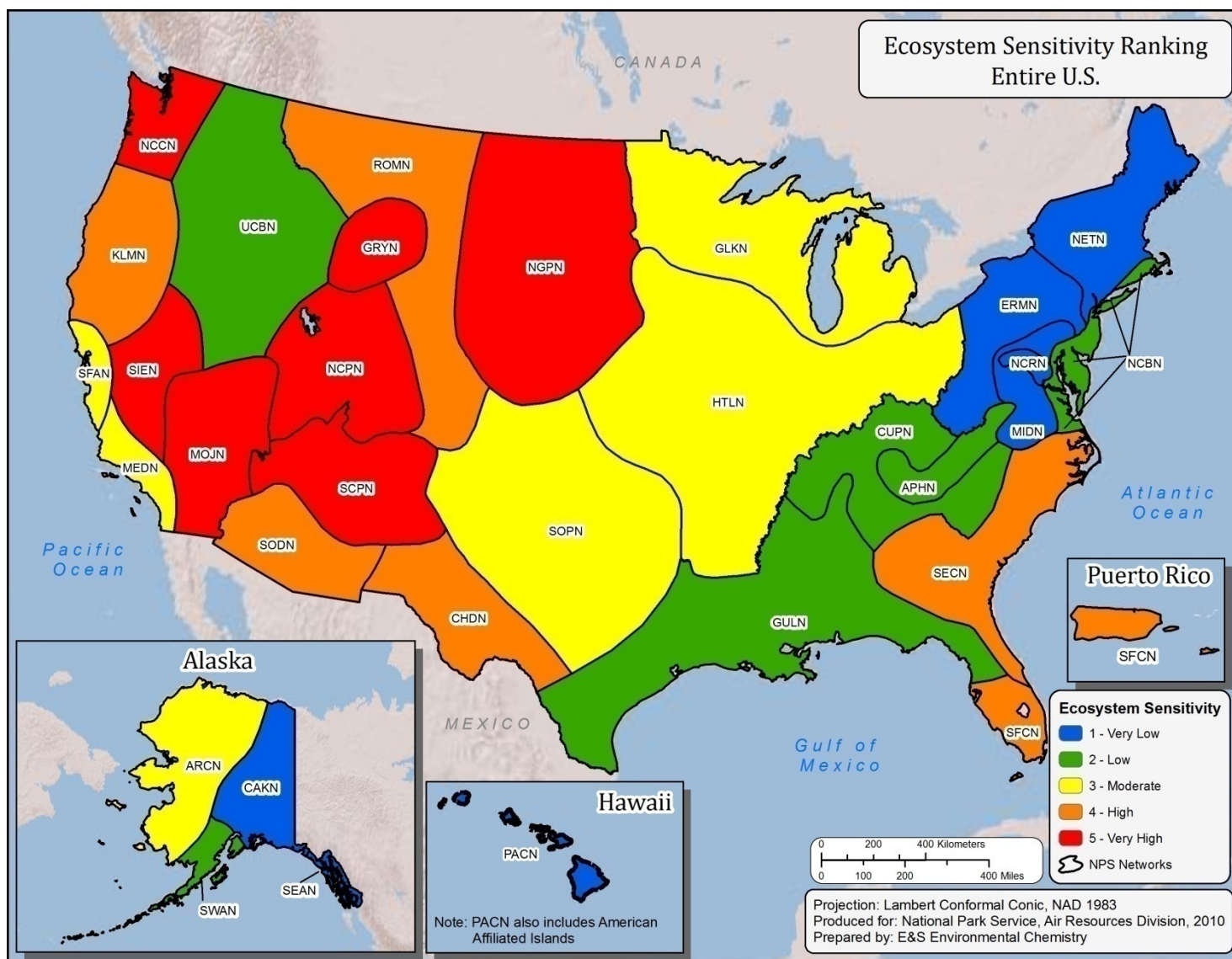


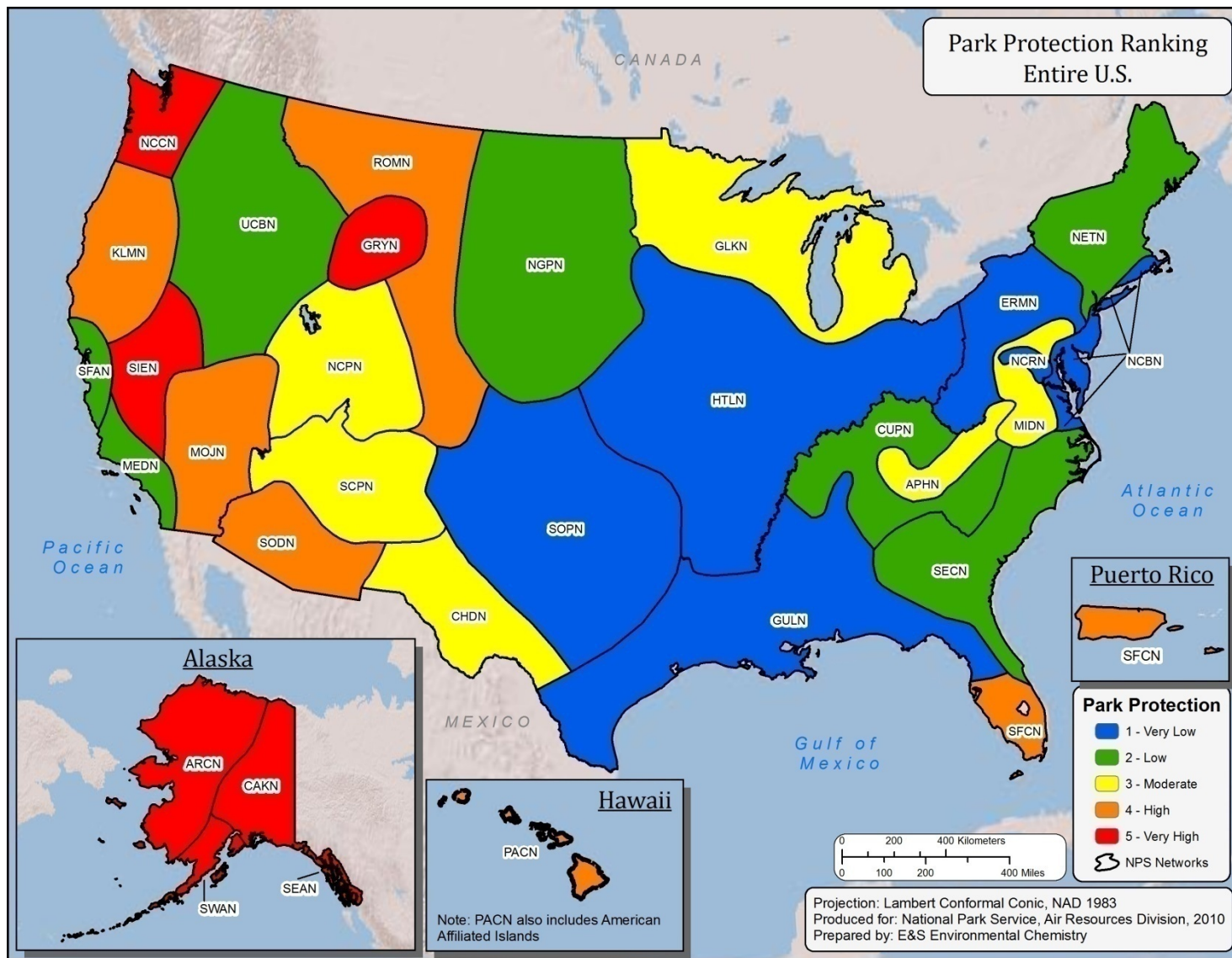
Figure 4. Results of the Summary Risk assessment to rank the 32 networks according to their likely risk of nutrient N enrichment effects, based on the average of the scores for N Pollutant Exposure, Ecosystem Sensitivity, and Park Protection metrics. Networks are color coded by quintile.



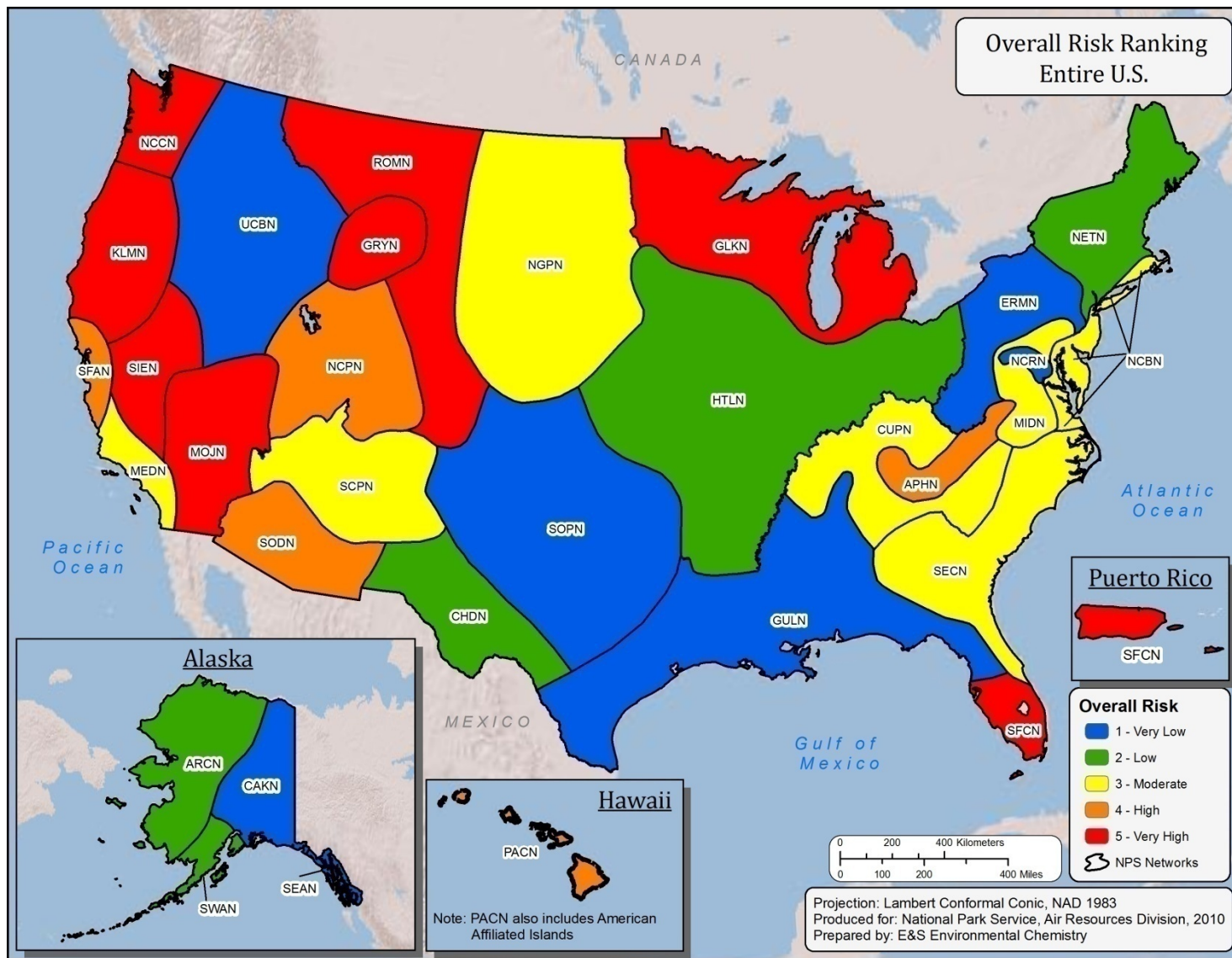
Map 4. Calculated N Pollutant Exposure, by network, across the United States.



Map 5. Calculated Ecosystem Sensitivity, by network, across the United States.



Map 6. Calculated Park Protection, by network, across the United States.



Map 7. Calculated Summary Risk, by network, across the United States.

The Summary Network Risk Ranking (Figure 4) was calculated as the average of the three theme rankings described above. The scale on this graph ranges from a theoretical minimum of 1.0 (average of three ranks, where each rank is the lowest for all variables) to a theoretical maximum of 32 (average of three ranks, where each rank was highest for all variables). In fact, the calculated averages ranged from about 12 to 23. In general, there was a larger differentiation among networks at the upper end of the distribution (left side of the graph). Differences among ranks were most pronounced for the approximately 20% of the networks that showed highest calculated risk. These included five western mountain networks (Sierra Nevada, North Coast and Cascades, Greater Yellowstone, Klamath, and Rocky Mountain), one wetland dominated network (South Florida/ Caribbean), one desert network (Mojave Desert), and the Great Lakes Network. The latter was ranked High to Moderate for each of the three risk themes. The calculated rankings, by network, for each of the three themes, plus the overall Summary Risk ranking, are shown in Maps 4 through 7. Networks are color coded on the maps from a ranking of very low (lowest quintile; blue) to very high (highest quintile; red) for each theme.

Overall scores among networks for Summary Risk do not exhibit a wide distribution of values. There are many cases where networks showing high Pollutant Exposure also show low Ecosystem Sensitivity, and vice versa. The end result is that the network Summary Risk ranking, which is calculated based on the three individual theme ranks, does not show large differences among networks, especially from the top of the lowest quintile to the bottom of the highest quintile. Rankings do show somewhat greater divergence at the extremes of the distributions, especially at the upper end of the ranking for Summary Risk. Thus, there is somewhat more confidence in concluding that the Summary Risk rankings for the Sierra Nevada, North Coast and Cascades, and South Florida/Caribbean Networks are indeed Very High than in concluding that the Summary Risk ranking for the Appalachian Highlands Network (ranked High) is actually at greater risk than the Northeast Temperate Network (ranked Low; Table 6, Figure 4).

3.1.2 Parks

All of the I&M parks, regardless of size, were ranked according to each of the three metrics used to represent the components of risk and for the Summary Risk. Results of park-specific rankings are summarized in Table 6 and in Appendix C. These results cannot be represented graphically in an effective manner because there are too many (272) I&M parks. Most of these parks are very small, and therefore contain only limited pollution-sensitive resources. There are 79 parks larger than 100 square miles in area. These are the parks large enough to generally be readily visible at the scale of the network maps. We therefore graph the park-specific results only for these larger parks. Results are given in Figures 5 through 8 for the N Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and Summary Risk metrics, respectively. In each case, the ranks shown for the large parks reflect rankings *relative to all parks regardless of size*. Bars on the graphs are color coded to reflect ranking quintiles. Parks in the highest quintile (highest 20% of risk rankings) are coded red. Parks in the second highest quintile are coded orange. This pattern is continued, from warm colors to cool colors, with the lowest quintile coded as blue, reflecting the 20% of parks having lowest risk. Note that only 4 of the 79 largest parks occur in the highest quintile for N Pollutant Exposure (Figure 5). This is because the smaller parks are disproportionately located in the eastern United States and are more heavily skewed towards high N Pollutant Exposure. In contrast, the large parks are more heavily skewed (compared to all parks regardless of size) towards high Ecosystem Sensitivity, Park Protection, and overall Summary Risk (Figures 6 through 8).

Table 6. Relative rankings of individual I&M parks, by network, for N Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and Summary Risk from atmospheric nutrient N enrichment.

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Appalachian Highlands	Big South Fork	High	Very Low	Moderate	Low
	Blue Ridge	High	Moderate	High	Very High
	Great Smoky Mountains	High	Very Low	Very High	Very High
	Obed	High	Very Low	Moderate	Low
Arctic	Bering Land Bridge	Very Low	Moderate	Moderate	Very Low
	Cape Krusenstern	Very Low	Very High	Moderate	Very Low
	Gates of the Arctic	Very Low	Moderate	Very High	Moderate
	Kobuk Valley	Very Low	Moderate	Very High	Low
	Noatak	Very Low	Moderate	Very High	Moderate
Central Alaska	Denali	Very Low	Low	Very High	Low
	Wrangell-St. Elias	Very Low	Low	Very High	Low
	Yukon-Charley Rivers	Very Low	Moderate	Moderate	Very Low
Chihuahuan Desert	Amistad	Low	High	Moderate	Low
	Big Bend	Very Low	Very High	Very High	Very High
	Carlsbad Caverns	Low	Very High	Very High	Very High
	Fort Davis	Very Low	Very High	Moderate	Very Low
	Guadalupe Mountains	Low	Very High	Very High	Very High
	White Sands	Very Low	High	Moderate	Very Low
Cumberland Piedmont	Abraham Lincoln Birthplace	Very High	Low	Moderate	Moderate
	Carl Sandburg Home	High	Moderate	Moderate	Moderate
	Chickamauga and Chattanooga	Very High	Very Low	Moderate	Moderate
	Cowpens	High	Very Low	Moderate	Low
	Cumberland Gap	High	Very Low	Moderate	Low
	Fort Donelson	High	Very Low	Moderate	Moderate
	Guilford Courthouse	Very High	Very Low	Moderate	Low
	Kings Mountain	High	Very Low	Moderate	Low
	Little River Canyon	Very High	Very Low	Moderate	Moderate
	Mammoth Cave	Very High	Very Low	Very High	Very High
	Ninety Six	High	Low	Moderate	Low
	Russell Cave	High	Very Low	Moderate	Low
	Shiloh	High	Low	Moderate	Moderate
	Stones River	High	Very Low	Moderate	Low
Eastern Rivers and Mountains	Allegheny Portage Railroad	Very High	Low	Moderate	High
	Bluestone	Moderate	Very Low	Moderate	Very Low
	Delaware Water Gap	Very High	Low	Moderate	High
	Fort Necessity	Very High	Moderate	Moderate	High
	Friendship Hill	Very High	Low	Moderate	High
	Gauley River	High	Very Low	Moderate	Low
	Johnstown Flood	Very High	Moderate	Moderate	High

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Eastern Rivers and Mountains continued	<i>New River Gorge</i>	High	Very Low	Moderate	Low
	Upper Delaware	High	Very Low	Moderate	Moderate
Great Lakes	<i>Apostle Islands</i>	Moderate	Very Low	Moderate	Very Low
	Grand Portage	Low	Low	Moderate	Very Low
	Indiana Dunes	Very High	High	Moderate	Very High
	<i>Isle Royale</i>	Low	Very Low	Very High	High
	Mississippi	Very High	Moderate	Moderate	High
	<i>Pictured Rocks</i>	Moderate	Moderate	Moderate	Low
	<i>Saint Croix</i>	Moderate	Very High	Moderate	High
	<i>Sleeping Bear Dunes</i>	Moderate	Moderate	Moderate	Low
	<i>Voyageurs</i>	Moderate	Low	Very High	Very High
Greater Yellowstone	<i>Bighorn Canyon</i>	Very Low	High	Moderate	Very Low
	<i>Grand Teton</i>	Low	Very High	Very High	Very High
	<i>Yellowstone</i>	Low	Very High	Very High	Very High
Gulf Coast	<i>Big Thicket</i>	High	Moderate	Moderate	High
	<i>Gulf Islands</i>	High	Low	High	Very High
	Jean Lafitte	High	High	Moderate	High
	Natchez Trace Parkway and National Scenic Trail	High	Low	Moderate	Low
	<i>Padre Island</i>	Moderate	Moderate	Moderate	Moderate
	Palo Alto Battlefield	Moderate	Moderate	Moderate	Low
	San Antonio Missions	Moderate	High	Moderate	High
	Vicksburg	Moderate	Very Low	Moderate	Very Low
Heartland	Arkansas Post	Moderate	Very Low	Moderate	Very Low
	<i>Buffalo</i>	Moderate	Moderate	High	Very High
	Cuyahoga Valley	Very High	Very Low	Moderate	High
	Effigy Mounds	High	Low	Moderate	Moderate
	George Washington Carver	High	Very Low	Moderate	Low
	Herbert Hoover	High	Low	Moderate	Moderate
	Homestead	High	High	Moderate	High
	Hopewell Culture	Very High	Very Low	Moderate	Moderate
	Hot Springs	Moderate	Very Low	Moderate	Very Low
	Lincoln Boyhood	Very High	Very Low	Moderate	Moderate
	<i>Ozark</i>	Moderate	Low	Moderate	Low
	Pea Ridge	Very High	Very Low	Moderate	Moderate
	Pipestone	Very High	High	Moderate	Very High
	Tallgrass Prairie	High	Very High	Moderate	High
	Wilson's Creek	Moderate	Low	Moderate	Low
Klamath	<i>Crater Lake</i>	Low	Moderate	Very High	Very High
	<i>Lassen Volcanic</i>	Low	High	Very High	Very High
	Lava Beds	Very Low	Very High	High	High
	Oregon Caves	Moderate	Very Low	Moderate	Very Low
	<i>Redwood</i>	Low	Very Low	Very High	High
	Whiskeytown	Low	Low	Moderate	Very Low

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Mediterranean Coast	Cabrillo	High	Very High	Moderate	High
	Channel Islands	Moderate	High	Moderate	Moderate
	Santa Monica Mountains	Very High	High	Moderate	High
Mid-Atlantic	Appomattox Court House	High	Low	Moderate	Low
	Booker T. Washington	Moderate	Very Low	Moderate	Very Low
	Eisenhower	Very High	Moderate	Moderate	Very High
	Fredericksburg and Spotsylvania	Very High	Low	Moderate	Moderate
	Gettysburg	Very High	Moderate	Moderate	Very High
	Hopewell Furnace	Very High	Moderate	Moderate	Very High
	Petersburg	Very High	Very Low	Moderate	Moderate
	Richmond	Very High	Low	Moderate	High
	Shenandoah	Very High	Very Low	Very High	Very High
	Valley Forge	Very High	High	Moderate	Very High
Mojave Desert	Death Valley	Low	Very High	Very High	Very High
	Great Basin	Very Low	Low	Moderate	Very Low
	Joshua Tree	Moderate	Very High	Very High	Very High
	Lake Mead	Low	Very High	Very High	Very High
	Manzanar	Low	Very High	Moderate	Low
	Mojave	Moderate	Very High	Very High	Very High
National Capital Region	Antietam	Very High	Very Low	Moderate	Moderate
	Catoctin Mountain	Very High	Very Low	Moderate	Moderate
	Chesapeake and Ohio Canal	Very High	Very Low	Moderate	Moderate
	George Washington	Very High	Low	Moderate	High
	Harpers Ferry	Very High	Very Low	Moderate	Moderate
	Manassas	Very High	Low	Moderate	High
	Monocacy	Very High	Low	Moderate	High
	National Capital Parks - East	Very High	Very Low	Moderate	High
	Prince William Forest	Very High	Very Low	Moderate	Moderate
	Rock Creek Park	Very High	Low	Moderate	High
	Wolf Trap National Park for the Performing Arts	Very High	Low	Moderate	High
North Coast and Cascades	Ebey's Landing	Moderate	Low	Moderate	Very Low
	Fort Vancouver	Moderate	Moderate	Moderate	Low
	Lewis and Clark	Moderate	Moderate	Moderate	Low
	Mount Rainier	Moderate	Very High	Very High	Very High
	North Cascades	Moderate	Very High	Very High	Very High
	Olympic	Moderate	Very High	Very High	Very High
	San Juan Island	High	High	Moderate	Moderate
Northeast Coastal and Barrier	Assateague Island	High	Moderate	Moderate	High
	Cape Cod	High	Moderate	Moderate	High
	Colonial	High	Moderate	Moderate	High
	Fire Island	Very High	Low	High	Very High
	Gateway	Very High	Moderate	Moderate	Very High

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Northeast Coastal and Barrier continued	George Washington Birthplace	Very High	High	Moderate	Very High
	Sagamore Hill	Very High	Low	Moderate	High
	Thomas Stone	Very High	Very Low	Moderate	High
Northeast Temperate	Acadia	Moderate	Low	Very High	High
	Boston Harbor Islands	Very High	Moderate	Moderate	High
	Home of Franklin D. Roosevelt	Very High	Low	Moderate	High
	Marsh-Billings-Rockefeller	Moderate	Very Low	Moderate	Very Low
	Minute Man	High	Low	Moderate	Moderate
	Morristown	Very High	Very Low	Moderate	High
	Saint-Gaudens	Moderate	Very Low	Moderate	Very Low
	Saratoga	Moderate	Low	Moderate	Low
	Saugus Iron Works	High	Moderate	Moderate	High
	Vanderbilt Mansion	Very High	Very Low	Moderate	Moderate
	Weir Farm	Very High	Moderate	Moderate	Very High
Northern Colorado Plateau	Arches	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
	Canyonlands	Very Low	Very High	Very High	Very High
	Capitol Reef	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
	Dinosaur	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
	Zion	Very Low	High	Very High	High
Northern Great Plains	Agate Fossil Beds	Low	Very High	Moderate	Moderate
	Badlands	Very Low	High	Very High	High
	Devils Tower	Low	High	Moderate	Very Low
	Fort Laramie	Moderate	High	Moderate	Low
	Fort Union Trading Post	Low	Moderate	Moderate	Very Low
	Jewel Cave	Low	Very Low	Moderate	Very Low
	Knife River Indian Villages	Moderate	Moderate	Moderate	Low
	Missouri	High	Moderate	Moderate	Moderate
	Mount Rushmore	Low	Very Low	High	Low
	Niobrara	Moderate	High	High	Very High
	Scotts Bluff	Moderate	Very High	Moderate	Moderate
	Theodore Roosevelt	Low	High	Very High	Very High
	Wind Cave	Low	Very High	Very High	Very High

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Pacific Island	American Memorial Park	No Data	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	No Data	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	No Data	Very Low	Moderate	Very Low
Rocky Mountain	Florissant Fossil Beds	Moderate	Moderate	Moderate	Very Low
	Glacier	Low	High	Very High	Very High
	Grant-Kohrs Ranch	Very Low	High	Moderate	Very Low
	Great Sand Dunes	Very Low	Very High	Very High	Very High
	Little Bighorn Battlefield	Very Low	Very High	Moderate	Low
	Rocky Mountain	Moderate	Very High	Very High	Very High
San Francisco Bay Area	Fort Point	Moderate	Low	Moderate	Low
	Golden Gate	High	Moderate	High	Very High
	John Muir	High	High	Moderate	High
	Muir Woods	High	Low	Moderate	Moderate
	Pinnacles	Moderate	High	High	Very High
	Point Reyes	High	High	High	Very High
Sierra Nevada	Devils Postpile	Low	Low	Very High	Moderate
	Kings Canyon	Low	Very High	Very High	Very High
	Sequoia	Moderate	Very High	Very High	Very High
	Yosemite	Moderate	Very High	Very High	Very High
Sonoran Desert	Casa Grande Ruins	Moderate	Very High	Moderate	Moderate
	Chiricahua	Very Low	High	Very High	High
	Coronado	Very Low	Very High	High	High
	Fort Bowie	Very Low	High	Moderate	Very Low
	Gila Cliff Dwellings	Very Low	Very High	High	Moderate
	Montezuma Castle	Low	Very High	Moderate	Moderate
	Organ Pipe Cactus	Low	Very High	Very High	Very High
	Saguaro	Low	Very High	Very High	Very High
	Tonto	Moderate	Very High	Moderate	Moderate
	Tumacacori	Low	High	Moderate	Low
	Tuzigoot	Low	Moderate	Moderate	Very Low
South Florida/Caribbean	Big Cypress	High	Very High	High	Very High
	Biscayne	High	Low	Moderate	Moderate
	Buck Island Reef	Very High	Very Low	Moderate	Moderate
	Dry Tortugas	Moderate	Very Low	Moderate	Very Low
	Everglades	Very High	High	Very High	Very High
	Virgin Islands	Very High	Very Low	Very High	Very High
Southeast Alaska	Glacier Bay	Very Low	Low	Very High	Low
	Klondike Gold Rush	Very Low	High	Moderate	Very Low

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Southeast Alaska continued	Sitka	Very Low	Moderate	Moderate	Very Low
Southeast Coast	Canaveral	High	Moderate	Moderate	Moderate
	Cape Hatteras	High	High	Moderate	High
	Cape Lookout	High	High	Moderate	High
	Castillo de San Marcos	High	Very Low	Moderate	Low
	Chattahoochee River	Very High	Low	Moderate	Moderate
	Congaree	High	Very High	High	Very High
	Cumberland Island	Moderate	High	High	Very High
	Fort Caroline	High	Moderate	Moderate	High
	Fort Frederica	High	High	Moderate	High
	Fort Matanzas	High	High	Moderate	High
	Fort Pulaski	Moderate	Very High	Moderate	High
	Fort Sumter	High	Very Low	Moderate	Low
	Horseshoe Bend	High	Low	Moderate	Moderate
	Kennesaw Mountain	Very High	Very Low	Moderate	Moderate
	Moore's Creek	Very High	Moderate	Moderate	High
	Ocmulgee	High	High	Moderate	High
	Timucaun Ecological and Historical Preserve	High	High	Moderate	High
Southern Colorado Plateau	Aztec Ruins	Moderate	High	Moderate	Low
	Bandelier	Low	High	Very High	High
	<i>Canyon de Chelly</i>	Low	Moderate	Moderate	Very Low
	Chaco Culture	Low	Very High	Moderate	Low
	<i>El Malpais</i>	Low	Low	High	Low
	El Morro	Low	High	Moderate	Very Low
	<i>Glen Canyon</i>	Very Low	High	High	Moderate
	<i>Grand Canyon</i>	Very Low	Very High	Very High	Very High
	Hubbell Trading Post	Low	Moderate	Moderate	Very Low
	Mesa Verde	Low	High	Very High	Very High
	Navajo	Very Low	Moderate	Moderate	Very Low
	<i>Petrified Forest</i>	Low	Very High	Very High	Very High
	Petroglyph	Low	Very High	Moderate	Low
	Rainbow Bridge	Very Low	High	Moderate	Very Low
	Salinas Pueblo Missions	Very Low	Very High	Moderate	Low
	Sunset Crater Volcano	Low	Low	Moderate	Very Low
	Walnut Canyon	Low	High	Moderate	Low
	Wupatki	Very Low	High	Moderate	Very Low
	Yucca House	Low	High	Moderate	Low
Southern Plains	Alibates Flint Quarries	Moderate	Moderate	Moderate	Moderate
	Bent's Old Fort	Low	High	Moderate	Low
	Capulin Volcano	Very Low	Moderate	Moderate	Very Low
	Chickasaw	High	Low	Moderate	Low
	Fort Larned	Moderate	High	Moderate	Moderate
	Fort Union	Very Low	Very High	Moderate	Very Low

Network	I&M Parks ² in Network	Relative Ranking of Individual Parks ¹			
		Nitrogen Pollutant Exposure	Ecosystem Sensitivity	Park Protection	Summary Risk
Southern Plains continued	Lake Meredith	Moderate	Moderate	Moderate	Moderate
	Lyndon B. Johnson	Moderate	Moderate	Moderate	Moderate
	Pecos	Low	Very High	Moderate	Low
	Washita Battlefield	Moderate	Very High	Moderate	High
Southwest Alaska	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
Upper Columbia Basin	Big Hole	Very Low	High	Moderate	Very Low
	City of Rocks	Low	High	Moderate	Low
	Craters of the Moon	Low	Moderate	High	Moderate
	Hagerman Fossil Beds	Moderate	Very High	Moderate	Moderate
	John Day Fossil Beds	Very Low	Very High	Moderate	Low
	Lake Roosevelt	Very Low	Moderate	Moderate	Very Low
	Nez Perce	Very Low	High	Moderate	Very Low
	Whitman Mission	Moderate	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 names are printed in bold italic for parks larger than 100 mi².

These rankings for the 79 largest I&M parks are shown in Maps 8-11. Each park is represented by a star, color coded to reflect its ranking. The ranks for each theme range from very low (blue) to very high (red). Individual park-specific results for all parks, regardless of size, are presented in tabular form and discussed in the individual network sections of this report. Some networks do not have any parks larger than 100 square miles. For such networks, Figures E through H are omitted.

3.2 Results by Network

Results for the individual I&M networks are discussed in more detail in an associated series of 32 reports. Each report provides network-specific information and maps for the three factors used in the risk analysis, including N pollutant exposure, ecosystem sensitivity, and level of park protection. Each network report has charts showing that network's relative ranking for each of the three factors, and the network's relative ranking in terms of overall risk from excess N enrichment. Network reports are available from the Air Resources Division of the NPS (<http://www.nature.nps.gov/air/Permits/ARIS/networks/n-sensitivity.cfm>) and the NPS NRInfo portal (<https://nrinfo.nps.gov/Reference.mvc/Profile?code=2168592>).

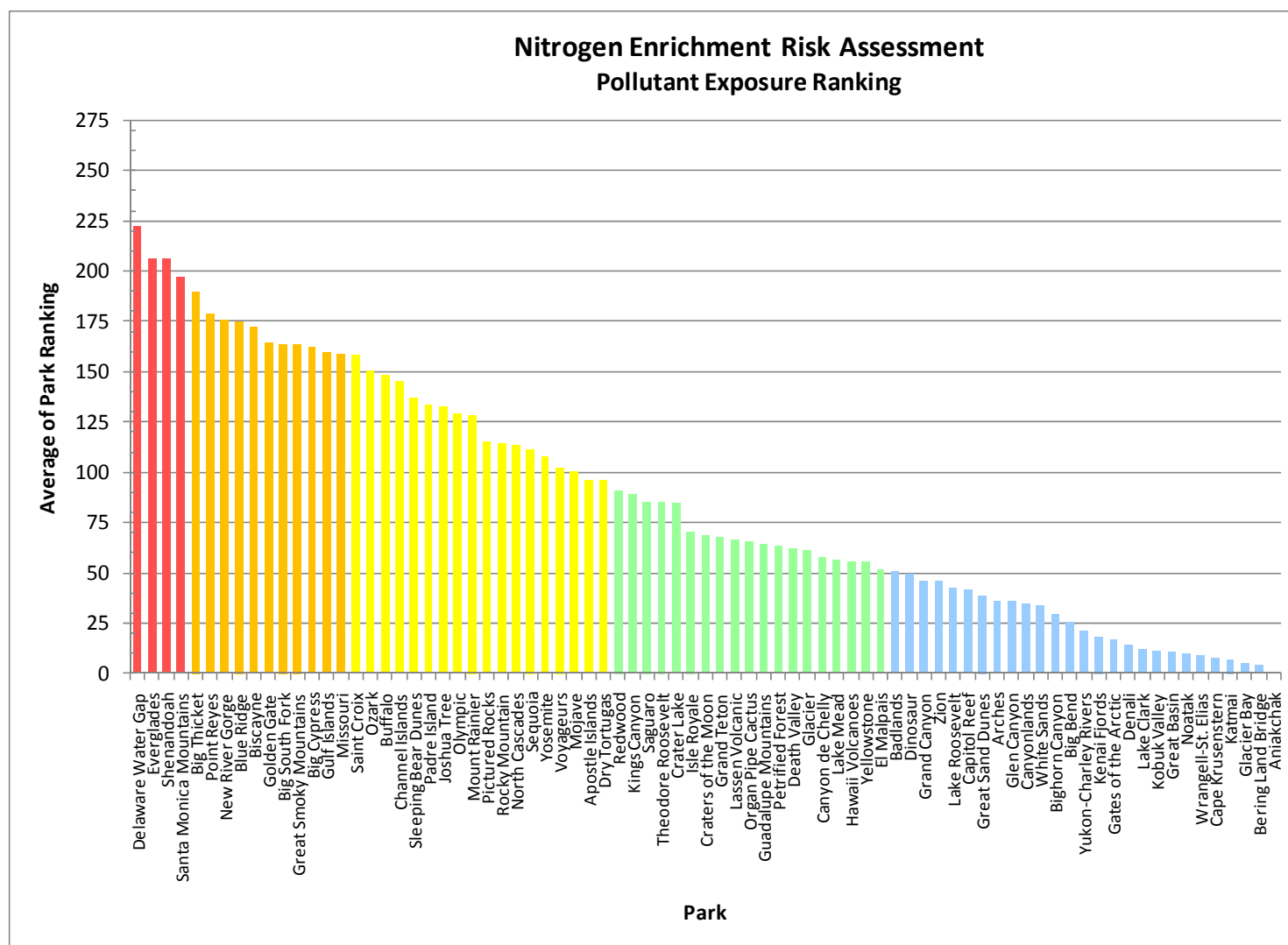


Figure 5. Calculated N Pollutant Exposure ranking, expressed relative to all I&M parks, for each of the 79 I&M parks larger than 100 square miles. Parks are color coded by quintile, from the highest 20% of rankings among all 272 I&M parks (red) to the lowest 20% of rankings (blue).

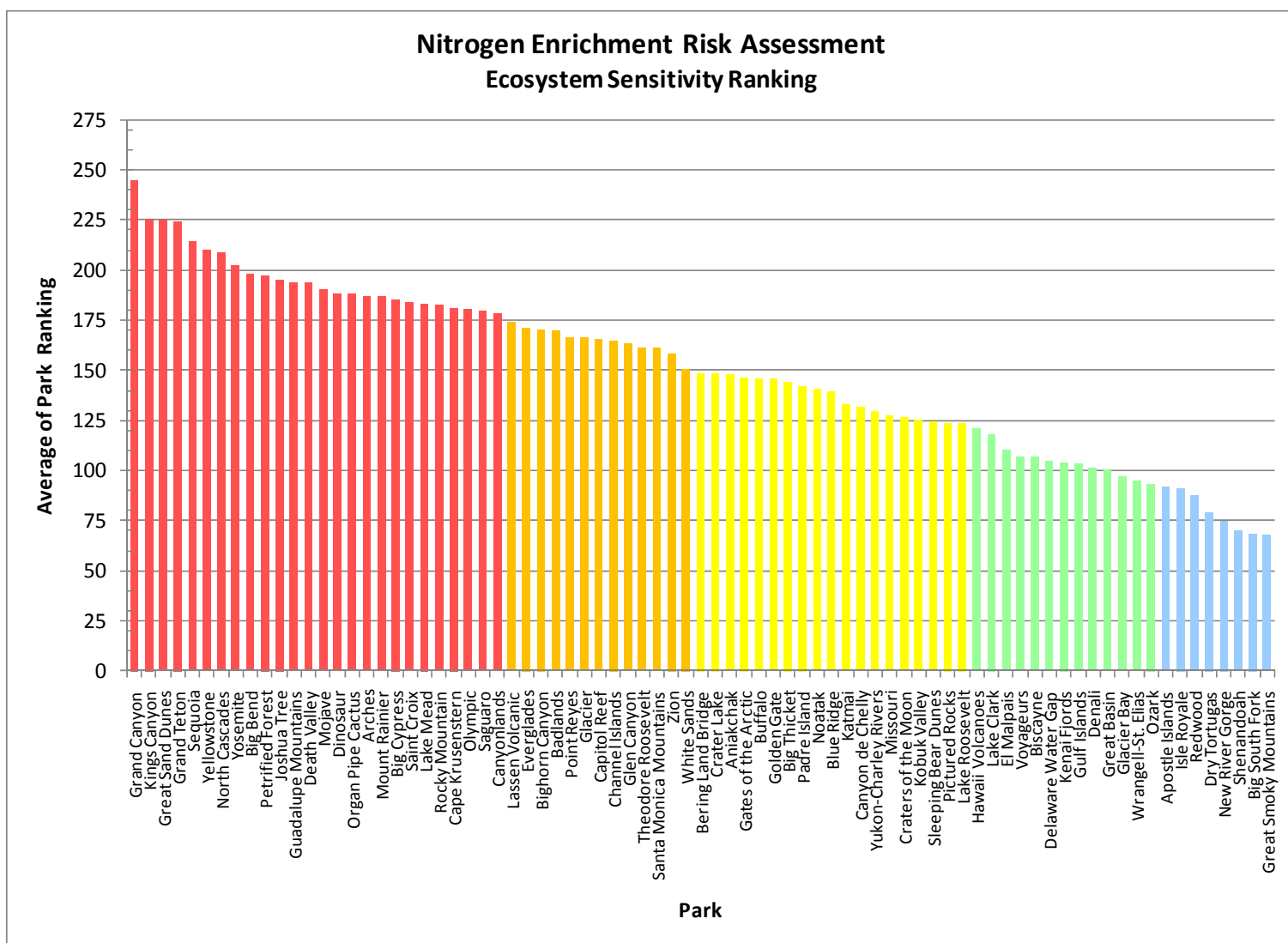


Figure 6. Calculated Ecosystem Sensitivity ranking, expressed relative to all I&M parks, for each of the 79 I&M parks larger than 100 square miles. Parks are color coded by quintile, from the highest 20% of rankings among all 272 I&M parks (red) to the lowest 20% of rankings (blue).

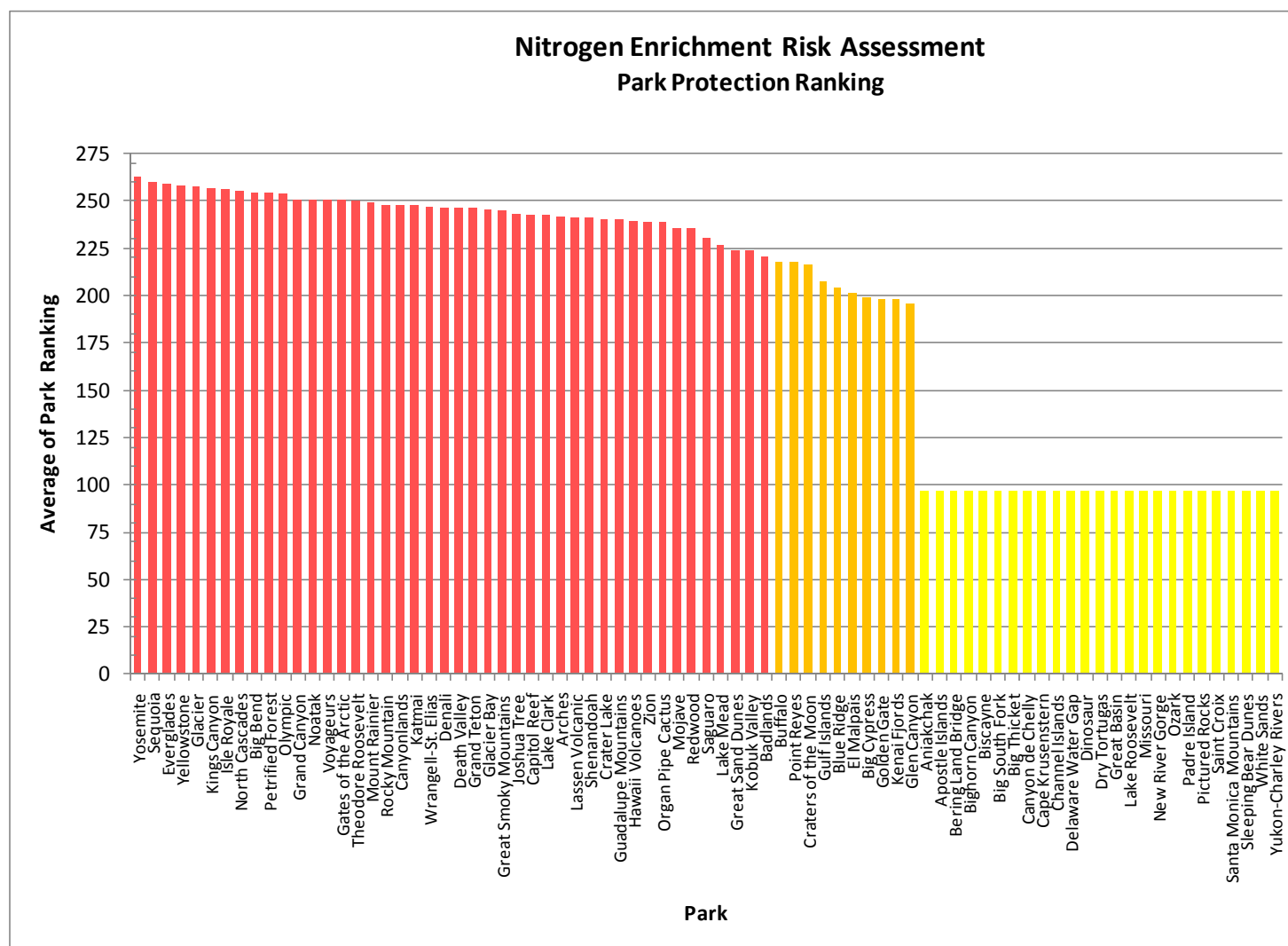


Figure 7. Calculated Park Protection ranking, expressed relative to all I&M parks, for each of the 79 I&M parks larger than 100 square miles. Parks are color coded by quintile, from the highest 20% of rankings among all 272 I&M parks (red) to the lowest 20% of rankings. The majority of parks had no land designated as wilderness or Class I. Averaging of Park Protection across all parks placed all of these parks that lacked any special protection into the middle quintile. Thus, there are no parks that receive a Park Protection ranking in the lowest (blue) or second lowest (green) quintile.

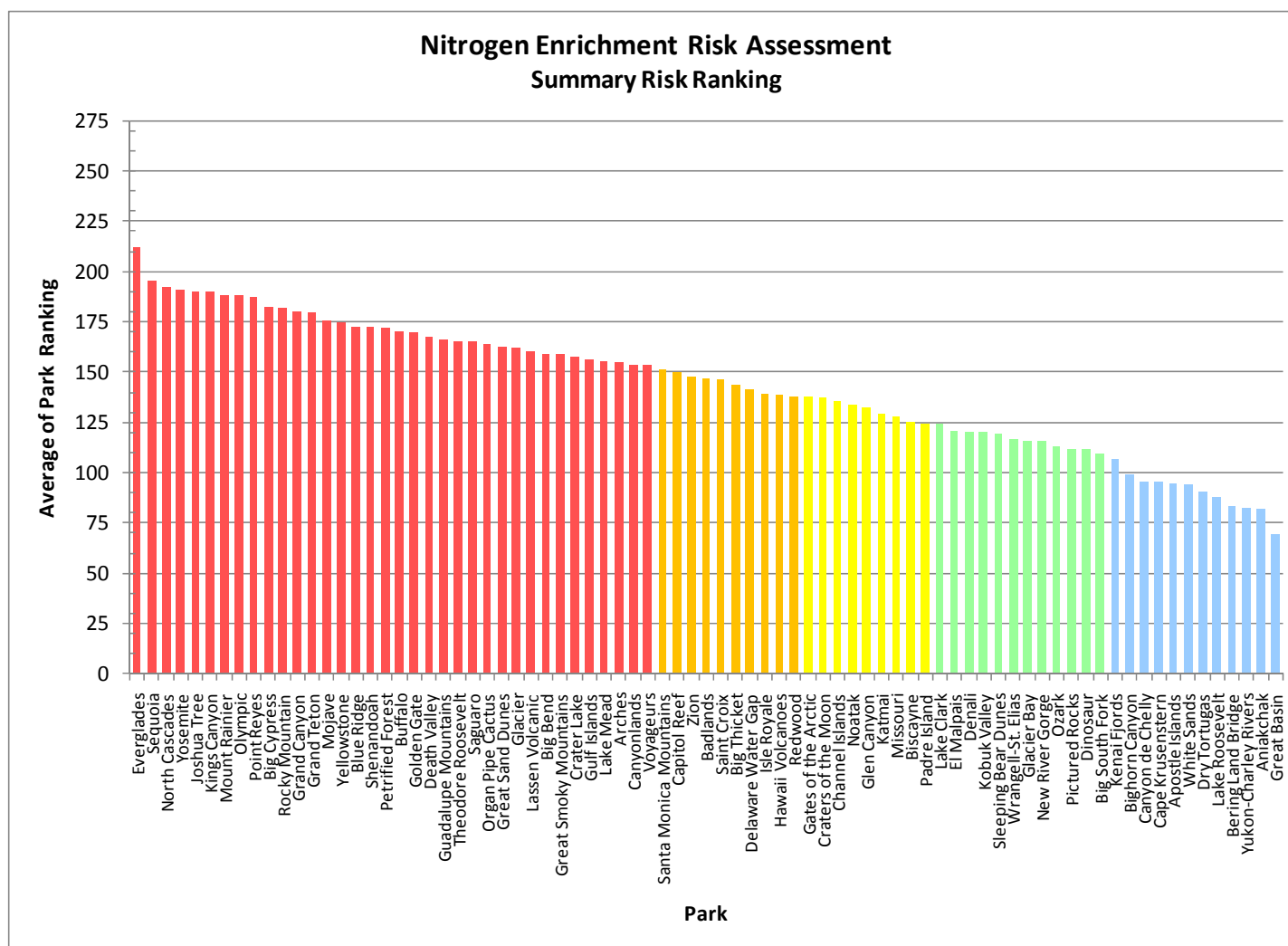
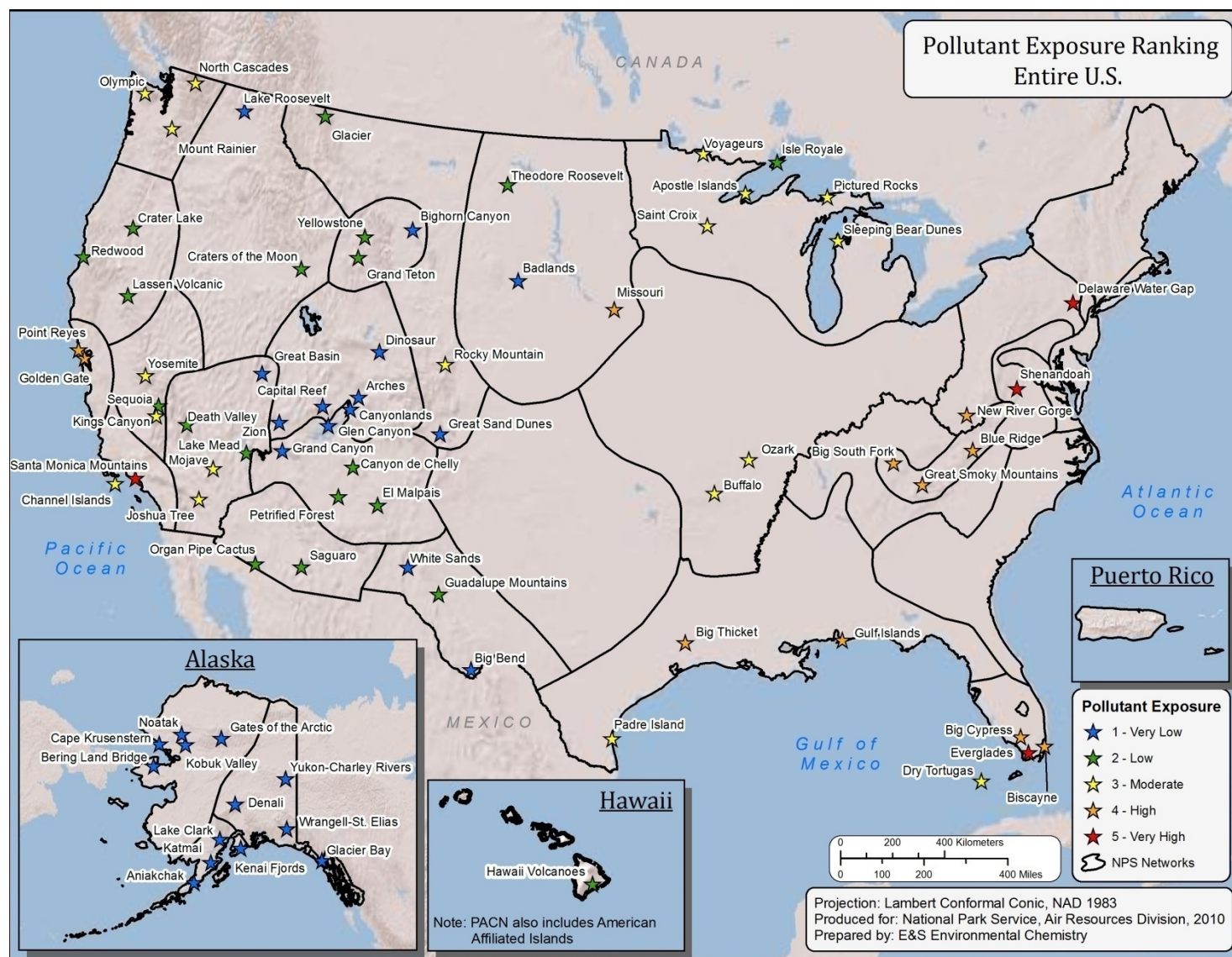
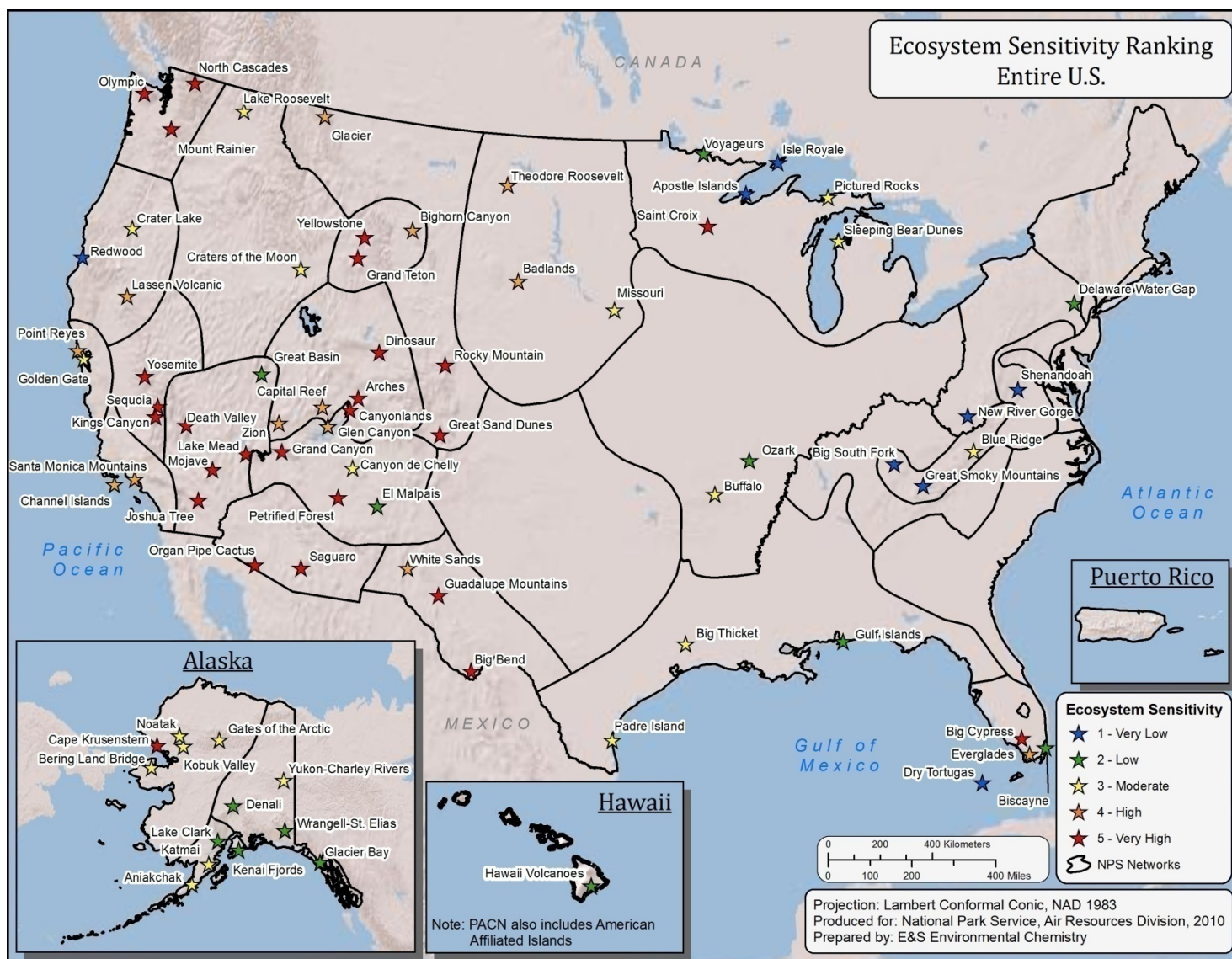


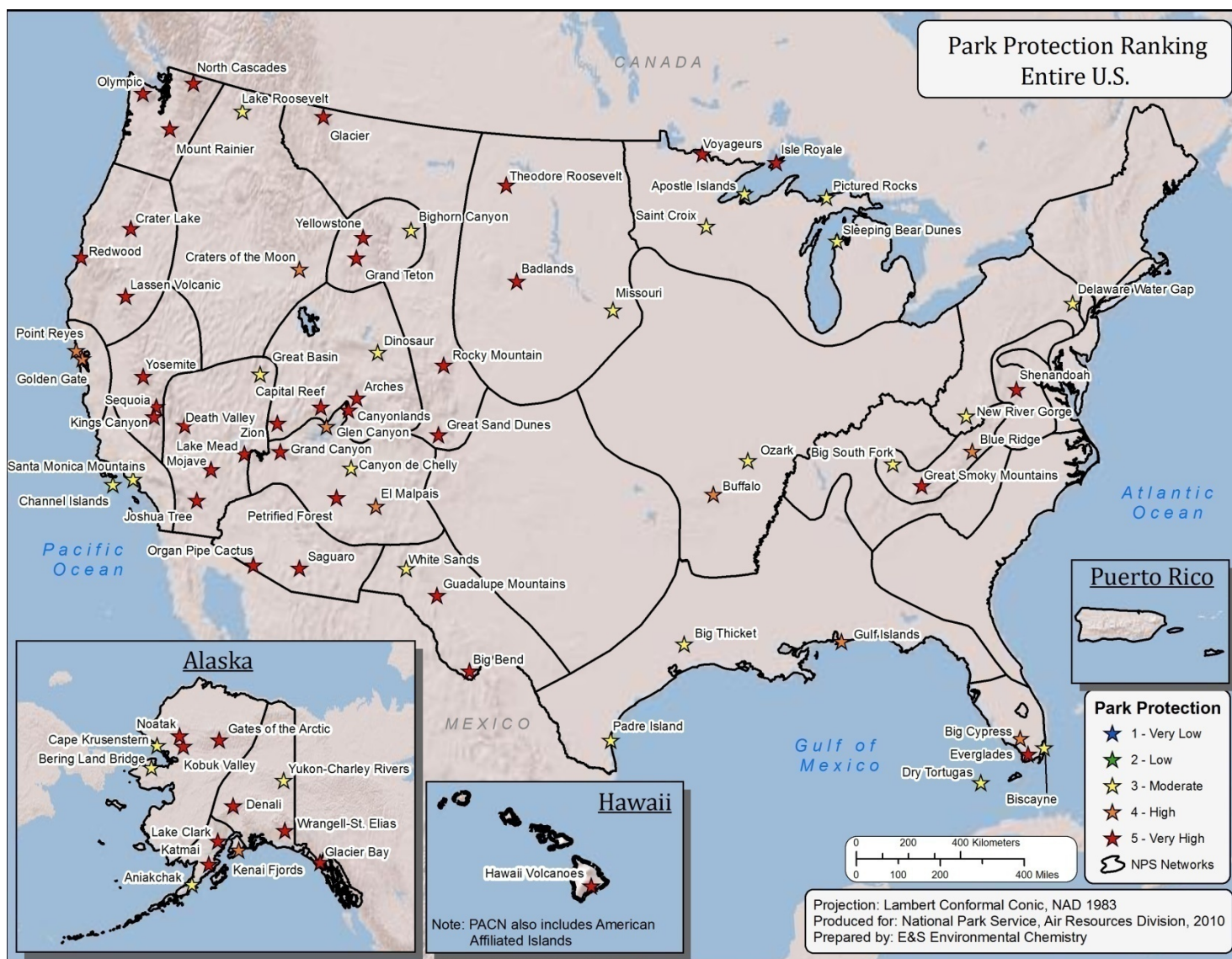
Figure 8. Results of the Summary Risk assessment to rank the 79 I&M parks that are larger than 100 square miles according to their likely risk of nutrient N enrichment effects, based on summing the scores for N Pollutant Exposure, Ecosystem Sensitivity, and Park Protection metrics. Parks are color coded by quintile, from the highest 20% of rankings among all 272 I&M parks (red) to the lowest 20% of rankings (blue). Note that these larger parks are skewed towards the higher risk rankings (highest quintiles; red and orange) compared with the smaller parks that do not appear on the graph.



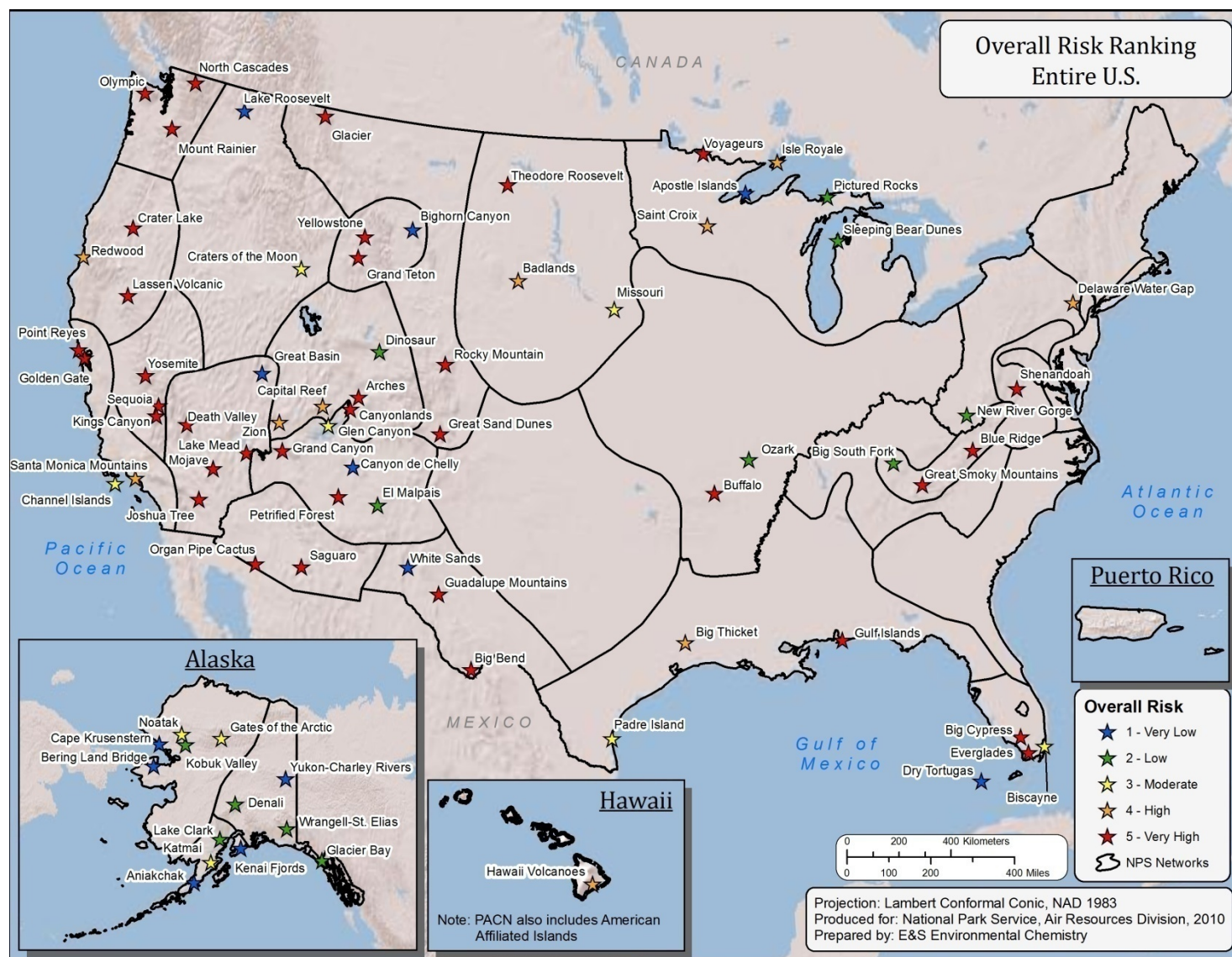
Map 8. Calculated N Pollutant Exposure, by park, across the United States for all I&M parks larger than 100 square miles.



Map 9. Calculated Ecosystem Sensitivity, by park, across the United States for all I&M parks larger than 100 square miles.



Map 10. Calculated Park Protection, by park, across the United States for all I&M parks larger than 100 square miles.



Map 11. Calculated Summary Risk, by park, across the United States for all I&M parks larger than 100 square miles.

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Appendix A: Sources of Vegetation Coverage Data

CODE	UNIT CODE	PARK NAME	Wetland								Non-wetland Vegetation						
			Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
APHN	BISO	Big South Fork NRRRA					x					x					
APHN	BLRI	Blue Ridge Parkway					x					x					
APHN	GRSM	Great Smoky Mountains NP					x					x					
APHN	OBRI	Obed WSR					x					x					
ARCN	BELA	Bering Land Bridge Npres				x								x			
ARCN	CAKR	Cape Krusenstern NMON					x							x			
ARCN	GAAR	Gates of the Arctic NPP					x							x			
ARCN	KOVA	Kobuk Valley NP				x								x			
ARCN	NOAT	Noatak Npres					x							x			
CAKN	DENA	Denali NPP					x							x			
CAKN	WRST	Wrangell-St. Elias NPP					x								x		
CAKN	YUCH	Yukon Charley Rivers Npres					x							x			
CHDN	AMIS	Amistad NRA					x					x					
CHDN	BIBE	Big Bend NP		x								x					
CHDN	CAVE	Carlsbad Caverns NP		x								x					
CHDN	FODA	Fort Davis NHS		x								x					
CHDN	GUMO	Guadalupe Mountains NP		x								x					

CODE	UNIT CODE	PARK NAME	Wetland								Non-wetland Vegetation						
			Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
ERMN	FRHI	Friendship Hill NHS						x								x	
ERMN	GARI	Gauley River NRA					x					x					
ERMN	JOFL	Johnstown Flood NMEM						x								x	
ERMN	NERI	New River Gorge NR					x					x					
ERMN	UPDE	Upper Delaware Scenic & Recreational River					x					x					
GLKN	APIS	Apostle Islands NL		x								x					
GLKN	GRPO	Grand Portage NMON					x					x					
GLKN	INDU	Indiana Dunes NL					x					x					
GLKN	ISRO	Isle Royale NP						x								x	
GLKN	MISS	Mississippi National River & Recreation Area					x					x					
GLKN	PIRO	Pictured Rocks NL					x					x					
GLKN	SACN	Saint Croix National Scenic Riverway					x					x					
GLKN	SLBE	Sleeping Bear Dunes NL					x					x					
GLKN	VOYA	Voyageurs NP						x								x	
GRYN	BICA	Bighorn Canyon NRA					x					x					
GRYN	GRTE	Grand Teton NP						x								x	
GRYN	YELL	Yellowstone NP					x					x					
GULN	BITH	Big Thicket Npres					x					x					

			Wetland								Non-wetland Vegetation							
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data	
GULN	GUIS	Gulf Islands NS					x					x						
GULN	JELA	Jean Lafitte NHP&Pres					x					x						
GULN	NATR	Natchez Trace Parkway					x					x						
GULN	PAAL	Palo Alto Battlefield NHS					x					x						
GULN	PAIS	Padre Island NS					x					x						
GULN	SAAN	San Antonio Missions NHP						x									x	
GULN	VICK	Vicksburg NMP		x								x						
HTLN	ARPO	Arkansas Post NMEM		x								x						
HTLN	BUFF	Buffalo National River		x								x						
HTLN	CUVA	Cuyahoga Valley NP		x								x						
HTLN	EFMO	Effigy Mounds NMON						x									x	
HTLN	GWCA	George Washington Carver NMON					x					x						
HTLN	HEHO	Herbert Hoover NHS					x					x						
HTLN	HOCU	Hopewell Culture NHP		x								x						
HTLN	HOME	Homestead National Monument of America					x					x						
HTLN	HOSP	Hot Springs NP					x					x						
HTLN	LIBO	Lincoln Boyhood NMEM					x					x						
HTLN	OZAR	Ozark National Scenic Riverways					x					x						
HTLN	PERI	Pea Ridge NMP		x								x						

			Wetland								Non-wetland Vegetation							
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data	
HTLN	PIPE	Pipestone NMON		x								x						
HTLN	TAPR	Tallgrass Prairie NPr		x								x						
HTLN	WICR	Wilson's Creek NB					x					x						
KLMN	CRLA	Crater Lake NP					x					x						
KLMN	LABE	Lava Beds NMON		x								x						
KLMN	LAVO	Lassen Volcanic NP					x					x						
KLMN	ORCA	Oregon Caves NMON		x								x						
KLMN	REDW	Redwood NP					x					x						
KLMN	WHIS	Whiskeytown NRA					x					x						
MEDN	CABR	Cabrillo NMON					x					x						
MEDN	CHIS	Channel Islands NP					x					x						
MEDN	SAMO	Santa Monica Mountains NRA					x					x						
MIDN	APCO	Appomattox Court House NHP					x					x						
MIDN	BOWA	Booker T. Washington NMON		x								x						
MIDN	EISE	Eisenhower NHS						x									x	
MIDN	FRSP	Fredericksburg & Spotsylvania County Memorial NMP					x					x						
MIDN	GETT	Gettysburg NMP						x									x	
MIDN	HOFU	Hopewell Furnace NHS						x									x	
MIDN	PETE	Petersburg NB					x					x						

			Wetland								Non-wetland Vegetation						
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
MIDN	RICH	Richmond NBP					x					x					
MIDN	SHEN	Shenandoah NP					x					x					
MIDN	VAFO	Valley Forge NHP						x								x	
MOJN	DEVA	Death Valley NP					x					x					
MOJN	GRBA	Great Basin NP					x					x					
MOJN	JOTR	Joshua Tree NP					x					x					
MOJN	LAME	Lake Mead NRA					x					x					
MOJN	MANZ	Manzanar NHS					x					x					
MOJN	MOJA	Mojave NPRES					x					x					
NCBN	ASIS	Assateague Island NS					x					x					
NCBN	CACO	Cape Cod NS					x					x					
NCBN	COLO	Colonial NHP					x					x					
NCBN	FIIS	Fire Island NS						x								x	
NCBN	GATE	Gateway NRA					x					x					
NCBN	GEWA	George Washington Birthplace NMON						x								x	
NCBN	SAHI	Sagamore Hill NHS					x					x					
NCBN	THST	Thomas Stone NHS					x					x					
NCCN	EBLA	Ebey's Landing National Historical Reserve					x					x					
NCCN	FOVA	Fort Vancouver NHS					x					x					

[illegible]

CODE	UNIT CODE	PARK NAME	Wetland								Non-wetland Vegetation						
			Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
NCPN	TICA	Timpanogos Cave NMON		x								x					
NCPN	ZION	Zion NP						x								x	
NCRN	ANTI	Antietam NB					x					x					
NCRN	CATO	Catoctin Mountain Park					x					x					
NCRN	CHOH	Chesapeake and Ohio Canal NHP						x								x	
NCRN	GWMP	George Washington Memorial Parkway					x					x					
NCRN	HAFE	Harpers Ferry NHP					x					x					
NCRN	MANA	Manassas NBP					x					x					
NCRN	MONO	Monocacy NB					x					x					
NCRN	NACE	National Capital Parks - East						x								x	
NCRN	PRWI	Prince William Forest Park					x					x					
NCRN	ROCR	Rock Creek Park						x								x	
NCRN	WOTR	Wolf Trap Farm Park					x					x					
NETN	ACAD	Acadia NP					x					x					
NETN	BOHA	Boston Harbor Islands NRA					x					x					
NETN	HOFR	Home of Franklin D Roosevelt					x					x					
NETN	MABI	Marsh-Billings-Rockefeller NHP					x					x					
NETN	MIMA	Minute Man NHP					x					x					
NETN	MORR	Morristown NHP					x					x					

CODE	UNIT CODE	PARK NAME	Wetland								Non-wetland Vegetation						
			Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
NETN	SAGA	Saint-Gaudens NHS					x					x					
NETN	SAIR	Saugus Iron Works NHS					x					x					
NETN	SARA	Saratoga NHP					x					x					
NETN	VAMA	Vanderbilt Mansion					x					x					
NETN	WEFA	Weir Farm NHS					x					x					
NGPN	AGFO	Agate Fossil Beds NMON						x								x	
NGPN	BADL	Badlands NP						x								x	
NGPN	DETO	Devils Tower NMON					x					x					
NGPN	FOLA	Fort Laramie NHS						x								x	
NGPN	FOUS	Fort Union Trading Post NHS					x					x					
NGPN	JECA	Jewel Cave NMON					x					x					
NGPN	KNRI	Knife River Indian Villages NHS					x					x					
NGPN	MNRR	Missouri National Recreational River					x					x					
NGPN	MORU	Mount Rushmore NMEM					x					x					
NGPN	NIOB	Niobrara National Scenic River					x					x					
NGPN	SCBL	Scotts Bluff NMON						x								x	
NGPN	THRO	Theodore Roosevelt NP						x								x	
NGPN	WICA	Wind Cave NP						x								x	
PACN	AMME	American Memorial Park	x								x						

			Wetland								Non-wetland Vegetation							
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data	
PACN	HALE	Haleakala NP			x								x					
PACN	HAVO	Hawaii Volcanoes NP				x								x				
PACN	KAHO	Kaloko-Honokohau NHP				x								x				
PACN	KALA	Kalaupapa NHP			x									x				
PACN	NPSA	National Park of American Samoa	x									x						
PACN	PUHE	Puukohola Heiau NHS			x									x				
PACN	PUHO	Pu'uuhonua o Honaunau NHP				x									x			
PACN	WAPA	War in the Pacific NHP	x									x						
ROMN	FLFO	Florissant Fossil Beds NMON						x									x	
ROMN	GLAC	Glacier NP						x									x	
ROMN	GRKO	Grant-Kohrs Ranch NHS					x						x					
ROMN	GRSA	Great Sand Dunes NP					x						x					
ROMN	LIBI	Little Bighorn Battlefield NMON		x									x					
ROMN	ROMO	Rocky Mountain NP		x									x					
SCPN	AZRU	Aztec Ruins NMON					x						x					
SCPN	BAND	Bandalier NMON					x						x					
SCPN	CACH	Canyon de Chelly NMON		x									x					
SCPN	CHCU	Chaco Culture NHP		x									x					
SCPN	ELMA	El Malpais NMON		x									x					

			Wetland								Non-wetland Vegetation							
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data	
SCPN	ELMO	El Morro NMON		x								x						
SCPN	GLCA	Glen Canyon NRA		x								x						
SCPN	GRCA	Grand Canyon NP		x								x						
SCPN	HUTR	Hubbell Trading Post NHS		x								x						
SCPN	MEVE	Mesa Verde NP					x					x						
SCPN	NAVA	Navajo NMON		x								x						
SCPN	PEFO	Petrified Forest NP		x								x						
SCPN	PETR	Petroglyph NMON		x								x						
SCPN	RABR	Rainbow Bridge NMON		x								x						
SCPN	SAPU	Salinas Pueblo Missions NMON		x								x						
SCPN	SUCR	Sunset Crater Volcano NMON		x								x						
SCPN	WACA	Walnut Canyon NMON						x									x	
SCPN	WUPA	Wupatki NMON						x									x	
SCPN	YUHO	Yucca House NMON		x								x						
SEAN	GLBA	Glacier Bay NPP					x							x				
SEAN	KLGO	Klondike Gold Rush NHP					x								x			
SEAN	SITK	Sitka NHP					x							x				
SECN	CAHA	Cape Hatteras NS					x					x						
SECN	CALO	Cape Lookout NS					x					x						

			Wetland								Non-wetland Vegetation						
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
SECN	CANA	Canaveral NS					x					x					
SECN	CASA	Castillo de San Marcos NMON					x					x					
SECN	CHAT	Chattahoochee River NRA					x					x					
SECN	COSW	Congaree Swamp NMON						x								x	
SECN	CUIS	Cumberland Island NS					x					x					
SECN	FOCA	Fort Caroline NMEM					x					x					
SECN	FOFR	Fort Frederica NMON					x					x					
SECN	FOMA	Fort Matanzas NMON					x					x					
SECN	FOPU	Fort Pulaski NMON					x					x					
SECN	FOSU	Fort Sumter NMON					x					x					
SECN	HOBE	Horseshoe Bend NMP					x					x					
SECN	KEMO	Kennesaw Mountain NBP					x					x					
SECN	MOCR	Moore's Creek NB					x					x					
SECN	OCMU	Ocmulgee NMON					x					x					
SECN	TIMU	Timucuan Ecological & Hist. Preserve					x					x					
SFAN	FOPO	Fort Point NHS					x					x					
SFAN	GOGA	Golden Gate NRA					x					x					
SFAN	JOMU	John Muir NHS					x					x					
SFAN	MUWO	Muir Woods NMON					x					x					

			Wetland								Non-wetland Vegetation						
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
SFAN	PINN	Pinnacles NMON					x					x					
SFAN	PORE	Point Reyes NS					x					x					
SFCN	BICY	Big Cypress Npres					x					x					
SFCN	BISC	Biscayne NP					x					x					
SFCN	BUIS	Buck Island Reef NMON							x								x
SFCN	DRTO	Dry Tortugas NP					x					x					
SFCN	EVER	Everglades NP					x					x					
SFCN	VIIS	Virgin Islands NP							x								x
SIEN	DEPO	Devils Postpile NMON					x					x					
SIEN	KICA	Kings Canyon NP					x					x					
SIEN	SEQU	Sequoia NP					x					x					
SIEN	YOSE	Yosemite NP					x					x					
SODN	CAGR	Casa Grande Ruins NMON		x								x					
SODN	CHIR	Chiricahua NMON		x								x					
SODN	CORO	Coronado NMEM		x								x					
SODN	FOBO	Fort Bowie NHS		x								x					
SODN	GICL	Gila Cliff Dwellings NMON					x					x					
SODN	MOCA	Montezuma Castle NMON		x								x					
SODN	ORPI	Organ Pipe Cactus NMON		x								x					

			Wetland								Non-wetland Vegetation						
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
SODN	SAGU	Saguaro NP		x								x					
SODN	TONT	Tonto NMON		x								x					
SODN	TUMA	Tumacacori NHP					x					x					
SODN	TUZI	Tuzigoot NMON		x								x					
SOPN	ALFL	Alibates Flint Quarries NMON					x					x					
SOPN	BEOL	Bent's Old Fort NHS		x								x					
SOPN	CAVO	Capulin Volcano NMON		x								x					
SOPN	CHIC	Chickasaw NRA					x					x					
SOPN	FOLS	Fort Larned NHS						x							x		
SOPN	FOUN	Fort Union NMON		x								x					
SOPN	LAMR	Lake Meredith NRA					x					x					
SOPN	LYJO	Lyndon B. Johnson NHP						x							x		
SOPN	PECO	Pecos NHP					x					x					
SOPN	WABA	Washita Battlefield NHS						x							x		
SWAN	ALAG	Alagnak WR			x								x				
SWAN	ANIA	Aniakchak NMON & Preserve			x								x				
SWAN	KATM	Katmai NPP					x							x			
SWAN	KEFJ	Kenai Fjords NP					x							x			
SWAN	LACL	Lake Clark NPP					x							x			

			Wetland								Non-wetland Vegetation						
CODE	UNIT CODE	PARK NAME	Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NWI ⁵	USGS ⁶	No Data		Forest Service ¹	Landfire ²	NLCD 2001 ³	NPS Data Store ⁴	NPS Data Store and NLCD 2001 ⁷	USGS ⁶	No Data
UCBN	BIHO	Big Hole NB		x								x					
UCBN	CIRO	City of Rocks National Reserve		x								x					
UCBN	CRMO	Craters of the Moon NMON					x					x					
UCBN	HAFO	Hagerman Fossil Beds NMON					x					x					
UCBN	JODA	John Day Fossil Beds NMON		x								x					
UCBN	LARO	Lake Roosevelt NRA					x					x					
UCBN	NEPE	Nez Perce NHP					x					x					
UCBN	WHMI	Whitman Mission NHS					x					x					

¹ Forest Service

² Landfire

³ NLCD 2001

⁴ NPS Data Store

⁵ NWI

⁶ USGS

⁷ NPS Data Store and NLCD 2001

<http://www.fs.fed.us/r5/spf/about/fhp-pacific-basin.shtml>

<http://www.landfire.gov/>

http://www.mrlc.gov/nlcd_multizone_map.php

<http://science.nature.nps.gov/nrdata/>

<http://www.fws.gov/wetlands/Data/DataDownload.html>

<http://biology.usgs.gov/npsveg/>

<http://science.nature.nps.gov/nrdata/>, http://www.mrlc.gov/nlcd_multizone_map.php

Appendix B: Rankings of all Park-Specific Variables for Each of the 271 I&M Parks

Table B-1. Pollutant Exposure Variables

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Average N Deposition (kg/ha/yr)	Ranking for Average N Deposition	N Emissions by County (tons/sq. mi ² /yr)	Ranking for N Emissions by County
Abraham Lincoln Birthplace	ABLI	Cumberland Piedmont	CUPN	0.16	12.80	198	6.47	209
Acadia	ACAD	Northeast Temperate	NETN	60.61	4.60	104	1.50	106
Agate Fossil Beds	AGFO	Northern Great Plains	NGPN	4.82	3.30	81	1.34	93
Alagnak	ALAG	Southwest Alaska	SWAN	48.36	No Data		0.03	3
Alibates Flint Quarries	ALFL	Southern Plains	SOPN	2.15	7.00	126.5	3.09	138
Allegheny Portage Railroad	ALPO	Eastern Rivers and Mountains	ERMN	1.67	14.40	219	7.41	221
American Memorial Park	AMME	Pacific Island	PACN	0.21	No Data		No Data	
Amistad	AMIS	Chihuahuan Desert	CHDN	89.95	5.40	114.5	0.74	45
Aniakchak	ANIA	Southwest Alaska	SWAN	942.96	No Data		0.01	1
Antietam	ANTI	National Capital Region	NCRN	5.08	13.60	208	8.87	242
Apostle Islands	APIS	Great Lakes	GLKN	107.42	4.70	107	1.24	85
Appomattox Court House	APCO	Mid Atlantic	MIDN	2.78	11.10	176.5	4.39	169
Arches	ARCH	Northern Colorado Plateau	NCPN	119.47	2.00	17.5	0.85	55
Arkansas Post	ARPO	Heartland	HTLN	0.66	11.40	182	2.93	134
Assateague Island	ASIS	Northeast Coastal and Barrier	NCBN	76.15	8.30	138	9.10	245
Aztec Ruins	AZRU	Southern Colorado Plateau	SCPN	0.49	3.60	91	1.44	98
Badlands	BADL	Northern Great Plains	NGPN	380.38	3.20	77	0.58	25
Bandelier	BAND	Southern Colorado Plateau	SCPN	52.80	2.80	64	1.01	67
Bent's Old Fort	BEOL	Southern Plains	SOPN	1.25	2.90	67.5	1.09	74
Bering Land Bridge	BELA	Arctic	ARCN	4352.99	No Data		0.03	4
Big Bend	BIBE	Chihuahuan Desert	CHDN	1270.68	2.30	35.5	0.41	15
Big Cypress	BICY	South Florida Caribbean	SFCN	1139.86	7.00	126.5	5.93	198

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Average N Deposition (kg/ha/yr)	Ranking for Average N Deposition	N Emissions by County (tons/sq. mi ² /yr)	Ranking for N Emissions by County
Big Hole	BIHO	Upper Columbia Basin	UCBN	1.05	2.30	35.5	0.32	13
Big South Fork	BISO	Appalachian Highlands	APHN	191.41	11.00	175	3.75	153
Big Thicket	BITH	Gulf Coast	GULN	138.78	10.70	171	6.40	208
Bighorn Canyon	BICA	Greater Yellowstone	GRYN	186.79	2.10	24	0.67	35
Biscayne	BISC	South Florida Caribbean	SFCN	274.36	6.20	124	7.32	220
Black Canyon of the Gunnison	BLCA	Northern Colorado Plateau	NCPN	48.99	2.40	42	0.72	43
Blue Ridge	BLRI	Appalachian Highlands	APHN	141.45	10.50	166.5	4.83	183
Bluestone	BLUE	Eastern Rivers and Mountains	ERMN	6.78	9.60	152.5	3.82	155
Booker T. Washington	BOWA	Mid Atlantic	MIDN	0.37	9.10	144.5	4.13	167
Boston Harbor Islands	BOHA	Northeast Temperate	NETN	2.49	No Data		8.03	231
Bryce Canyon	BRCA	Northern Colorado Plateau	NCPN	56.46	2.10	24	0.62	30
Buck Island Reef	BUIS	South Florida Caribbean	SFCN	29.67	No Data		7.96	229
Buffalo	BUFF	Heartland	HTLN	149.99	9.60	152.5	3.33	144
Cabrillo	CABR	Mediterranean Coast	MEDN	0.25	3.60	91	7.85	227
Canaveral	CANA	Southeast Coast	SECN	90.58	7.70	135	7.08	212
Canyon de Chelly	CACH	Southern Colorado Plateau	SCPN	144.62	1.70	4.5	1.65	111
Canyonlands	CANY	Northern Colorado Plateau	NCPN	523.32	1.90	12.5	0.86	57
Cape Cod	CACO	Northeast Coastal and Barrier	NCBN	63.35	5.90	121.5	10.74	260
Cape Hatteras	CAHA	Southeast Coast	SECN	48.58	7.10	129	5.51	196
Cape Krusenstern	CAKR	Arctic	ARCN	1031.30	No Data		0.07	8
Cape Lookout	CALO	Southeast Coast	SECN	43.66	7.10	129	6.78	211
Capitol Reef	CARE	Northern Colorado Plateau	NCPN	381.42	2.10	24	0.86	59
Capulin Volcano	CAVO	Southern Plains	SOPN	1.24	2.50	49.5	0.69	37
Carl Sandburg Home	CARL	Cumberland Piedmont	CUPN	0.42	8.90	143	4.95	185
Carlsbad Caverns	CAVE	Chihuahuan Desert	CHDN	73.24	2.90	67.5	1.14	79
Casa Grande Ruins	CAGR	Sonoran Desert	SODN	0.73	3.70	93.5	2.22	124

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Castillo de San Marcos	CASA	Southeast Coast	SECN	0.03	8.60	140.5	6.34	205
Catoctin Mountain	CATO	National Capital Region	NCRN	8.92	15.40	228	9.34	250
Cedar Breaks	CEBR	Northern Colorado Plateau	NCPN	9.59	3.00	70.5	0.57	24
Chaco Culture	CHCU	Southern Colorado Plateau	SCPN	54.36	2.20	30	1.49	105
Channel Islands	CHIS	Mediterranean Coast	MEDN	382.75	2.40	42	9.25	248
Chattahoochee River	CHAT	Southeast Coast	SECN	13.59	13.90	212.5	6.48	210
Chesapeake and Ohio Canal	CHOH	National Capital Region	NCRN	32.95	12.70	196.5	8.60	238
Chickamauga and Chattanooga	CHCH	Cumberland Piedmont	CUPN	12.86	13.00	201.5	6.23	203
Chickasaw	CHIC	Southern Plains	SOPN	15.60	11.10	176.5	3.43	147
Chiricahua	CHIR	Sonoran Desert	SODN	19.01	2.30	35.5	0.71	41
City of Rocks	CIRO	Upper Columbia Basin	UCBN	22.79	2.60	55.5	1.34	92
Colonial	COLO	Northeast Coastal and Barrier	NCBN	14.70	11.40	182	5.39	193
Colorado	COLM	Northern Colorado Plateau	NCPN	31.90	2.40	42	0.83	52
Congaree	COSW	Southeast Coast	SECN	37.89	9.70	156	4.41	170
Coronado	CORO	Sonoran Desert	SODN	7.60	2.10	24	1.08	71
Cowpens	COWP	Cumberland Piedmont	CUPN	1.33	9.70	156	4.78	179
Crater Lake	CRLA	Klamath	KLMN	284.04	2.70	60	1.51	109
Craters of the Moon	CRMO	Upper Columbia Basin	UCBN	733.96	2.60	55.5	1.20	81
Cumberland Gap	CUGA	Cumberland Piedmont	CUPN	38.84	10.70	171	3.44	150
Cumberland Island	CUIS	Southeast Coast	SECN	56.92	6.10	123	4.71	178
Curecanti	CURE	Northern Colorado Plateau	NCPN	64.08	2.00	17.5	0.80	49
Cuyahoga Valley	CUVA	Heartland	HTLN	53.36	21.80	239	11.00	261
Death Valley	DEVA	Mojave Desert	MOJN	5314.15	1.80	8.5	1.78	116
Delaware Water Gap	DEWA	Eastern Rivers and Mountains	ERMN	107.20	11.60	185	10.54	259
Denali	DENA	Central Alaska	CAKN	9419.51	No Data		0.39	14
Devils Postpile	DEPO	Sierra Nevada	SIEN	1.24	2.20	30	2.05	121

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Devils Tower	DETO	Northern Great Plains	NGPN	2.11	3.10	73.5	0.60	29
Dinosaur	DINO	Northern Colorado Plateau	NCPN	329.42	2.10	24	1.10	75
Dry Tortugas	DRT0	South Florida Caribbean	SFCN	107.68	No Data		1.41	96
Ebey's Landing	EBLA	North Coast and Cascades	NCCN	27.90	2.10	24	3.98	159
Effigy Mounds	EFMO	Heartland	HTLN	3.88	11.60	185	5.17	188
Eisenhower	EISE	Mid Atlantic	MIDN	1.09	15.30	227	9.69	255
El Malpais	ELMA	Southern Colorado Plateau	SCPN	182.63	2.20	30	1.09	73
El Morro	ELMO	Southern Colorado Plateau	SCPN	2.00	2.50	49.5	1.21	83
Everglades	EVER	South Florida Caribbean	SFCN	2404.11	No Data		6.35	206
Fire Island	FIIS	Northeast Coastal and Barrier	NCBN	30.72	12.40	193.5	14.84	268
Florissant Fossil Beds	FLFO	Rocky Mountain	ROMN	9.36	3.30	81	2.19	123
Fort Bowie	FOBO	Sonoran Desert	SODN	1.56	2.30	35.5	0.71	42
Fort Caroline	FOCA	Southeast Coast	SECN	0.22	11.90	188.5	4.82	182
Fort Davis	FODA	Chihuahuan Desert	CHDN	0.73	2.40	42	0.58	26
Fort Donelson	FODO	Cumberland Piedmont	CUPN	0.86	12.60	195	5.77	197
Fort Frederica	FOFR	Southeast Coast	SECN	0.44	9.70	156	4.10	165
Fort Laramie	FOLA	Northern Great Plains	NGPN	1.34	3.50	88	1.51	108
Fort Larned	FOLS	Southern Plains	SOPN	1.10	8.60	140.5	2.67	130
Fort Matanzas	FOMA	Southeast Coast	SECN	0.47	9.10	144.5	7.14	215
Fort Necessity	FONE	Eastern Rivers and Mountains	ERMN	1.44	15.00	225	7.82	226
Fort Point	FOPO	San Francisco Bay Area	SFAN	0.04	2.30	35.5	9.56	254
Fort Pulaski	FOPU	Southeast Coast	SECN	8.66	7.10	129	3.06	137
Fort Sumter	FOSU	Southeast Coast	SECN	0.36	No Data		4.81	181
Fort Union	FOUN	Southern Plains	SOPN	1.13	2.40	42	0.56	22
Fort Union Trading Post	FOUS	Northern Great Plains	NGPN	0.69	3.30	81	0.71	40
Fort Vancouver	FOVA	North Coast and Cascades	NCCN	0.34	7.60	134	3.19	140
Fossil Butte	FOBU	Northern Colorado Plateau	NCPN	13.00	2.40	42	1.38	94

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Fredericksburg and Spotsylvania	FRSP	Mid Atlantic	MIDN	16.22	11.40	182	7.66	223
Friendship Hill	FRHI	Eastern Rivers and Mountains	ERMN	1.03	13.00	201.5	7.92	228
Gates of the Arctic	GAAR	Arctic	ARCN	13238.15	No Data		0.42	17
Gateway	GATE	Northeast Coastal and Barrier	NCBN	42.16	14.00	214	14.27	266
Gauley River	GARI	Eastern Rivers and Mountains	ERMN	17.43	11.70	187	4.78	180
George Washington	GWMP	National Capital Region	NCRN	10.50	16.20	233	9.18	246
George Washington Birthplace	GEWA	Northeast Coastal and Barrier	NCBN	0.70	13.20	207	8.94	244
George Washington Carver	GWCA	Heartland	HTLN	0.32	12.30	192	4.59	174
Gettysburg	GETT	Mid Atlantic	MIDN	9.32	15.50	229	9.78	258
Gila Cliff Dwellings	GICL	Sonoran Desert	SODN	0.95	2.50	49.5	0.42	16
Glacier	GLAC	Rocky Mountain	ROMN	1575.11	4.30	100	0.56	23
Glacier Bay	GLBA	Southeast Alaska	SEAN	5133.10	No Data		0.03	5
Glen Canyon	GLCA	Southern Colorado Plateau	SCPN	1954.63	1.80	8.5	0.98	64
Golden Gate	GOGA	San Francisco Bay Area	SFAN	122.52	4.70	107	7.60	222
Golden Spike	GOSP	Northern Colorado Plateau	NCPN	4.17	3.20	77	1.49	104
Grand Canyon	GRCA	Southern Colorado Plateau	SCPN	1886.97	2.20	30	0.97	62
Grand Portage	GRPO	Great Lakes	GLKN	1.10	3.10	73.5	1.26	87
Grand Teton	GRTE	Greater Yellowstone	GRYN	484.21	4.50	101.5	0.66	34
Grant-Kohrs Ranch	GRKO	Rocky Mountain	ROMN	2.47	1.80	8.5	0.49	19
Great Basin	GRBA	Mojave Desert	MOJN	120.61	1.60	1.5	0.49	20
Great Sand Dunes	GRSA	Rocky Mountain	ROMN	191.54	2.00	17.5	0.87	60
Great Smoky Mountains	GRSM	Appalachian Highlands	APHN	810.14	9.60	152.5	4.63	175
Guadalupe Mountains	GUMO	Chihuahuan Desert	CHDN	137.32	2.70	60	1.02	68
Guilford Courthouse	GUCO	Cumberland Piedmont	CUPN	0.34	12.40	193.5	6.10	200
Gulf Islands	GUIS	Gulf Coast	GULN	188.25	6.50	125	5.41	194

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Hagerman Fossil Beds	HAFO	Upper Columbia Basin	UCBN	6.74	5.10	111	1.44	99
Haleakala	HALE	Pacific Island	PACN	45.72	No Data		1.23	84
Harpers Ferry	HAFE	National Capital Region	NCRN	5.80	13.10	205	8.54	237
Hawaii Volcanoes	HAVO	Pacific Island	PACN	340.82	No Data		0.86	56
Herbert Hoover	HEHO	Heartland	HTLN	0.29	13.00	201.5	5.18	189
Home of Franklin D. Roosevelt	HOFR	Northeast Temperate	NETN	1.40	11.30	179	8.93	243
Homestead	HOME	Heartland	HTLN	0.35	12.70	196.5	4.24	168
Hopewell Culture	HOCU	Heartland	HTLN	1.75	13.90	212.5	8.39	234
Hopewell Furnace	HOFU	Mid Atlantic	MIDN	1.33	16.50	235.5	12.51	263
Horseshoe Bend	HOBE	Southeast Coast	SECN	3.20	9.60	152.5	5.36	192
Hot Springs	HOSP	Heartland	HTLN	8.54	9.20	146.5	2.90	133
Hovenweep	HOVE	Northern Colorado Plateau	NCPN	1.26	2.50	49.5	1.30	90
Hubbell Trading Post	HUTR	Southern Colorado Plateau	SCPN	0.25	2.00	17.5	1.69	113
Indiana Dunes	INDU	Great Lakes	GLKN	24.78	14.10	215.5	9.76	256
Isle Royale	ISRO	Great Lakes	GLKN	858.95	3.00	70.5	1.06	70
Jean Lafitte	JELA	Gulf Coast	GULN	29.05	10.20	161.5	6.27	204
Jewel Cave	JECA	Northern Great Plains	NGPN	1.95	3.50	88	0.70	38
John Day Fossil Beds	JODA	Upper Columbia Basin	UCBN	21.83	1.60	1.5	1.24	86
John Muir	JOMU	San Francisco Bay Area	SFAN	0.54	8.00	136.5	8.16	232
Johnstown Flood	JOFL	Eastern Rivers and Mountains	ERMN	0.27	14.70	222	7.22	217
Joshua Tree	JOTR	Mojave Desert	MOJN	1,239.59	4.60	104	4.03	161
Kalaupapa	KALA	Pacific Island	PACN	16.76	No Data		8.00	230
Kaloko-Honokohau	KAHO	Pacific Island	PACN	0.98	No Data		1.01	66
Katmai	KATM	Southwest Alaska	SWAN	6,395.15	No Data		0.05	7
Kenai Fjords	KEFJ	Southwest Alaska	SWAN	1,043.23	No Data		0.47	18
Kennesaw Mountain	KEMO	Southeast Coast	SECN	5.68	15.20	226	7.32	219
Kings Canyon	KICA	Sierra Nevada	SIEN	717.54	2.60	55.5	2.19	122

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Kings Mountain	KIMO	Cumberland Piedmont	CUPN	6.19	10.40	164	4.99	186
Klondike Gold Rush	KLGO	Southeast Alaska	SEAN	20.27	No Data		0.04	6
Knife River Indian Villages	KNRI	Northern Great Plains	NGPN	2.67	4.70	107	1.68	112
Kobuk Valley	KOVA	Arctic	ARCN	2,736.12	No Data		0.17	11
Lake Clark	LACL	Southwest Alaska	SWAN	6,299.00	No Data		0.18	12
Lake Mead	LAME	Mojave Desert	MOJN	2,332.47	2.50	49.5	0.97	63
Lake Meredith	LAMR	Southern Plains	SOPN	65.04	7.20	131	3.03	136
Lake Roosevelt	LARO	Upper Columbia Basin	UCBN	163.61	1.90	12.5	1.08	72
Lassen Volcanic	LAVO	Klamath	KLMN	167.62	3.40	85	0.77	47
Lava Beds	LABE	Klamath	KLMN	72.88	1.80	8.5	0.82	51
Lewis and Clark	LEWI	North Coast and Cascades	NCCN	5.58	4.50	101.5	3.75	154
Lincoln Boyhood	LIBO	Heartland	HTLN	0.30	14.10	215.5	7.09	213
Little Bighorn Battlefield	LIBI	Rocky Mountain	ROMN	1.22	2.40	42	0.84	54
Little River Canyon	LIRI	Cumberland Piedmont	CUPN	21.37	13.10	205	7.17	216
Lyndon B. Johnson	LYJO	Southern Plains	SOPN	2.62	8.00	136.5	3.25	142
Mammoth Cave	MACA	Cumberland Piedmont	CUPN	80.23	12.90	199	6.37	207
Manassas	MANA	National Capital Region	NCRN	8.01	14.40	219	8.54	236
Manzanar	MANZ	Mojave Desert	MOJN	1.27	1.70	4.5	2.01	120
Marsh-Billings-Rockefeller	MABI	Northeast Temperate	NETN	1.00	7.50	133	2.82	132
Mesa Verde	MEVE	Southern Colorado Plateau	SCPN	83.31	3.20	77	1.33	91
Minute Man	MIMA	Northeast Temperate	NETN	1.49	10.70	171	7.11	214
Mississippi	MISS	Great Lakes	GLKN	84.11	14.60	221	5.24	190
Missouri	MNRR	Northern Great Plains	NGPN	107.87	10.10	160	3.93	158
Mojave	MOJA	Mojave Desert	MOJN	2,483.84	3.40	85	1.75	115
Monocacy	MONO	National Capital Region	NCRN	2.53	14.20	217	9.40	252
Montezuma Castle	MOCA	Sonoran Desert	SODN	1.33	2.60	55.5	1.64	110
Moore's Creek	MOCR	Southeast Coast	SECN	0.16	16.00	232	7.29	218
Morristown	MORR	Northeast Temperate	NETN	2.67	14.40	219	12.94	264

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Mount Rainier	MORA	North Coast and Cascades	NCCN	367.56	4.90	109	3.43	148
Mount Rushmore	MORU	Northern Great Plains	NGPN	2.02	3.80	96.5	0.59	28
Muir Woods	MUW O	San Francisco Bay Area	SFAN	0.90	5.40	114.5	9.48	253
Natchez Trace Parkway and National Scenic Trail	NATR	Gulf Coast	GULN	71.52	10.80	173	4.10	166
National Capital Parks - East	NACE	National Capital Region	NCRN	7.18	16.50	235.5	9.78	257
National Park of American Samoa	NPSA	Pacific Island	PACN	16.66	No Data		No Data	
Natural Bridges	NABR	Northern Colorado Plateau	NCPN	11.56	2.00	17.5	0.83	53
Navajo	NAVA	Southern Colorado Plateau	SCPN	0.94	1.70	4.5	0.99	65
New River Gorge	NERI	Eastern Rivers and Mountains	ERMN	109.98	11.30	179	4.51	172
Nez Perce	NEPE	Upper Columbia Basin	UCBN	6.91	2.30	35.5	0.68	36
Ninety Six	NISI	Cumberland Piedmont	CUPN	1.50	9.20	146.5	4.63	176
Niobrara	NIOB	Northern Great Plains	NGPN	42.37	5.90	121.5	1.39	95
Noatak	NOAT	Arctic	ARCN	10,255.62	No Data		0.17	10
North Cascades	NOCA	North Coast and Cascades	NCCN	782.91	3.80	96.5	2.77	131
Obed	OBRI	Appalachian Highlands	APHN	8.32	12.00	190.5	3.98	160
Ocmulgee	OCMU	Southeast Coast	SECN	1.08	10.50	166.5	5.11	187
Olympic	OLYM	North Coast and Cascades	NCCN	1,428.42	3.80	96.5	4.05	162
Oregon Caves	ORCA	Klamath	KLMN	0.73	2.80	64	1.84	118
Organ Pipe Cactus	ORPI	Sonoran Desert	SODN	516.70	1.70	4.5	2.32	126
Ozark	OZAR	Heartland	HTLN	128.62	9.30	149	3.47	151
Padre Island	PAIS	Gulf Coast	GULN	204.94	5.40	114.5	3.50	152
Palo Alto Battlefield	PAAL	Gulf Coast	GULN	5.33	5.40	114.5	3.34	145
Pea Ridge	PERI	Heartland	HTLN	6.67	16.60	237	4.44	171
Pecos	PECO	Southern Plains	SOPN	10.20	3.10	73.5	0.79	48
Petersburg	PETE	Mid Atlantic	MIDN	5.24	13.70	209.5	5.24	191

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Petrified Forest	PEFO	Southern Colorado Plateau	SCPN	348.65	2.50	49.5	1.12	77
Petroglyph	PETR	Southern Colorado Plateau	SCPN	11.25	3.70	93.5	0.90	61
Pictured Rocks	PIRO	Great Lakes	GLKN	115.12	8.70	142	1.27	88
Pinnacles	PINN	San Francisco Bay Area	SFAN	42.42	5.00	110	6.04	199
Pipe Spring	PISP	Northern Colorado Plateau	NCPN	0.06	2.10	24	0.65	32
Pipestone	PIPE	Heartland	HTLN	0.44	14.80	223.5	4.67	177
Point Reyes	PORE	San Francisco Bay Area	SFAN	115.77	5.50	117.5	8.63	239
Prince William Forest	PRWI	National Capital Region	NCRN	17.33	13.10	205	8.69	240
Pu'uuhonua o Honaunau	PUHO	Pacific Island	PACN	0.28	No Data		0.86	58
Puukohola Heiau	PUHE	Pacific Island	PACN	0.12	No Data		1.04	69
Rainbow Bridge	RABR	Southern Colorado Plateau	SCPN	0.25	1.90	12.5	0.66	33
Redwood	REDW	Klamath	KLMN	180.69	2.90	67.5	1.74	114
Richmond	RICH	Mid Atlantic	MIDN	2.37	13.00	201.5	6.13	201
Rock Creek Park	ROCR	National Capital Region	NCRN	4.23	16.40	234	9.38	251
Rocky Mountain	ROMO	Rocky Mountain	ROMN	417.06	4.20	99	2.57	129
Russell Cave	RUCA	Cumberland Piedmont	CUPN	0.50	12.00	190.5	5.45	195
Sagamore Hill	SAHI	Northeast Coastal and Barrier	NCBN	0.11	15.90	231	13.55	265
Saguaro	SAGU	Sonoran Desert	SODN	146.02	2.80	64	1.50	107
Saint Croix	SACN	Great Lakes	GLKN	152.70	10.00	158.5	3.91	157
Saint-Gaudens	SAGA	Northeast Temperate	NETN	0.22	7.30	132	3.39	146
Salinas Pueblo Missions	SAPU	Southern Colorado Plateau	SCPN	1.66	2.50	49.5	0.72	44
San Antonio Missions	SAAN	Gulf Coast	GULN	1.29	10.90	174	3.31	143
San Juan Island	SAJH	North Coast and Cascades	NCCN	2.69	No Data		4.09	163
Santa Monica Mountains	SAMO	Mediterranean Coast	MEDN	241.96	10.60	169	7.79	225
Saratoga	SARA	Northeast Temperate	NETN	4.49	10.30	163	2.95	135
Saugus Iron Works	SAIR	Northeast Temperate	NETN	0.02	5.80	120	7.67	224
Scotts Bluff	SCBL	Northern Great Plains	NGPN	5.06	5.50	117.5	1.89	119
Sequoia	SEQU	Sierra Nevada	SIEN	635.94	3.80	96.5	2.40	127

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Shenandoah	SHEN	Mid Atlantic	MIDN	301.99	13.70	209.5	6.14	202
Shiloh	SHIL	Cumberland Piedmont	CUPN	6.38	11.30	179	3.84	156
Sitka	SITK	Southeast Alaska	SEAN	0.17	No Data		0.03	2
Sleeping Bear Dunes	SLBE	Great Lakes	GLKN	109.72	9.30	149	2.26	125
Stones River	STRI	Cumberland Piedmont	CUPN	1.11	11.90	188.5	4.84	184
Sunset Crater Volcano	SUCR	Southern Colorado Plateau	SCPN	4.75	2.70	60	1.12	76
Tallgrass Prairie	TAPR	Heartland	HTLN	17.05	11.60	185	4.10	164
Theodore Roosevelt	THRO	Northern Great Plains	NGPN	109.97	3.60	91	1.18	80
Thomas Stone	THST	Northeast Coastal and Barrier	NCBN	0.50	13.80	211	9.20	247
Timpanogos Cave	TICA	Northern Colorado Plateau	NCPN	0.39	5.70	119	1.47	102
Timucaun Ecological and Historical Preserve	TIMU	Southeast Coast	SECN	71.40	10.50	166.5	4.56	173
Tonto	TONT	Sonoran Desert	SODN	1.75	3.50	88	1.81	117
Tumacacori	TUMA	Sonoran Desert	SODN	0.57	2.20	30	1.29	89
Tuzigoot	TUZI	Sonoran Desert	SODN	1.27	2.50	49.5	1.45	101
Upper Delaware	UPDE	Eastern Rivers and Mountains	ERMN	86.17	10.00	158.5	8.22	233
Valley Forge	VAFO	Mid Atlantic	MIDN	5.39	15.80	230	14.28	267
Vanderbilt Mansion	VAMA	Northeast Temperate	NETN	0.33	10.50	166.5	8.82	241
Vicksburg	VICK	Gulf Coast	GULN	2.58	9.30	149	3.24	141
Virgin Islands	VIIS	South Florida Caribbean	SFCN	23.07	No Data		8.49	235
Voyageurs	VOYA	Great Lakes	GLKN	320.18	4.60	104	1.45	100
Walnut Canyon	WACA	Southern Colorado Plateau	SCPN	5.58	2.70	60	1.20	82
War in the Pacific	WAPA	Pacific Island	PACN	2.98	No Data		No Data	
Washita Battlefield	WABA	Southern Plains	SOPN	0.49	8.40	139	2.41	128
Weir Farm	WEFA	Northeast Temperate	NETN	0.09	14.80	223.5	11.65	262
Whiskeytown	WHIS	Klamath	KLMN	65.29	5.30	112	0.76	46
White Sands	WHS	Chihuahuan Desert	CHDN	238.07	2.00	17.5	0.80	50

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Average N Deposition (kg/ha/yr)	Ranking for Average N Deposition	N Emissions by County (tons/sq. mi²/yr)	Ranking for N Emissions by County
Whitman Mission	WHMI	Upper Columbia Basin	UCBN	0.16	3.30	81	1.48	103
Wilson's Creek	WICR	Heartland	HTLN	3.73	10.20	161.5	3.18	139
Wind Cave	WICA	Northern Great Plains	NGPN	44.26	3.30	81	0.70	39
Wolf Trap National Park for the Performing Arts	WOTR	National Capital Region	NCRN	0.21	16.80	238	9.29	249
Wrangell-St. Elias	WRST	Central Alaska	CAKN	20,593.55	No Data		0.11	9
Wupatki	WUPA	Southern Colorado Plateau	SCPN	55.39	1.90	12.5	1.13	78
Yellowstone	YELL	Greater Yellowstone	GRYN	3,438.28	3.40	85	0.59	27
Yosemite	YOSE	Sierra Nevada	SIEN	1,164.65	2.90	67.5	3.43	149
Yucca House	YUHO	Southern Colorado Plateau	SCPN	0.06	3.10	73.5	1.43	97
Yukon-Charley Rivers	YUCH	Central Alaska	CAKN	3,938.77	No Data		0.50	21
Zion	ZION	Northern Colorado Plateau	NCPN	231.05	2.70	60	0.63	31

Table B-2. Ecosystem Sensitivity Variables

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Abraham Lincoln Birthplace	ABLI	Cumberland Piedmont	CUPN	0.16	2.36	59	0	126
Acadia	ACAD	Northeast Temperate	NETN	60.61	8.91	101	0	126
Agate Fossil Beds	AGFO	Northern Great Plains	NGPN	4.82	92.22	264	0	126
Alagnak	ALAG	Southwest Alaska	SWAN	48.36	30.40	164	0	126
Alibates Flint Quarries	ALFL	Southern Plains	SOPN	2.15	30.26	163	0	126
Allegheny Portage Railroad	ALPO	Eastern Rivers and Mountains	ERMN	1.67	6.57	92	0	126
American Memorial Park	AMME	Pacific Island	PACN	0.21	21.37	145	0	126
Amistad	AMIS	Chihuahuan Desert	CHDN	89.95	48.80	209	0	126
Aniakchak	ANIA	Southwest Alaska	SWAN	942.96	32.15	169	0	126
Antietam	ANTI	National Capital Region	NCRN	5.08	0.51	34	0	126
Apostle Islands	APIS	Great Lakes	GLKN	107.42	2.33	58	0	126
Appomattox Court House	APCO	Mid Atlantic	MIDN	2.78	3.68	62	0	126
Arches	ARCH	Northern Colorado Plateau	NCPN	119.47	85.11	247	0	126
Arkansas Post	ARPO	Heartland	HTLN	0.66	0.05	15	0	126
Assateague Island	ASIS	Northeast Coastal and Barrier	NCBN	76.15	21.41	146	0	126
Aztec Ruins	AZRU	Southern Colorado Plateau	SCPN	0.49	40.23	185	0	126
Badlands	BADL	Northern Great Plains	NGPN	380.38	51.45	213	0	126
Bandelier	BAND	Southern Colorado Plateau	SCPN	52.80	44.92	203	0	126
Bent's Old Fort	BEOL	Southern Plains	SOPN	1.25	42.05	192	0	126
Bering Land Bridge	BELA	Arctic	ARCN	4,352.99	33.24	171	0	126
Big Bend	BIBE	Chihuahuan Desert	CHDN	1,270.68	96.94	270	0	126
Big Cypress	BICY	South Florida Caribbean	SFCN	1,139.86	82.52	245	0	126
Big Hole	BIHO	Upper Columbia Basin	UCBN	1.05	49.52	210	0	126
Big South Fork	BISO	Appalachian Highlands	APHN	191.41	0.03	11	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Big Thicket	BITH	Gulf Coast	GULN	138.78	29.28	162	0	126
Bighorn Canyon	BICA	Greater Yellowstone	GRYN	186.79	57.95	215	0	126
Biscayne	BISC	South Florida Caribbean	SFCN	274.36	6.22	87	0	126
Black Canyon of the Gunnison	BLCA	Northern Colorado Plateau	NCPN	48.99	20.45	141	0	126
Blue Ridge	BLRI	Appalachian Highlands	APHN	141.45	0.12	19	3	259
Bluestone	BLUE	Eastern Rivers and Mountains	ERMN	6.78	0.00	5	0	126
Booker T. Washington	BOWA	Mid Atlantic	MIDN	0.37	0.08	18	0	126
Boston Harbor Islands	BOHA	Northeast Temperate	NETN	2.49	14.89	126	0	126
Bryce Canyon	BRCA	Northern Colorado Plateau	NCPN	56.46	11.20	115	0	126
Buck Island Reef	BUIS	South Florida Caribbean	SFCN	29.67	0.00	5	0	126
Buffalo	BUFF	Heartland	HTLN	149.99	0.71	37	1	255
Cabrillo	CABR	Mediterranean Coast	MEDN	0.25	72.27	235	0	126
Canaveral	CANA	Southeast Coast	SECN	90.58	14.52	124	0	126
Canyon de Chelly	CACH	Southern Colorado Plateau	SCPN	144.62	19.60	137	0	126
Canyonlands	CANY	Northern Colorado Plateau	NCPN	523.32	68.45	231	0	126
Cape Cod	CACO	Northeast Coastal and Barrier	NCBN	63.35	31.29	168	0	126
Cape Hatteras	CAHA	Southeast Coast	SECN	48.58	50.03	211	0	126
Cape Krusenstern	CAKR	Arctic	ARCN	1,031.30	72.50	236	0	126
Cape Lookout	CALO	Southeast Coast	SECN	43.66	63.05	225	0	126
Capitol Reef	CARE	Northern Colorado Plateau	NCPN	381.42	45.38	205	0	126
Capulin Volcano	CAVO	Southern Plains	SOPN	1.24	18.47	132	0	126
Carl Sandburg Home	CARL	Cumberland Piedmont	CUPN	0.42	0.00	5	1	255
Carlsbad Caverns	CAVE	Chihuahuan Desert	CHDN	73.24	88.25	256	0	126
Casa Grande Ruins	CAGR	Sonoran Desert	SODN	0.73	88.74	258	0	126
Castillo de San Marcos	CASA	Southeast Coast	SECN	0.03	0.16	20	0	126
Catoctin Mountain	CATO	National Capital Region	NCRN	8.92	0.45	30	0	126
Cedar Breaks	CEBR	Northern Colorado Plateau	NCPN	9.59	6.08	85	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Chaco Culture	CHCU	Southern Colorado Plateau	SCPN	54.36	94.08	267	0	126
Channel Islands	CHIS	Mediterranean Coast	MEDN	382.75	45.08	204	0	126
Chattahoochee River	CHAT	Southeast Coast	SECN	13.59	4.00	67	0	126
Chesapeake and Ohio Canal	CHOH	National Capital Region	NCRN	32.95	0.17	21	0	126
Chickamauga and Chattanooga	CHCH	Cumberland Piedmont	CUPN	12.86	0.71	38	0	126
Chickasaw	CHIC	Southern Plains	SOPN	15.60	8.65	99	0	126
Chiricahua	CHIR	Sonoran Desert	SODN	19.01	46.65	206	0	126
City of Rocks	CIRO	Upper Columbia Basin	UCBN	22.79	58.98	218	0	126
Colonial	COLO	Northeast Coastal and Barrier	NCBN	14.70	19.83	138	0	126
Colorado	COLM	Northern Colorado Plateau	NCPN	31.90	9.95	105	0	126
Congaree	COSW	Southeast Coast	SECN	37.89	82.88	246	0	126
Coronado	CORO	Sonoran Desert	SODN	7.60	73.41	238	0	126
Cowpens	COWP	Cumberland Piedmont	CUPN	1.33	0.00	5	0	126
Crater Lake	CRLA	Klamath	KLMN	284.04	1.05	42	1	255
Craters of the Moon	CRMO	Upper Columbia Basin	UCBN	733.96	16.26	127	0	126
Cumberland Gap	CUGA	Cumberland Piedmont	CUPN	38.84	0.55	35	0	126
Cumberland Island	CUIS	Southeast Coast	SECN	56.92	38.85	183	0	126
Curecanti	CURE	Northern Colorado Plateau	NCPN	64.08	13.90	120	1	255
Cuyahoga Valley	CUVA	Heartland	HTLN	53.36	1.01	40	0	126
Death Valley	DEVA	Mojave Desert	MOJN	5,314.15	90.09	261	0	126
Delaware Water Gap	DEWA	Eastern Rivers and Mountains	ERMN	107.20	5.98	84	0	126
Denali	DENA	Central Alaska	CAKN	9,419.51	4.85	76	0	126
Devils Postpile	DEPO	Sierra Nevada	SIEN	1.24	4.43	74	0	126
Devils Tower	DETO	Northern Great Plains	NGPN	2.11	35.38	174	0	126
Dinosaur	DINO	Northern Colorado Plateau	NCPN	329.42	85.91	251	0	126
Dry Tortugas	DRTO	South Florida Caribbean	SFCN	107.68	0.50	32	0	126
Ebey's Landing	EBLA	North Coast and Cascades	NCCN	27.90	7.47	96	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Effigy Mounds	EFMO	Heartland	HTLN	3.88	12.72	118	0	126
Eisenhower	EISE	Mid Atlantic	MIDN	1.09	19.39	136	0	126
El Malpais	ELMA	Southern Colorado Plateau	SCPN	182.63	6.70	94	0	126
El Morro	ELMO	Southern Colorado Plateau	SCPN	2.00	43.73	198	0	126
Everglades	EVER	South Florida Caribbean	SFCN	2,404.11	58.14	216	0	126
Fire Island	FIIS	Northeast Coastal and Barrier	NCBN	30.72	10.95	111	0	126
Florissant Fossil Beds	FLFO	Rocky Mountain	ROMN	9.36	13.10	119	0	126
Fort Bowie	FOBO	Sonoran Desert	SODN	1.56	61.60	222	0	126
Fort Caroline	FOCA	Southeast Coast	SECN	0.22	20.65	142	0	126
Fort Davis	FODA	Chihuahuan Desert	CHDN	0.73	86.88	253	0	126
Fort Donelson	FODO	Cumberland Piedmont	CUPN	0.86	0.63	36	0	126
Fort Frederica	FOFR	Southeast Coast	SECN	0.44	58.19	217	0	126
Fort Laramie	FOLA	Northern Great Plains	NGPN	1.34	62.87	224	0	126
Fort Larned	FOLS	Southern Plains	SOPN	1.10	50.47	212	0	126
Fort Matanzas	FOMA	Southeast Coast	SECN	0.47	42.78	195	0	126
Fort Necessity	FONE	Eastern Rivers and Mountains	ERMN	1.44	22.01	147	0	126
Fort Point	FOPO	San Francisco Bay Area	SFAN	0.04	4.33	73	0	126
Fort Pulaski	FOPU	Southeast Coast	SECN	8.66	81.53	244	0	126
Fort Sumter	FOSU	Southeast Coast	SECN	0.36	1.32	47	0	126
Fort Union	FOUN	Southern Plains	SOPN	1.13	89.48	259	0	126
Fort Union Trading Post	FOUS	Northern Great Plains	NGPN	0.69	30.66	165	0	126
Fort Vancouver	FOVA	North Coast and Cascades	NCCN	0.34	21.16	144	0	126
Fossil Butte	FOBU	Northern Colorado Plateau	NCPN	13.00	86.01	252	0	126
Fredericksburg and Spotsylvania	FRSP	Mid Atlantic	MIDN	16.22	4.14	69	0	126
Friendship Hill	FRHI	Eastern Rivers and Mountains	ERMN	1.03	11.14	114	0	126
Gates of the Arctic	GAAR	Arctic	ARCN	13,238.15	31.09	167	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Gateway	GATE	Northeast Coastal and Barrier	NCBN	42.16	18.90	134	0	126
Gauley River	GARI	Eastern Rivers and Mountains	ERMN	17.43	0.08	17	0	126
George Washington	GWMP	National Capital Region	NCRN	10.50	10.63	108	0	126
George Washington Birthplace	GEWA	Northeast Coastal and Barrier	NCBN	0.70	44.06	200	0	126
George Washington Carver	GWCA	Heartland	HTLN	0.32	0.33	28	0	126
Gettysburg	GETT	Mid Atlantic	MIDN	9.32	22.73	149	0	126
Gila Cliff Dwellings	GICL	Sonoran Desert	SODN	0.95	77.39	239	0	126
Glacier	GLAC	Rocky Mountain	ROMN	1,575.11	4.20	71	9	261
Glacier Bay	GLBA	Southeast Alaska	SEAN	5,133.10	4.06	68	0	126
Glen Canyon	GLCA	Southern Colorado Plateau	SCPN	1,954.63	44.35	201	0	126
Golden Gate	GOGA	San Francisco Bay Area	SFAN	122.52	31.08	166	0	126
Golden Spike	GOSP	Northern Colorado Plateau	NCPN	4.17	87.95	255	0	126
Grand Canyon	GRCA	Southern Colorado Plateau	SCPN	1,886.97	71.13	234	1	255
Grand Portage	GRPO	Great Lakes	GLKN	1.10	3.80	63	0	126
Grand Teton	GRTE	Greater Yellowstone	GRYN	484.21	39.50	184	33	264
Grant-Kohrs Ranch	GRKO	Rocky Mountain	ROMN	2.47	59.25	219	0	126
Great Basin	GRBA	Mojave Desert	MOJN	120.61	4.51	75	0	126
Great Sand Dunes	GRSA	Rocky Mountain	ROMN	191.54	41.91	190	5	260
Great Smoky Mountains	GRSM	Appalachian Highlands	APHN	810.14	0.02	10	0	126
Guadalupe Mountains	GUMO	Chihuahuan Desert	CHDN	137.32	91.21	262	0	126
Guilford Courthouse	GUCO	Cumberland Piedmont	CUPN	0.34	0.00	5	0	126
Gulf Islands	GUIS	Gulf Coast	GULN	188.25	5.37	80	0	126
Hagerman Fossil Beds	HAFO	Upper Columbia Basin	UCBN	6.74	89.99	260	0	126
Haleakala	HALE	Pacific Island	PACN	45.72	20.22	139	0	126
Harpers Ferry	HAFE	National Capital Region	NCRN	5.80	1.40	49	0	126
Hawaii Volcanoes	HAVO	Pacific Island	PACN	340.82	11.61	116	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Herbert Hoover	HEHO	Heartland	HTLN	0.29	2.96	60	0	126
Home of Franklin D. Roosevelt	HOFR	Northeast Temperate	NETN	1.40	6.37	91	0	126
Homestead	HOME	Heartland	HTLN	0.35	44.83	202	0	126
Hopewell Culture	HOCU	Heartland	HTLN	1.75	0.45	31	0	126
Hopewell Furnace	HOFU	Mid Atlantic	MIDN	1.33	20.90	143	0	126
Horseshoe Bend	HOBE	Southeast Coast	SECN	3.20	6.29	90	0	126
Hot Springs	HOSP	Heartland	HTLN	8.54	0.18	23	0	126
Hovenweep	HOVE	Northern Colorado Plateau	NCPN	1.26	80.18	243	0	126
Hubbell Trading Post	HUTR	Southern Colorado Plateau	SCPN	0.25	22.77	150	0	126
Indiana Dunes	INDU	Great Lakes	GLKN	24.78	41.33	188	0	126
Isle Royale	ISRO	Great Lakes	GLKN	858.95	2.12	57	0	126
Jean Lafitte	JELA	Gulf Coast	GULN	29.05	41.15	186	0	126
Jewel Cave	JECA	Northern Great Plains	NGPN	1.95	2.11	55	0	126
John Day Fossil Beds	JODA	Upper Columbia Basin	UCBN	21.83	91.56	263	0	126
John Muir	JOMU	San Francisco Bay Area	SFAN	0.54	37.70	182	0	126
Johnstown Flood	JOFL	Eastern Rivers and Mountains	ERMN	0.27	23.99	154	0	126
Joshua Tree	JOTR	Mojave Desert	MOJN	1,239.59	92.34	265	0	126
Kalaupapa	KALA	Pacific Island	PACN	16.76	5.30	79	0	126
Kaloko-Honokohau	KAHO	Pacific Island	PACN	0.98	35.40	175	0	126
Katmai	KATM	Southwest Alaska	SWAN	6,395.15	20.40	140	0	126
Kenai Fjords	KEFJ	Southwest Alaska	SWAN	1,043.23	5.61	82	0	126
Kennesaw Mountain	KEMO	Southeast Coast	SECN	5.68	0.77	39	0	126
Kings Canyon	KICA	Sierra Nevada	SIEN	717.54	37.26	180	444	271
Kings Mountain	KIMO	Cumberland Piedmont	CUPN	6.19	0.03	13	0	126
Klondike Gold Rush	KLGO	Southeast Alaska	SEAN	20.27	43.81	199	0	126
Knife River Indian Villages	KNRI	Northern Great Plains	NGPN	2.67	28.02	161	0	126
Kobuk Valley	KOVA	Arctic	ARCN	2,736.12	14.65	125	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Lake Clark	LACL	Southwest Alaska	SWAN	6,299.00	10.87	110	0	126
Lake Mead	LAME	Mojave Desert	MOJN	2,332.47	78.57	241	0	126
Lake Meredith	LAMR	Southern Plains	SOPN	65.04	35.26	173	0	126
Lake Roosevelt	LARO	Upper Columbia Basin	UCBN	163.61	14.14	121	0	126
Lassen Volcanic	LAVO	Klamath	KLMN	167.62	5.85	83	37	265
Lava Beds	LABE	Klamath	KLMN	72.88	73.09	237	0	126
Lewis and Clark	LEWI	North Coast and Cascades	NCCN	5.58	25.50	157	0	126
Lincoln Boyhood	LIBO	Heartland	HTLN	0.30	0.51	33	0	126
Little Bighorn Battlefield	LIBI	Rocky Mountain	ROMN	1.22	85.64	248	0	126
Little River Canyon	LIRI	Cumberland Piedmont	CUPN	21.37	0.36	29	0	126
Lyndon B. Johnson	LYJO	Southern Plains	SOPN	2.62	34.71	172	0	126
Mammoth Cave	MACA	Cumberland Piedmont	CUPN	80.23	0.18	22	0	126
Manassas	MANA	National Capital Region	NCRN	8.01	12.19	117	0	126
Manzanar	MANZ	Mojave Desert	MOJN	1.27	88.62	257	0	126
Marsh-Billings-Rockefeller	MABI	Northeast Temperate	NETN	1.00	1.92	54	0	126
Mesa Verde	MEVE	Southern Colorado Plateau	SCPN	83.31	41.28	187	0	126
Minute Man	MIMA	Northeast Temperate	NETN	1.49	8.98	102	0	126
Mississippi	MISS	Great Lakes	GLKN	84.11	22.53	148	0	126
Missouri	MNRR	Northern Great Plains	NGPN	107.87	17.41	128	0	126
Mojave	MOJA	Mojave Desert	MOJN	2,483.84	87.51	254	0	126
Monocacy	MONO	National Capital Region	NCRN	2.53	4.93	77	0	126
Montezuma Castle	MOCA	Sonoran Desert	SODN	1.33	92.36	266	0	126
Moores Creek	MOCR	Southeast Coast	SECN	0.16	17.45	129	0	126
Morristown	MORR	Northeast Temperate	NETN	2.67	1.22	45	0	126
Mount Rainier	MORA	North Coast and Cascades	NCCN	367.56	10.33	107	44	266
Mount Rushmore	MORU	Northern Great Plains	NGPN	2.02	0.08	16	0	126
Muir Woods	MUWO	San Francisco Bay Area	SFAN	0.90	4.24	72	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Natchez Trace Parkway and National Scenic Trail	NATR	Gulf Coast	GULN	71.52	6.18	86	0	126
National Capital Parks - East	NACE	National Capital Region	NCRN	7.18	0.24	26	0	126
National Park of American Samoa	NPSA	Pacific Island	PACN	16.66	3.92	65	0	126
Natural Bridges	NABR	Northern Colorado Plateau	NCPN	11.56	9.02	103	0	126
Navajo	NAVA	Southern Colorado Plateau	SCPN	0.94	25.22	156	0	126
New River Gorge	NERI	Eastern Rivers and Mountains	ERMN	109.98	0.20	24	0	126
Nez Perce	NEPE	Upper Columbia Basin	UCBN	6.91	60.19	221	0	126
Ninety Six	NISI	Cumberland Piedmont	CUPN	1.50	8.82	100	0	126
Niobrara	NIOB	Northern Great Plains	NGPN	42.37	41.71	189	0	126
Noatak	NOAT	Arctic	ARCN	10,255.62	24.19	155	0	126
North Cascades	NOCA	North Coast and Cascades	NCCN	782.91	22.87	151	53	267
Obed	OBRI	Appalachian Highlands	APHN	8.32	0.03	12	0	126
Ocmulgee	OCMU	Southeast Coast	SECN	1.08	36.22	177	0	126
Olympic	OLYM	North Coast and Cascades	NCCN	1,428.42	8.18	98	29	263
Oregon Caves	ORCA	Klamath	KLMN	0.73	0.00	5	0	126
Organ Pipe Cactus	ORPI	Sonoran Desert	SODN	516.70	85.84	250	0	126
Ozark	OZAR	Heartland	HTLN	128.62	3.67	61	0	126
Padre Island	PAIS	Gulf Coast	GULN	204.94	25.93	159	0	126
Palo Alto Battlefield	PAAL	Gulf Coast	GULN	5.33	23.26	153	0	126
Pea Ridge	PERI	Heartland	HTLN	6.67	0.32	27	0	126
Pecos	PECO	Southern Plains	SOPN	10.20	67.46	230	0	126
Petersburg	PETE	Mid Atlantic	MIDN	5.24	1.27	46	0	126
Petrified Forest	PEFO	Southern Colorado Plateau	SCPN	348.65	94.90	268	0	126
Petroglyph	PETR	Southern Colorado Plateau	SCPN	11.25	95.69	269	0	126
Pictured Rocks	PIRO	Great Lakes	GLKN	115.12	14.20	122	0	126
Pinnacles	PINN	San Francisco Bay Area	SFAN	42.42	63.52	226	0	126
Pipe Spring	PISP	Northern Colorado Plateau	NCPN	0.06	66.99	229	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Pipestone	PIPE	Heartland	HTLN	0.44	55.75	214	0	126
Point Reyes	PORE	San Francisco Bay Area	SFAN	115.77	48.04	207	0	126
Prince William Forest	PRWI	National Capital Region	NCRN	17.33	2.12	56	0	126
Pu'u'honua o Honaunau	PUHO	Pacific Island	PACN	0.28	11.03	112	0	126
Puukohola Heiau	PUHE	Pacific Island	PACN	0.12	0.00	5	0	126
Rainbow Bridge	RABR	Southern Colorado Plateau	SCPN	0.25	36.68	179	0	126
Redwood	REDW	Klamath	KLMN	180.69	1.49	50	0	126
Richmond	RICH	Mid Atlantic	MIDN	2.37	10.18	106	0	126
Rock Creek Park	ROCR	National Capital Region	NCRN	4.23	5.49	81	0	126
Rocky Mountain	ROMO	Rocky Mountain	ROMN	417.06	7.94	97	101	268
Russell Cave	RUCA	Cumberland Piedmont	CUPN	0.50	0.00	5	0	126
Sagamore Hill	SAHI	Northeast Coastal and Barrier	NCBN	0.11	6.64	93	0	126
Saguaro	SAGU	Sonoran Desert	SODN	146.02	70.26	233	0	126
Saint Croix	SACN	Great Lakes	GLKN	152.70	11.11	113	1	255
Saint-Gaudens	SAGA	Northeast Temperate	NETN	0.22	1.82	52	0	126
Salinas Pueblo Missions	SAPU	Southern Colorado Plateau	SCPN	1.66	77.69	240	0	126
San Antonio Missions	SAAN	Gulf Coast	GULN	1.29	42.71	194	0	126
San Juan Island	SAJH	North Coast and Cascades	NCCN	2.69	37.28	181	0	126
Santa Monica Mountains	SAMO	Mediterranean Coast	MEDN	241.96	43.11	196	0	126
Saratoga	SARA	Northeast Temperate	NETN	4.49	6.28	89	0	126
Saugus Iron Works	SAIR	Northeast Temperate	NETN	0.02	32.83	170	0	126
Scotts Bluff	SCBL	Northern Great Plains	NGPN	5.06	69.67	232	0	126
Sequoia	SEQU	Sierra Nevada	SIEN	635.94	27.04	160	205	269
Shenandoah	SHEN	Mid Atlantic	MIDN	301.99	0.04	14	0	126
Shiloh	SHIL	Cumberland Piedmont	CUPN	6.38	7.11	95	0	126
Sitka	SITK	Southeast Alaska	SEAN	0.17	23.12	152	0	126
Sleeping Bear Dunes	SLBE	Great Lakes	GLKN	109.72	14.26	123	0	126

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Stones River	STRI	Cumberland Piedmont	CUPN	1.11	1.38	48	0	126
Sunset Crater Volcano	SUCR	Southern Colorado Plateau	SCPN	4.75	3.95	66	0	126
Tallgrass Prairie	TAPR	Heartland	HTLN	17.05	85.83	249	0	126
Theodore Roosevelt	THRO	Northern Great Plains	NGPN	109.97	43.26	197	0	126
Thomas Stone	THST	Northeast Coastal and Barrier	NCBN	0.50	1.87	53	0	126
Timpanogos Cave	TICA	Northern Colorado Plateau	NCPN	0.39	1.01	41	0	126
Timucaun Ecological and Historical Preserve	TIMU	Southeast Coast	SECN	71.40	59.73	220	0	126
Tonto	TONT	Sonoran Desert	SODN	1.75	96.97	271	0	126
Tumacacori	TUMA	Sonoran Desert	SODN	0.57	66.67	228	0	126
Tuzigoot	TUZI	Sonoran Desert	SODN	1.27	17.46	130	0	126
Upper Delaware	UPDE	Eastern Rivers and Mountains	ERMN	86.17	1.16	44	0	126
Valley Forge	VAFO	Mid Atlantic	MIDN	5.39	42.49	193	0	126
Vanderbilt Mansion	VAMA	Northeast Temperate	NETN	0.33	1.73	51	0	126
Vicksburg	VICK	Gulf Coast	GULN	2.58	0.23	25	0	126
Virgin Islands	VIIS	South Florida Caribbean	SFCN	23.07	0.00	5	0	126
Voyageurs	VOYA	Great Lakes	GLKN	320.18	6.23	88	0	126
Walnut Canyon	WACA	Southern Colorado Plateau	SCPN	5.58	48.36	208	0	126
War in the Pacific	WAPA	Pacific Island	PACN	2.98	1.08	43	0	126
Washita Battlefield	WABA	Southern Plains	SOPN	0.49	79.53	242	0	126
Weir Farm	WEFA	Northeast Temperate	NETN	0.09	17.90	131	0	126
Whiskeytown	WHIS	Klamath	KLMN	65.29	9.42	104	0	126
White Sands	WHSa	Chihuahuan Desert	CHDN	238.07	35.59	176	0	126
Whitman Mission	WHMI	Upper Columbia Basin	UCBN	0.16	10.69	109	0	126
Wilson's Creek	WICR	Heartland	HTLN	3.73	4.17	70	0	126
Wind Cave	WICA	Northern Great Plains	NGPN	44.26	62.10	223	1	255

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Percent Sensitive Vegetation Types	Ranking for Percent Sensitive Vegetation Types	Number of High Elevation Lakes	Ranking for Number of High Elevation Lakes
Wolf Trap National Park for the Performing Arts	WOTR	National Capital Region	NCRN	0.21	4.99	78	0	126
Wrangell-St. Elias	WRST	Central Alaska	CAKN	20,593.55	3.90	64	0	126
Wupatki	WUPA	Southern Colorado Plateau	SCPN	55.39	66.09	227	0	126
Yellowstone	YELL	Greater Yellowstone	GRYN	3,438.28	25.89	158	19	262
Yosemite	YOSE	Sierra Nevada	SIEN	1,164.65	19.38	135	229	270
Yucca House	YUHO	Southern Colorado Plateau	SCPN	0.06	36.24	178	0	126
Yukon-Charley Rivers	YUCH	Central Alaska	CAKN	3,938.77	18.70	133	0	126
Zion	ZION	Northern Colorado Plateau	NCPN	231.05	41.99	191	0	126

Table B-3. Park Protection Variables

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Abraham Lincoln Birthplace	ABLI	Cumberland Piedmont	CUPN	0.16	0.00	97	0.00	97
Acadia	ACAD	Northeast Temperate	NETN	60.61	58.88	223	97.15	235
Agate Fossil Beds	AGFO	Northern Great Plains	NGPN	4.82	0.00	97	0.00	97
Alagnak	ALAG	Southwest Alaska	SWAN	48.36	1.82	207	3.77	205
Alibates Flint Quarries	ALFL	Southern Plains	SOPN	2.15	0.00	97	0.00	97
Allegheny Portage Railroad	ALPO	Eastern Rivers and Mountains	ERMN	1.67	0.00	97	0.00	97
American Memorial Park	AMME	Pacific Island	PACN	0.21	0.00	97	0.00	97
Amistad	AMIS	Chihuahuan Desert	CHDN	89.95	0.00	97	0.00	97
Aniakchak	ANIA	Southwest Alaska	SWAN	942.96	0.00	97	0.00	97
Antietam	ANTI	National Capital Region	NCRN	5.08	0.00	97	0.00	97
Apostle Islands	APIS	Great Lakes	GLKN	107.42	0.00	97	0.00	97
Appomattox Court House	APCO	Mid Atlantic	MIDN	2.78	0.00	97	0.00	97
Arches	ARCH	Northern Colorado Plateau	NCPN	119.47	119.36	231	99.91	252
Arkansas Post	ARPO	Heartland	HTLN	0.66	0.00	97	0.00	97
Assateague Island	ASIS	Northeast Coastal and Barrier	NCBN	76.15	0.00	97	0.00	97
Aztec Ruins	AZRU	Southern Colorado Plateau	SCPN	0.49	0.00	97	0.00	97
Badlands	BADL	Northern Great Plains	NGPN	380.38	97.83	228	25.72	213
Bandelier	BAND	Southern Colorado Plateau	SCPN	52.80	40.93	216	77.52	224
Bent's Old Fort	BEOL	Southern Plains	SOPN	1.25	0.00	97	0.00	97
Bering Land Bridge	BELA	Arctic	ARCN	4,352.99	0.00	97	0.00	97
Big Bend	BIBE	Chihuahuan Desert	CHDN	1,270.68	1268.29	258	99.81	251
Big Cypress	BICY	South Florida Caribbean	SFCN	1,139.86	0.24	202	0.02	196
Big Hole	BIHO	Upper Columbia Basin	UCBN	1.05	0.00	97	0.00	97
Big South Fork	BISO	Appalachian Highlands	APHN	191.41	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Big Thicket	BITH	Gulf Coast	GULN	138.78	0.00	97	0.00	97
Bighorn Canyon	BICA	Greater Yellowstone	GRYN	186.79	0.00	97	0.00	97
Biscayne	BISC	South Florida Caribbean	SFCN	274.36	0.00	97	0.00	97
Black Canyon of the Gunnison	BLCA	Northern Colorado Plateau	NCPN	48.99	24.94	214	50.90	217
Blue Ridge	BLRI	Appalachian Highlands	APHN	141.45	1.42	205	1.01	203
Bluestone	BLUE	Eastern Rivers and Mountains	ERMN	6.78	0.00	97	0.00	97
Booker T. Washington	BOWA	Mid Atlantic	MIDN	0.37	0.00	97	0.00	97
Boston Harbor Islands	BOHA	Northeast Temperate	NETN	2.49	0.00	97	0.00	97
Bryce Canyon	BRCA	Northern Colorado Plateau	NCPN	56.46	55.72	221	98.69	239
Buck Island Reef	BUIS	South Florida Caribbean	SFCN	29.67	0.00	97	0.00	97
Buffalo	BUFF	Heartland	HTLN	149.99	56.30	222	37.54	214
Cabrillo	CABR	Mediterranean Coast	MEDN	0.25	0.00	97	0.00	97
Canaveral	CANA	Southeast Coast	SECN	90.58	0.00	97	0.00	97
Canyon de Chelly	CACH	Southern Colorado Plateau	SCPN	144.62	0.00	97	0.00	97
Canyonlands	CANY	Northern Colorado Plateau	NCPN	523.32	521.48	249	99.65	246
Cape Cod	CACO	Northeast Coastal and Barrier	NCBN	63.35	0.00	97	0.00	97
Cape Hatteras	CAHA	Southeast Coast	SECN	48.58	0.00	97	0.00	97
Cape Krusenstern	CAKR	Arctic	ARCN	1,031.30	0.00	97	0.00	97
Cape Lookout	CALO	Southeast Coast	SECN	43.66	0.00	97	0.00	97
Capitol Reef	CARE	Northern Colorado Plateau	NCPN	381.42	378.81	245	99.32	240
Capulin Volcano	CAVO	Southern Plains	SOPN	1.24	0.00	97	0.00	97
Carl Sandburg Home	CARL	Cumberland Piedmont	CUPN	0.42	0.00	97	0.00	97
Carlsbad Caverns	CAVE	Chihuahuan Desert	CHDN	73.24	73.24	224	100.00	260
Casa Grande Ruins	CAGR	Sonoran Desert	SODN	0.73	0.00	97	0.00	97
Castillo de San Marcos	CASA	Southeast Coast	SECN	0.03	0.00	97	0.00	97
Catoctin Mountain	CATO	National Capital Region	NCRN	8.92	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Cedar Breaks	CEBR	Northern Colorado Plateau	NCPN	9.59	0.01	196	0.09	199
Chaco Culture	CHCU	Southern Colorado Plateau	SCPN	54.36	0.00	97	0.00	97
Channel Islands	CHIS	Mediterranean Coast	MEDN	382.75	0.00	97	0.00	97
Chattahoochee River	CHAT	Southeast Coast	SECN	13.59	0.00	97	0.00	97
Chesapeake and Ohio Canal	CHOH	National Capital Region	NCRN	32.95	0.00	97	0.00	97
Chickamauga and Chattanooga	CHCH	Cumberland Piedmont	CUPN	12.86	0.00	97	0.00	97
Chickasaw	CHIC	Southern Plains	SOPN	15.60	0.00	97	0.00	97
Chiricahua	CHIR	Sonoran Desert	SODN	19.01	19.00	211	99.97	257
City of Rocks	CIRO	Upper Columbia Basin	UCBN	22.79	0.00	97	0.00	97
Colonial	COLO	Northeast Coastal and Barrier	NCBN	14.70	0.00	97	0.00	97
Colorado	COLM	Northern Colorado Plateau	NCPN	31.90	0.00	97	0.00	97
Congaree	COSW	Southeast Coast	SECN	37.89	24.67	213	65.12	222
Coronado	CORO	Sonoran Desert	SODN	7.60	0.00	194	0.04	198
Cowpens	COWP	Cumberland Piedmont	CUPN	1.33	0.00	97	0.00	97
Crater Lake	CRLA	Klamath	KLMN	284.04	282.58	237	99.49	244
Craters of the Moon	CRMO	Upper Columbia Basin	UCBN	733.96	73.45	225	10.01	207
Cumberland Gap	CUGA	Cumberland Piedmont	CUPN	38.84	0.00	97	0.00	97
Cumberland Island	CUIS	Southeast Coast	SECN	56.92	12.26	210	21.55	212
Curecanti	CURE	Northern Colorado Plateau	NCPN	64.08	0.00	97	0.00	97
Cuyahoga Valley	CUVA	Heartland	HTLN	53.36	0.00	97	0.00	97
Death Valley	DEVA	Mojave Desert	MOJN	5,314.15	4287.99	266	80.69	227
Delaware Water Gap	DEWA	Eastern Rivers and Mountains	ERMN	107.20	0.00	97	0.00	97
Denali	DENA	Central Alaska	CAKN	9,419.51	7318.68	268	77.70	225
Devils Postpile	DEPO	Sierra Nevada	SIEN	1.24	1.24	204	100.00	265
Devils Tower	DETO	Northern Great Plains	NGPN	2.11	0.00	97	0.00	97
Dinosaur	DINO	Northern Colorado Plateau	NCPN	329.42	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Dry Tortugas	DRTO	South Florida Caribbean	SFCN	107.68	0.00	97	0.00	97
Ebey's Landing	EBLA	North Coast and Cascades	NCCN	27.90	0.00	97	0.00	97
Effigy Mounds	EFMO	Heartland	HTLN	3.88	0.00	97	0.00	97
Eisenhower	EISE	Mid Atlantic	MIDN	1.09	0.00	97	0.00	97
El Malpais	ELMA	Southern Colorado Plateau	SCPN	182.63	0.51	203	0.28	200
El Morro	ELMO	Southern Colorado Plateau	SCPN	2.00	0.00	97	0.00	97
Everglades	EVER	South Florida Caribbean	SFCN	2,404.11	2403.21	262	99.96	256
Fire Island	FIIS	Northeast Coastal and Barrier	NCBN	30.72	3.86	208	12.56	210
Florissant Fossil Beds	FLFO	Rocky Mountain	ROMN	9.36	0.00	97	0.00	97
Fort Bowie	FOBO	Sonoran Desert	SODN	1.56	0.00	97	0.00	97
Fort Caroline	FOCA	Southeast Coast	SECN	0.22	0.00	97	0.00	97
Fort Davis	FODA	Chihuahuan Desert	CHDN	0.73	0.00	97	0.00	97
Fort Donelson	FODO	Cumberland Piedmont	CUPN	0.86	0.00	97	0.00	97
Fort Frederica	FOFR	Southeast Coast	SECN	0.44	0.00	97	0.00	97
Fort Laramie	FOLA	Northern Great Plains	NGPN	1.34	0.00	97	0.00	97
Fort Larned	FOLS	Southern Plains	SOPN	1.10	0.00	97	0.00	97
Fort Matanzas	FOMA	Southeast Coast	SECN	0.47	0.00	97	0.00	97
Fort Necessity	FONE	Eastern Rivers and Mountains	ERMN	1.44	0.00	97	0.00	97
Fort Point	FOPO	San Francisco Bay Area	SFAN	0.04	0.00	97	0.00	97
Fort Pulaski	FOPU	Southeast Coast	SECN	8.66	0.00	97	0.00	97
Fort Sumter	FOSU	Southeast Coast	SECN	0.36	0.00	97	0.00	97
Fort Union	FOUN	Southern Plains	SOPN	1.13	0.00	97	0.00	97
Fort Union Trading Post	FOUS	Northern Great Plains	NGPN	0.69	0.00	97	0.00	97
Fort Vancouver	FOVA	North Coast and Cascades	NCCN	0.34	0.00	97	0.00	97
Fossil Butte	FOBU	Northern Colorado Plateau	NCPN	13.00	0.00	97	0.00	97
Fredericksburg and Spotsylvania	FRSP	Mid Atlantic	MIDN	16.22	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Friendship Hill	FRHI	Eastern Rivers and Mountains	ERMN	1.03	0.00	97	0.00	97
Gates of the Arctic	GAAR	Arctic	ARCN	13,238.15	11323.27	270	85.54	231
Gateway	GATE	Northeast Coastal and Barrier	NCBN	42.16	0.00	97	0.00	97
Gauley River	GARI	Eastern Rivers and Mountains	ERMN	17.43	0.00	97	0.00	97
George Washington	GWMP	National Capital Region	NCRN	10.50	0.00	97	0.00	97
George Washington Birthplace	GEWA	Northeast Coastal and Barrier	NCBN	0.70	0.00	97	0.00	97
George Washington Carver	GWCA	Heartland	HTLN	0.32	0.00	97	0.00	97
Gettysburg	GETT	Mid Atlantic	MIDN	9.32	0.00	97	0.00	97
Gila Cliff Dwellings	GICL	Sonoran Desert	SODN	0.95	0.01	195	0.57	202
Glacier	GLAC	Rocky Mountain	ROMN	1,575.11	1574.29	260	99.95	255
Glacier Bay	GLBA	Southeast Alaska	SEAN	5,133.10	4099.87	265	79.87	226
Glen Canyon	GLCA	Southern Colorado Plateau	SCPN	1,954.63	0.01	198	0.00	194
Golden Gate	GOGA	San Francisco Bay Area	SFAN	122.52	0.03	199	0.03	197
Golden Spike	GOSP	Northern Colorado Plateau	NCPN	4.17	0.00	97	0.00	97
Grand Canyon	GRCA	Southern Colorado Plateau	SCPN	1,886.97	1876.00	261	99.42	241
Grand Portage	GRPO	Great Lakes	GLKN	1.10	0.00	97	0.00	97
Grand Teton	GRTE	Greater Yellowstone	GRYN	484.21	482.43	248	99.63	245
Grant-Kohrs Ranch	GRKO	Rocky Mountain	ROMN	2.47	0.00	97	0.00	97
Great Basin	GRBA	Mojave Desert	MOJN	120.61	0.00	97	0.00	97
Great Sand Dunes	GRSA	Rocky Mountain	ROMN	191.54	116.33	230	60.73	218
Great Smoky Mountains	GRSM	Appalachian Highlands	APHN	810.14	794.98	253	98.13	237
Guadalupe Mountains	GUMO	Chihuahuan Desert	CHDN	137.32	136.86	233	99.66	247
Guilford Courthouse	GUCO	Cumberland Piedmont	CUPN	0.34	0.00	97	0.00	97
Gulf Islands	GUIS	Gulf Coast	GULN	188.25	11.46	209	6.09	206
Hagerman Fossil Beds	HAFO	Upper Columbia Basin	UCBN	6.74	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Haleakala	HALE	Pacific Island	PACN	45.72	44.12	217	96.50	234
Harpers Ferry	HAFE	National Capital Region	NCRN	5.80	0.00	97	0.00	97
Hawaii Volcanoes	HAVO	Pacific Island	PACN	340.82	335.98	241	98.58	238
Herbert Hoover	HEHO	Heartland	HTLN	0.29	0.00	97	0.00	97
Home of Franklin D. Roosevelt	HOFR	Northeast Temperate	NETN	1.40	0.00	97	0.00	97
Homestead	HOME	Heartland	HTLN	0.35	0.00	97	0.00	97
Hopewell Culture	HOCU	Heartland	HTLN	1.75	0.00	97	0.00	97
Hopewell Furnace	HOFU	Mid Atlantic	MIDN	1.33	0.00	97	0.00	97
Horseshoe Bend	HOBE	Southeast Coast	SECN	3.20	0.00	97	0.00	97
Hot Springs	HOSP	Heartland	HTLN	8.54	0.00	97	0.00	97
Hovenweep	HOVE	Northern Colorado Plateau	NCPN	1.26	0.00	97	0.00	97
Hubbell Trading Post	HUTR	Southern Colorado Plateau	SCPN	0.25	0.00	97	0.00	97
Indiana Dunes	INDU	Great Lakes	GLKN	24.78	0.00	97	0.00	97
Isle Royale	ISRO	Great Lakes	GLKN	858.95	858.69	254	99.97	258
Jean Lafitte	JELA	Gulf Coast	GULN	29.05	0.00	97	0.00	97
Jewel Cave	JECA	Northern Great Plains	NGPN	1.95	0.00	97	0.00	97
John Day Fossil Beds	JODA	Upper Columbia Basin	UCBN	21.83	0.00	97	0.00	97
John Muir	JOMU	San Francisco Bay Area	SFAN	0.54	0.00	97	0.00	97
Johnstown Flood	JOFL	Eastern Rivers and Mountains	ERMN	0.27	0.00	97	0.00	97
Joshua Tree	JOTR	Mojave Desert	MOJN	1,239.59	1066.56	255	86.04	232
Kalaupapa	KALA	Pacific Island	PACN	16.76	0.00	97	0.00	97
Kaloko-Honokohau	KAHO	Pacific Island	PACN	0.98	0.00	97	0.00	97
Katmai	KATM	Southwest Alaska	SWAN	6,395.15	5172.55	267	80.88	228
Kenai Fjords	KEFJ	Southwest Alaska	SWAN	1,043.23	0.20	201	0.02	195
Kennesaw Mountain	KEMO	Southeast Coast	SECN	5.68	0.00	97	0.00	97
Kings Canyon	KICA	Sierra Nevada	SIEN	717.54	717.54	251	100.00	263
Kings Mountain	KIMO	Cumberland Piedmont	CUPN	6.19	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Klondike Gold Rush	KLGO	Southeast Alaska	SEAN	20.27	0.00	97	0.00	97
Knife River Indian Villages	KNRI	Northern Great Plains	NGPN	2.67	0.00	97	0.00	97
Kobuk Valley	KOVA	Arctic	ARCN	2,736.12	284.69	238	10.40	209
Lake Clark	LACL	Southwest Alaska	SWAN	6,299.00	4084.94	264	64.85	221
Lake Mead	LAME	Mojave Desert	MOJN	2,332.47	349.45	243	14.98	211
Lake Meredith	LAMR	Southern Plains	SOPN	65.04	0.00	97	0.00	97
Lake Roosevelt	LARO	Upper Columbia Basin	UCBN	163.61	0.00	97	0.00	97
Lassen Volcanic	LAVO	Klamath	KLMN	167.62	167.18	234	99.74	248
Lava Beds	LABE	Klamath	KLMN	72.88	46.65	219	64.01	220
Lewis and Clark	LEWI	North Coast and Cascades	NCCN	5.58	0.00	97	0.00	97
Lincoln Boyhood	LIBO	Heartland	HTLN	0.30	0.00	97	0.00	97
Little Bighorn Battlefield	LIBI	Rocky Mountain	ROMN	1.22	0.00	97	0.00	97
Little River Canyon	LIRI	Cumberland Piedmont	CUPN	21.37	0.00	97	0.00	97
Lyndon B. Johnson	LYJO	Southern Plains	SOPN	2.62	0.00	97	0.00	97
Mammoth Cave	MACA	Cumberland Piedmont	CUPN	80.23	80.23	226	100.00	269
Manassas	MANA	National Capital Region	NCRN	8.01	0.00	97	0.00	97
Manzanar	MANZ	Mojave Desert	MOJN	1.27	0.00	97	0.00	97
Marsh-Billings-Rockefeller	MABI	Northeast Temperate	NETN	1.00	0.00	97	0.00	97
Mesa Verde	MEVE	Southern Colorado Plateau	SCPN	83.31	83.31	227	100.00	261
Minute Man	MIMA	Northeast Temperate	NETN	1.49	0.00	97	0.00	97
Mississippi	MISS	Great Lakes	GLKN	84.11	0.00	97	0.00	97
Missouri	MNRR	Northern Great Plains	NGPN	107.87	0.00	97	0.00	97
Mojave	MOJA	Mojave Desert	MOJN	2,483.84	1135.83	256	45.73	215
Monocacy	MONO	National Capital Region	NCRN	2.53	0.00	97	0.00	97
Montezuma Castle	MOCA	Sonoran Desert	SODN	1.33	0.00	97	0.00	97
Moores Creek	MOCR	Southeast Coast	SECN	0.16	0.00	97	0.00	97
Morristown	MORR	Northeast Temperate	NETN	2.67	0.00	97	0.00	97
Mount Rainier	MORA	North Coast and Cascades	NCCN	367.56	367.35	244	99.94	254

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Mount Rushmore	MORU	Northern Great Plains	NGPN	2.02	0.01	197	0.46	201
Muir Woods	MUWO	San Francisco Bay Area	SFAN	0.90	0.00	97	0.00	97
Natchez Trace Parkway and National Scenic Trail	NATR	Gulf Coast	GULN	71.52	0.00	97	0.00	97
National Capital Parks - East	NACE	National Capital Region	NCRN	7.18	0.00	97	0.00	97
National Park of American Samoa	NPSA	Pacific Island	PACN	16.66	0.00	97	0.00	97
Natural Bridges	NABR	Northern Colorado Plateau	NCPN	11.56	0.00	97	0.00	97
Navajo	NAVA	Southern Colorado Plateau	SCPN	0.94	0.00	97	0.00	97
New River Gorge	NERI	Eastern Rivers and Mountains	ERMN	109.98	0.00	97	0.00	97
Nez Perce	NEPE	Upper Columbia Basin	UCBN	6.91	0.00	97	0.00	97
Ninety Six	NISI	Cumberland Piedmont	CUPN	1.50	0.00	97	0.00	97
Niobrara	NIOB	Northern Great Plains	NGPN	42.37	1.50	206	3.55	204
Noatak	NOAT	Arctic	ARCN	10,255.62	9069.04	269	88.43	233
North Cascades	NOCA	North Coast and Cascades	NCCN	782.91	782.70	252	99.97	259
Obed	OBRI	Appalachian Highlands	APHN	8.32	0.00	97	0.00	97
Ocmulgee	OCMU	Southeast Coast	SECN	1.08	0.00	97	0.00	97
Olympic	OLYM	North Coast and Cascades	NCCN	1,428.42	1424.79	259	99.75	249
Oregon Caves	ORCA	Klamath	KLMN	0.73	0.00	97	0.00	97
Organ Pipe Cactus	ORPI	Sonoran Desert	SODN	516.70	434.63	247	84.12	230
Ozark	OZAR	Heartland	HTLN	128.62	0.00	97	0.00	97
Padre Island	PAIS	Gulf Coast	GULN	204.94	0.00	97	0.00	97
Palo Alto Battlefield	PAAL	Gulf Coast	GULN	5.33	0.00	97	0.00	97
Pea Ridge	PERI	Heartland	HTLN	6.67	0.00	97	0.00	97
Pecos	PECO	Southern Plains	SOPN	10.20	0.00	97	0.00	97
Petersburg	PETE	Mid Atlantic	MIDN	5.24	0.00	97	0.00	97
Petrified Forest	PEFO	Southern Colorado Plateau	SCPN	348.65	348.65	242	100.00	267
Petroglyph	PETR	Southern Colorado Plateau	SCPN	11.25	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Pictured Rocks	PIRO	Great Lakes	GLKN	115.12	0.00	97	0.00	97
Pinnacles	PINN	San Francisco Bay Area	SFAN	42.42	26.42	215	62.29	219
Pipe Spring	PISP	Northern Colorado Plateau	NCPN	0.06	0.00	97	0.00	97
Pipestone	PIPE	Heartland	HTLN	0.44	0.00	97	0.00	97
Point Reyes	PORE	San Francisco Bay Area	SFAN	115.77	53.00	220	45.78	216
Prince William Forest	PRWI	National Capital Region	NCRN	17.33	0.00	97	0.00	97
Pu'u'honua o Honaunau	PUHO	Pacific Island	PACN	0.28	0.00	97	0.00	97
Puukohola Heiau	PUHE	Pacific Island	PACN	0.12	0.00	97	0.00	97
Rainbow Bridge	RABR	Southern Colorado Plateau	SCPN	0.25	0.00	97	0.00	97
Redwood	REDW	Klamath	KLMN	180.69	176.65	235	97.77	236
Richmond	RICH	Mid Atlantic	MIDN	2.37	0.00	97	0.00	97
Rock Creek Park	ROCR	National Capital Region	NCRN	4.23	0.00	97	0.00	97
Rocky Mountain	ROMO	Rocky Mountain	ROMN	417.06	416.14	246	99.78	250
Russell Cave	RUCA	Cumberland Piedmont	CUPN	0.50	0.00	97	0.00	97
Sagamore Hill	SAHI	Northeast Coastal and Barrier	NCBN	0.11	0.00	97	0.00	97
Saguaro	SAGU	Sonoran Desert	SODN	146.02	122.03	232	83.57	229
Saint Croix	SACN	Great Lakes	GLKN	152.70	0.00	97	0.00	97
Saint-Gaudens	SAGA	Northeast Temperate	NETN	0.22	0.00	97	0.00	97
Salinas Pueblo Missions	SAPU	Southern Colorado Plateau	SCPN	1.66	0.00	97	0.00	97
San Antonio Missions	SAAN	Gulf Coast	GULN	1.29	0.00	97	0.00	97
San Juan Island	SAJH	North Coast and Cascades	NCCN	2.69	0.00	97	0.00	97
Santa Monica Mountains	SAMO	Mediterranean Coast	MEDN	241.96	0.00	97	0.00	97
Saratoga	SARA	Northeast Temperate	NETN	4.49	0.00	97	0.00	97
Saugus Iron Works	SAIR	Northeast Temperate	NETN	0.02	0.00	97	0.00	97
Scotts Bluff	SCBL	Northern Great Plains	NGPN	5.06	0.00	97	0.00	97
Sequoia	SEQU	Sierra Nevada	SIEN	635.94	635.94	250	100.00	270
Shenandoah	SHEN	Mid Atlantic	MIDN	301.99	300.38	239	99.46	243

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Shiloh	SHIL	Cumberland Piedmont	CUPN	6.38	0.00	97	0.00	97
Sitka	SITK	Southeast Alaska	SEAN	0.17	0.00	97	0.00	97
Sleeping Bear Dunes	SLBE	Great Lakes	GLKN	109.72	0.00	97	0.00	97
Stones River	STRI	Cumberland Piedmont	CUPN	1.11	0.00	97	0.00	97
Sunset Crater Volcano	SUCR	Southern Colorado Plateau	SCPN	4.75	0.00	97	0.00	97
Tallgrass Prairie	TAPR	Heartland	HTLN	17.05	0.00	97	0.00	97
Theodore Roosevelt	THRO	Northern Great Plains	NGPN	109.97	109.97	229	100.00	271
Thomas Stone	THST	Northeast Coastal and Barrier	NCBN	0.50	0.00	97	0.00	97
Timpanogos Cave	TICA	Northern Colorado Plateau	NCPN	0.39	0.04	200	10.34	208
Timucaun Ecological and Historical Preserve	TIMU	Southeast Coast	SECN	71.40	0.00	97	0.00	97
Tonto	TONT	Sonoran Desert	SODN	1.75	0.00	97	0.00	97
Tumacacori	TUMA	Sonoran Desert	SODN	0.57	0.00	97	0.00	97
Tuzigoot	TUZI	Sonoran Desert	SODN	1.27	0.00	97	0.00	97
Upper Delaware	UPDE	Eastern Rivers and Mountains	ERMN	86.17	0.00	97	0.00	97
Valley Forge	VAFO	Mid Atlantic	MIDN	5.39	0.00	97	0.00	97
Vanderbilt Mansion	VAMA	Northeast Temperate	NETN	0.33	0.00	97	0.00	97
Vicksburg	VICK	Gulf Coast	GULN	2.58	0.00	97	0.00	97
Virgin Islands	VIIS	South Florida Caribbean	SFCN	23.07	23.07	212	100.00	265
Voyageurs	VOYA	Great Lakes	GLKN	320.18	320.18	240	100.00	262
Walnut Canyon	WACA	Southern Colorado Plateau	SCPN	5.58	0.00	97	0.00	97
War in the Pacific	WAPA	Pacific Island	PACN	2.98	0.00	97	0.00	97
Washita Battlefield	WABA	Southern Plains	SOPN	0.49	0.00	97	0.00	97
Weir Farm	WEFA	Northeast Temperate	NETN	0.09	0.00	97	0.00	97
Whiskeytown	WHIS	Klamath	KLMN	65.29	0.00	97	0.00	97
White Sands	WHS	Chihuahuan Desert	CHDN	238.07	0.00	97	0.00	97

Park Name	Park Code	Network Name	Network Code	Park Area (sq. mi.)	Area of Park Receiving Special Protection	Ranking for Area of Park Receiving Special Protection	Percent of Park Receiving Special Protection	Park Ranking for Percent of Park Receiving Special Protection
Whitman Mission	WHMI	Upper Columbia Basin	UCBN	0.16	0.00	97	0.00	97
Wilson's Creek	WICR	Heartland	HTLN	3.73	0.00	97	0.00	97
Wind Cave	WICA	Northern Great Plains	NGPN	44.26	44.26	218	100.00	265
Wolf Trap National Park for the Performing Arts	WOTR	National Capital Region	NCRN	0.21	0.00	97	0.00	97
Wrangell-St. Elias	WRST	Central Alaska	CAKN	20,593.55	15151.73	271	73.58	223
Wupatki	WUPA	Southern Colorado Plateau	SCPN	55.39	0.00	97	0.00	97
Yellowstone	YELL	Greater Yellowstone	GRYN	3,438.28	3435.56	263	99.92	253
Yosemite	YOSE	Sierra Nevada	SIEN	1,164.65	1164.65	257	100.00	268
Yucca House	YUHO	Southern Colorado Plateau	SCPN	0.06	0.00	97	0.00	97
Yukon-Charley Rivers	YUCH	Central Alaska	CAKN	3,938.77	0.00	97	0.00	97
Zion	ZION	Northern Colorado Plateau	NCPN	231.05	229.77	236	99.45	242

Appendix C: Ranking Scores for N Pollutant Exposure, Ecosystem Sensitivity, Park Protection, and Overall Risk for Each of the 271 I&M Parks

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
ABLI	Abraham Lincoln Birthplace	CUPN	Cumberland Piedmont	203.5	92.5	97	131.00
ACAD	Acadia	NETN	Northeast Temperate	105	113.5	229	149.17
AGFO	Agate Fossil Beds	NGPN	Northern Great Plains	87	195	97	126.33
ALAG	Alagnak	SWAN	Southwest Alaska	3	145	206	118.00
ALFL	Alibates Flint Quarries	SOPN	Southern Plains	132.25	144.5	97	124.58
ALPO	Allegheny Portage Railroad	ERMN	Eastern Rivers and Mountains	220	109	97	142.00
AMME	American Memorial Park	PACN	Pacific Island	ND	135.5	97	116.25
AMIS	Amistad	CHDN	Chihuahuan Desert	79.75	167.5	97	114.75
ANIA	Aniakchak	SWAN	Southwest Alaska	1	147.5	97	81.83
ANTI	Antietam	NCRN	National Capital Region	225	80	97	134.00
APIS	Apostle Islands	GLKN	Great Lakes	96	92	97	95.00
APCO	Appomattox Court House	MIDN	Mid Atlantic	172.75	94	97	121.25
ARCH	Arches	NCPN	Northern Colorado Plateau	36.25	186.5	241.5	154.75
ARPO	Arkansas Post	HTLN	Heartland	158	70.5	97	108.50
ASIS	Assateague Island	NCBN	Northeast Coastal and Barrier	191.5	136	97	141.50
AZRU	Aztec Ruins	SCPN	Southern Colorado Plateau	94.5	155.5	97	115.67
BADL	Badlands	NGPN	Northern Great Plains	51	169.5	220.5	147.00
BAND	Bandelier	SCPN	Southern Colorado Plateau	65.5	164.5	220	150.00
BEOL	Bent's Old Fort	SOPN	Southern Plains	70.75	159	97	108.92
BELA	Bering Land Bridge	ARCN	Arctic	4	148.5	97	83.17
BIBE	Big Bend	CHDN	Chihuahuan Desert	25.25	198	254.5	159.25
BICY	Big Cypress	SFCN	South Florida / Caribbean	162.25	185.5	199	182.25
BIHO	Big Hole	UCBN	Upper Columbia Basin	24.25	168	97	96.42

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
BISO	Big South Fork	APHN	Appalachian Highlands	164	68.5	97	109.83
BITH	Big Thicket	GULN	Gulf Coast	189.5	144	97	143.50
BICA	Bighorn Canyon	GRYN	Greater Yellowstone	29.5	170.5	97	99.00
BISC	Biscayne	SFCN	South Florida / Caribbean	172	106.5	97	125.17
BLCA	Black Canyon of the Gunnison	NCPN	Northern Colorado Plateau	42.5	133.5	215.5	130.50
BLRI	Blue Ridge	APHN	Appalachian Highlands	174.75	139	204	172.58
BLUE	Bluestone	ERMN	Eastern Rivers and Mountains	153.75	65.5	97	105.42
BOWA	Booker T. Washington	MIDN	Mid Atlantic	155.75	72	97	108.25
BOHA	Boston Harbor Islands	NETN	Northeast Temperate	231	126	97	151.33
BRCA	Bryce Canyon	NCPN	Northern Colorado Plateau	27	120.5	230	125.83
BUIS	Buck Island Reef	SFCN	South Florida / Caribbean	229	65.5	97	130.50
BUFF	Buffalo	HTLN	Heartland	148.25	146	218	170.75
CABR	Cabrillo	MEDN	Mediterranean Coast	159	180.5	97	145.50
CANA	Canaveral	SECN	Southeast Coast	173.5	125	97	131.83
CACH	Canyon de Chelly	SCPN	Southern Colorado Plateau	57.75	131.5	97	95.42
CANY	Canyonlands	NCPN	Northern Colorado Plateau	34.75	178.5	247.5	153.58
CACO	Cape Cod	NCBN	Northeast Coastal and Barrier	190.75	147	97	144.92
CAHA	Cape Hatteras	SECN	Southeast Coast	162.5	168.5	97	142.67
CAKR	Cape Krusenstern	ARCN	Arctic	8	181	97	95.33
CALO	Cape Lookout	SECN	Southeast Coast	170	175.5	97	147.50
CARE	Capitol Reef	NCPN	Northern Colorado Plateau	41.5	165.5	242.5	149.83
CAVO	Capulin Volcano	SOPN	Southern Plains	43.25	129	97	89.75
CARL	Carl Sandburg Home	CUPN	Cumberland Piedmont	164	130	97	130.33
CAVE	Carlsbad Caverns	CHDN	Chihuahuan Desert	73.25	191	242	168.75
CAGR	Casa Grande Ruins	SODN	Sonoran Desert	108.75	192	97	132.58
CASA	Castillo de San Marcos	SECN	Southeast Coast	172.75	73	97	114.25
CATO	Catoctin Mountain	NCRN	National Capital Region	239	78	97	138.00

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
CEBR	Cedar Breaks	NCPN	Northern Colorado Plateau	47.25	105.5	197.5	116.75
CHCU	Chaco Culture	SCPN	Southern Colorado Plateau	67.5	196.5	97	120.33
CHIS	Channel Islands	MEDN	Mediterranean Coast	145	165	97	135.67
CHAT	Chattahoochee River	SECN	Southeast Coast	211.25	96.5	97	134.92
CHOH	Chesapeake and Ohio Canal	NCRN	National Capital Region	217.25	73.5	97	129.25
CHCH	Chickamauga and Chattanooga	CUPN	Cumberland Piedmont	202.25	82	97	127.08
CHIC	Chickasaw	SOPN	Southern Plains	161.75	112.5	97	123.75
CHIR	Chiricahua	SODN	Sonoran Desert	38.25	166	234	146.08
CIRO	City of Rocks	UCBN	Upper Columbia Basin	73.75	172	97	114.25
COLO	Colonial	NCBN	Northeast Coastal and Barrier	187.5	132	97	138.83
COLM	Colorado	NCPN	Northern Colorado Plateau	47	115.5	97	86.50
COSW	Congaree	SECN	Southeast Coast	163	186	217.5	188.83
CORO	Coronado	SODN	Sonoran Desert	47.5	182	196	141.83
COWP	Cowpens	CUPN	Cumberland Piedmont	167.5	65.5	97	110.00
CRLA	Crater Lake	KLMN	Klamath	84.5	148.5	240.5	157.83
CRMO	Craters of the Moon	UCBN	Upper Columbia Basin	68.25	126.5	216	136.92
CUGA	Cumberland Gap	CUPN	Cumberland Piedmont	160.5	80.5	97	112.67
CUIS	Cumberland Island	SECN	Southeast Coast	150.5	154.5	211	172.00
CURE	Curecanti	NCPN	Northern Colorado Plateau	33.25	187.5	97	105.92
CUVA	Cuyahoga Valley	HTLN	Heartland	250	83	97	143.33
DEVA	Death Valley	MOJN	Mojave Desert	62.25	193.5	246.5	167.42
DEWA	Delaware Water Gap	ERMN	Eastern Rivers and Mountains	222	105	97	141.33
DENA	Denali	CAKN	Central Alaska	14	101	246.5	120.50
DEPO	Devils Postpile	SIEN	Sierra Nevada	75.5	100	234.5	136.67
DETO	Devils Tower	NGPN	Northern Great Plains	51.25	150	97	99.42
DINO	Dinosaur	NCPN	Northern Colorado Plateau	49.5	188.5	97	111.67
DRT0	Dry Tortugas	SFCN	South Florida / Caribbean	96	79	97	90.67

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
EBLA	Ebey's Landing	NCCN	North Coast and Cascades	91.5	111	97	99.83
EFMO	Effigy Mounds	HTLN	Heartland	186.5	122	97	135.17
EISE	Eisenhower	MIDN	Mid Atlantic	241	131	97	156.33
ELMA	<i>El Malpais</i>	SCPN	Southern Colorado Plateau	51.5	110	201.5	121.00
ELMO	El Morro	SCPN	Southern Colorado Plateau	66.25	162	97	108.42
EVER	<i>Everglades</i>	SFCN	South Florida / Caribbean	206	171	259	212.00
FIIS	Fire Island	NCBN	Northeast Coastal and Barrier	230.75	118.5	209	186.08
FLFO	Florissant Fossil Beds	ROMN	Rocky Mountain	102	122.5	97	107.17
FOBO	Fort Bowie	SODN	Sonoran Desert	38.75	174	97	103.25
FOCA	Fort Caroline	SECN	Southeast Coast	185.25	134	97	138.75
FODA	Fort Davis	CHDN	Chihuahuan Desert	34	189.5	97	106.83
FODO	Fort Donelson	CUPN	Cumberland Piedmont	196	81	97	124.67
FOFR	Fort Frederica	SECN	Southeast Coast	160.5	171.5	97	143.00
FOLA	Fort Laramie	NGPN	Northern Great Plains	98	175	97	123.33
FOLS	Fort Larned	SOPN	Southern Plains	135.25	169	97	133.75
FOMA	Fort Matanzas	SECN	Southeast Coast	179.75	160.5	97	145.75
FONE	Fort Necessity	ERMN	Eastern Rivers and Mountains	225.5	136.5	97	153.00
FOPO	Fort Point	SFAN	San Francisco Bay Area	144.75	99.5	97	113.75
FOPU	Fort Pulaski	SECN	Southeast Coast	133	185	97	138.33
FOSU	Fort Sumter	SECN	Southeast Coast	181	86.5	97	121.50
FOUN	Fort Union	SOPN	Southern Plains	32	192.5	97	107.17
FOUS	Fort Union Trading Post	NGPN	Northern Great Plains	60.5	145.5	97	101.00
FOVA	Fort Vancouver	NCCN	North Coast and Cascades	137	135	97	123.00
FOBU	Fossil Butte	NCPN	Northern Colorado Plateau	68	189	97	118.00
FRSP	Fredericksburg and Spotsylvania	MIDN	Mid Atlantic	202.5	97.5	97	132.33
FRHI	Friendship Hill	ERMN	Eastern Rivers and Mountains	214.75	120	97	143.92
GAAR	<i>Gates of the Arctic</i>	ARCN	Arctic	17	146.5	250.5	138.00
GATE	Gateway	NCBN	Northeast Coastal and Barrier	240	130	97	155.67

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
GARI	Gauley River	ERMN	Eastern Rivers and Mountains	183.5	71.5	97	117.33
GWMP	George Washington	NCRN	National Capital Region	239.5	117	97	151.17
GEWA	George Washington Birthplace	NCBN	Northeast Coastal and Barrier	225.5	163	97	161.83
GWCA	George Washington Carver	HTLN	Heartland	183	77	97	119.00
GETT	Gettysburg	MIDN	Mid Atlantic	243.5	137.5	97	159.33
GICL	Gila Cliff Dwellings	SODN	Sonoran Desert	32.75	182.5	198.5	137.92
GLAC	Glacier	ROMN	Rocky Mountain	61.5	166	257.5	161.67
GLBA	Glacier Bay	SEAN	Southeast Alaska	5	97	245.5	115.83
GLCA	Glen Canyon	SCPN	Southern Colorado Plateau	36.25	163.5	196	131.92
GOGA	Golden Gate	SFAN	San Francisco Bay Area	164.5	146	198	169.50
GOSP	Golden Spike	NCPN	Northern Colorado Plateau	90.5	190.5	97	126.00
GRCA	Grand Canyon	SCPN	Southern Colorado Plateau	46	244.5	251	180.50
GRPO	Grand Portage	GLKN	Great Lakes	80.25	94.5	97	90.58
GRTE	Grand Teton	GRYN	Greater Yellowstone	67.75	224	246.5	179.42
GRKO	Grant-Kohrs Ranch	ROMN	Rocky Mountain	13.75	172.5	97	94.42
GRBA	Great Basin	MOJN	Mojave Desert	10.75	100.5	97	69.42
GRSA	Great Sand Dunes	ROMN	Rocky Mountain	38.75	225	224	162.58
GRSM	Great Smoky Mountains	APHN	Appalachian Highlands	163.75	68	245	158.92
GUMO	Guadalupe Mountains	CHDN	Chihuahuan Desert	64	194	240	166.00
GUCO	Guilford Courthouse	CUPN	Cumberland Piedmont	196.75	65.5	97	119.75
GUIS	Gulf Islands	GULN	Gulf Coast	159.5	103	207.5	156.67
HAFO	Hagerman Fossil Beds	UCBN	Upper Columbia Basin	105	193	97	131.67
HALE	Haleakala	PACN	Pacific Island	84	132.5	225.5	147.33
HAFE	Harpers Ferry	NCRN	National Capital Region	221	87.5	97	135.17
HAVO	Hawaii Volcanoes	PACN	Pacific Island	56	121	239.5	138.83
HEHO	Herbert Hoover	HTLN	Heartland	195.25	93	97	128.42
HOFR	Home of Franklin D. Roosevelt	NETN	Northeast Temperate	211	108.5	97	138.83

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
HOME	Homestead	HTLN	Heartland	182.25	164	97	147.75
HOCU	Hopewell Culture	HTLN	Heartland	223.25	78.5	97	132.92
HOFU	Hopewell Furnace	MIDN	Mid Atlantic	249.25	134.5	97	160.25
HOBE	Horseshoe Bend	SECN	Southeast Coast	172.25	108	97	125.75
HOSP	Hot Springs	HTLN	Heartland	139.75	74.5	97	103.75
HOVE	Hovenweep	NCPN	Northern Colorado Plateau	69.75	184.5	97	117.08
HUTR	Hubbell Trading Post	SCPN	Southern Colorado Plateau	65.25	138	97	100.08
INDU	Indiana Dunes	GLKN	Great Lakes	235.75	157	97	163.25
ISRO	Isle Royale	GLKN	Great Lakes	70.25	91.5	256	139.25
JELA	Jean Lafitte	GULN	Gulf Coast	182.75	156	97	145.25
JECA	Jewel Cave	NGPN	Northern Great Plains	63	90.5	97	83.50
JODA	John Day Fossil Beds	UCBN	Upper Columbia Basin	43.75	194.5	97	111.75
JOMU	John Muir	SFAN	San Francisco Bay Area	184.25	154	97	145.08
JOFL	Johnstown Flood	ERMN	Eastern Rivers and Mountains	219.5	140	97	152.17
JOTR	Joshua Tree	MOJN	Mojave Desert	132.5	195.5	243.5	190.50
KALA	Kalaupapa	PACN	Pacific Island	230	102.5	97	143.17
KAHO	Kaloko-Honokohau	PACN	Pacific Island	66	150.5	97	104.50
KATM	Katmai	SWAN	Southwest Alaska	7	133	247.5	129.17
KEFJ	Kenai Fjords	SWAN	Southwest Alaska	18	104	198	106.67
KEMO	Kennesaw Mountain	SECN	Southeast Coast	222.5	82.5	97	134.00
KICA	Kings Canyon	SIEN	Sierra Nevada	88.75	225.5	257	190.42
KIMO	Kings Mountain	CUPN	Cumberland Piedmont	175	69.5	97	113.83
KLGO	Klondike Gold Rush	SEAN	Southeast Alaska	6	162.5	97	88.50
KNRI	Knife River Indian Villages	NGPN	Northern Great Plains	109.5	143.5	97	116.67
KOVA	Kobuk Valley	ARCN	Arctic	11	125.5	223.5	120.00
LACL	Lake Clark	SWAN	Southwest Alaska	12	118	242.5	124.17
LAME	Lake Mead	MOJN	Mojave Desert	56.25	183.5	227	155.58

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
LAMR	Lake Meredith	SOPN	Southern Plains	133.5	149.5	97	126.67
LARO	Lake Roosevelt	UCBN	Upper Columbia Basin	42.25	123.5	97	87.58
LAVO	Lassen Volcanic	KLMN	Klamath	66	174	241	160.33
LABE	Lava Beds	KLMN	Klamath	29.75	181.5	219.5	143.58
LEWI	Lewis and Clark	NCCN	North Coast and Cascades	127.75	141.5	97	122.08
LIBO	Lincoln Boyhood	HTLN	Heartland	214.25	79.5	97	130.25
LIBI	Little Bighorn Battlefield	ROMN	Rocky Mountain	48	187	97	110.67
LIRI	Little River Canyon	CUPN	Cumberland Piedmont	210.5	77.5	97	128.33
LYJO	Lyndon B. Johnson	SOPN	Southern Plains	139.25	149	97	128.42
MACA	Mammoth Cave	CUPN	Cumberland Piedmont	203	74	247.5	174.83
MANA	Manassas	NCRN	National Capital Region	227.5	121.5	97	148.67
MANZ	Manzanar	MOJN	Mojave Desert	62.25	191.5	97	116.92
MABI	Marsh-Billings-Rockefeller	NETN	Northeast Temperate	132.5	90	97	106.50
MEVE	Mesa Verde	SCPN	Southern Colorado Plateau	84	156.5	244	161.50
MIMA	Minute Man	NETN	Northeast Temperate	192.5	114	97	134.50
MISS	Mississippi	GLKN	Great Lakes	205.5	137	97	146.50
MNRR	Missouri	NGPN	Northern Great Plains	159	127	97	127.67
MOJA	Mojave	MOJN	Mojave Desert	100	190	235.5	175.17
MONO	Monocacy	NCRN	National Capital Region	234.5	101.5	97	144.33
MOCA	Montezuma Castle	SODN	Sonoran Desert	82.75	196	97	125.25
MOCR	Moore's Creek	SECN	Southeast Coast	225	127.5	97	149.83
MORR	Morristown	NETN	Northeast Temperate	241.5	85.5	97	141.33
MORA	Mount Rainier	NCCN	North Coast and Cascades	128.5	186.5	249	188.00
MORU	Mount Rushmore	NGPN	Northern Great Plains	62.25	71	199	110.75
MUWO	Muir Woods	SFAN	San Francisco Bay Area	183.75	99	97	126.58
NATR	Natchez Trace Parkway and National Scenic Trail	GULN	Gulf Coast	169.5	106	97	124.17
NACE	National Capital Parks - East	NCRN	National Capital Region	246.25	76	97	139.75

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
NPSA	National Park of American Samoa	PACN	Pacific Island	ND	95.5	97	96.25
NABR	Natural Bridges	NCPN	Northern Colorado Plateau	35.25	114.5	97	82.25
NAVA	Navajo	SCPN	Southern Colorado Plateau	34.75	141	97	90.92
NERI	New River Gorge	ERMN	Eastern Rivers and Mountains	175.5	75	97	115.83
NEPE	Nez Perce	UCBN	Upper Columbia Basin	35.75	173.5	97	102.08
NISI	Ninety Six	CUPN	Cumberland Piedmont	161.25	113	97	123.75
NIOB	Niobrara	NGPN	Northern Great Plains	108.25	157.5	205	156.92
NOAT	Noatak	ARCN	Arctic	10	140.5	251	133.83
NOCA	North Cascades	NCCN	North Coast and Cascades	113.75	209	255.5	192.75
OBRI	Obed	APHN	Appalachian Highlands	175.25	69	97	113.75
OCMU	Ocmulgee	SECN	Southeast Coast	176.75	151.5	97	141.75
OLYM	Olympic	NCCN	North Coast and Cascades	129.25	180.5	254	187.92
ORCA	Oregon Caves	KLMN	Klamath	91	65.5	97	84.50
ORPI	Organ Pipe Cactus	SODN	Sonoran Desert	65.25	188	238.5	163.92
OZAR	Ozark	HTLN	Heartland	150	93.5	97	113.50
PAIS	Padre Island	GULN	Gulf Coast	133.25	142.5	97	124.25
PAAL	Palo Alto Battlefield	GULN	Gulf Coast	129.75	139.5	97	122.08
PERI	Pea Ridge	HTLN	Heartland	204	76.5	97	125.83
PECO	Pecos	SOPN	Southern Plains	60.75	178	97	111.92
PETE	Petersburg	MIDN	Mid Atlantic	200.25	86	97	127.75
PEFO	Petrified Forest	SCPN	Southern Colorado Plateau	63.25	197	254.5	171.58
PETR	Petroglyph	SCPN	Southern Colorado Plateau	77.25	197.5	97	123.92
PIRO	Pictured Rocks	GLKN	Great Lakes	115	124	97	112.00
PINN	Pinnacles	SFAN	San Francisco Bay Area	154.5	176	217	182.50
PISP	Pipe Spring	NCPN	Northern Colorado Plateau	28	177.5	97	100.83
PIPE	Pipestone	HTLN	Heartland	200.25	170	97	155.75
PORE	Point Reyes	SFAN	San Francisco Bay Area	178.25	166.5	218	187.58

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
PRWI	Prince William Forest	NCRN	National Capital Region	222.5	91	97	136.83
PUHO	Pu'uhonua o Honaunau	PACN	Pacific Island	58	119	97	91.33
PUHE	Puukohola Heiau	PACN	Pacific Island	69	65.5	97	77.17
RABR	Rainbow Bridge	SCPN	Southern Colorado Plateau	22.75	152.5	97	90.75
REDW	Redwood	KLMN	Klamath	90.75	88	235.5	138.08
RICH	Richmond	MIDN	Mid Atlantic	201.25	116	97	138.08
ROCR	Rock Creek Park	NCRN	National Capital Region	242.5	103.5	97	147.67
ROMO	Rocky Mountain	ROMN	Rocky Mountain	114	182.5	248	181.50
RUCA	Russell Cave	CUPN	Cumberland Piedmont	192.75	65.5	97	118.42
SAHI	Sagamore Hill	NCBN	Northeast Coastal and Barrier	248	109.5	97	151.50
SAGU	Saguaro	SODN	Sonoran Desert	85.5	179.5	230.5	165.17
SACN	Saint Croix	GLKN	Great Lakes	157.75	184	97	146.25
SAGA	Saint-Gaudens	NETN	Northeast Temperate	139	89	97	108.33
SAPU	Salinas Pueblo Missions	SCPN	Southern Colorado Plateau	46.75	183	97	108.92
SAAN	San Antonio Missions	GULN	Gulf Coast	158.5	160	97	138.50
SAJH	San Juan Island	NCCN	North Coast and Cascades	163	153.5	97	137.83
SAMO	Santa Monica Mountains	MEDN	Mediterranean Coast	197	161	97	151.67
SARA	Saratoga	NETN	Northeast Temperate	149	107.5	97	117.83
SAIR	Saugus Iron Works	NETN	Northeast Temperate	172	148	97	139.00
SCBL	Scotts Bluff	NGPN	Northern Great Plains	118.25	179	97	131.42
SEQU	Sequoia	SIEN	Sierra Nevada	111.75	214.5	260	195.42
SHEN	Shenandoah	MIDN	Mid Atlantic	205.75	70	241	172.25
SHIL	Shiloh	CUPN	Cumberland Piedmont	167.5	110.5	97	125.00
SITK	Sitka	SEAN	Southeast Alaska	2	139	97	79.33
SLBE	Sleeping Bear Dunes	GLKN	Great Lakes	137	124.5	97	119.50
STRI	Stones River	CUPN	Cumberland Piedmont	186.25	87	97	123.42
SUCR	Sunset Crater Volcano	SCPN	Southern Colorado Plateau	68	96	97	87.00

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
TAPR	Tallgrass Prairie	HTLN	Heartland	174.5	187.5	97	153.00
THRO	<i>Theodore Roosevelt</i>	NGPN	Northern Great Plains	85.5	161.5	250	165.67
THST	Thomas Stone	NCBN	Northeast Coastal and Barrier	229	89.5	97	138.50
TICA	Timpanogos Cave	NCPN	Northern Colorado Plateau	110.5	83.5	204	132.67
TIMU	Timucaun Ecological and Historical Preserve	SECN	Southeast Coast	169.75	173	97	146.58
TONT	Tonto	SODN	Sonoran Desert	102.5	198.5	97	132.67
TUMA	Tumacacori	SODN	Sonoran Desert	59.5	177	97	111.17
TUZI	Tuzigoot	SODN	Sonoran Desert	75.25	128	97	100.08
UPDE	Upper Delaware	ERMN	Eastern Rivers and Mountains	195.75	85	97	125.92
VAFO	Valley Forge	MIDN	Mid Atlantic	248.5	159.5	97	168.33
VAMA	Vanderbilt Mansion	NETN	Northeast Temperate	203.75	88.5	97	129.75
VICK	Vicksburg	GULN	Gulf Coast	145	75.5	97	105.83
VIIS	Virgin Islands	SFCN	South Florida / Caribbean	235	65.5	238.5	179.67
VOYA	<i>Voyageurs</i>	GLKN	Great Lakes	102	107	251	153.33
WACA	Walnut Canyon	SCPN	Southern Colorado Plateau	71	167	97	111.67
WAPA	War in the Pacific	PACN	Pacific Island	ND	84.5	97	90.75
WABA	Washita Battlefield	SOPN	Southern Plains	133.5	184	97	138.17
WEFA	Weir Farm	NETN	Northeast Temperate	242.75	128.5	97	156.08
WHIS	Whiskeytown	KLMN	Klamath	79	115	97	97.00
WHSA	<i>White Sands</i>	CHDN	Chihuahuan Desert	33.75	151	97	93.92
WHMI	Whitman Mission	UCBN	Upper Columbia Basin	92	117.5	97	102.17
WICR	Wilson's Creek	HTLN	Heartland	150.25	98	97	115.08
WICA	Wind Cave	NGPN	Northern Great Plains	60	239	241.5	180.17
WOTR	Wolf Trap National Park for the Performing Arts	NCRN	National Capital Region	243.5	102	97	147.50
WRST	<i>Wrangell-St. Elias</i>	CAKN	Central Alaska	9	95	247	117.00
WUPA	Wupatki	SCPN	Southern Colorado Plateau	45.25	176.5	97	106.25

Park Code	I&M Parks ¹	Network Code	Network Name	Park Ranking ²			
				Average of Pollutant Exposure	Average of Ecosystem Sensitivity	Average of Park Protection	Overall Risk
YELL	<i>Yellowstone</i>	GRYN	Greater Yellowstone	56	210	258	174.67
YOSE	<i>Yosemite</i>	SIEN	Sierra Nevada	108.25	202.5	262.5	191.08
YUHO	Yucca House	SCPN	Southern Colorado Plateau	85.25	152	97	111.42
YUCH	<i>Yukon-Charley Rivers</i>	CAKN	Central Alaska	21	129.5	97	82.50
ZION	<i>Zion</i>	NCPN	Northern Colorado Plateau	45.5	158.5	239	147.67
¹ Park name is printed in bold italic for parks larger than 100 square miles. ² Ranges of rankings were as follows: Pollutant Exposure: 1.0 to 250.0 Ecosystem Sensitivity: 65.3 to 244.0 Park Protection: 97.0 to 262.5 Overall Risk: 69.3 to 211.9							

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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National Park Service
U.S. Department of the Interior



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