APPENDIX D

CONCENTRATIONS OF SELECTED ANALYTES IN RURAL NEW YORK STATE SURFACE SOILS: A SUMMARY REPORT ON THE STATEWIDE RURAL SURFACE SOIL SURVEY

AUGUST 2005

CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

SUMMARY

The statewide Survey to Describe Concentration Ranges for Selected Analytes in Rural New York State Surface Soils ("Rural Soil Survey") was conducted jointly by the New York State Departments of Environmental Conservation (NYS DEC) and Health (NYS DOH). The objective of the study was to define analyte concentration ranges in rural surface soils from points of human contact with soil and from habitat areas.

Rural properties (*n* = 125) were randomly selected for sampling using a digitized grid map and a random number generator. Field staff collected at least two types of surface soil samples at each property: a "source-distant" sample and a "remote" sample. Source-distant samples were obtained from areas that were reasonable points of human contact with soil, such as yards and trails, but at least five meters distant from potential pollution sources such as trash, roads, driveways or structures. Remote samples were collected from areas that were at least 20 paces (about 15 meters) distant from margins of human activity. At a randomly selected subset of properties, staff also collected a "near source" soil sample near a roadway or driveway. After completion of sampling, NYS DEC staff reviewed field documentation and aerial photographs to identify a subset of remote samples that were collected from habitat areas marginally influenced by human activities.

Soil samples were analyzed for selected volatile organic compounds, semi-volatile organic compounds, organochlorine pesticides, Aroclor mixtures of polychlorinated biphenyls, metals, amenable cyanide and total cyanide using analytical methods commonly employed during contaminated site investigations. Based on the review of laboratory analytical and quality control data it appeared that several organic compounds on the survey's analyte list that were reported in low concentrations (typically less than 100 parts-per-billion) in soil samples may not have actually been present in rural soils. Most of these organic compounds were solvents commonly employed in analytical laboratories, or plasticizers that may leach from plastics used during sampling (plastic trowels) or chemical analysis (*e.g.*, caps, tubing). These compounds were not evaluated during the statistical analysis phase. The remaining data were accepted.

Laboratory analytical data were received for 120 source-distant, 121 remote and 28 near source samples, for a total of 269 samples. The survey protocol called for the avoidance of orchards and characterization of analyte concentrations in habitat areas, so a reduced data set was created by excluding data from four samples collected at known orchards, as well as data from remote areas that were not habitat. The reduced data set contained laboratory analytical data for 118 source-distant, 96 habitat and 28 near source samples, for a total of 242 samples[1]. This report discusses analyses of the reduced data set unless otherwise indicated. The survey findings may be briefly summarized as follows:

Volatile Organic Compounds (VOCs)
Most survey VOCs were rarely if ever detected in rural soil samples. After removal of data points suspected of reflecting laboratory or field contamination, the most frequently detected VOC was *m*/*p*-xylene, which was detected in 8 of 242 samples (3.3%). The highest VOC concentration reported was 79 ppb for the solvent stabilizer 1,4-dioxane in a source-distant soil sample.

Semi-volatile Organic Compounds (SVOCs)

[1] Analytical results were not received for semi-volatile organic compounds in one habitat sample.

Most survey SVOCs were not detected in any rural soil samples, but several polycyclic aromatic hydrocarbons (PAHs) were detected, primarily in near source samples.

Organochlorine Pesticides (OCPs)
Survey OCP residues were detected in 2 of 242 rural soil samples (0.8%). Specifically, one source-distant soil sample contained 4,4-DDD, alpha-chlordane, gamma-chlordane and heptachlor epoxide at concentrations of 10 ppb or less, and another source-distant sample contained Endosulfan I at 15 ppb. No OCPs were detected in rural near source or habitat surface soils.

Aroclor Mixtures of Polychlorinated Biphenyls (Aroclors)
Survey Aroclors were detected in 4 of 242 rural soil samples (1.7%). Specifically, Aroclor 1016 was detected in one source-distant sample at a concentration of 72 ppb, and Aroclor 1260 was detected in one habitat sample and two near source samples at 47, 32 and 20 ppb, respectively.

Elements (Metals)
As expected, all survey metals except antimony, thallium and silver were detected in the majority of rural soil samples, and several metals were detected in all samples.

Cyanide
Neither total nor amenable cyanide was detected in any surface soil sample.

INTRODUCTION

In 2004, the New York State Departments of Environmental Conservation (NYS DEC) and Health (NYS DOH) developed a protocol for a statewide survey to characterize concentrations of selected analytes in rural surface soils. The protocol outlined a process for the random selection of rural properties for sampling and collection of soil samples in areas that were reasonable points of human contact, as well as soil samples from habitat areas.

The public was notified of the survey in the May 19, 2004 Environmental Notice Bulletin, which provided a link to the draft survey protocol and established a 30-day comment period. The agencies also discussed the survey with stakeholders at public meetings held throughout the State in connection with the new Brownfield Cleanup Program.

During the public comment period, the agencies received a number of verbal and written comments, many of which are addressed in this report.

The draft survey protocol indicated that surface soil samples would be collected from points of human contact that were at least 20 paces from identifiable sources of soil contamination such as roads or structures. Some reviewers disagreed with this restriction, which excluded surface soils near common sources of diffuse pollution (*e.g.*, roads, parking lots or driveways). While near-source analyte concentrations were not the focus of the survey, the survey was augmented to include sampling near rural roads and driveways.

Reviewers of the original survey protocol also noted the potential for naturally elevated concentrations of some metals in some regions. The agencies agreed to provide elemental concentration maps to assist in assessing the potential for regional anomalies. Elemental concentration maps for all frequently detected metals (*i.e.*, all except antimony and thallium) are provided in this report.

Reviewers suggested that soil type should be an important consideration during survey design. Both soil type *and* land use may potentially influence concentrations of analytes. This was an important consideration during survey design and the probabilistic approach to selecting land parcels was intended to ensure representative sampling of rural soil types and rural land uses. Geographical information system (GIS) software was used to match sampling locations to soil orders and suborders, and reasonably representative sampling was confirmed.

Feedback from field staff resulted in two changes to the survey protocol within the first days of soil sampling. The draft survey protocol indicated that source-distant surface soil samples would be collected from points of human contact that were at least 20 paces distant from roads, pavement, structures, outfalls, drainage swales or drip lines. Early in the implementation phase of the survey, the human contact and distance requirements for source-distant samples proved incompatible, and the minimum distance from sources was reduced to 10 meters or, if that was not possible, the greatest distance that could be obtained without leaving a property. Ultimately, a minimum distance of five meters from any potential pollution source was obtained for source-distant samples, with most samples collected at least 10 meters from any such source.

The draft survey protocol also indicated that habitat surface soil samples would be collected at least 100 yards distant from the edge of areas of regular human activity such as yards, golf courses, farms, athletic fields, areas of fill, mines, roads, pavement, structures, burn barrels,

outfalls, drainage swales or drip lines, etc. The distance requirement for habitat samples proved difficult to obtain. In an effort to ensure a representative number of habitat soil samples, field staff collected soil from remote areas at least 20 paces (approximately 15 meters) from the edge of areas of regular human activity when possible, or otherwise from areas of limited human activity. These samples were termed "remote" samples. After implementation of the survey, NYS DEC staff reviewed sampling documentation and aerial photographs to identify a subset of 96 "habitat" samples -- remote samples that were collected from habitat areas marginally influenced by human activities.

A. PROJECT DESIGN

The survey was conducted jointly by the New York State Departments of Environmental Conservation (NYS DEC) and Health (NYS DOH). It consisted of four phases: (1) sample site selection, (2) sample collection and transport, (3) laboratory analysis and data reporting, and (4) data analysis.

I. Purpose of the Statewide Survey

The survey was conducted to determine concentration ranges for selected analytes in surface soils of rural New York State. The survey determined ranges for analytes in three types of surface soil samples:

- "Source-Distant" - surface soil samples from areas that were considered reasonable points of human contact, at least five meters from any potential pollution source

- "Remote" - surface soil samples from areas that were at least 20 paces (about 15 meters) distant from margins of regular human activity, unless that distance could not be obtained, in which case remote samples were collected from areas of limited human activity.

- "Near Source" - surface soil samples from areas typically two meters distant from a road or driveway.[2]

All samples were free of readily discernible contamination. After completion of sampling, NYS DEC staff reviewed field documentation and aerial photographs to identify a subset of 96 "habitat" samples -- remote samples that were collected from habitat areas marginally influenced by human activities.

II. Definitions

"Surface soil" was the uppermost five centimeters (for source-distant and near source samples) or 15 centimeters (for remote/habitat samples) of soil immediately below vegetative cover. In the absence of vegetative cover, surface soil was the uppermost five (or 15) centimeters of soil.

"Rural" areas were those so designated by the United States census for the year 2000. The Census Bureau's classification of "rural" consisted of all territory, population, and housing units located outside of urbanized areas (UAs) and urban clusters (UCs). We delineated UA and UC boundaries to encompass densely settled territory, which consisted of:

- core census block groups or blocks that had a population density of at least 1,000 people per square mile, and

- surrounding census blocks that had an overall density of at least 500 people per square mile.

[2] In some cases, near source samples were collected more than two meters (up to about three meters) from a road or driveway.

UAs consisted of contiguous, densely settled census blocks that met minimum population density requirements, along with adjacent densely settled census blocks that together encompassed a population of at least 50,000 people. UCs consisted of contiguous, densely settled census block groups and census blocks that met minimum population density requirements, along with adjacent densely settled census blocks that together encompassed a population of at least 2,500 people, but fewer than 50,000 people.[3] Under certain conditions, less densely settled territory was considered to be part of each UA or UC. UAs and UCs for New York State are listed in Appendix "A."

"Reasonable point of human contact" referred to a place where people have a regular opportunity to contact soil. This included such places as residential yards, farms, and parks (near trails), but excluded such places as swamps, bogs, and paved areas.

"Readily Discernable Contamination" was that which was known or suspected based on current or past site uses, proximity to major pollution sources, or conditions encountered during soil sampling such as the presence of waste, unusual odors, or unusual discoloration.

"Habitat areas marginally influenced by human activities" or "habitat areas" were locations that (1) provided environmental conditions that could sustain plant and animal life and (2) were at least 15 meters distant from the edge of areas of regular human activity such as yards, golf courses, farms, athletic fields, areas of fill, mines, etc.

III. Number of Samples Collected

In selecting source-distant and remote locations to sample, consideration was given to the number required to establish the nature of concentration distributions for individual contaminants, accounting for potential loss of data due to quality control and logistical considerations. The number of near source sampling locations was selected based on the number needed to evaluate differences between concentrations of analytes in near source and paired source-distant samples. A more detailed discussion of sample number determination and statistical power considerations follows.

Source-Distant and Remote Samples. When determining the number of source-distant and remote samples, the agencies considered statistical power and sampling density (samples collected per square-kilometer).

StudySize version 1.0.8 (CreoStat HB, Sweden) was used to generate statistical power curves. Concentration distributions were expected to vary among the many survey analytes and the specifics of those distributions (*e.g.*, means, standard deviations) were uncertain. The agencies therefore took a generic approach when examining the relationship between sample number (*n*) and statistical power. Specifically, the influence of sample *n* on the width of a 95 percent confidence interval around the mean concentration of an anlayte was assessed.[4] The results indicated that the width of a confidence interval around the mean shrinks substantially up to about 100 samples, after which the shrinkage is less pronounced as more samples are added.

---

[3] http://www.census.gov/geo/www/ua/uafedreg031502.pdf accessed in March 2004.

[4] A standard deviation (SD) of 0.3 was assumed, with no mean specified. Although the widths of confidence intervals will depend on the assumed SD, shapes of the power curves are independent of the mean or assumed SD.

This suggests that a survey target of about 125 samples would strike an efficient balance between statistical power and cost considerations.

The sampling density that would be achieved by the proposed survey target of 125 samples was compared to the sampling density achieved by Shacklette and Boerngen[5] in their nationwide survey, which remains a commonly cited source of data on background concentrations of metals in soil.[6] For most metals of interest, Shacklette and Boerngen collected and analyzed 25 soil samples from (mostly) rural fields in New York State. That number of samples corresponds to about one sample per 4,400 square kilometers of rural land. The proposed survey target of 125 samples would achieve a sampling density of about one sample per 900 square kilometers of rural land.

Based on statistical power and sampling density considerations, the agencies set a target of 125 source-distant and 125 remote surface soil samples.

Near Source Samples. Power calculations assumed that near source samples would be matched with source-distant samples, and that Student's paired *t*-test would be used to compare analyte concentrations in near source and source-distant samples. Once again, the agencies took a generic approach when examining the relationship between sample number (*n*) and statistical power. Specifically, the impact of increasing *n* on the magnitude of the mean difference in analyte concentrations that would be statistically significant was assessed.[7] The magnitude of the difference shrinks substantially up to about 25 or 30 samples, after which the shrinkage is less pronounced with added samples. This suggested that a survey target of about 30 near source samples would strike an efficient balance between statistical power and cost considerations.

The agencies recognized that violations of *t*-test distribution assumptions would occur for some survey analytes, possibly leading to the use of distribution-free statistical tests. In general, such tests were expected to be somewhat less powerful than Student's paired *t*-test for differences following a normal distribution, but more appropriate -- and potentially more powerful -- for differences not following a normal distribution.

Based on statistical power considerations, the agencies set a target of 31 near source soil samples.

IV. Sample Site Selection

Determination of Sampling Areas. Geographic information system (GIS) software (MapInfo Professional Version 7.0, MapInfo Corporation, Troy, NY) was used to create a map of New York State indicating areas designated as “rural” by the United States Census Bureau. A grid comprised of one-kilometer square cells, created several years ago for an unrelated GIS project, was laid over the State map such that approximately 125,000 cell centroids fell within the State boundaries, excluding off-shore waters. Each centroid was consecutively numbered

---

[5] Shacklette, H.T., and Boerngen, J.G., 1984, Element concentrations in soils and other surficial materials of the conterminous United States: U.S. Geological Survey Professional Paper 1270, 105 p.

[6] Shacklette and Boerngen did not survey surface soil, but rather subsurface soil collected from about 20 centimeters beneath the ground surface. Although some regional soils have been characterized for some analytes, we do not know of any other representative statewide data on contaminant concentrations in surface soil.

[7] 80 percent power and an alpha of 0.05 were assumed.

beginning in the upper left-hand corner and proceeding from left to right along the first row, and similarly along ensuing rows from top to bottom, until all centroids possessed a unique number.

Randomly selecting 125 sampling areas from among approximately 125,000 cell centroids across the State could have resulted in large land areas (*i.e.*, land areas of more than 50 miles in radius) without sampling sites. In order to decrease the likelihood of creating large gaps during assignment of sampling areas, the State map was divided into five nearly equal regions containing approximately 25,000 cell centroids each. Five regions were chosen because that number allowed for the dispersion of points across the State without excluding any large land areas.

The first three regions began at the westernmost, northernmost and southernmost points in New York State and extended east, south and north (respectively) until approximately 25,000 cell centroids were encompassed. The fourth and fifth regions were created by dividing the remaining land area in half. For each of the five regions, cell centroids were ordered by their unique identifiers from the lowest to the highest, and then renumbered from one to about 25,000, with the maximum depending on the exact size of the region.

For each region, a random number generator was employed to create a list of unique whole numbers ranging from one to the number of centroids in the region. Beginning at the top of the random number list, the first centroid located on accessible rural land was designated as the first sampling area, the second centroid located on accessible rural land was designated the second sampling area, and so on until 25 sampling areas were designated. The total number of designated areas across the State was 25 areas x 5 regions = 125 areas. For each region, a list of five alternative areas was generated using the next five numbers on the region's random number list. When designated sampling areas proved inappropriate, areas from the list of alternatives were selected to achieve the target of 125 soil samples, as summarized below.

Rejected Sampling Areas. There were 25 original sampling areas randomly designated in each of the five regions, along with five randomly designated alternative sites. Four initially designated sampling areas not meeting the survey requirements (two each in the *Northern* and *Western Regions*) were replaced by alternatives as follows:

Northern Region

An initial, randomly selected sampling area was located in a water body in Franklin County. This sampling area was replaced with a randomly selected alternative area in St. Lawrence County.

An initial, randomly selected sampling area was located in a sparsely inhabited region of St. Lawrence County, on land owned by a bankrupt paper manufacturer (Deferiet Paper Company). The paper manufacturer was the sole landowner within a mile of the sampling area and the firm's successor in interest could not be determined. This sampling area was replaced with a randomly selected alternative area in Franklin County.

Western Region

An initial, randomly selected sampling area was located near two inactive hazardous waste disposal sites in Orleans County. This sampling area was replaced with a randomly selected alternative area in Steuben County.

An initial, randomly selected sampling area was located at an inactive hazardous waste disposal site in Cattaraugus County. This sampling area was replaced with a randomly selected alternative area in Cattaraugus County.

After the changes indicated above, a total of 125 sampling areas were designated for collection of matched source-distant and remote surface soil samples. A near source sample was designated at approximately every fourth sampling area, creating a subset of 31 areas where near source samples were to be collected.

Permission to Sample. Names, addresses, and telephone numbers of property owners were obtained using the State's database of real property records and community telephone directories. Verbal permission to collect soil samples was obtained from property owners by telephone prior to entering the field.

When permission to sample could not be obtained from the owner of an originally designated property, the nearest property where permission to sample could be obtained was selected for sampling, provided that it was no more than one mile from the initial sampling point. Some property owners either did not respond to telephone calls or elected not to participate. As a result, staff telephoned 284 property owners before gaining permission to sample at 125 properties.

Determination of Sampling Points. Geographic coordinates and maps indicating designated sampling areas were provided to field staff, who proceeded to the areas and evaluated sampling opportunities. If a designated sampling area could not be accessed by automobile, field staff proceeded as near as possible to the designated area. To characterize a reasonable point of human exposure, staff then sampled the nearest point that was:

- Primarily soil (rather than rock, gravel, peat, etc.)
- Free of unusual odors, discoloration or non-soil materials (like trash)
- If possible, at least 20 paces (about 15 meters) distant from roads, pavement, structures, outfalls, drainage swales or drip lines[8]
- At least one-half mile from an active or inactive industrial facility, waste disposal site, orchard[9], or other major pollution source
- Not in a swamp, bog, wilderness or other area where soil contact is rare
- Otherwise a reasonable point of potential human exposure

[8] The original survey goal of collecting source-distant samples from points of human contact that were at least 20 paces from any sources of contamination was modified to reflect conditions reported by field staff. Staff sometimes could not locate a reasonable point of human contact at a distance of 20 paces from any source, so the required distance was reduced.

[9] Soil at active and former orchards is sometimes contaminated with agricultural chemicals, such as lead arsenate.

A near source sample was also collected at designated locations. The exact sampling location was along an imaginary line extending from the site of the source-distant sample to the nearest roadway or driveway, and approximately two meters from the roadway or driveway.

Remote samples were collected at all properties according to instructions provided by NYS DEC staff. Remote areas were:

- Primarily soil (rather than rock, gravel, peat, etc.)
- Free of unusual odors, discoloration or non-soil materials
- If possible, at least 20 paces (about 15 meters) distant from the edge of areas of regular human activity such as yards, golf courses, farms, athletic fields, areas of fill, mines, roads, pavement, structures, burn barrels, outfalls, drainage swales or drip lines, etc.[10]
- At least one-half mile from an active or inactive industrial facility, waste disposal site, orchard, or other major pollution source
- In areas not inundated by water at the time of the sample collection

V. Sample Collection and Transport

Sampling instructions were included in the packet of materials provided to samplers (see Appendix "B").

Samples were collected using clean plastic or stainless steel trowels to fill glass bottles with soil. Stainless steel trowels were only used on rare occasions when the ground was too hard for plastic trowels. Rocks and large soil fragments were excluded.

Soil samples were collected from the uppermost five centimeters (for source-distant and near source samples) or 15 centimeters (for remote samples) of soil immediately below vegetative cover. In the absence of vegetative cover, surface soil was the uppermost five (or 15) centimeters of soil.

In most cases, the location of each sample was logged in a manner that provided enough information to geocode the sampling point in a geographic information system. In some cases, this information was not available and the sampler designated the sampling location using aerial photographs overlain onto a GIS map. Sometimes sampling locations were determined from samplers' field notes, which included descriptions of the immediate area including roads, trails, structures, litter, waterways and prominent land features if present. In many cases the sampling area was also photo-documented and descriptions of each photograph were recorded.

Transportation and Chain of Custody. At each location, separate soil samples were collected for each laboratory analysis as per laboratory requirements and duplicate samples (source-

[10] The original survey goal of collecting samples from habitat areas at least 100 yards from the margin of human activity was modified to reflect conditions reported by field staff. Staff sometimes could not obtain a sample at a distance of 100 yards, so the minimum distance was reduced.

distant and remote/habitat) were collected for archiving. After collection, samples for laboratory analysis were chilled and mailed to a designated DEC contract laboratory for analysis. Archive samples were sent to the Wadsworth Center in Albany, New York, where they are being held pending further analyses.[11] Field staff followed normal chain of custody procedures and a chain of custody form accompanied samples.

Sampling Personnel. Field work was performed by agency staff familiar with environmental sampling.

VI. Laboratory Analysis and Data Reporting

Chemtech Environmental, Inc. of Mountainside, New Jersey, a NYS DEC contract laboratory accredited for all relevant analyses by the NYS DOH Environmental Laboratory Approval Program (ELAP), analyzed the soil samples. Chemtech provided NYS DEC Analytical Services Protocol (ASP) deliverables including data validation packages that were further reviewed by NYS DEC staff with expertise in the field of analytical chemistry.

Survey analytes were those found on target compound and target analyte lists for laboratory analytical methods routinely applied at contaminated sites, as follows:

- Volatile Target Compound List [US EPA Method 8260B]
- Semivolatile Target Compound List [US EPA Method 8270C]
- Pesticides/Aroclors (PCBs) - Target Compound List [US EPA Methods 8081A and 8082]
- Target Analyte List metals [US EPA Method 6010B (metals except Hg) and US EPA Method 7471A (Hg)]
- Total and amenable cyanide [US EPA Method 9012A]

Each list is attached to this document (see Appendix “C”). All concentration data were reported on an analyte weight per dry soil weight basis. Organic analyte concentrations were reported in micrograms per kilogram (parts-per-billion or "ppb"). Inorganic analyte concentrations were reported in micrograms per gram (parts-per-million or "ppm").

Detection and reporting limits were those specified by the methods and were consistent with limits achieved during investigations of contaminated sites.

Quality Assurance/Quality Control. Some surface soil samples were analyzed in duplicate or spiked to assess precision and bias. Surrogates were employed as required to confirm adequate recovery.

Organic and inorganic analyses included one field duplicate sample analysis for approximately every 10 samples collected. Laboratory analytical results from field duplicate samples were only used for comparisons with results from primary samples. The purpose of these comparisons was to quantify the combined geospatial/laboratory analytical variability encountered.

[11] No determinations have been made regarding laboratory analyses of archived soil samples.

Chemtech performed initial reviews of laboratory data quality before data reports were issued to the NYS DEC. NYS DEC staff then performed an independent data validation review.

VII. Assignment of Soil Order and Suborder

Concentrations of analytes in soils may be influenced by anthropogenic and natural factors. One of the more important natural factors is soil type. For example, clay minerals sometimes concentrate trace elements (Jiang *et al*., 2005), and background concentrations of elements in surface soils can vary greatly based on soil order and suborder (Chen *et al*., 2002). The rural survey sampling locations were evaluated to confirm that a representative subset of rural soil types were sampled.

Soil types may be defined in a number of ways. The rural soil survey employed the soil scheme used by the United States Department of Agriculture. Soil order is the highest category in the USDA soil taxonomy, distinguishing soils in relation to the five soil-forming factors (climate, organisms, parent material, time and relief).

A map of USDA soil orders and soil suborders was created using MapInfo Professional Version 7.0 (MapInfo Corporation, Troy, NY), employing data from the State Soil Geographic (STATSGO) database for New York State. This map was used to generate a summary table allowing the agencies to confirm representative sampling of soil orders.

B. DATA ANALYSIS METHODS

I. ASSESSMENT OF DATA QUALITY

Laboratory analytical packages were reviewed by the contract laboratory and NYS DEC Division of Remediation staff to identify data quality concerns. Data qualifiers were evaluated and results from dilution re-analyses of samples were substituted for initial results that were outside of the instrument calibration range. Blank contamination was noted and assessed for data quality implications.

The contract laboratory assigned a number of qualifiers based on its reviews, including “J” qualifiers indicating estimated concentrations and, very rarely, “E” qualifiers indicating concentrations outside the calibration range. Estimated concentrations were accepted as detected values for purposes of constructing data bases. When "E" qualifiers were encountered, the results of follow-up analyses were substituted for the original qualified values.

Field sampling notes, photo-documentation and aerial photographs were reviewed and samplers were interviewed to confirm conformance with the survey protocol.

Differences in analyte concentrations between primary and field duplicate samples were evaluated using SAS (SAS Institute Inc., Cary, N.C.). Relative percentage differences (RPD) between analyte concentrations in sample pairs were computed as $RPD = [2(x1 – x2)/(x1 + x2)]100\%$. Mean RPDs for anlaytes were also calculated. Only analytes detected in at least 10 percent of rural soil samples were considered during RPD assessments.

II. DISTRIBUTION OF SAMPLING LOCATIONS

Sampling locations were plotted using a GIS (MapInfo) to generate maps illustrating the survey’s spatial coverage. GIS was employed to generate a table indicating the number of samples collected in each county.

III. DESCRIPTIVE STATISTICS

A. Analytes Not Detected. For each data set (source-distant, habitat and near source), analytes not detected in any sample were listed and their method detection limits were summarized using minima and maxima. These analytes were not considered further.

B. Detected Analytes. For each data set (source-distant, habitat and near source), concentration distributions for all analytes detected in at least one sample were summarized using percentiles calculated employing the empirical distribution function with averaging, which is the SAS default for determining percentile values. Data filling techniques were sometimes required to address “non-detects” (*i.e.*, analyte concentrations below MDLs). Such data were converted to the MDL prior to calculating percentiles, and "less than" signs were inserted into percentile tables to indicate when analytes were not detected. Percentiles that are MDL values merely reflect the distribution of MDLs and do not necessarily reflect distributions of analyte concentrations.

The geospatial distributions of metals that were detected in the majority of rural soil samples were illustrated by plotting sampling points on maps. The size of each point corresponded to the magnitude of the concentration value reported.

C. RESULTS

I. ASSESSMENT OF DATA QUALITY

Analytes Not Considered. The laboratory analytical data were validated by the contract laboratory and were further reviewed by NYS DEC staff with expertise in the field of analytical chemistry. Based on issues identified during the review of laboratory analytical and quality control data, as well as staff experience at contaminated sites, the following organic chemicals were present, or may have been present, in one or more rural surface soil samples solely or in part due to laboratory or field contamination of soil samples: acetone, chloroform, 2-butanone, dibutyl-n-phthalate, ethanol, methylene chloride, phenol, 1,2,4-trichlorobenzene, cyclohexane, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, tetrachloroethylene and trichlorofluoromethane.

Most of these are solvents commonly employed in analytical laboratories and plasticizers that may leach from plastics used during sampling (plastic trowels) or chemical analysis (caps, tubing). These chemicals were not evaluated during the statistical analysis phase. In addition, two toluene observations were removed due to apparent laboratory contamination. The remaining data were deemed suitable for the intended purposes of the survey.

Missing Values. One near source sample was not collected. In addition, analytical results were not received for five source-distant, four habitat, and two near source samples that were collected (see Table 1). These factors reduced sample numbers to 120 source-distant, 28 near source, and 121 habitat samples. Analytical results were not received for semi-volatile organic compounds in one habitat sample. Delta-BHC results were only reported for 39 source-distant, 10 near source and 62 habitat samples.

Protocol Adherence. A review of aerial photographs of sampling areas, sampling photo-documentation, and samplers' field notes indicated divergence from the survey protocol at some sampled land parcels (see Table 1). Owners of two rural properties reported that the properties were formerly orchards. Laboratory analytical data for samples collected on these properties were not used because the survey protocol prohibited sampling at known orchards.

Although the original survey protocol called for remote/habitat samples to be collected at least 100 yards distant from the margin of human activity, practical constraints during sampling resulted in a reduction of the minimum distance to 20 paces (about 15 meters). Remote/habitat samples were collected at all properties, but later reviews of collection photographs, field notes and aerial photography indicated that 25 properties did not include habitat areas conforming to even the modified survey protocol (see Table 1 and Appendix D). The 25 remote samples collected laboratory analytical data for 25 remote samples that did not conform to the modified protocol were not considered during the data analysis.

Several properties were not large or diverse enough to allow for the originally required distance of 20 paces (about 15 meters) between the source-distant soil sample and the nearest road or driveway. Field staff advised survey staff of the problem within one day of commencing sampling efforts. The absence of acceptable sampling locations suggested a need for greater flexibility in the definition of suitable soils. The protocol was therefore modified and survey staff were allowed to collect source-distant samples as near as five meters from a potential source. However, the original requirement of 20 paces was achieved at the majority of properties.

One rural property was sampled despite the presence of an inactive hazardous waste disposal site about one-quarter mile away. Laboratory analytical data for the soil samples collected on that property were retained for purposes of background determinations because site investigations established a low potential for off-site migration of site contaminants. A review of analyte concentrations in the sample supported this judgement, identifying no unusual patterns.

In summary, removal of data for samples collected at locations inconsistent with the survey protocol reduced the number of source-distant samples collected to 118. A similar analysis performed on the habitat sampling locations reduced that data set to 96 samples.

Field Duplicate Samples. Field quality control information, which consisted of field duplicate samples, was reviewed. There were 24 pairs of field duplicate samples collected and analyzed in the study. These included 11 source-distant pairs, 3 near source pairs and 10 habitat pairs. The 24 pairs of field duplicate samples represent an approximate 1:10 frequency of soil sample duplication for the planned survey. Field duplicate samples were analyzed for all survey target analytes, resulting in a total of 4,218 possible RPD comparisons, but many of these comparisons were for analytes that were never or rarely detected in paired samples. Analysis of field duplicates included the calculation of relative percent differences (RPDs) and these results are provided in Table 3 for selected PAHs and metals (those that had over 60 percent detected values in any data set). We established a screening criterion of +/- 50 percent RPD for each observation in field duplicate analyses; the reported field duplicate data are evaluated against this criterion.[12]

RPDs were not calculated for pairs in which one or both of the results were below the limit of detection. For the selected PAHs and metals, a total of 18 of the 471 calculated RPDs (4 percent) exceeded the +/- 50 percent criterion: 1 of 24 for aluminum, 2 of 20 for arsenic, 1 of 24 for barium, 2 of 20 for cadmium, 1 of 24 for chromium, 1 of 24 for iron, 2 of 24 for magnesium, 1 of 24 for manganese, 2 of 24 for mercury, 2 of 24 for nickel, 1 of 24 for selenium, and 2 of 16 for sodium.

The largest RPDs were of 100, 93, 90 and 86 percent for selenium, arsenic, cadmium and nickel, respectively.

Based on analytical results for laboratory duplicate analyses, which indicated acceptable precision, some of the larger RPDs appear to have resulted from intrinsic variability in analyte concentrations at some sampling locations.

Representation of Rural Soil Orders. Figure 1 illustrates the geospatial distribution of soil orders in New York State. Of the 12 soil orders, seven are recognized in New York State. These are Alfisols, Entisols, Histosols, Inceptisols, Mollisols, Spodosols and Utilisols. Three soil orders predominate in rural settings: Alfisols, Inceptisols and Spodosols. As the agencies selected sampling locations at random, the three dominant soil orders of rural New York State were sampled approximately in proportion to their prevalence in rural settings (see Table 4).

Elemental concentrations may differ among soil suborders as well, but probabilistic sampling resulted in proportional representation of rural soil suborders.

---

[12] This is more than the conventional criterion of 20 percent used for duplicate samples collected as "split samples" from a well-mixed composite sample. The higher criterion was established to account for increased variability in analyte concentrations due to collection of two discrete (not split) samples.

II. DISTRIBUTION OF SAMPLING LOCATIONS

The final sampling locations are indicated in Figure 2 (for source-distant samples) Figure 3 (for habitat samples) and Figure 4 (for near source samples). The counties where samples were collected are indicated in Table 2.

III. DESCRIPTIVE STATISTICS

Tables 5a,b and c indicate analytes that were not detected in rural soil samples, along with corresponding MDL ranges. Analyte concentration percentiles (quantiles) for each sample type (source-distant, near source and habitat are reported in Tables 6a, b and c. Percentile values preceded with "<" ("less than") are MDLs and do not indicate actual analyte detections. On rare occasions, one or more MDL values for an analyte exceeded an actual detection. In such cases the detected level occupied a lower percentile rank than the MDL and the analyte's maximum value was flagged with an asterisk.

References:

Chen M, Ma LQ & Harris W.G. (2002) Arsenic concentrations in Florida surface soils: influence of soil type and properties. *Soil Sci. Soc. Am. J.* 66:632-640.

Jiang W, Zhang S, Shan X et al. (2005) Adsorption of arsenate on soils. Part 2: Modeling the relationship between adsorption capacity and soil physiochemical properties using 16 Chinese soils. *Environ. Pollution* 138:285-289.

APPENDIX "A"

URBANIZED AREAS AND URBAN CLUSTERS
(Source: Census 2000)

Urbanized Areas

The following Census 2000 urbanized areas are within (or include portions of) New York State:

1. Albany
2. Binghamton
3. Bridgeport—Stamford, CT
4. Buffalo
5. Danbury, CT
6. Elmira
7. Glens Falls
8. Ithaca
9. Kingston
10. Middletown
11. New York—Newark, NJ
12. Poughkeepsie—Newburgh
13. Rochester
14. Saratoga Springs
15. Syracuse
16. Utica

Urban Clusters

The following Census 2000 urban clusters are within (or include portions of) New York State:

1. Akron
2. Albion
3. Alfred
4. Amsterdam
5. Arcade
6. Attica
7. Auburn
8. Avon
9. Batavia
10. Bath
11. Bradford, PA
12. Brocton
13. Caledonia
14. Canajoharie
15. Canandaigua
16. Canton
17. Carthage
18. Catskill
19. Cazenovia
20. Chittenango
21. Churchville
22. Cobleskill
23. Cold Spring
24. Corinth
25. Corning
26. Cortland
27. Coxsackie
28. Dannemora
29. Dansville
30. Dryden
31. Dunkirk—Fredonia
32. Ellenville
33. Geneseo
34. Geneva
35. Gloversville
36. Goshen
37. Gouverneur
38. Gowanda
39. Granville
40. Greenwich
41. Hamilton
42. Hamlin (town)
43. Highland Mills
44. Holley
45. Hoosick Falls
46. Hornell
47. Hudson
48. Ilion—Herkimer
49. Jamestown
50. Lake Placid
51. Le Roy
52. Liberty
53. Lima
54. Little Falls
55. Livonia
56. Lockport
57. Lowville
58. Lyons
59. Malone
60. Massena
61. Mattituck
62. Mechanicville
63. Medina
64. Montgomery—Maybrook
65. Monticello
66. Moravia
67. Mount Morris
68. Newark
69. Newfane
70. New Paltz
71. Norwich
72. Ogdensburg
73. Olean
74. Oneida
75. Oneonta
76. Oswego
77. Owego
78. Pawling
79. Penn Yan
80. Perry
81. Plattsburgh
82. Port Jervis
83. Potsdam
84. Ravena
85. Red Hook
86. Rhinebeck
87. Riverhead
88. Rome
89. Sag Harbor
90. Salamanca
91. Saranac Lake
92. Sayre, PA--Waverly, NY
93. Scottsville
94. Sidney
95. Silver Creek
96. Skaneateles
97. Sodus
98. Southold
99. Springs
100. Springville
101. Ticonderoga (town)
102. Tupper Lake
103. Valatie
104. Walton
105. Walworth (town)
106. Warrensburg
107. Warsaw
108. Warwick
109. Watertown
110. Watkins Glen
111. Weedsport
112. Wellsville
113. Westfield
114. West Hurley
115. Woodridge
116. Wurtsboro

APPENDIX "B"

RURAL BACKGROUND SOIL SURVEY
DETAILED SOIL SAMPLE COLLECTION PROTOCOL

1. Envision a square of sufficient size to fill the jars required. We guess that this may be from 10 x 10 to 25 x 25 inches wide, depending on sampling depth and how many bottles you need to fill.

2. Clear away vegetative cover, if any, from the square.

If collecting only a regular sample with no duplicate, fill:

a. One 8-oz. jar and one 2-oz. jar using soil from various portions of the square

b. One 8-oz. (archive) jar using soil from various portions of the square

If collecting both a regular sample and a duplicate, divide the square into four roughly equal quadrants ...

1	2
3	4

... and fill:

a. One 8-oz. jar and one 2-oz. jar using only soil from quadrants 1 and 4 (this is the regular sample)

b. One 8-oz. jar and one 2-oz. jar using only soil from quadrants 2 and 3 (this is the dupe)

c. One 8-oz. jar using soil from all four quadrants (this is the archival sample)

NOTES

For regular health samples ("source-distant" and "near source"), their archivals, and their duplicates, please scrape to a depth of 2 inches b.g.s.

For habitat samples, their archivals, and their duplicates, please scrape or dig to a depth of 6 inches b.g.s.

Please exclude pebbles, stones and roots to the extent possible.

APPENDIX "C"

Rural Soil Survey Analytes

Rural Soil Survey Target Compound List for Volatiles by USEPA 8260B

COMPOUND	CAS #	COMPOUND	CAS #
Dichlorodifluoromethane	75-71-8	trans-1,2-Dichloropropene	10061-02-6
Chloromethane	74-87-3	1,1,2-Trichloroethane	79-00-5
Bromomethane	74-83-9	Tetrachloroethene	127-18-4
Vinyl chloride	75-01-4	2-Hexanone	591-78-6
Chloroethane	75-00-3	Dibromochloromethane	124-48-1
Trichlorofluormethane	75-69-4	1,2-Dibromoethane	106-93-4
1,1-Dichloroethene	75-35-4	Chlorobenzene	108-90-7
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	Ethylbenzene	100-41-4
Acetone	67-64-1	m-Xylene	108-38-3
Carbon disulfide	75-15-0	o-Xylene	95-47-6
Methyl acetate	79-20-9	p-Xylene	106-42-3
Methylene chloride	75-09-2	Naphthalene	91-20-3
trans-1,2-Dichloroethene	156-60-5	Styrene	100-42-5
Methyl-tert-butyl ether	1634-04-4	Bromoform	75-25-2
1,1-Dichloroethane	75-34-3	Isopropylbenzene	98-82-8
cis-1,2-Dichloroethene	156-59-2	1,1,2,2-Tetrachloroethane	79-34-5
2-Butanone	78-93-3	1,3-Dichlorobenzene	541-73-1
Chloroform	67-66-3	1,4-Dichlorobenzene	106-46-7
1,1,1-Trichloroethane	71-55-6	1,2-Dichlorobenzene	95-50-1
Cyclohexane	110-82-7	1,2-Dibromo-3-chloropropane	96-12-8
Carbon tetrachloride	56-23-5	1,2,4-Trichlorobenzene	120-82-1
Benzene	71-43-2	Ethanol	64-17-5
1,2-Dichloroethane	107-06-2	Methanol	67-56-1
Trichloroethene	79-01-6	tert-Butanol	75-65-0
Methylcyclohexane	108-87-2	p-Isopropyltoluene	99-87-6
1,2-Dichloropropane	78-87-5	1,2,4-Trimethylbenzene	95-63-6
Bromochloromethane	75-27-4	1,3,5-Trimethylbenzene	108-67-8
cis-1,3-Dichloropropene	10061-01-5	sec-Butylbenzene	135-98-8
4-Methyl-2-pentanone	108-10-1	tert-Butylbenzene	98-06-6
Toluene	108-88-3	n-Butylbenzene	104-51-8

Rural Soil Survey Target Compound List for Semi-volatiles by USEPA 8270C

COMPOUND	CAS #	COMPOUND	CAS #
Phenol	108-92-2	4-Nitrophenol	100-02-7
bis(2-Chloroethyl)ether	111-44-4	Dibenzofuran	132-64-9
2-Chlorophenol	95-57-8	2,4-Dinitrotoluene	121-14-2
2-Methylphenol	95-48-7	Diethylphthalate	84-66-2
2,2'-oxybis(1-Chloropropane)	108-60-1	4-Chlorophenylphenylether	7005-72-3
4-Methylphenol	106-44-5	Fluorene	86-73-7
N-Nitroso-di-n-propylamine	621-64-7	4-Nitroaniline	100-01-6
Hexachloroethane	67-72-1	4,6-Dinitro-2-methylphenol	534-52-1
Nitrobenzene	98-95-3	N-nitrosodiphenylamine	86-30-6
Isophorone	78-59-1	4-Bromophenylphenylether	101-55-3
2-Nitrophenol	88-75-5	Hexachlorobenzene	118-74-1
2,4-Dimethylphenol	105-67-9	Pentachlorophenol	87-86-5
bis(2-Chloroethoxy)methane	111-91-1	Phenanthrene	85-01-8
2,4-Dichlorophenol	120-83-2	Anthracene	120-12-7
1,2,4-Trichlorobenzene	120-82-1	Carbazole	86-74-8
4-Chloroaniline	106-47-8	Di-n-butylphthalate	84-74-2
Hexachlorobutadiene	87-68-3	Fluoranthene	206-44-0
4-Chloro-3-methylphenol	59-50-7	Pyrene	129-00-0
2-Methylnaphthalene	91-57-6	Butylbenzylphthalate	85-68-7
Hexachlorocyclopentadiene	77-47-4	3,3'-Dichlorobenzidine	91-94-1
2,4,6-Trichlorophenol	88-06-2	Benzo(a)anthracene	56-55-3
2,4,5-Trichlorophenol	95-95-4	Chrysene	218-01-9
2-Chloronaphthalene	91-58-7	bis(2-Ethylhexyl)phthalate	117-81-7
2-Nitroaniline	88-74-7	Di-n-octylphthalate	117-84-0
Dimethyl phthalate	131-11-3	Benzo(b)fluoranthene	205-99-2
Acenaphthylene	208-96-8	Benzo(k)fluoranthene	207-08-9
2.6-Dinitrotoluene	606-20-2	Benzo(a)pyrene	50-32-8
3-Nitroaniline	99-09-2	Indeno(1,2,3-cd)pyrene	193-39-5
Acenapthene	83-32-9	Dibenzo(a,h)anthracene	53-70-3
2,4-Dinitrophenol	51-28-5	Benzo(g,h,i)perylene	191-24-2

Rural Soil Survey Target Compound List for Organochlorine Pesticides by USEPA 8081A

COMPOUND		COMPOUND	CAS #
Aldrin	309-00-2	Dieldrin	60-57-1
alpha-BHC	319-84-6	Endosulfan I	959-98-8
beta-BHC	319-85-7	Endosulfan II	33213-65-9
Lindane	58-89-9	Endosulfan sulfate	1031-07-8
gamma-BHC	319-86-8	Endrin	72-20-8
Chlorobenzilate	510-15-6	Endrin aldehyde	7421-93-4
trans-Chlordane	5103-71-9	Endrin ketone	53494-70-5
cis-Chlordane	5103-74-2	Heptachlor	76-44-8
Chlordane - not otherwise specified	57-74-9	Heptachlor epoxide	1024-57-3
DBCP	96-12-8	Hexachlorobenzene	118-74-1
4,4'-DDD	72-54-8	Hexachlorocyclopentadiene	77-47-4
4,4'-DDE	72-55-9	Isodrin	465-73-6
4,4'-DDT	50-29-3	Methoxychlor	72-43-5
Diallate	2303-16-4	Toxaphene	8801-35-2

Rural Soil Survey Target Compound List for Polychlorinated Biphenyls by USEPA 8082

COMPOUND	CAS #
Aroclor 1016	12674-11-2
Aroclor 1221	11104-28-2
Aroclor 1232	11141-16-5
Aroclor 1242	53469-21-9
Aroclor 1248	12672-29-6
Aroclor 1254	11097-69-1
Aroclor 1260	11096-82-5

Rural Soil Survey Target Analyte List for Total Metals by USEPA 6010B

Aluminum	Lead
Antimony	Magnesium
Arsenic	Manganese
Barium	Nickel
Beryllium	Potassium
Cadmium	Selenium
Calcium	Silver
Chromium	Sodium
Cobalt	Thallium
Copper	Vanadium
Iron	Zinc

Other Analyses:
Total Mercury by USEPA 7471A Cold Vapor Atomic Absorption
Total and Amenable Cyanide by USEPA 9012A

APPENDIX "D"

Habitat Area Sampling Protocol, Quality Review, and Data Analysis

The habitat area sampling protocol described the process for taking a "habitat area" soil sample as part of the ecological component of the New York State *Survey to Describe Concentration Ranges of Selected Analytes in Rural New York State Surface Soils*. This appendix provides the definition of habitat and the sampling protocol as originally proposed, as well as a description of the NYSDEC quality review of the sampling locations and analytical data leading to the selection of a final habitat area data set for establishing rural soil concentrations for habitat areas.

Habitat Area Concept

The ecological component of the survey was designed to measure contaminant concentrations in rural soils that are only marginally influenced by human activity. For purposes of this survey, the concept of habitat is simply a vegetated area which is outside the sphere of regular human activity, is largely undisturbed and provides an area for plants and animals to live, grow, forage, make a nest or burrow etc. A habitat area is a natural landscape rather than a managed one. Therefore, any areas where native soils and vegetation have been significantly altered or disturbed are not considered "only marginally influenced". Likewise, any areas that have been chemically treated or are specifically managed to exclude biota by practices such as pesticide spraying and herbicide treatments are not considered appropriate for habitat area sampling. Examples of natural landscapes include woodlands, meadows, untreated pastureland, fallow fields, streambanks, wetlands, shrubby areas, and successional fields. While agricultural fields may provide habitat, active agricultural fields are not considered appropriate for habitat area sampling due to the alteration of the soil and the use of fertilizers, herbicides and/or pesticides.

Characteristics of a Habitat Area Sample

This sample will contain the uppermost six inches of soil immediately below vegetative cover. In the absence of vegetative cover, the sample will contain the uppermost six inches. An appropriate habitat area sampling location should have the characteristics listed on the attached checklist.

Selecting the Habitat Area Sample Location

After collecting the public health component sample, observe the landscape in the surrounding area to locate the margin of human activity by looking for the transition from the managed to the natural landscape. Select the nearest location that appears to be a habitat area. Proceed to that location and take the sample. While sampling:

1. Please photograph and log the location of the sample in a manner that provides enough information to evaluate the sampling point and geocode the point in a geographic information system.

2. Please also classify the soil as to type, and record a description of the immediate area including roads, trails, structures, litter, waterways and prominent land features.

3. If any information is available on current and past uses of the location, please note.

Habitat Areas Sample Location Review

Habitat area soil samples (n = 125) were collected by the New York State Department of Health (NYSDOH) during the ecological component of the *Survey to Describe Concentration Ranges of Selected Analytes in Rural New York State Surface Soils*. The purpose of these samples was to characterize contaminant concentrations in rural soils from habitat areas in proximity to human use. As shown in the attached checklist, samplers were provided with guidelines on distances to be maintained from points of human activity which were shorter than the 100 yards in the original protocol. On a practical basis, however, and due to the conditions of field sampling, it was not feasible for the samplers to meet even these modified distances in some cases.

In order to ensure that the samples were collected in habitat areas, after the soil samples were collected, and prior to any review of the analytical data, field notes and documentation were reviewed to ensure that all sample locations met the definition of habitat as outlined by the protocol.

Procedure

The location for each human health soil sample was plotted on a map of New York using the GPS coordinates provided by the soil sampler or using the sampler's description of the sample location. The sample locations were overlain on a aerial photograph using Arcview 3.0. Data collection sheets and sampling notes were reviewed to determine where the habitat area sample was taken in relation to the human health soil sample. Each location was then checked to see if the protocol was met by reviewing the data collection sheets, all sampling notes, and the aerial photograph. Unless there was direct evidence to the contrary, it was assumed that the protocol was followed and that all criteria were met. If a sample was taken from a location that did not meet the habitat area protocol, the sample was flagged and the reason(s) recorded (see Summary Report Table 1). In cases where it was unclear whether the location was acceptable due to lack of sufficient documentation, the location was assumed to have met the criteria, but the sample was flagged as requiring further scrutiny during data analysis, and the reason for the uncertainty was recorded.

Results

One hundred and twenty five (125) habitat area soil samples were collected. Analytical data were not received from the laboratory for 4 samples (see Summary Report); the locations of those habitat area samples were not reviewed. Of the remaining 121 samples, 25 were in locations that did not meet the protocol for habitat area sampling (see Summary Report Table 1). Therefore, 96 habitat area soil samples

were retained for analysis as the final habitat area data set. For 11 samples, collection

photographs, sampling notes, or the aerial photograph indicated that the sample was taken from a location of questionable habitat characteristics, however there was no definitive data to indicate that the sample should be removed from the habitat area dataset. These samples were flagged as deserving additional scrutiny during data analysis.

Data Quality Review

Data were received for 24 inorganics, 61 volatile organic compounds (VOCs), 55 semi-
volatile organic compounds (SVOCs), 17 pesticides, and 7 PCB Aroclors. For one sample, data for all SVOCs were missing from the laboratory report. All lab qualified data were retained for analysis. Several analytes were considered lab contaminants and those data were removed from the habitat area dataset. (see Summary Report).

Data Analysis

Descriptive statistics (number of detections, minimum and maximum detection, median, and various percentiles) were calculated for all analytes detected in at least 10% of the samples. For analytes with fewer than 10% detections in this statewide survey, the detection of the analyte was considered too rare an event to legitimately calculate a statewide rural soil background concentration for habitat areas. The final habitat area data set contained 21 inorganics, 1 VOC, and 2 SVOCs with sufficient number of detections for establishing a background value for habitat areas (Table D-1).

Figure 1. Soil orders of New York State.

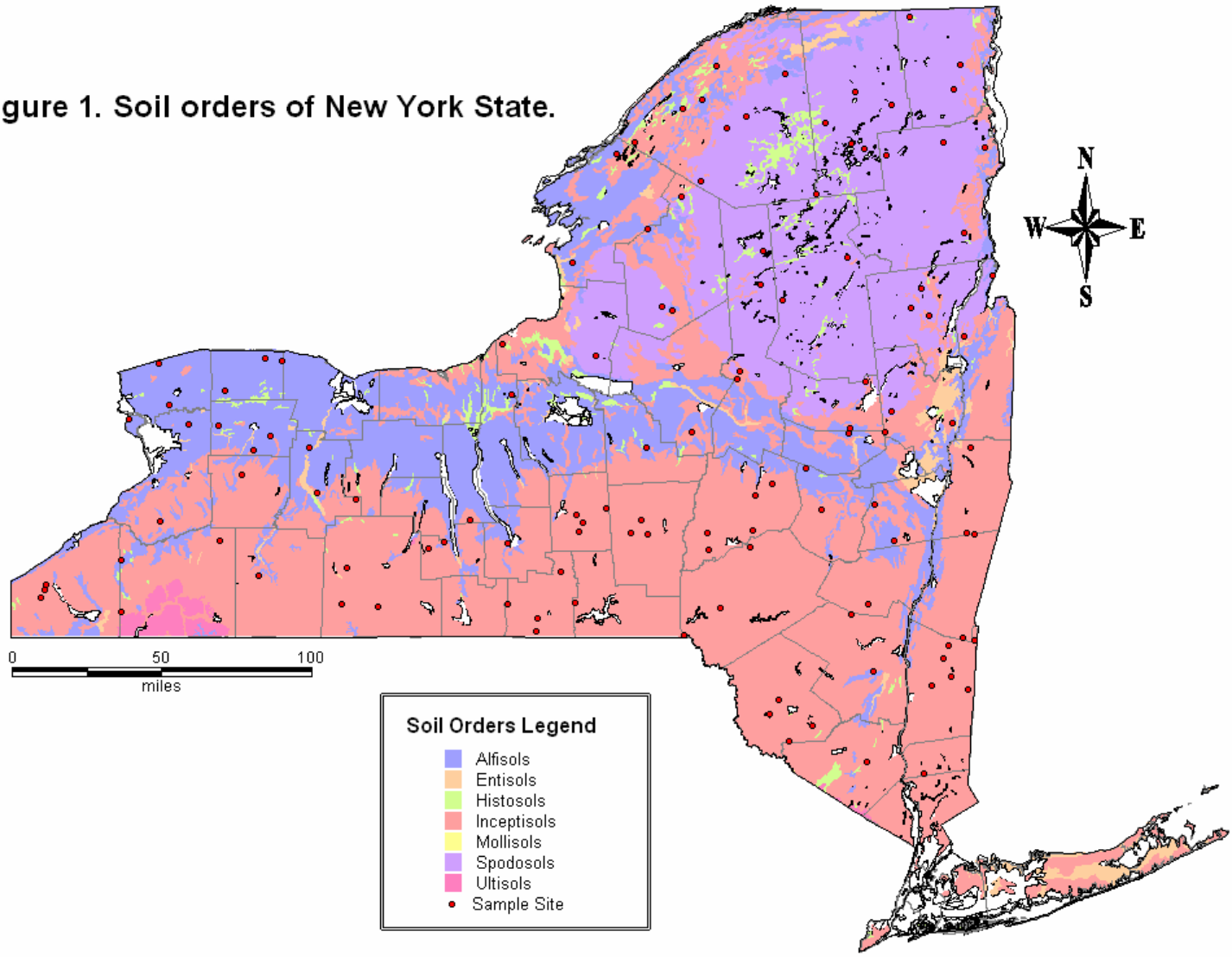

Figure 2. Surface soil sampling locations for source-distant samples.

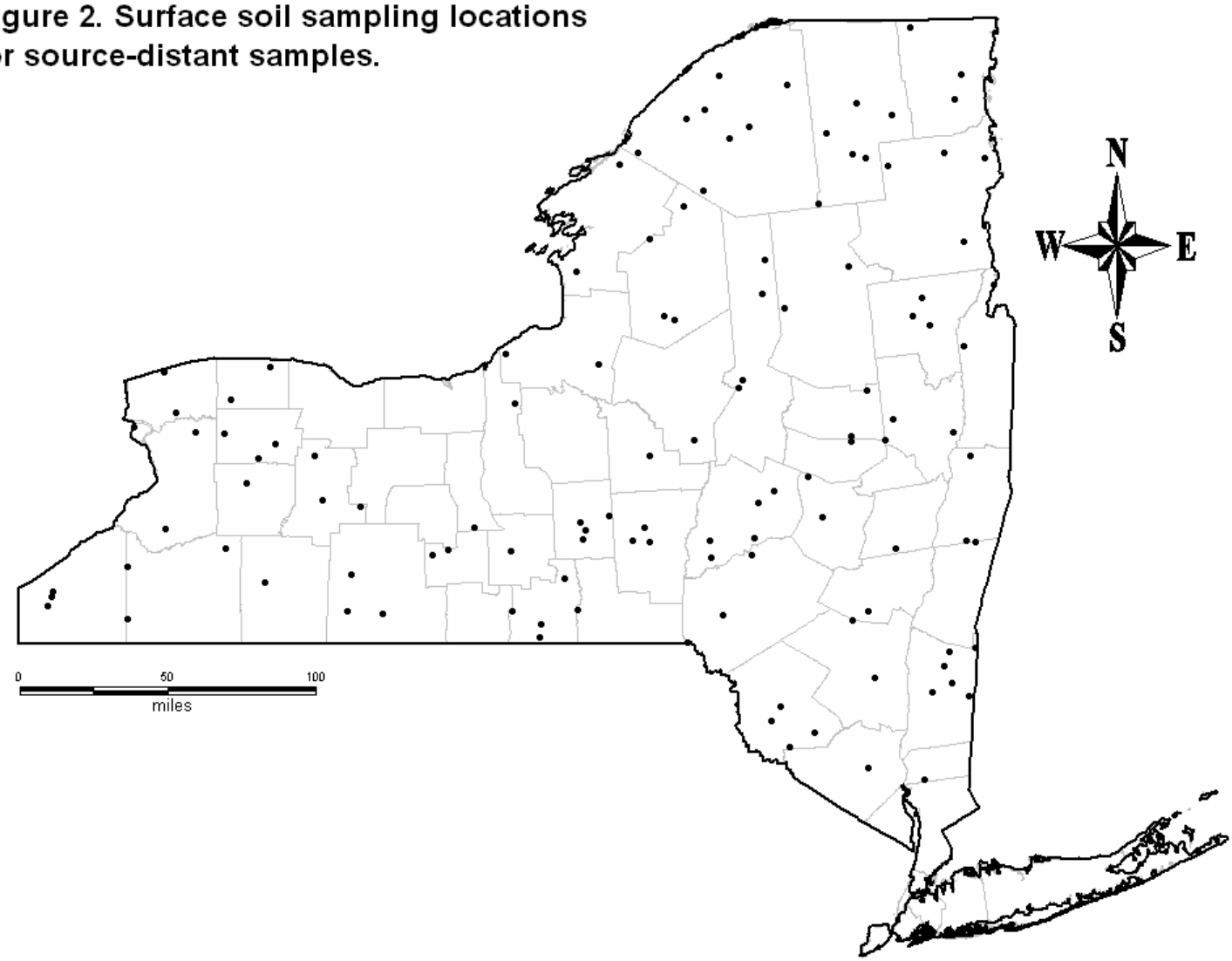

Figure 3. Surface soil sampling locations for habitat area samples.

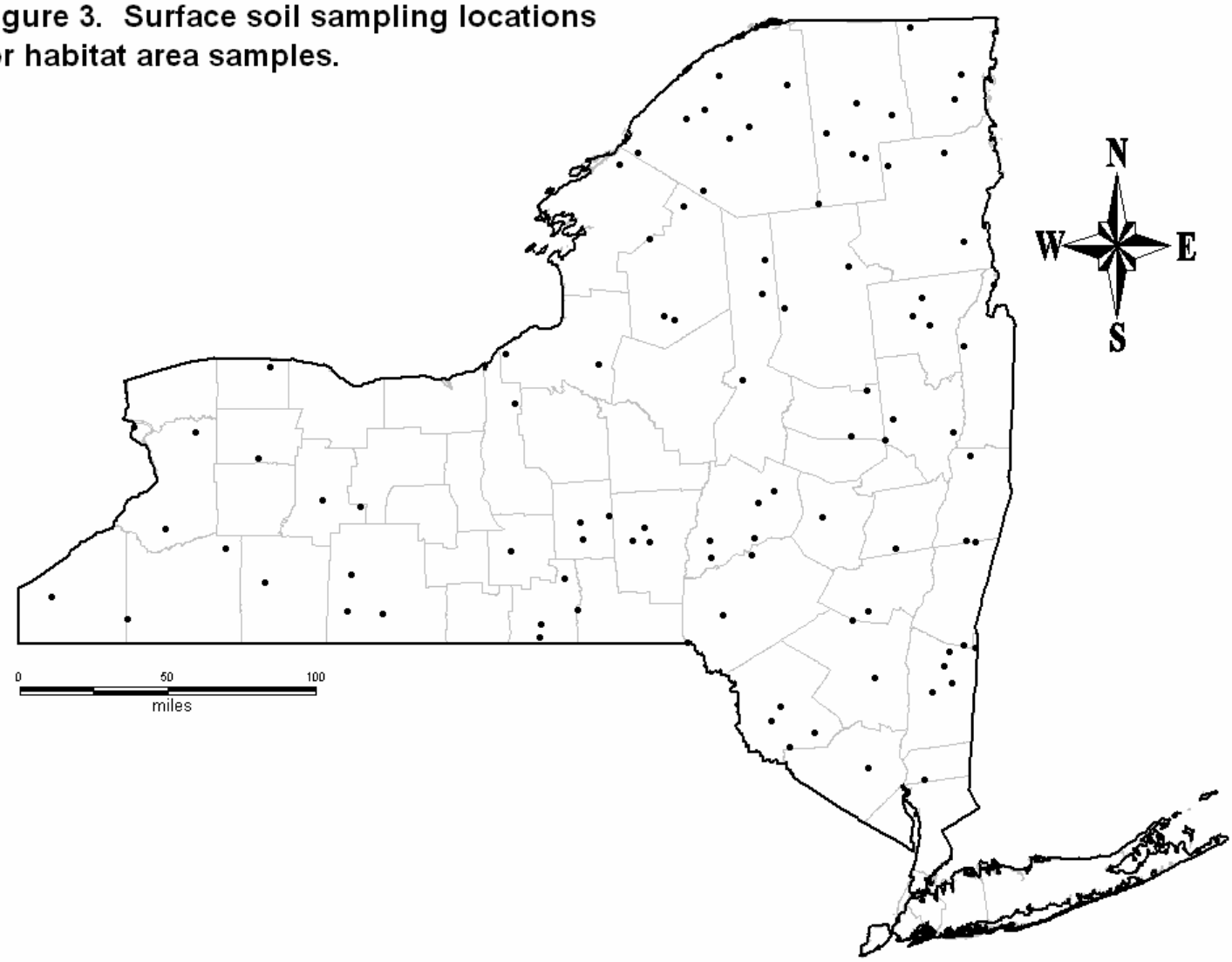

Figure 4. Surface soil sampling locations for near source samples.

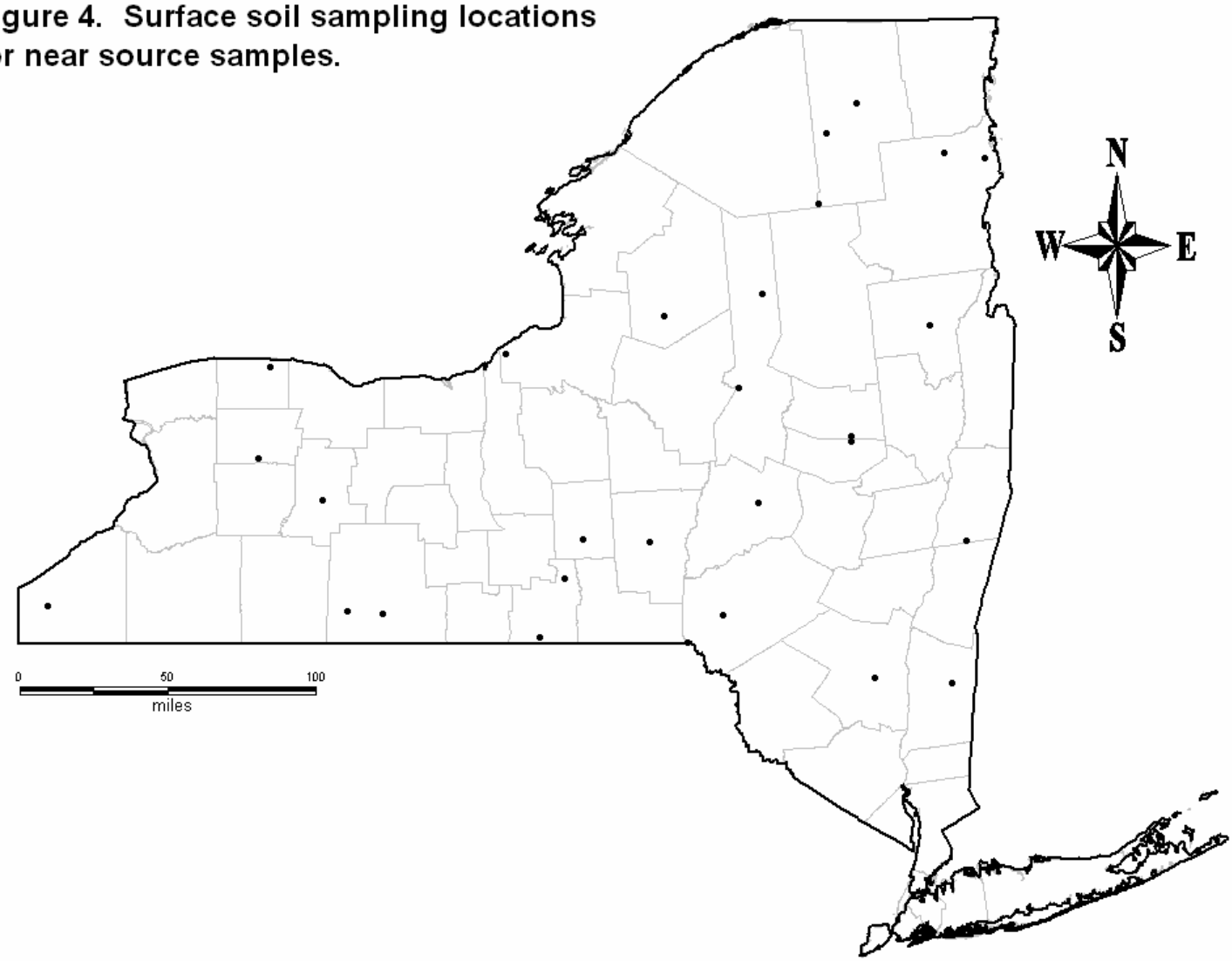

Figure Ag-1. Silver concentrations in rural source-distant surface soil samples.

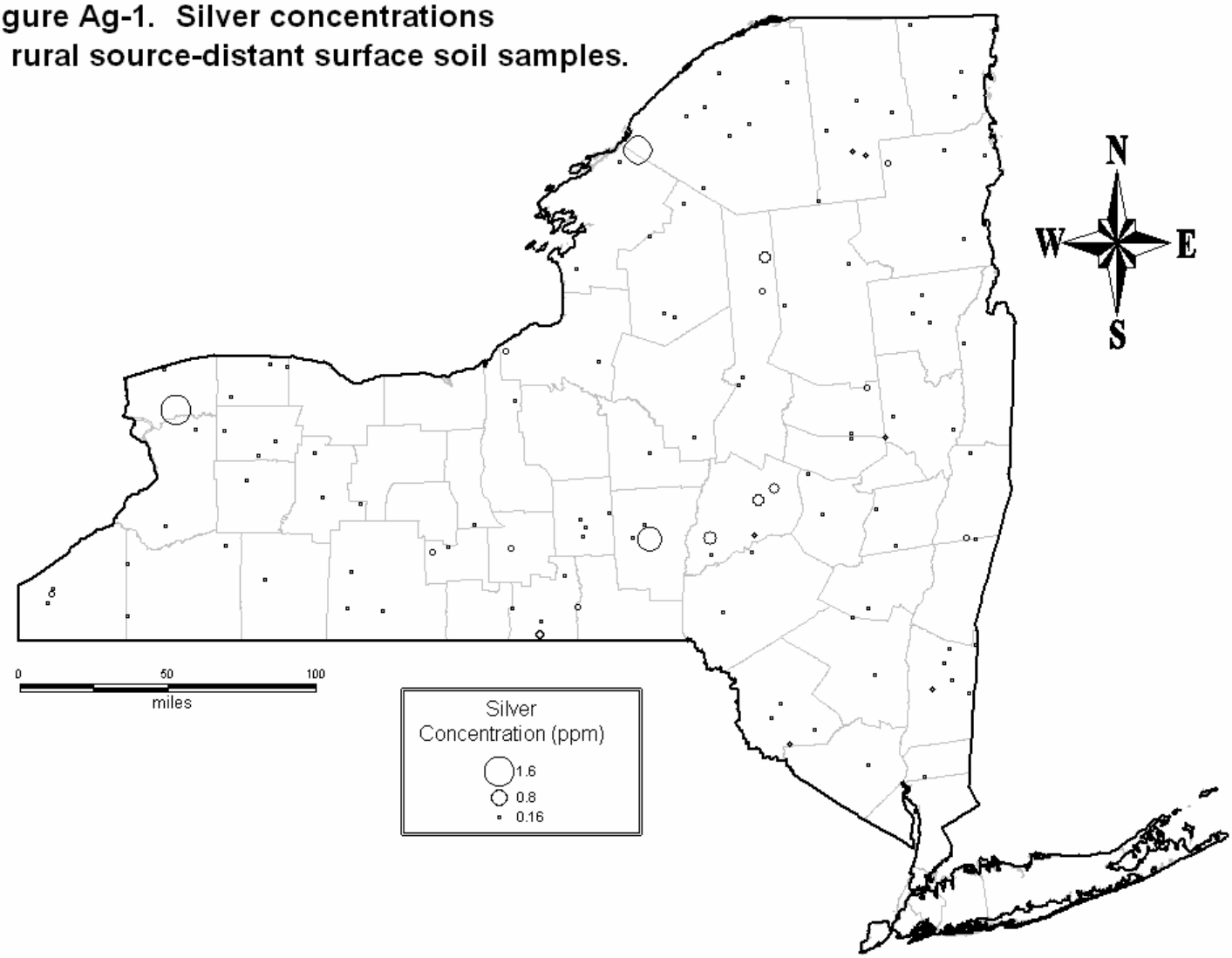

Figure Ag-2. Silver concentrations in rural habitat surface soil samples.

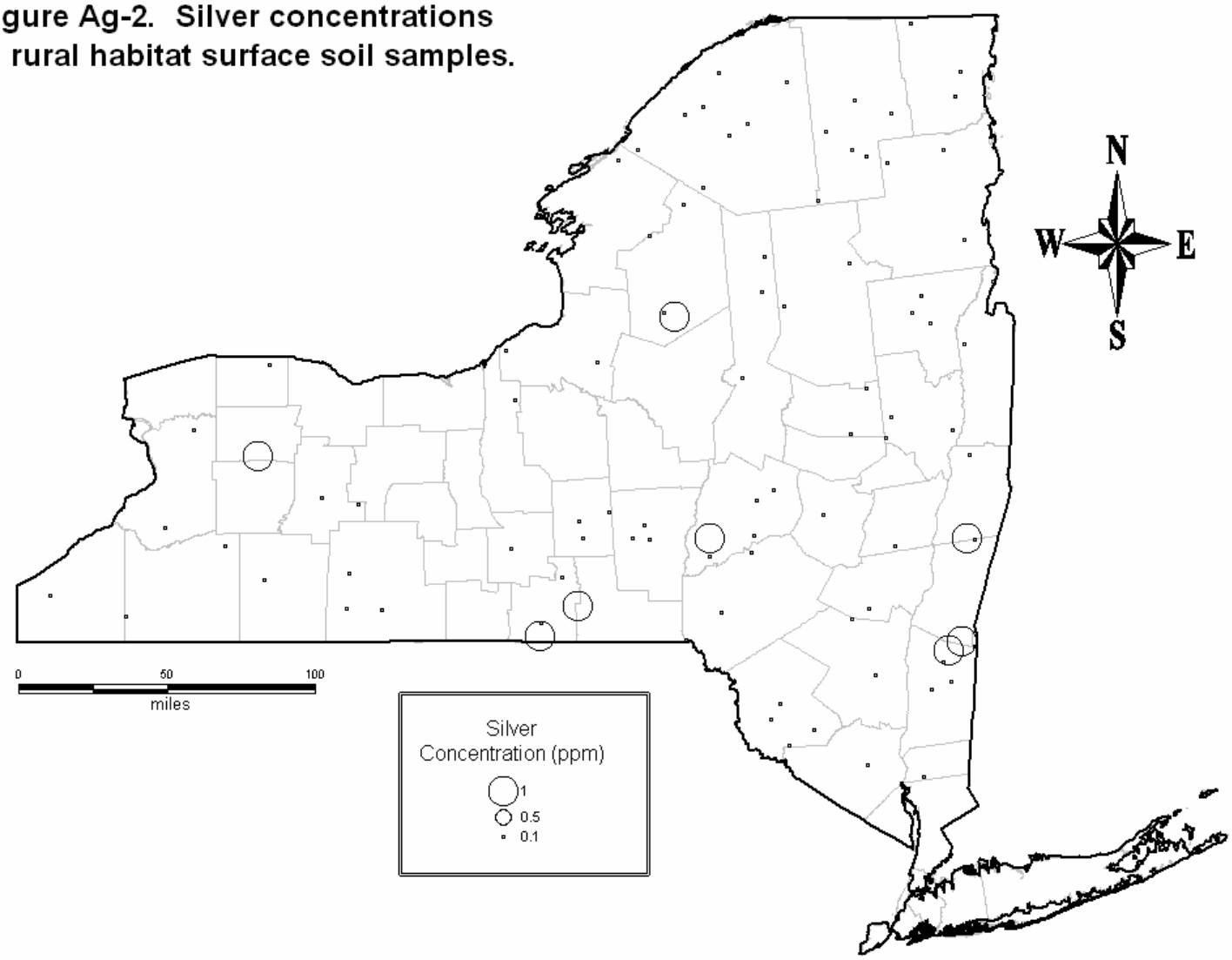

Figure Al-1. Aluminium concentrations in rural source-distant surface soil samples.

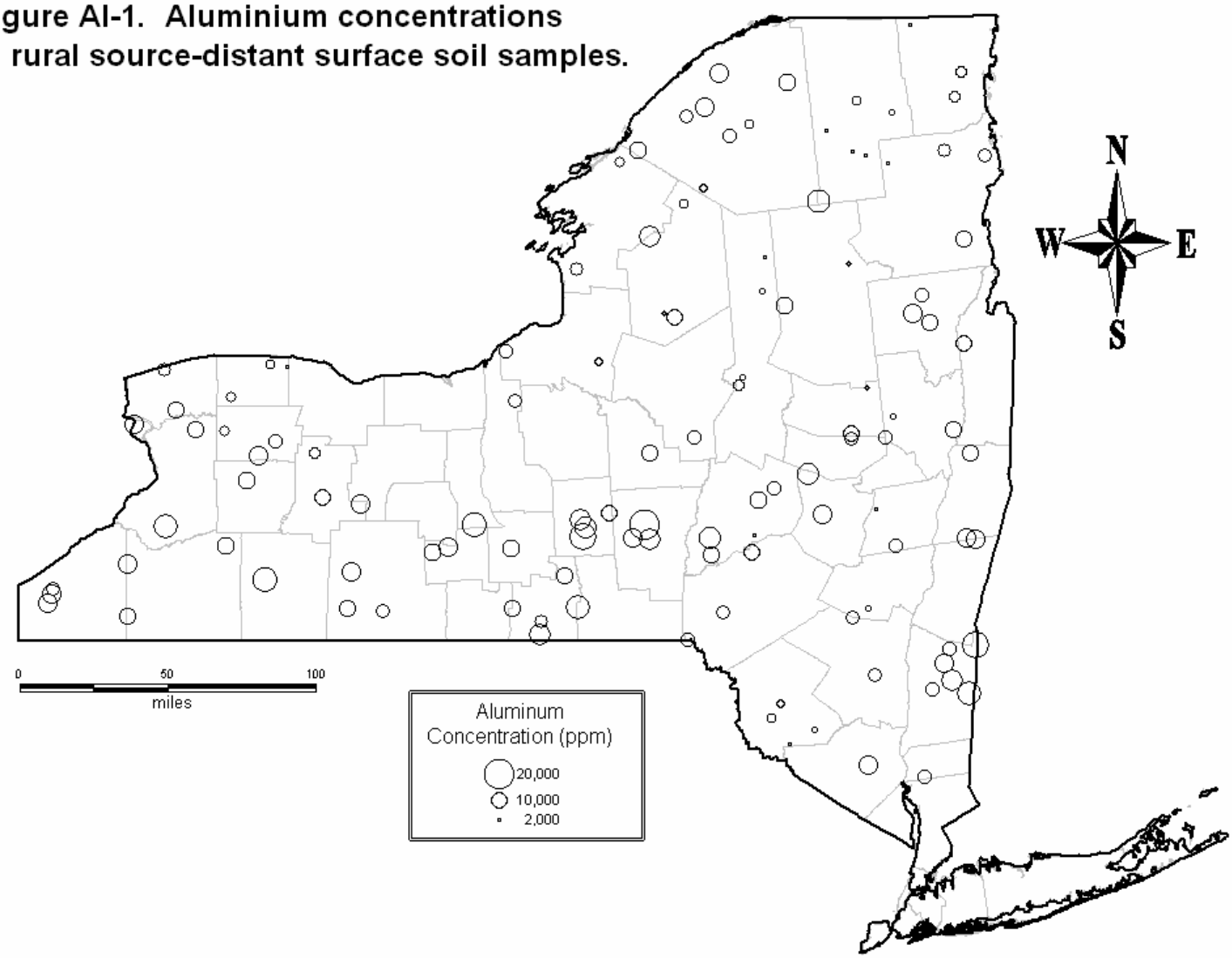

Figure Al-2. Aluminum concentrations in rural habitat surface soil samples.

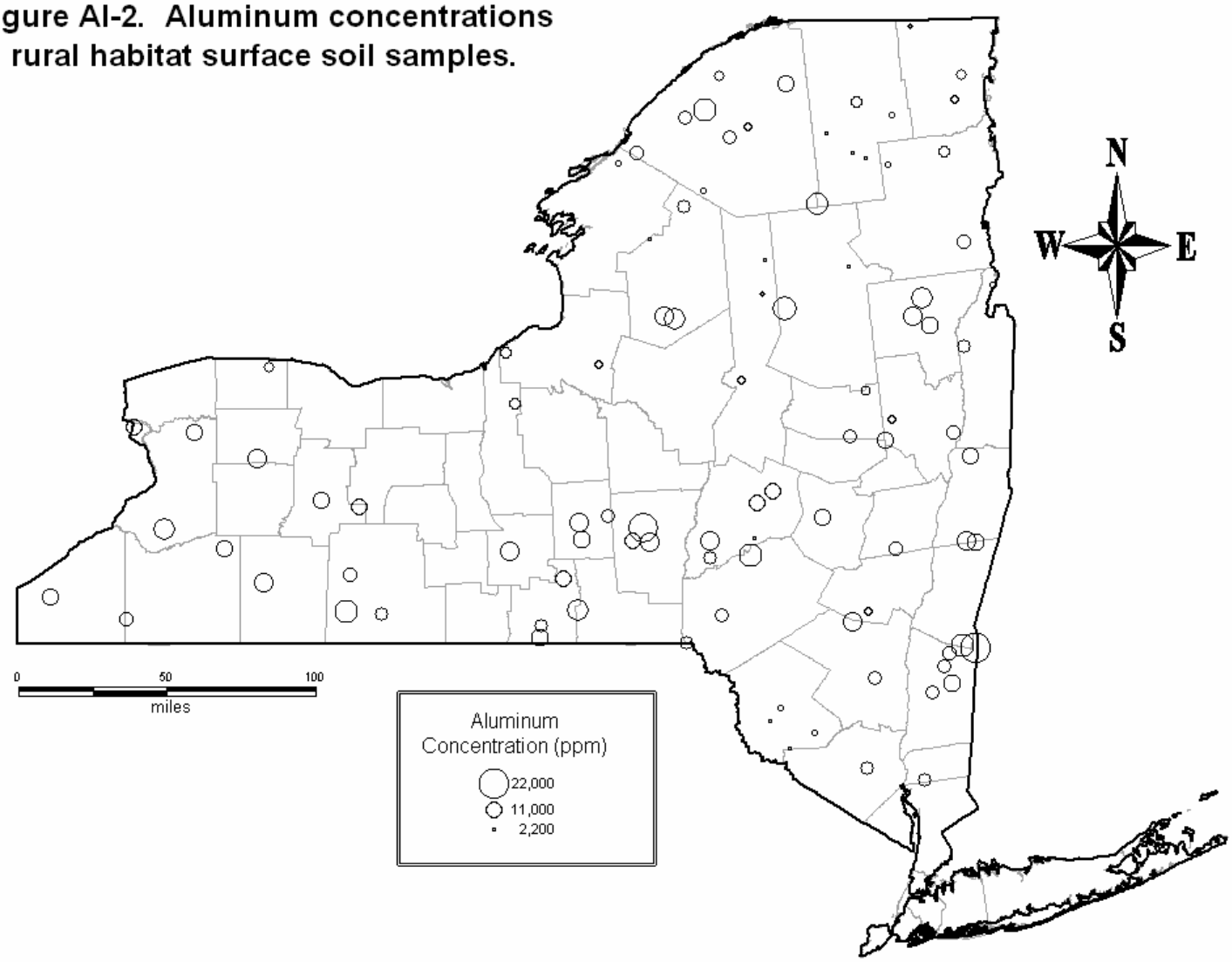

Figure As-1. Arsenic concentrations in rural source-distant surface soil samples.

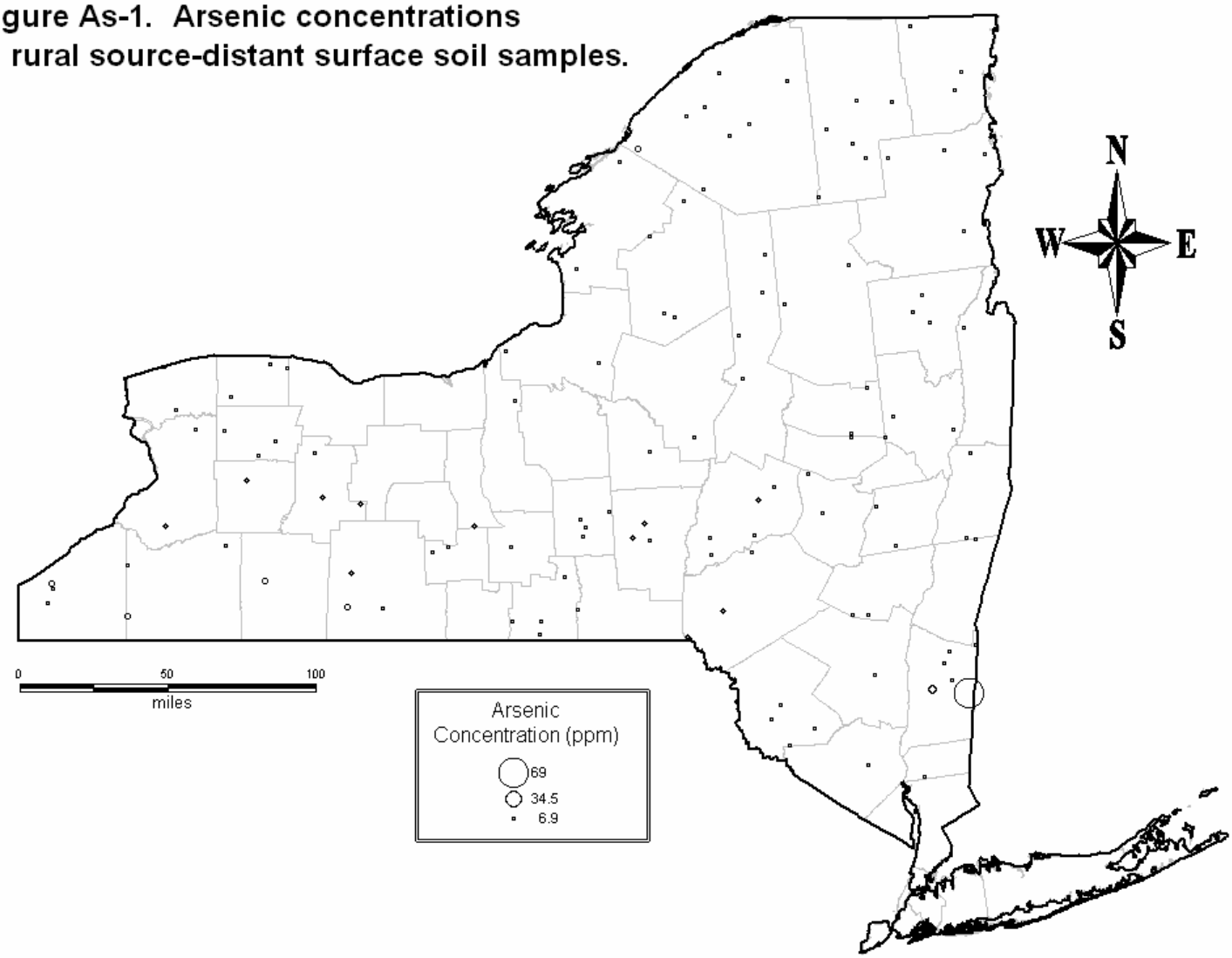

Figure As-2. Arsenic concentrations in rural habitat surface soil samples.

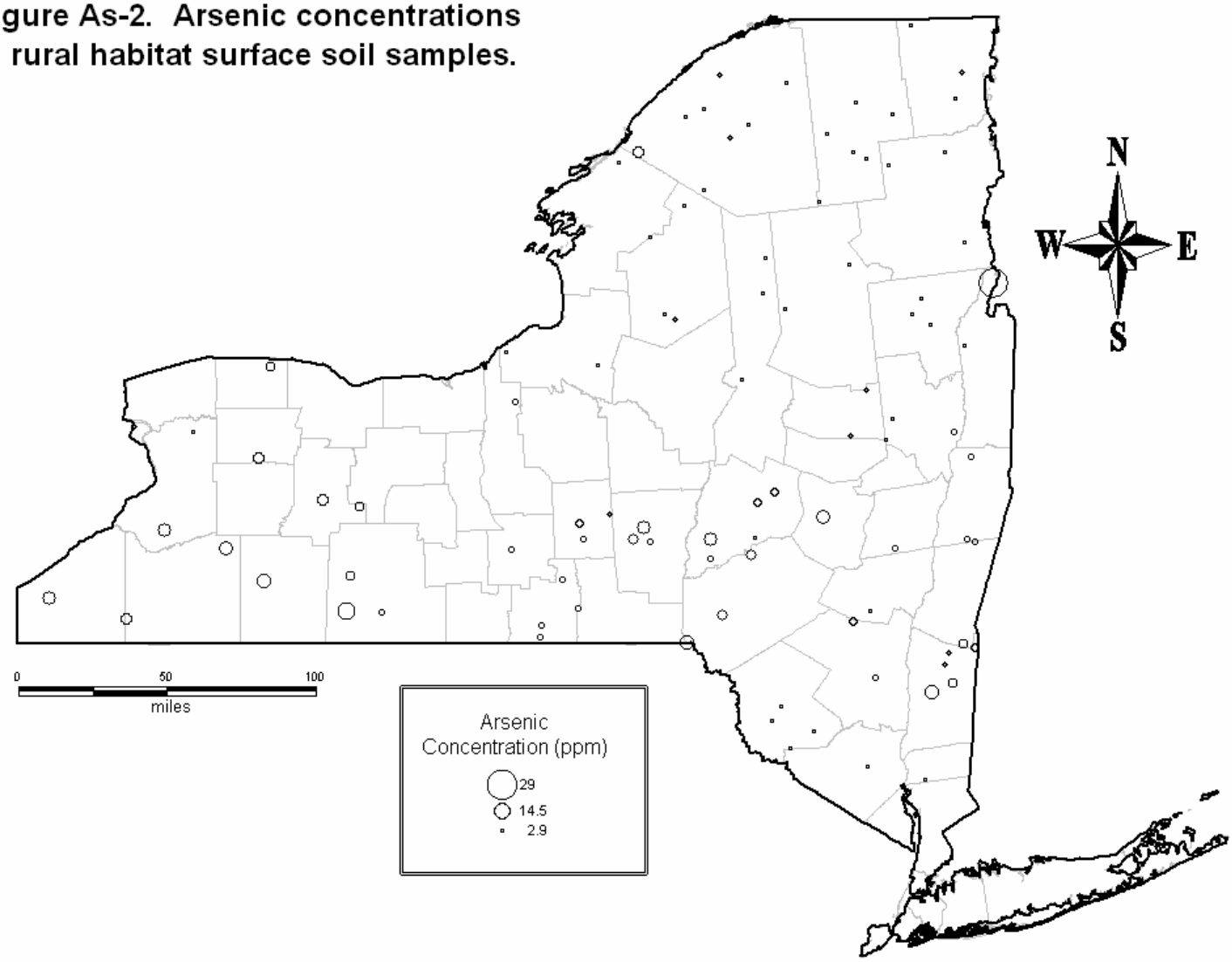

Figure Ba-1. Barium concentrations in rural source-distant surface soil samples.

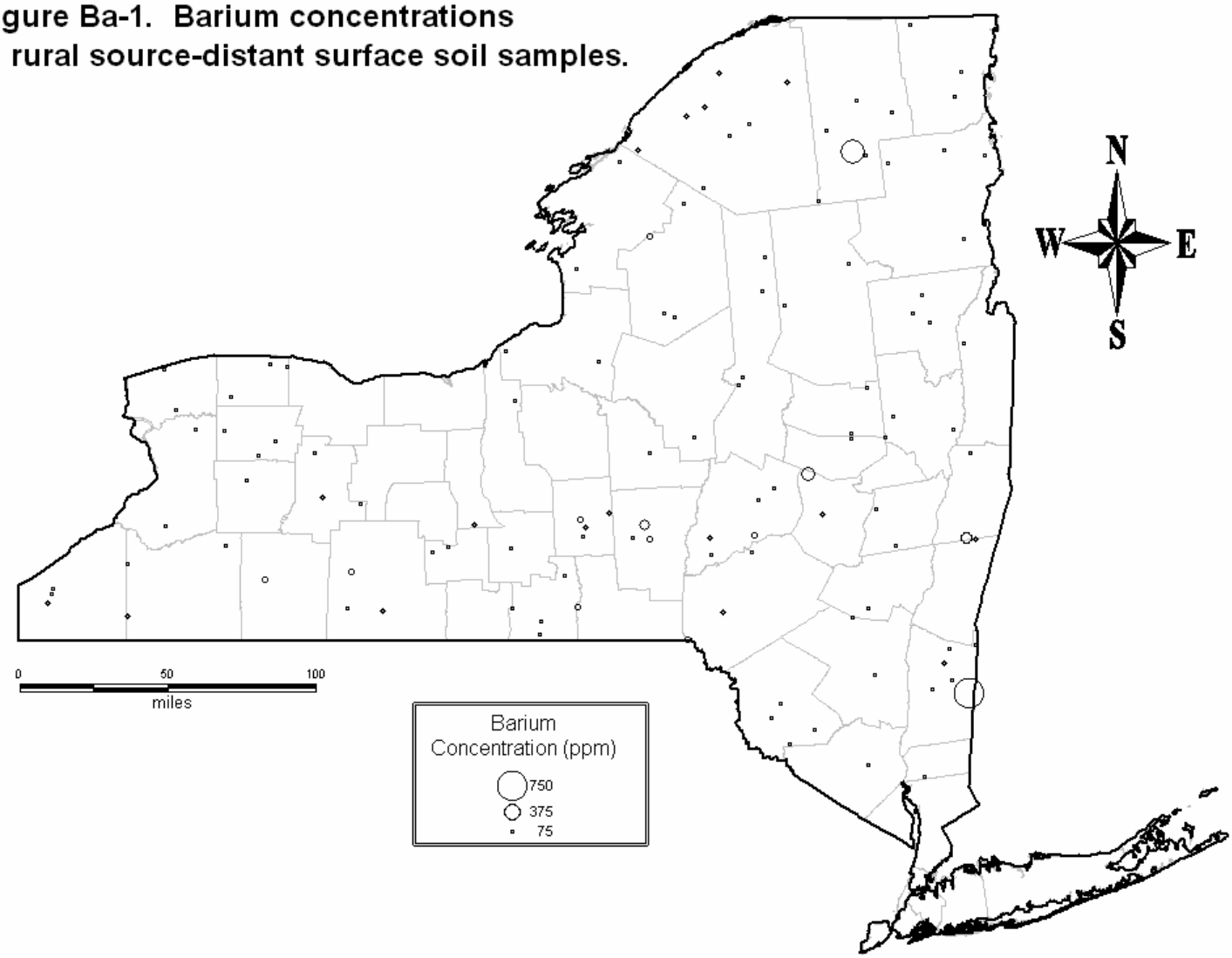

Figure Ba-2. Barium concentrations in rural habitat surface soil samples.

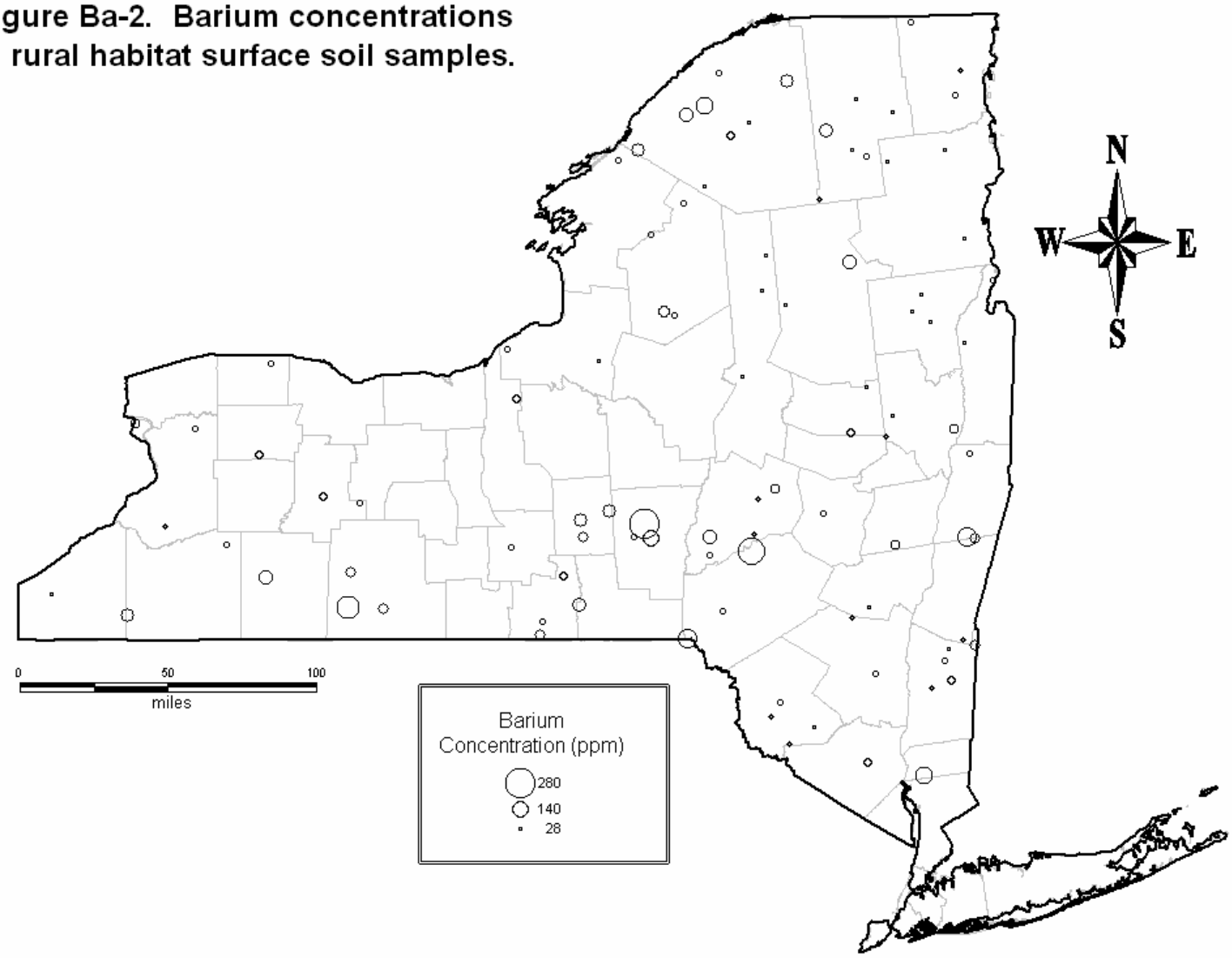

Figure Be-1. Beryllium concentrations in rural source-distant surface soil samples.

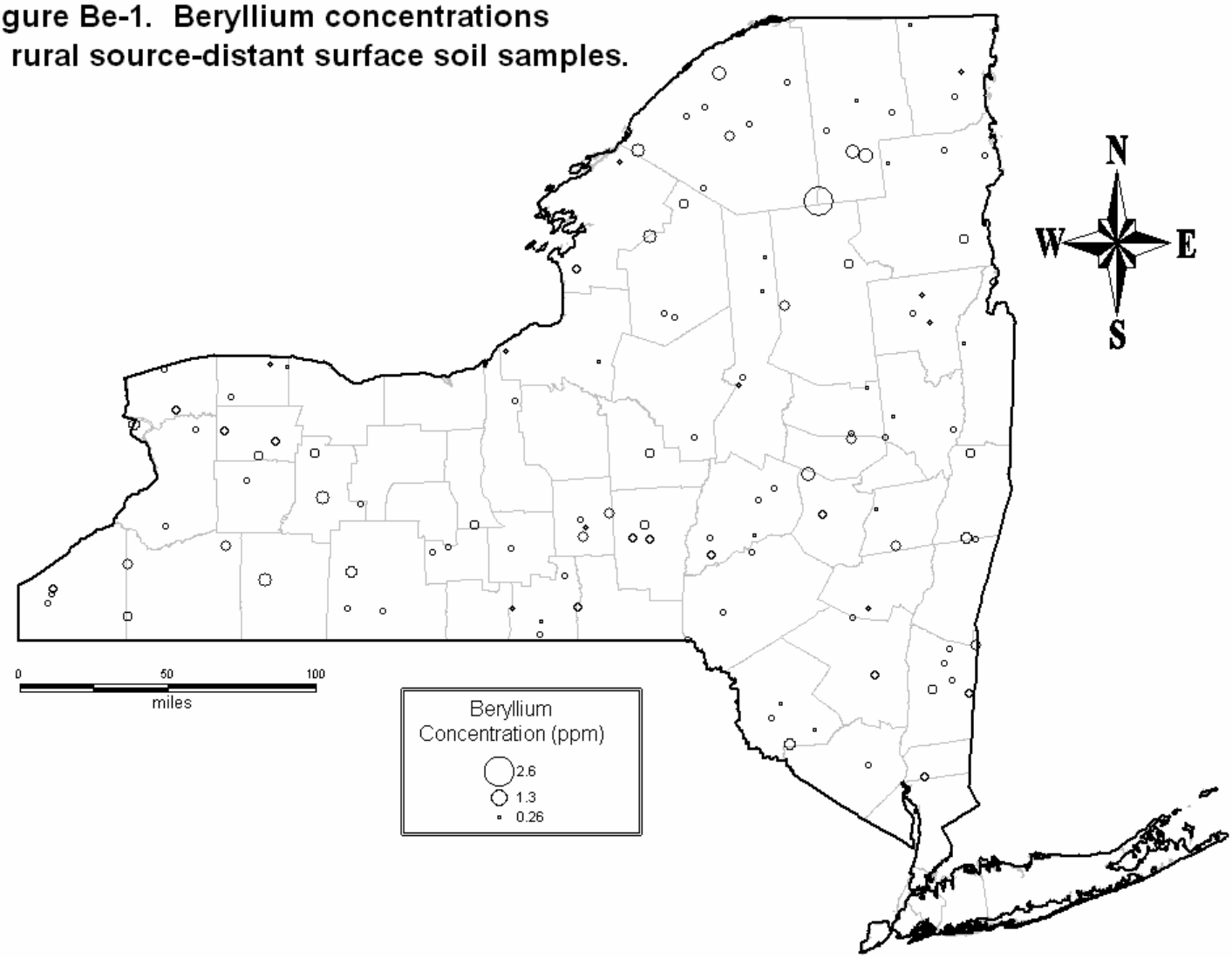

Figure Be-2. Beryllium concentrations in rural habitat surface soil samples.

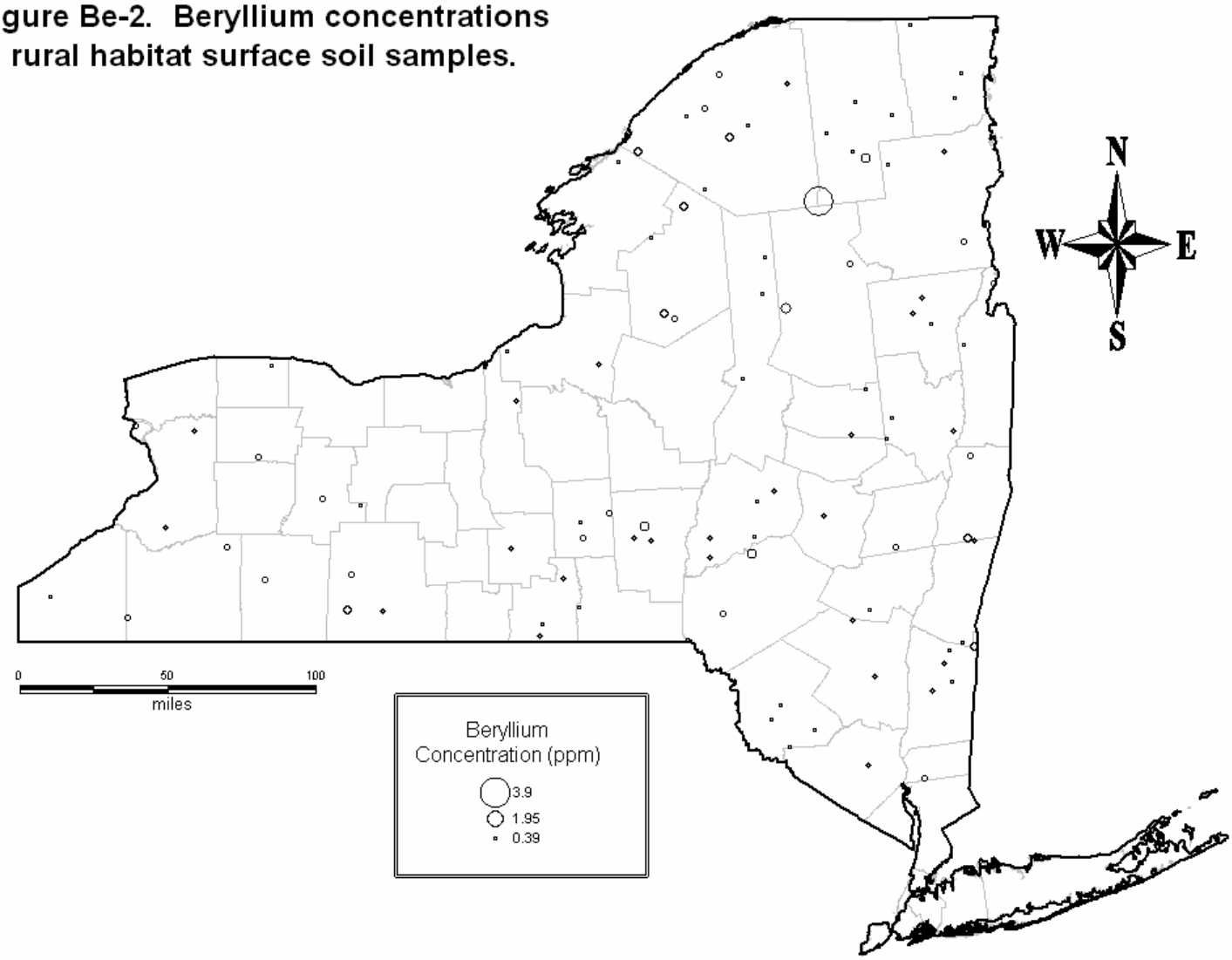

Figure Ca-1. Calcium concentrations in rural source-distant surface soil samples.

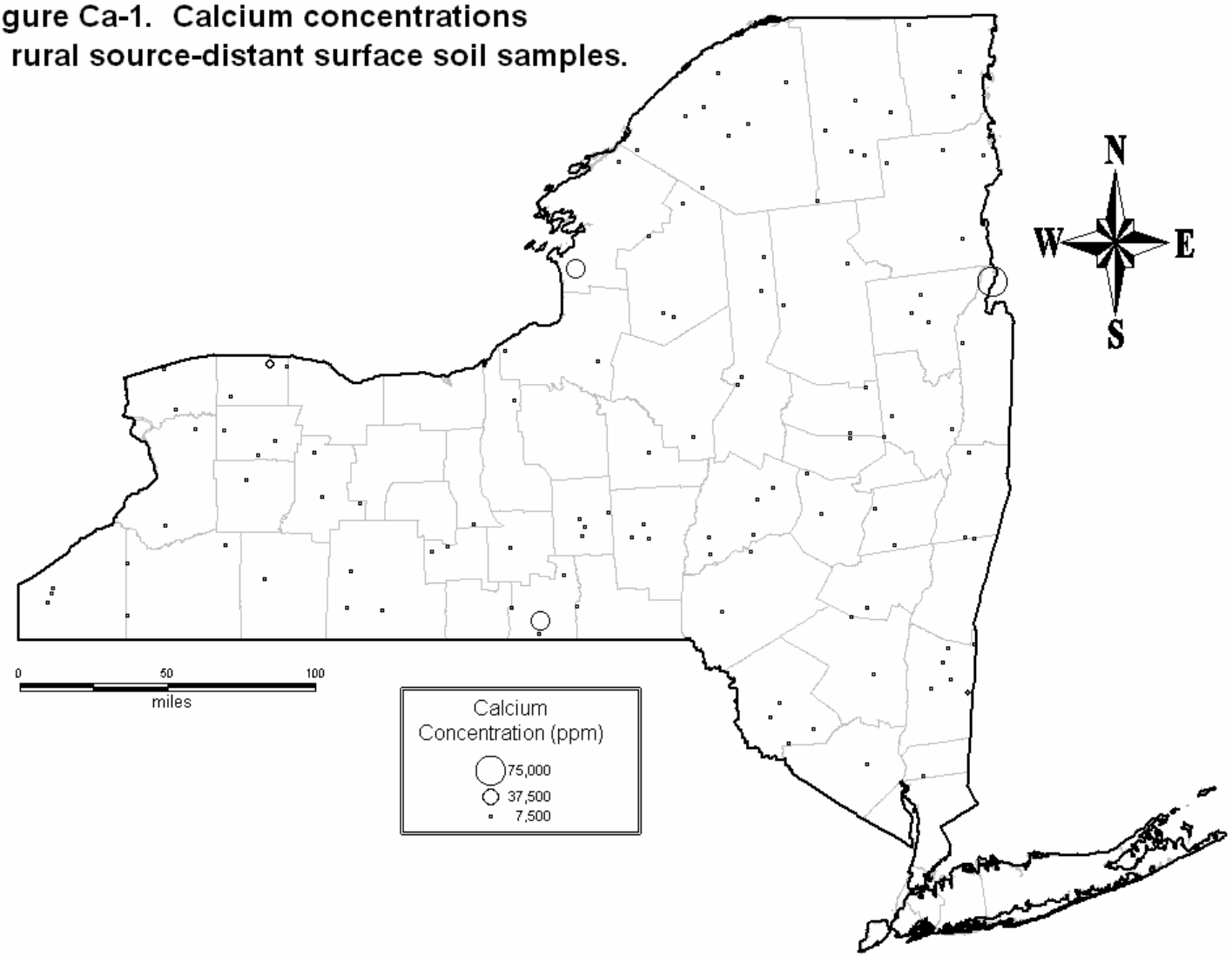

Figure Ca-2. Calcium concentrations in rural habitat surface soil samples.

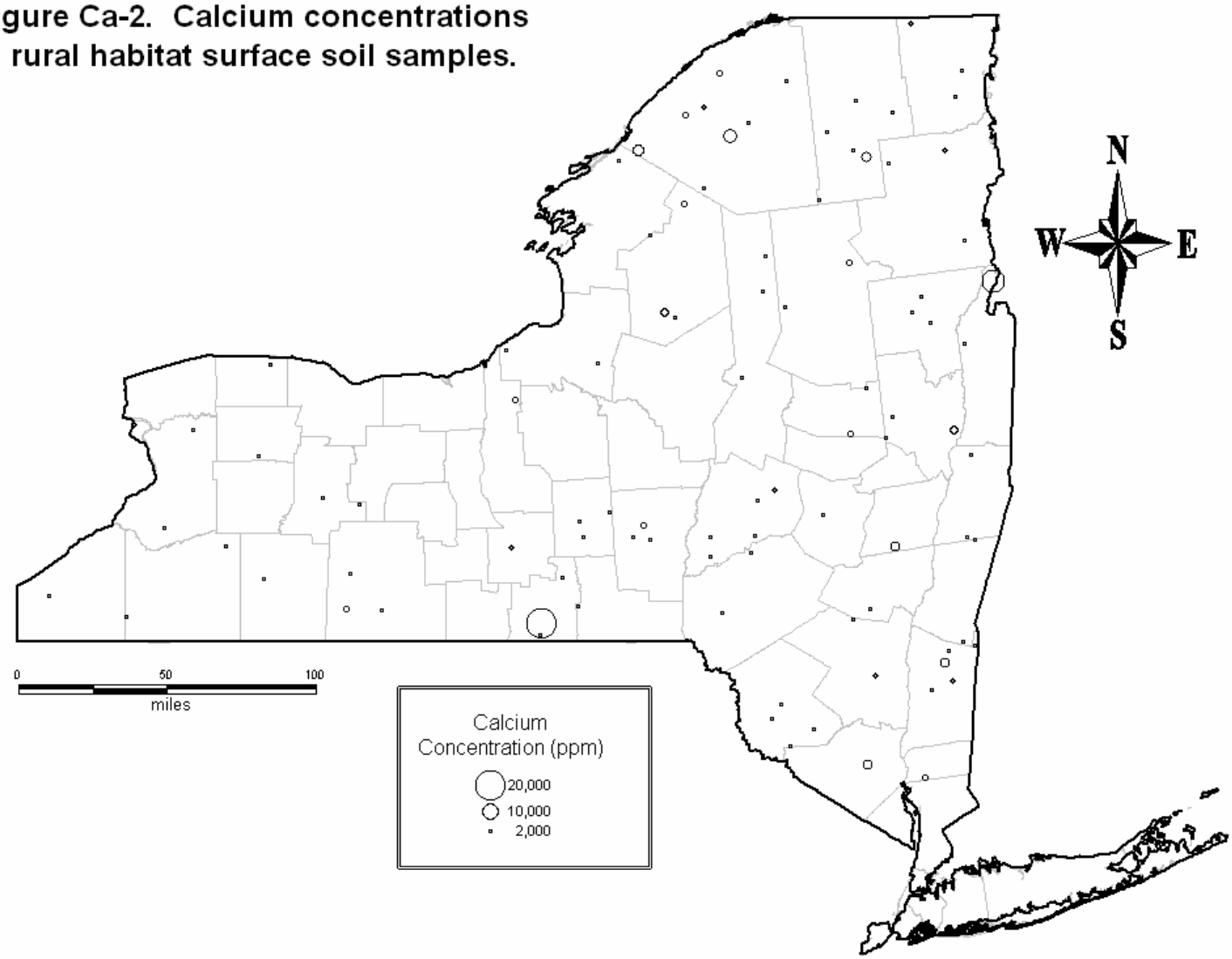

Figure Cd-1. Cadmium concentrations in rural source-distant surface soil samples.

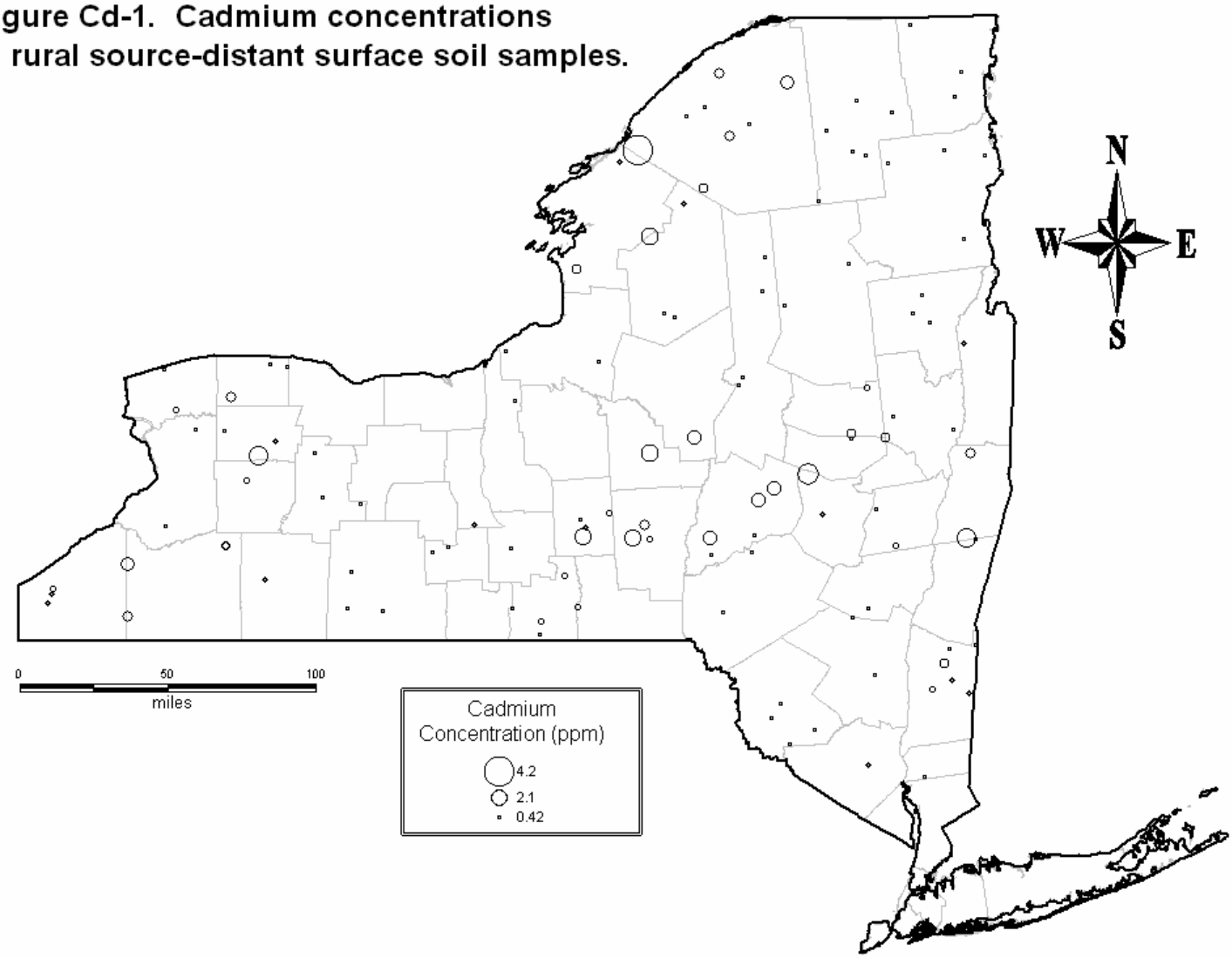

Figure Cd-2. Cadmium concentrations in rural habitat surface soil samples.

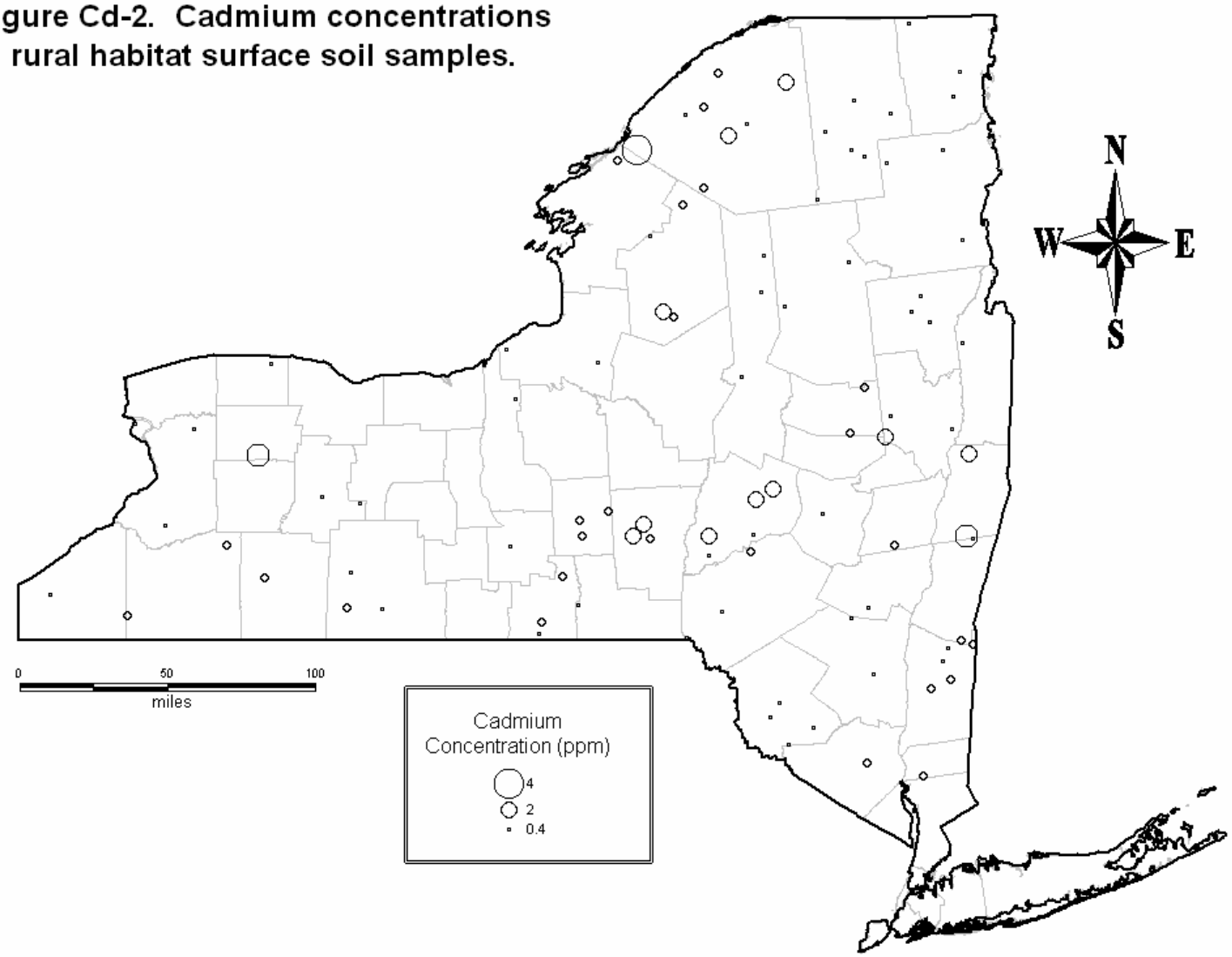

Figure Co-1. Cobalt concentrations in rural source-distant surface soil samples.

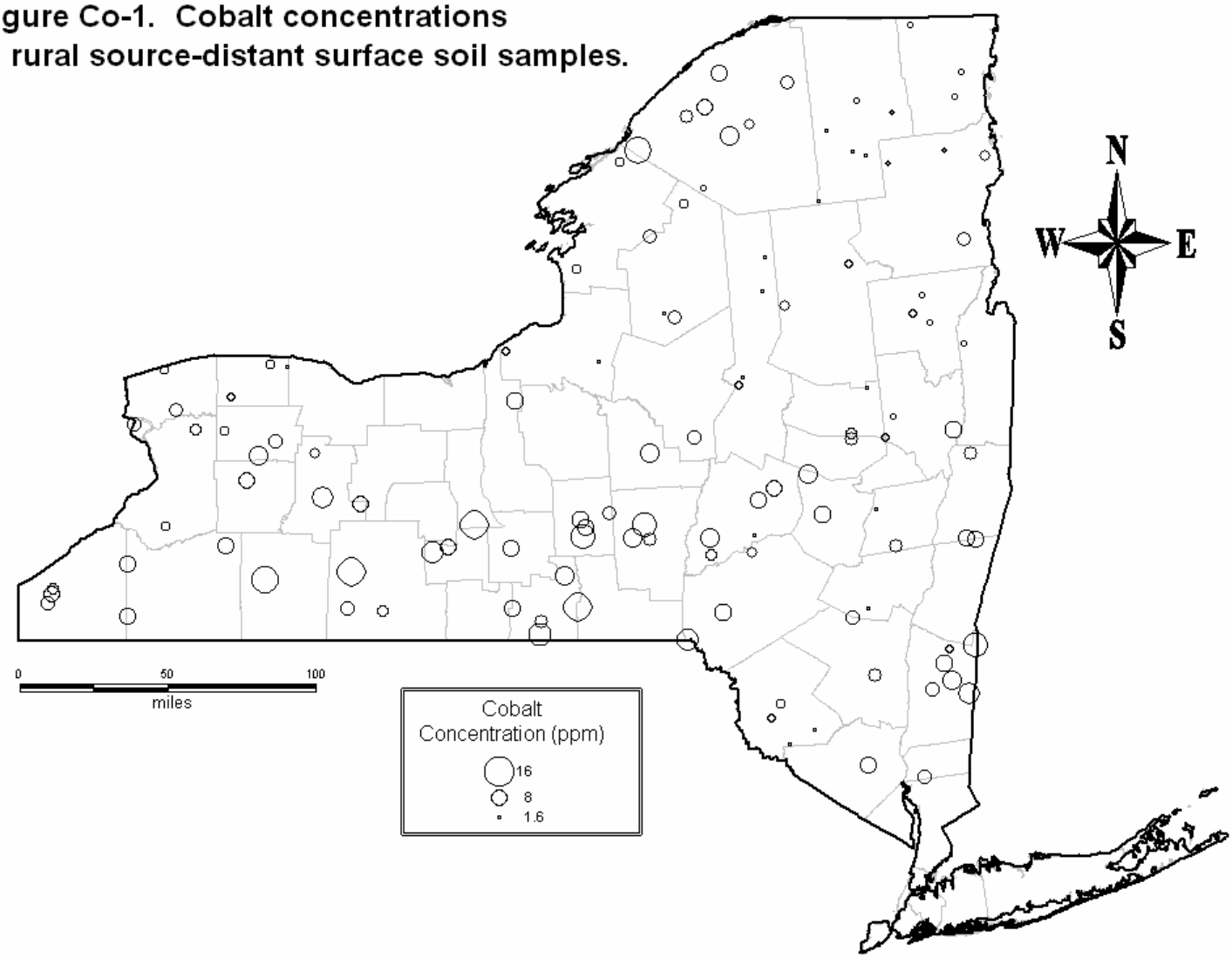

Figure Co-2. Cobalt concentrations in rural habitat surface soil samples.

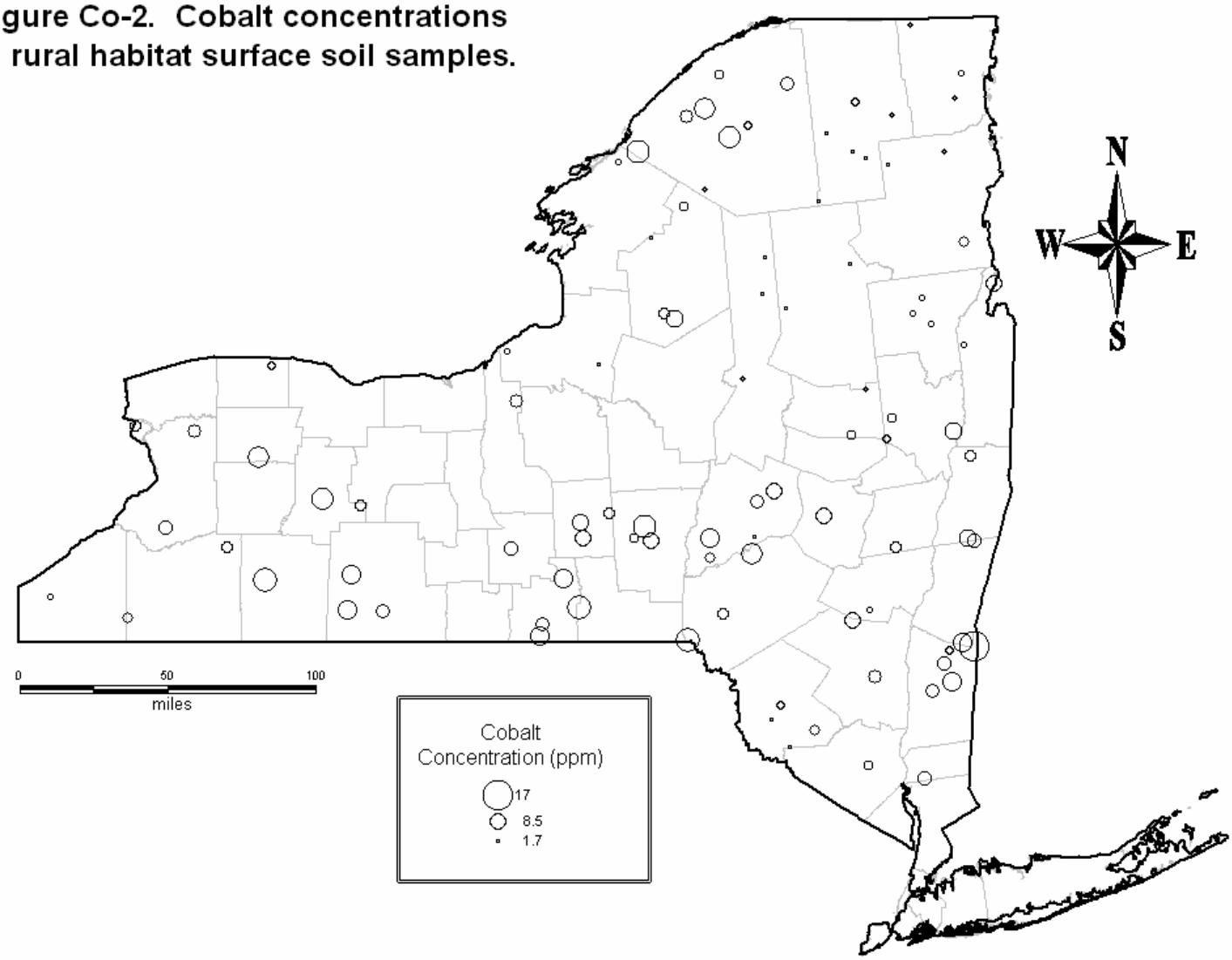

Figure Cr-1. Chromium concentrations in rural source-distant surface soil samples.

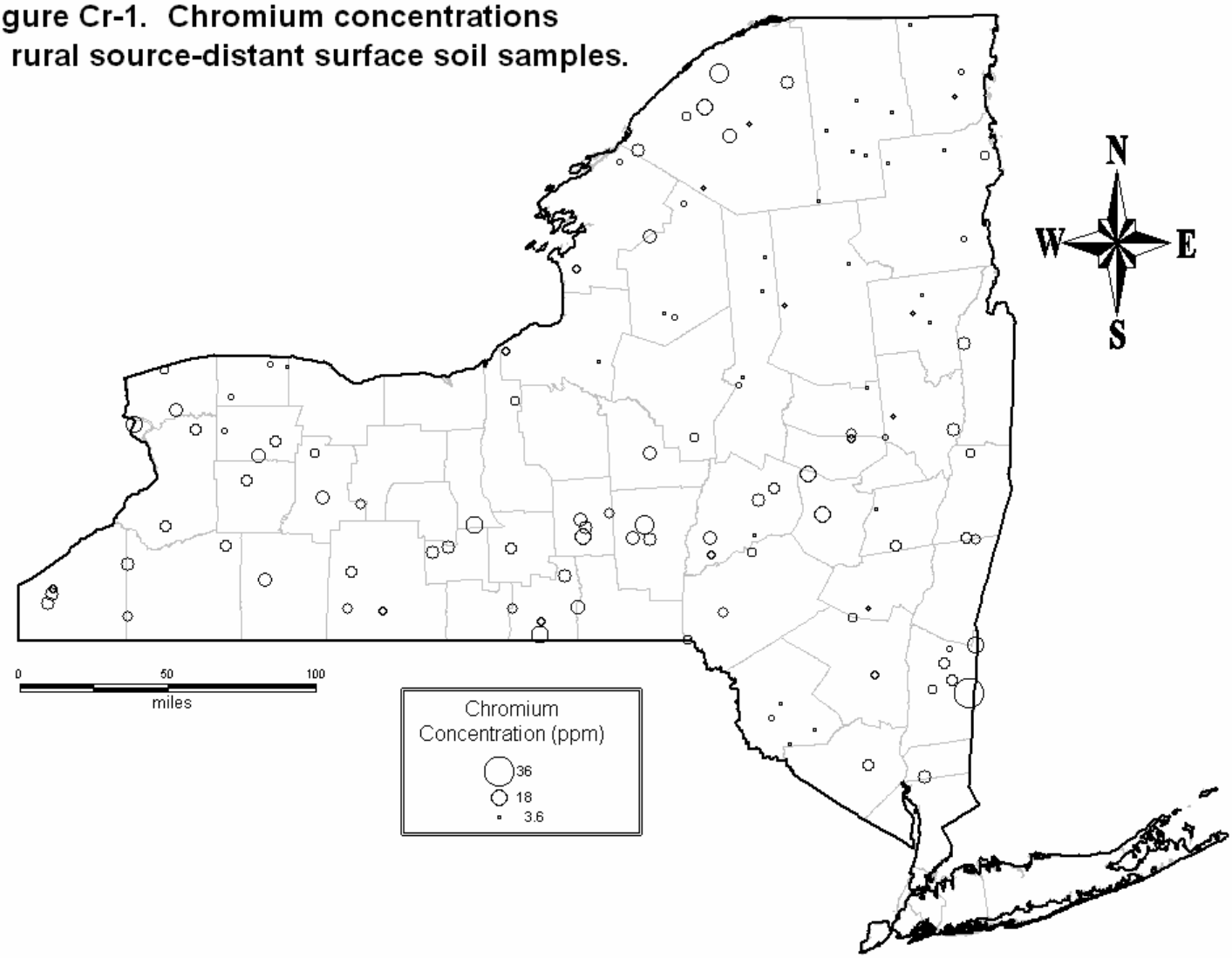

Figure Cr-2. Chromium concentrations in rural habitat surface soil samples.

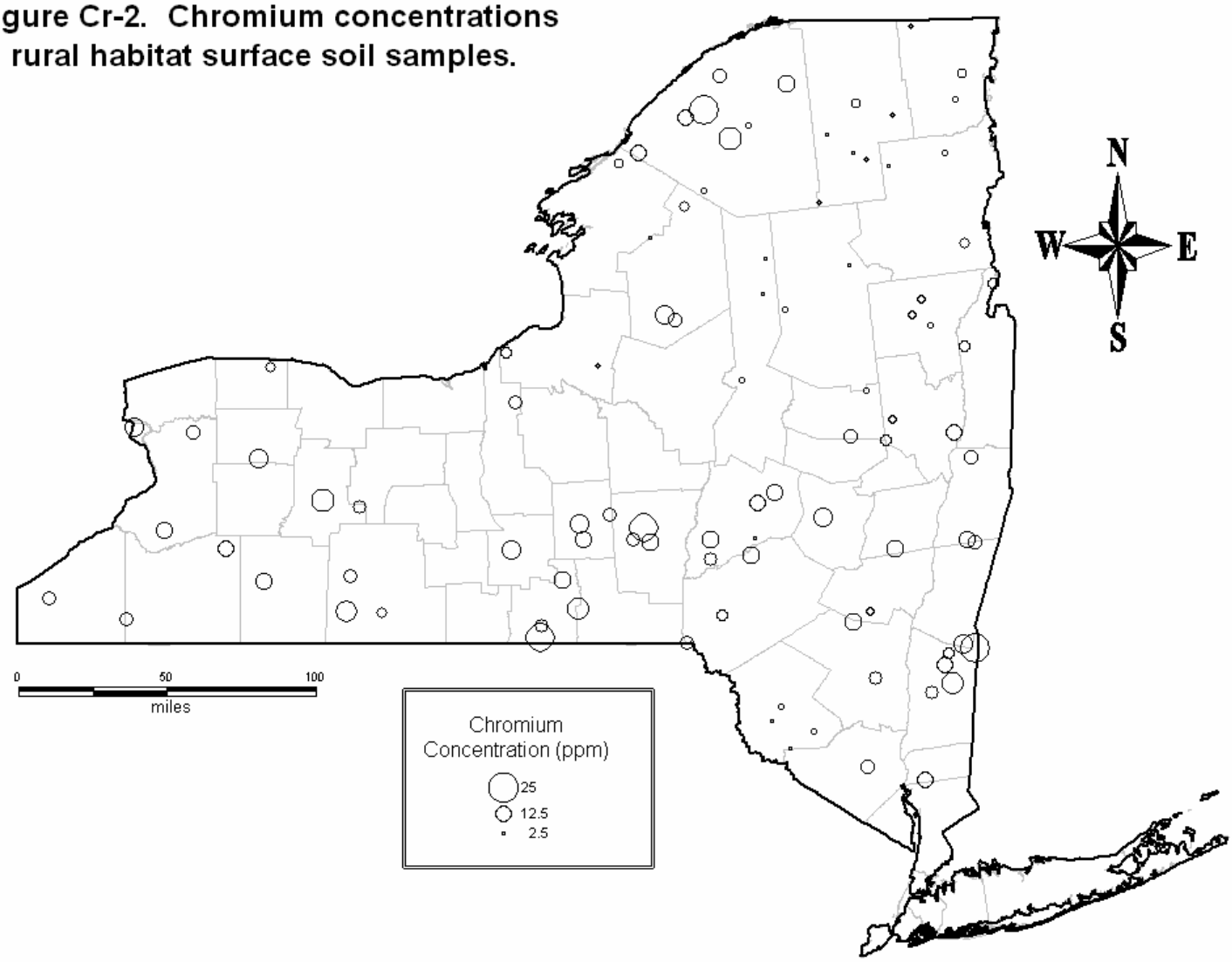

Figure Cu-1. Copper concentrations in rural source-distant surface soil samples.

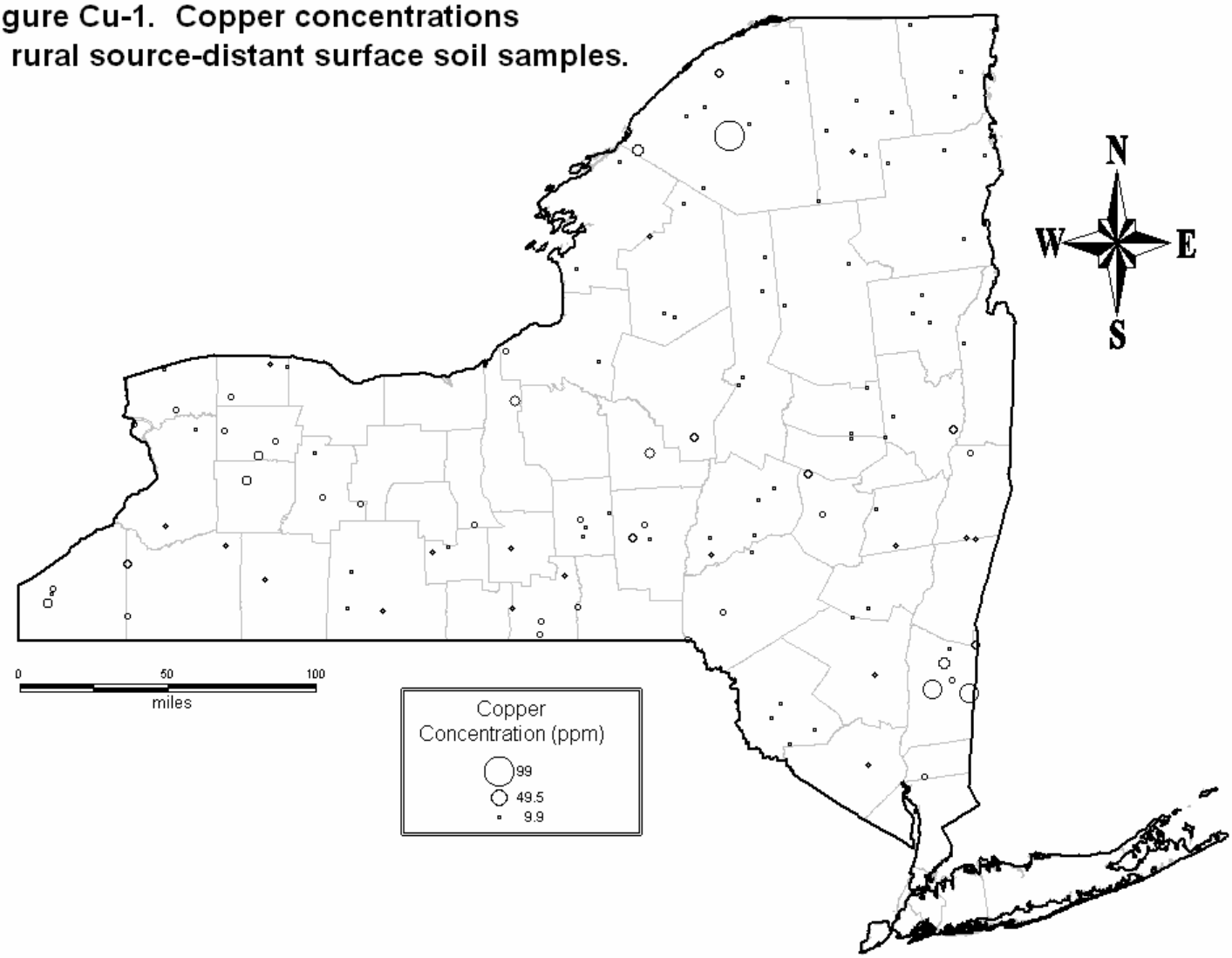

Figure Cu-2. Copper concentrations in rural habitat surface soil samples.

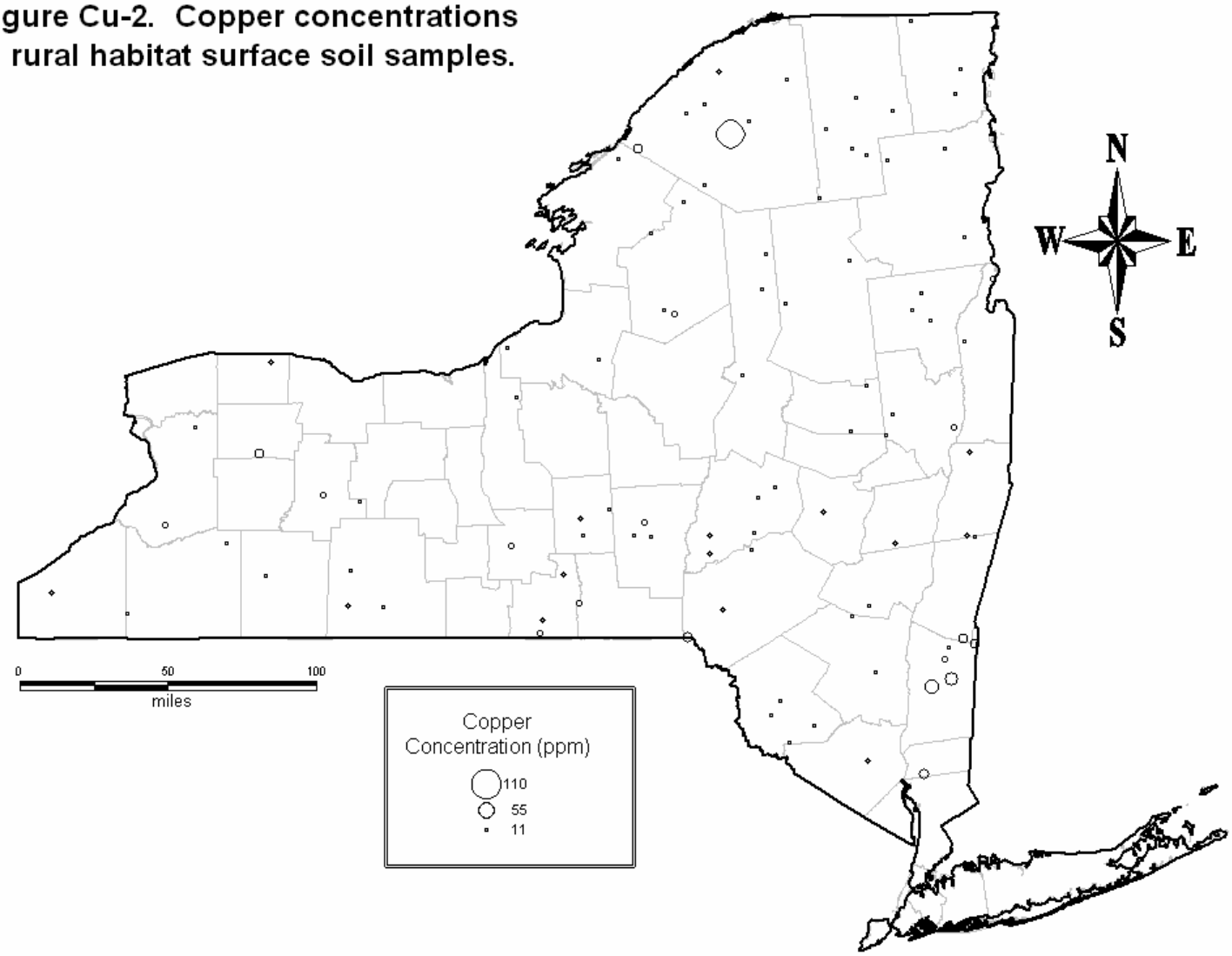

Figure Fe-1. Iron concentrations in rural source-distant surface soil samples.

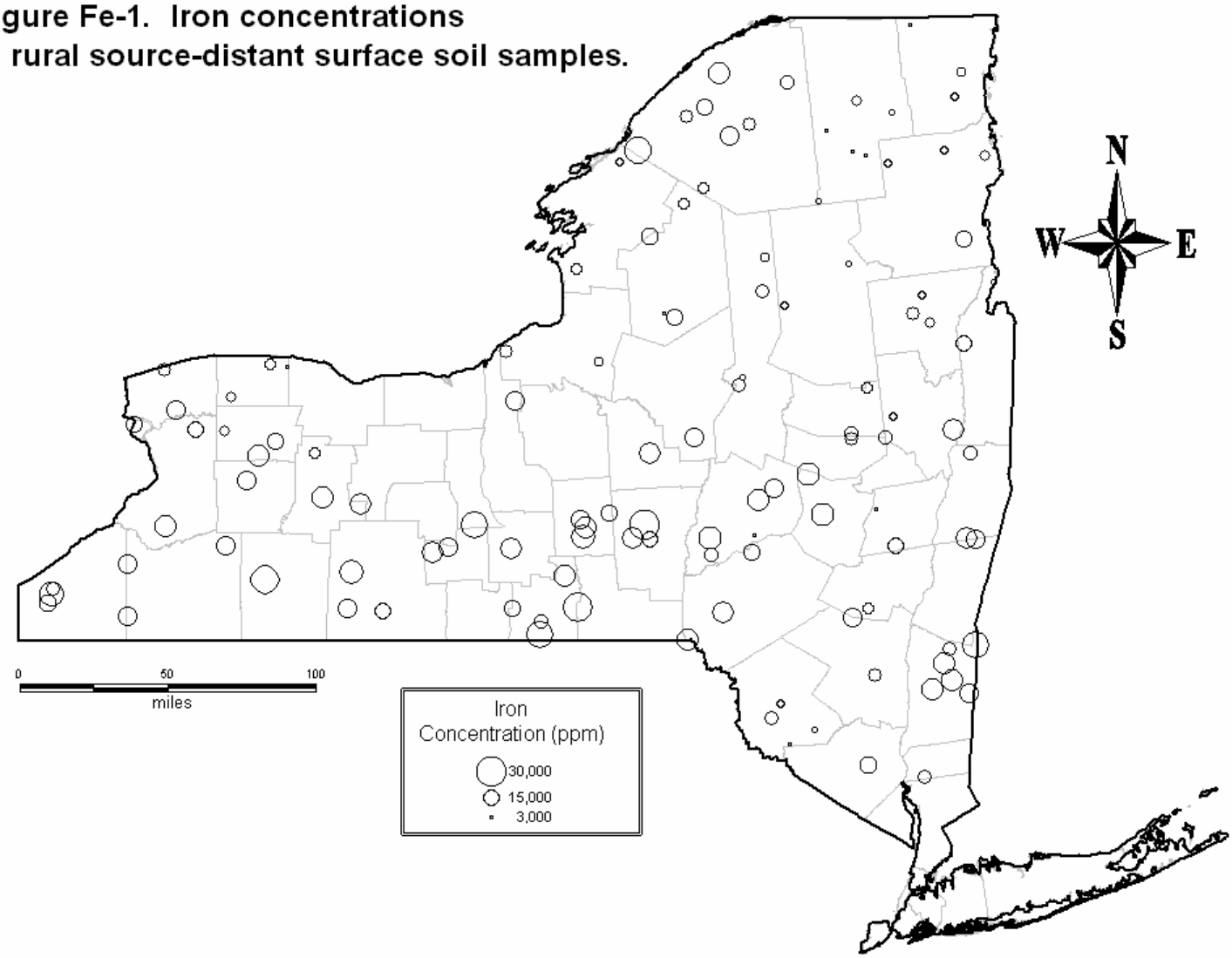

Figure Fe-2. Iron concentrations in rural habitat surface soil samples.

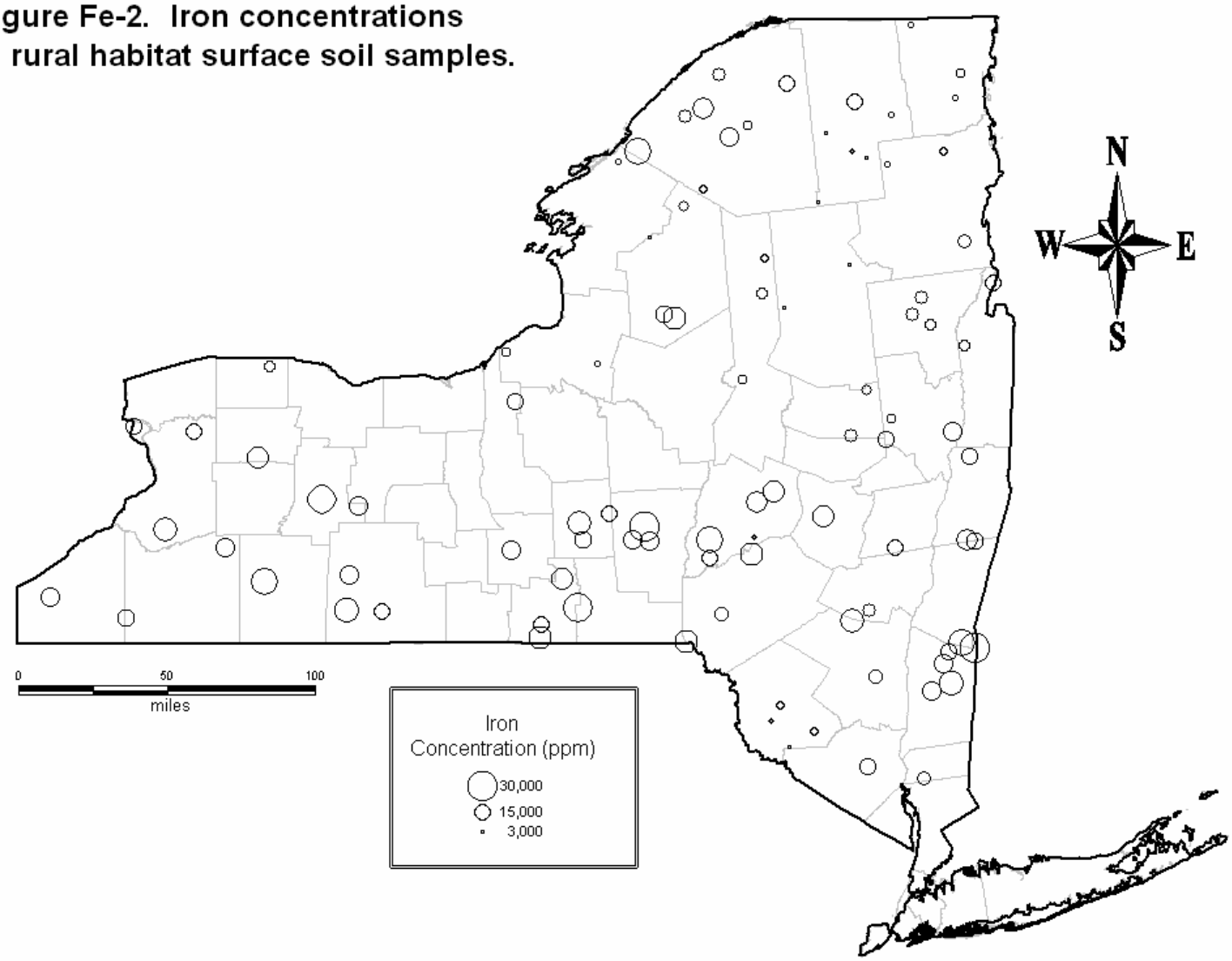

Figure Hg-1. Mercury concentrations in rural source-distant surface soil samples.

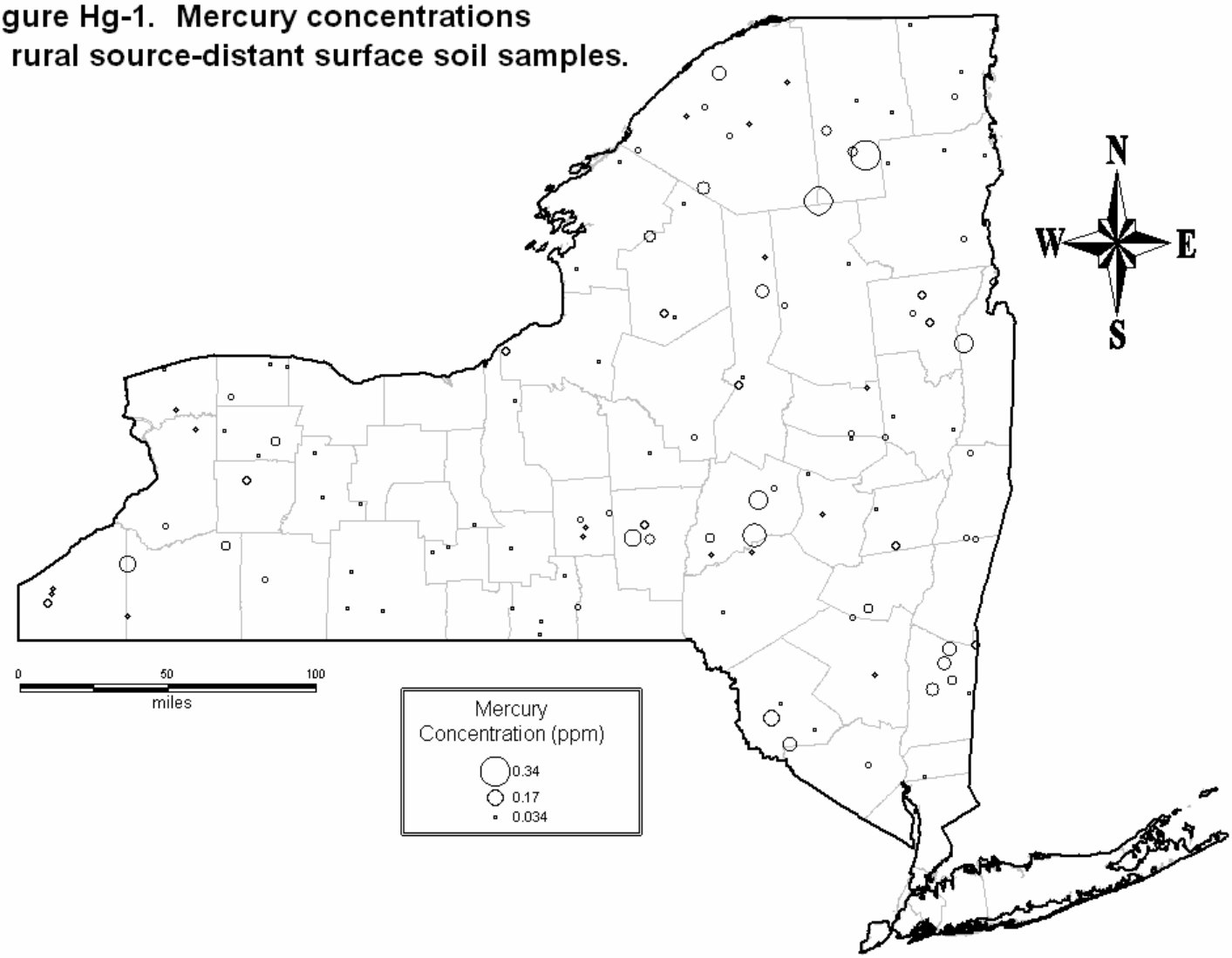

Figure Hg-2. Mercury concentrations in rural habitat surface soil samples.

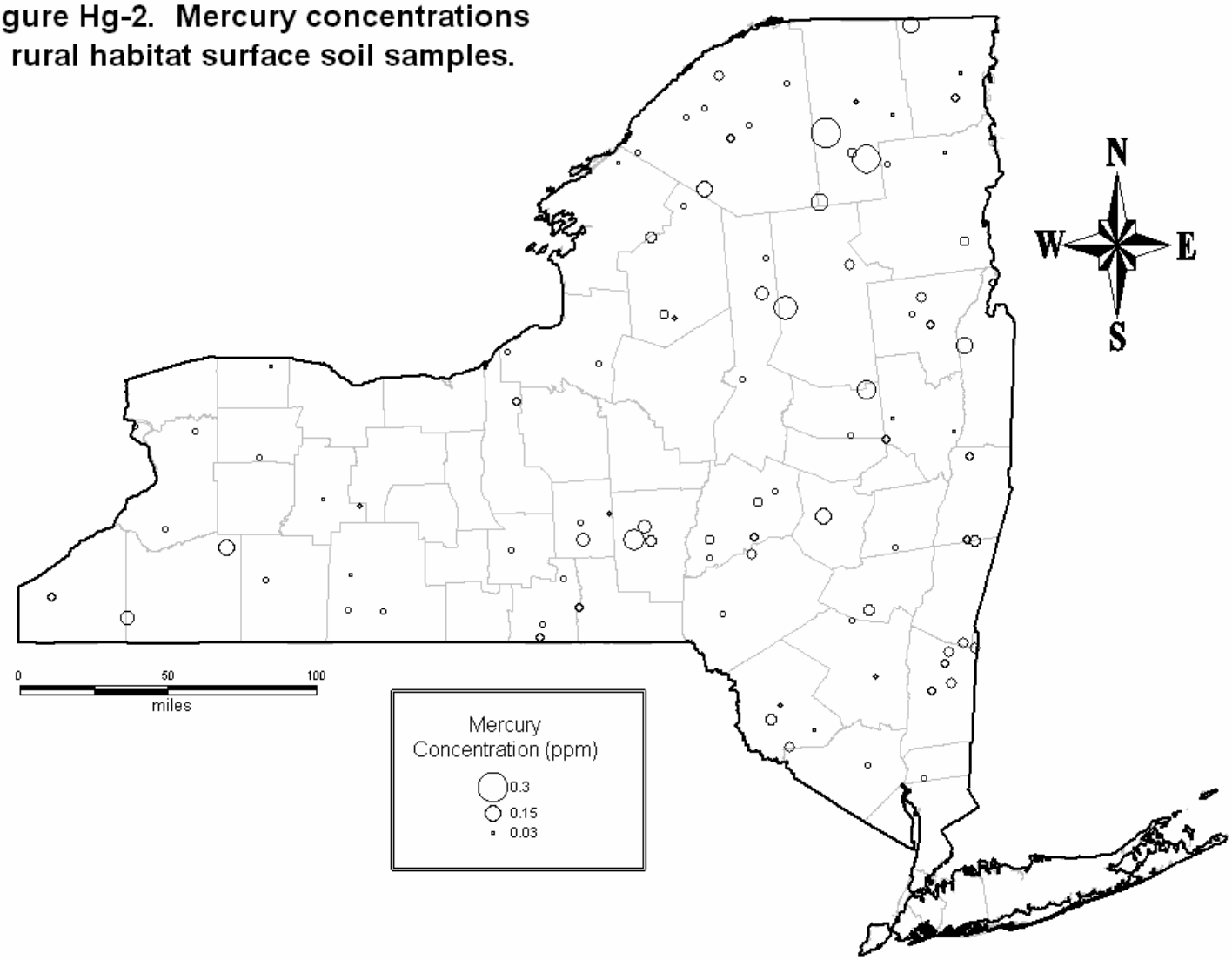

Figure K-1. Potassium concentrations in rural source-distant surface soil samples.

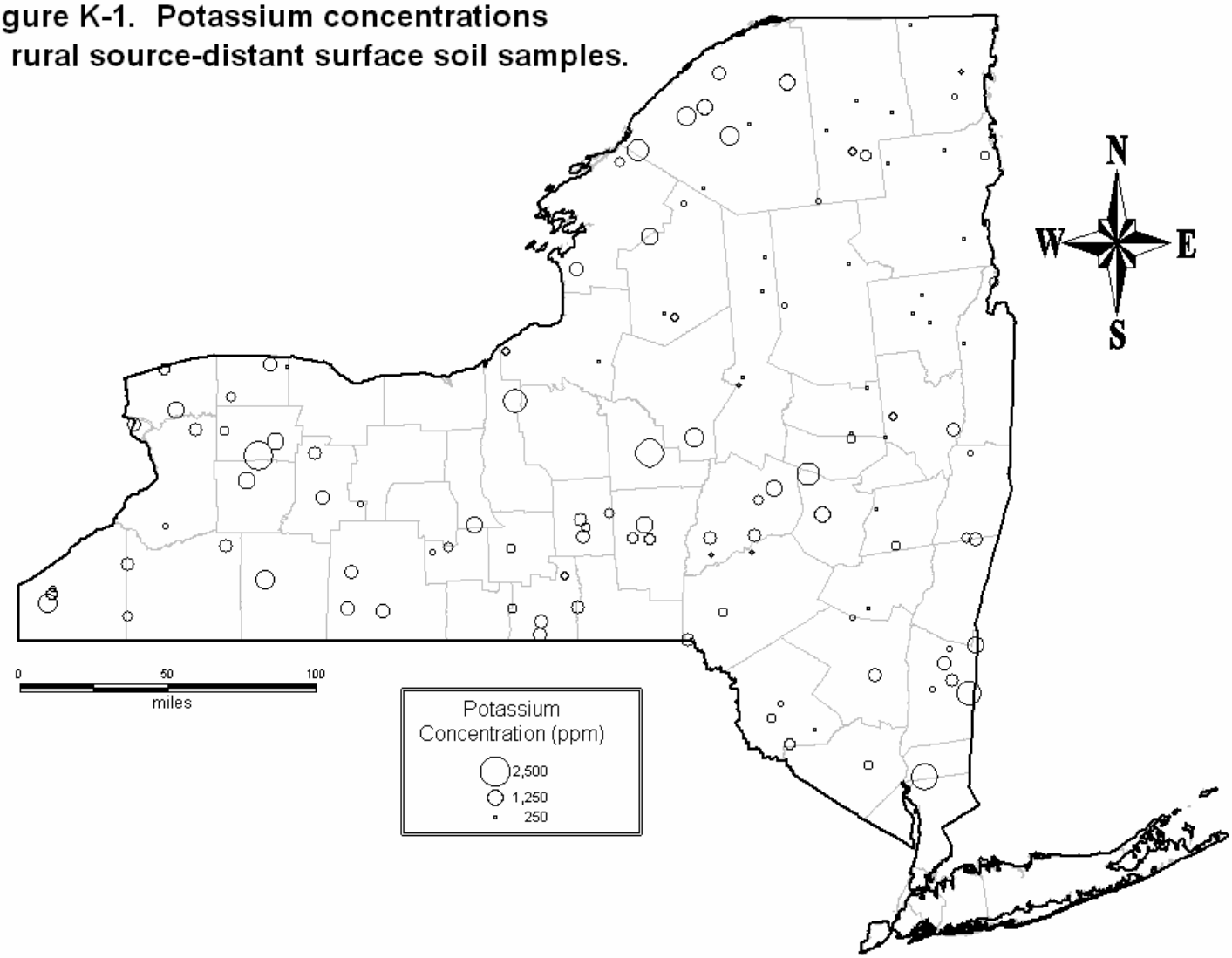

Figure K-2. Potassium concentrations in rural habitat surface soil samples.

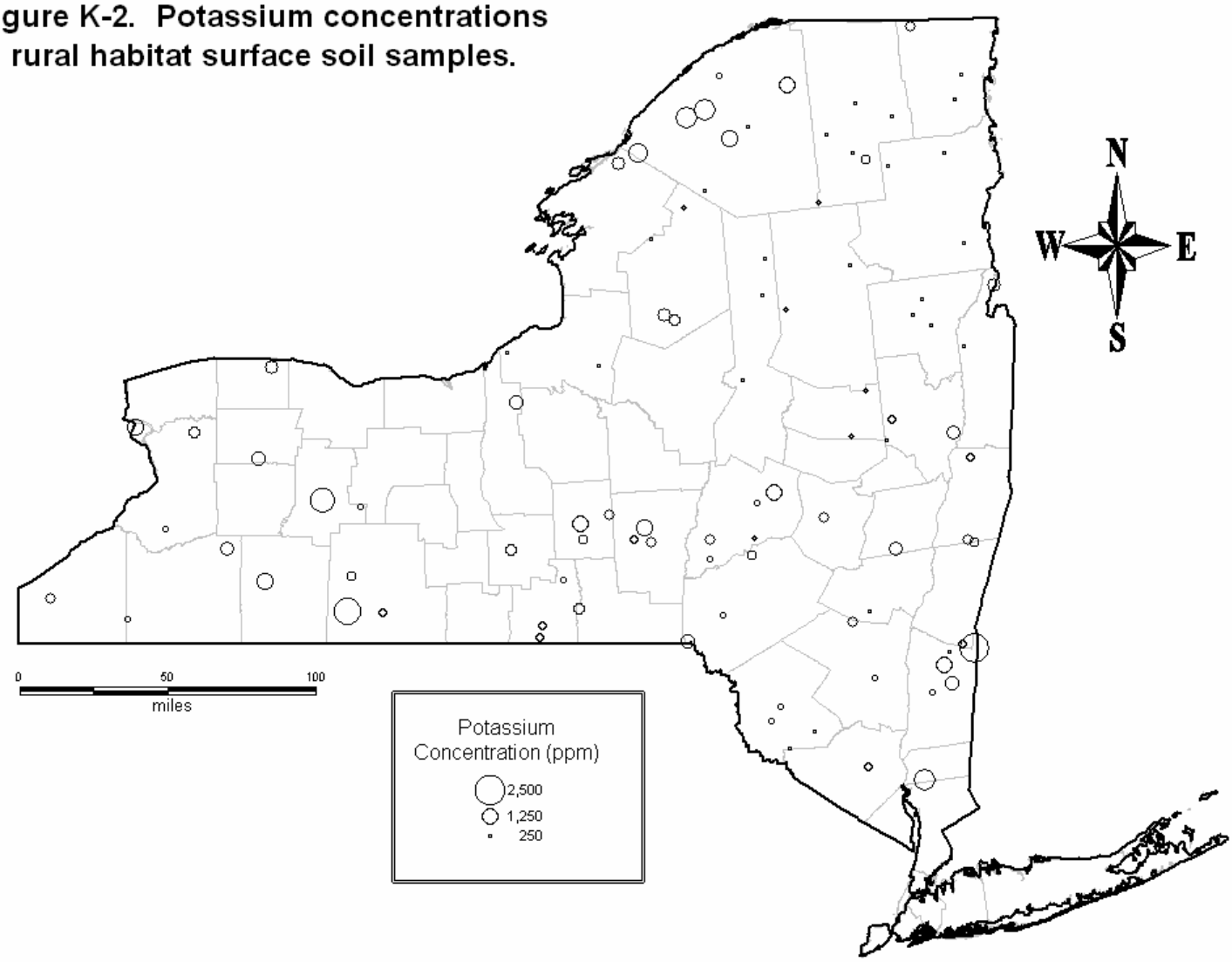

Figure Mg-1. Magnesium concentrations in rural source-distant surface soil samples.

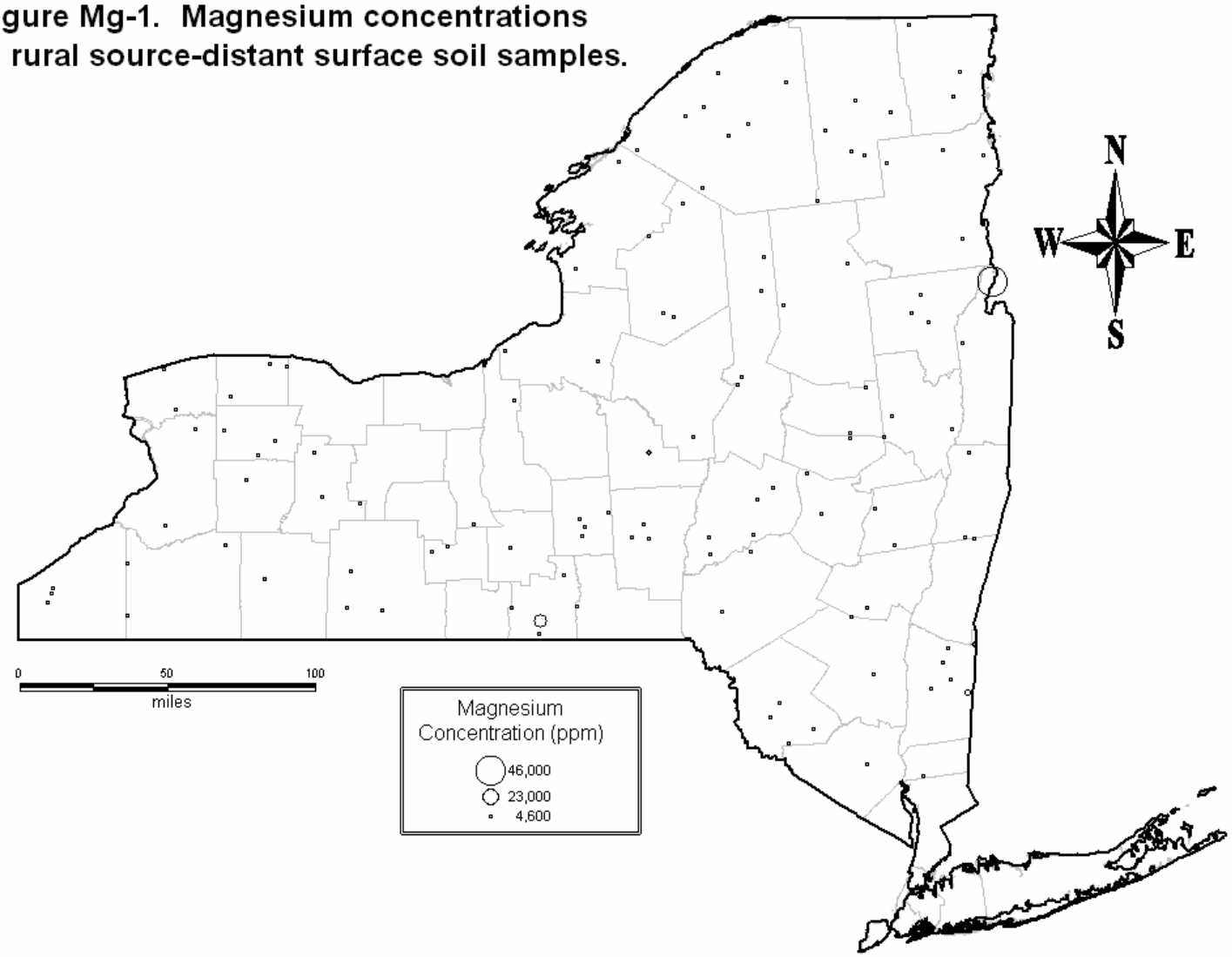

Figure Mg-2. Magnesium concentrations in rural habitat surface soil samples.

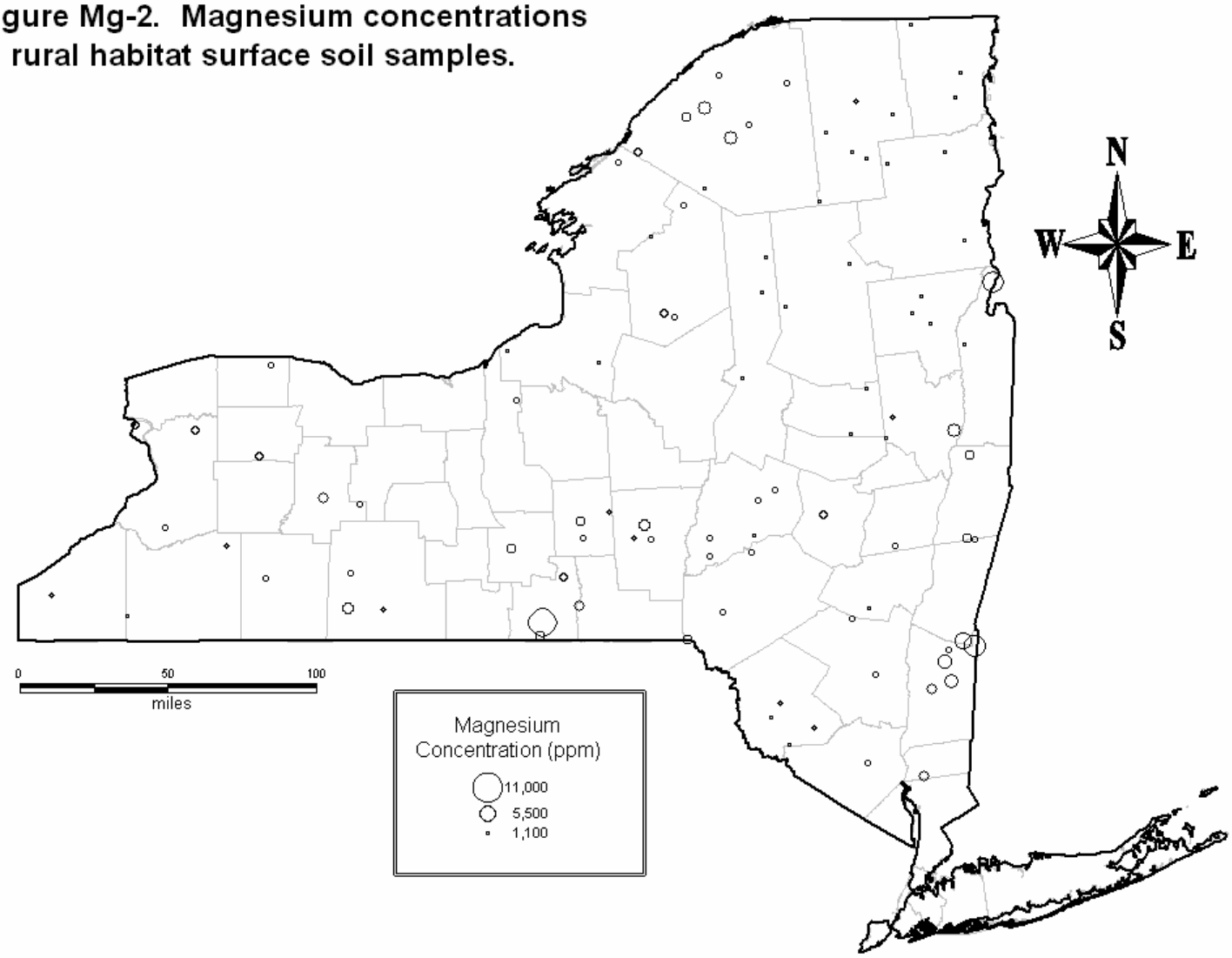

Figure Mn-1. Manganese concentrations in rural source-distant surface soil samples.

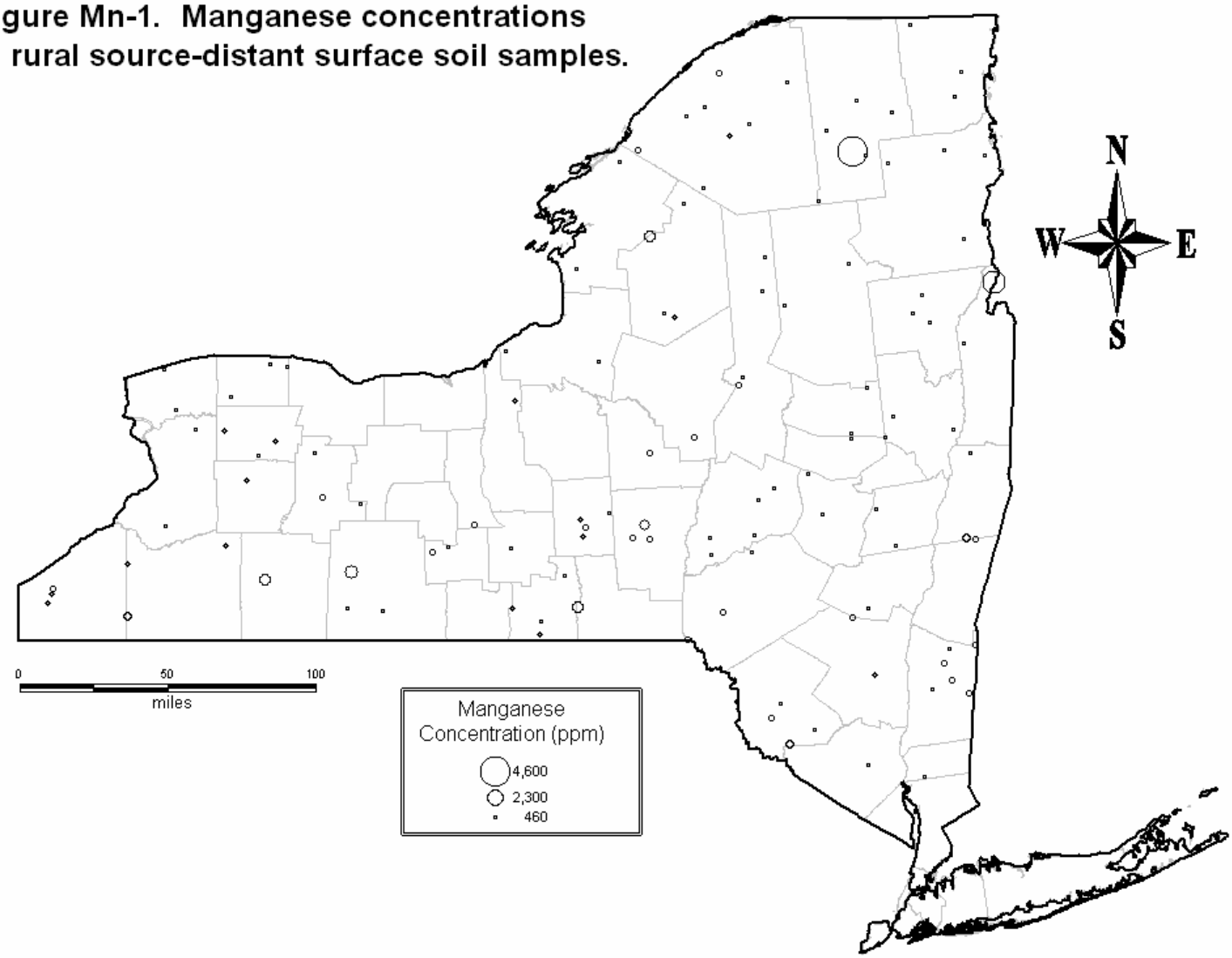

Figure Mn-2. Manganese concentrations in rural habitat surface soil samples.

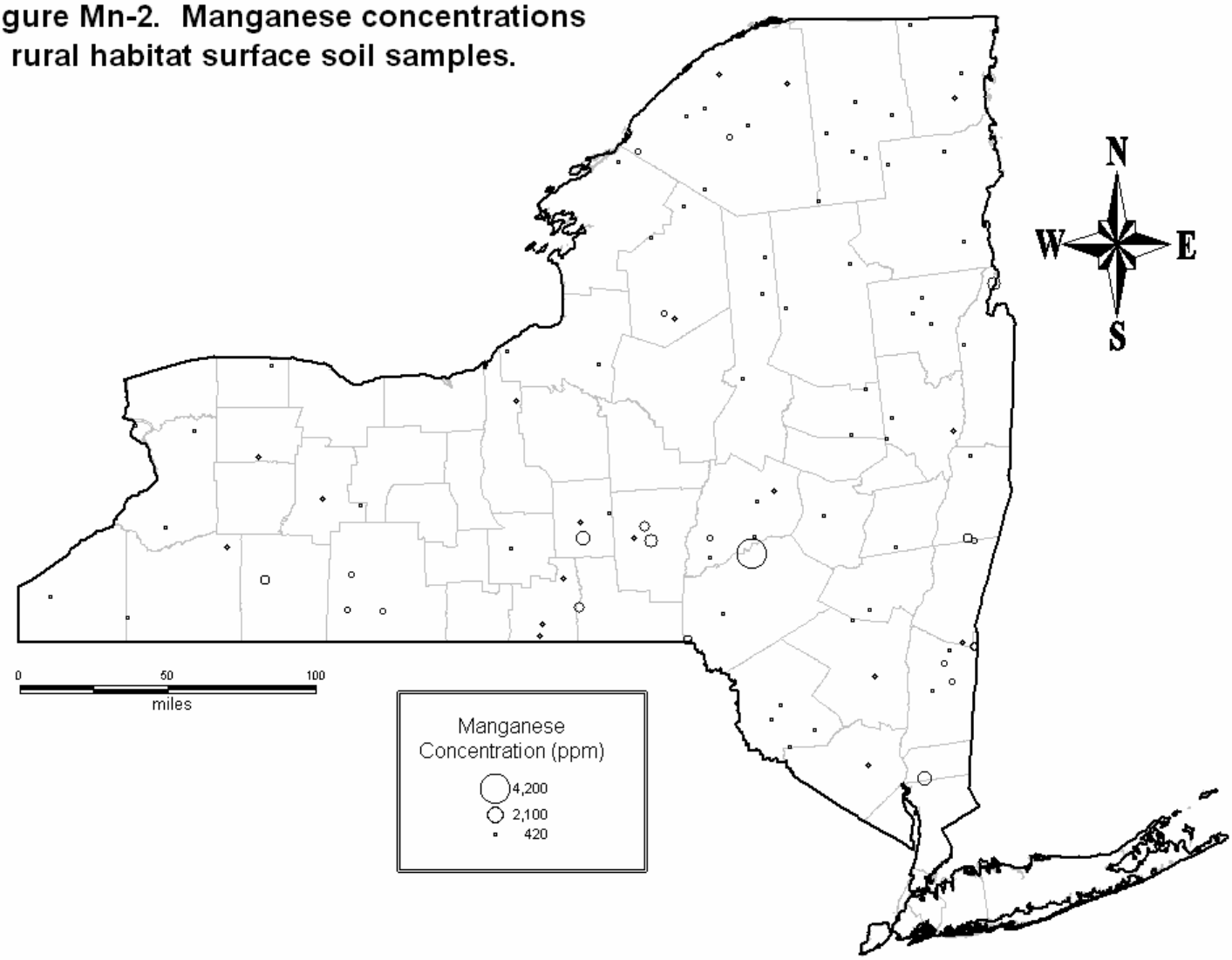

Figure Na-1. Sodium concentrations in rural source-distant surface soil samples.

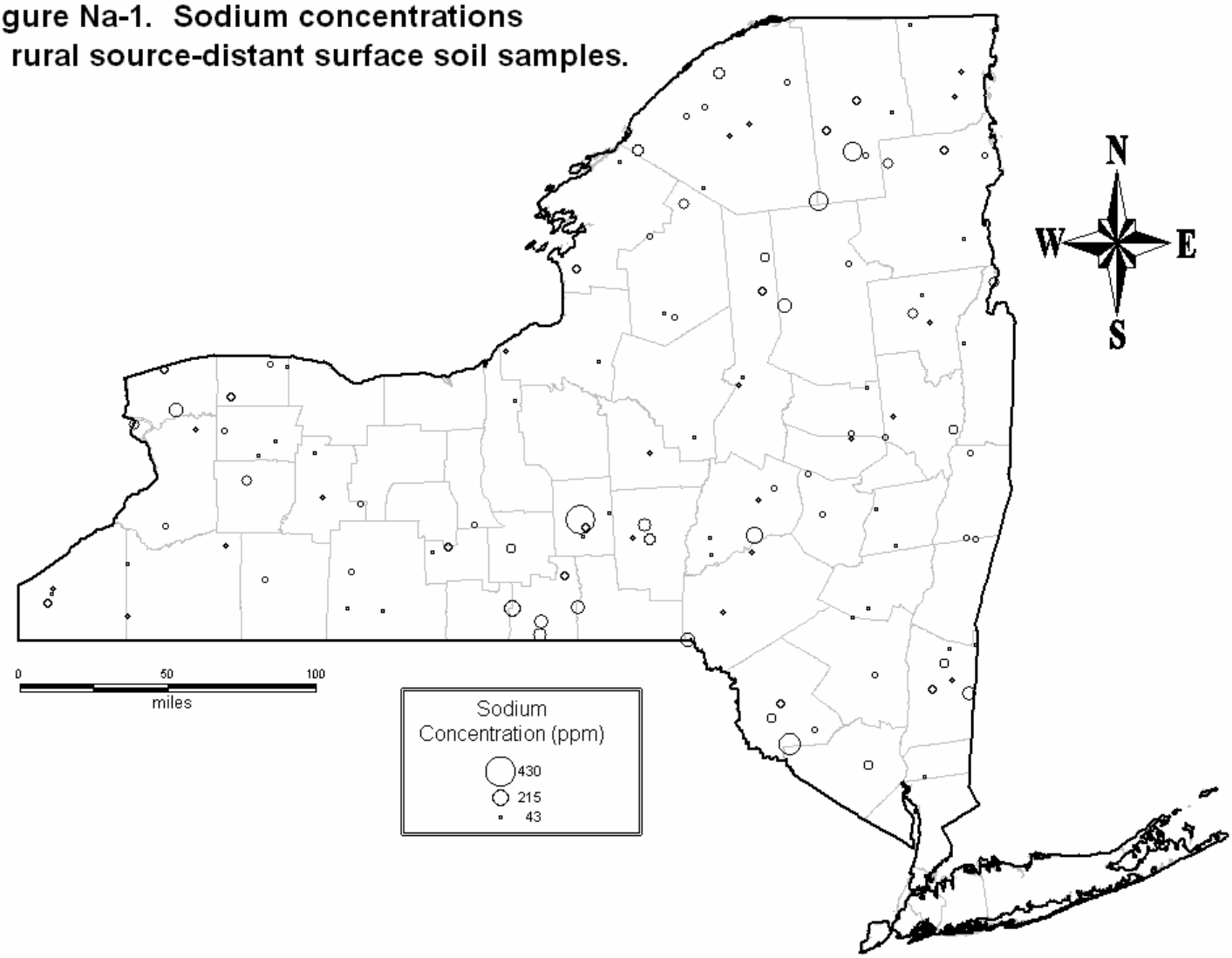

Figure Na-2. Sodium concentrations in rural habitat surface soil samples.

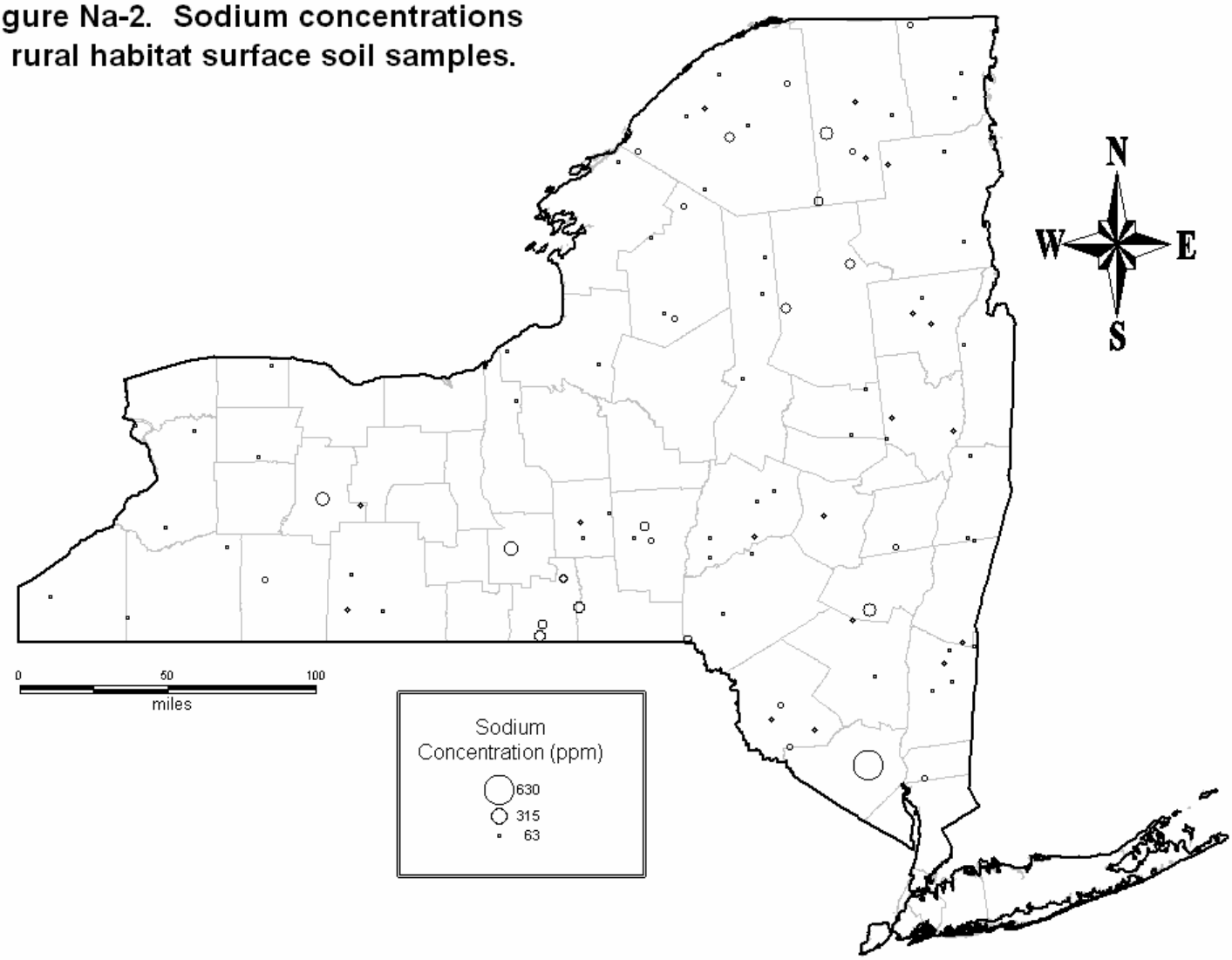

Figure Ni-1. Nickel concentrations in rural source-distant surface soil samples.

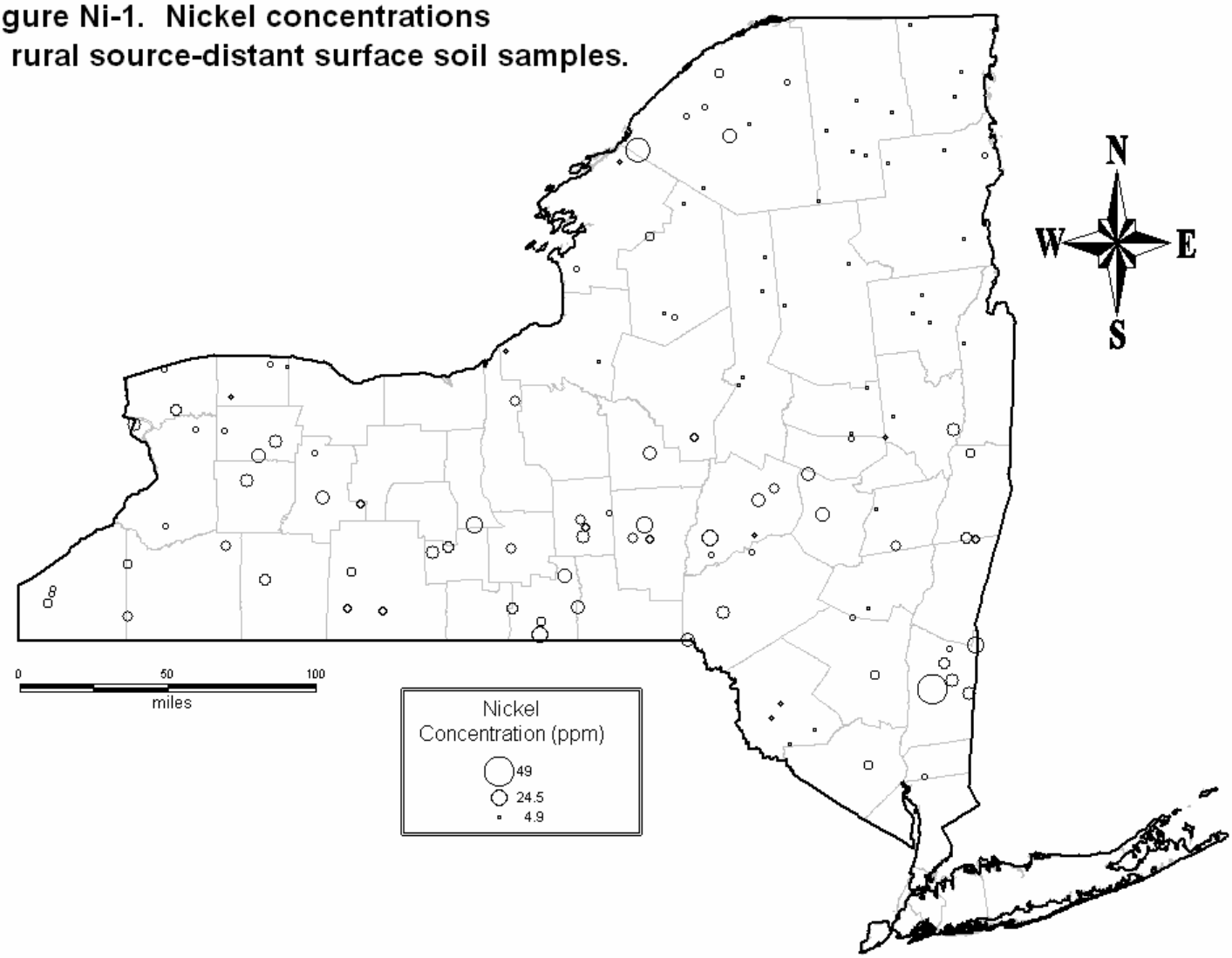

Figure Ni-2. Nickel concentrations in rural habitat surface soil samples.

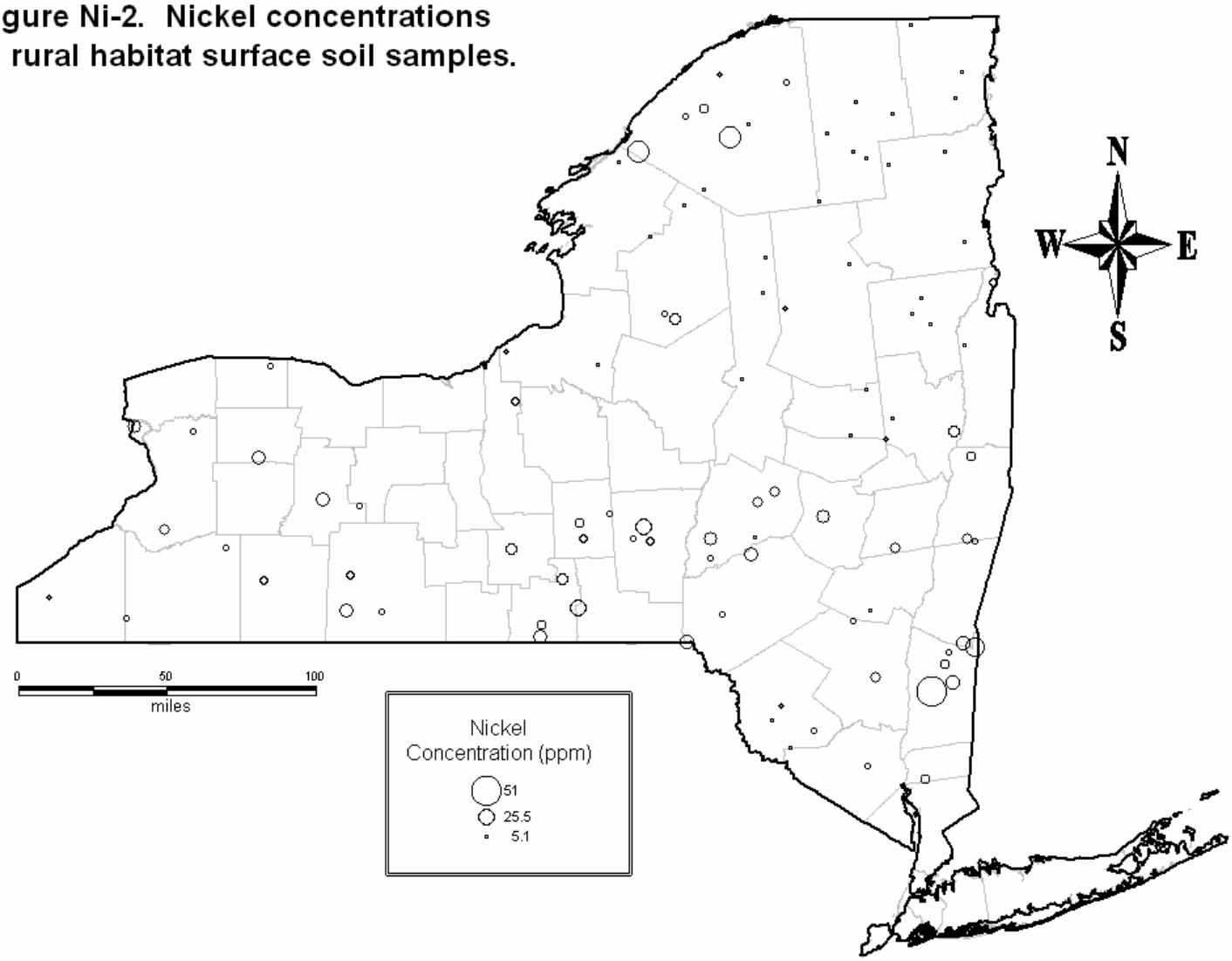

Figure Pb-1. Lead concentrations in rural source-distant surface soil samples.

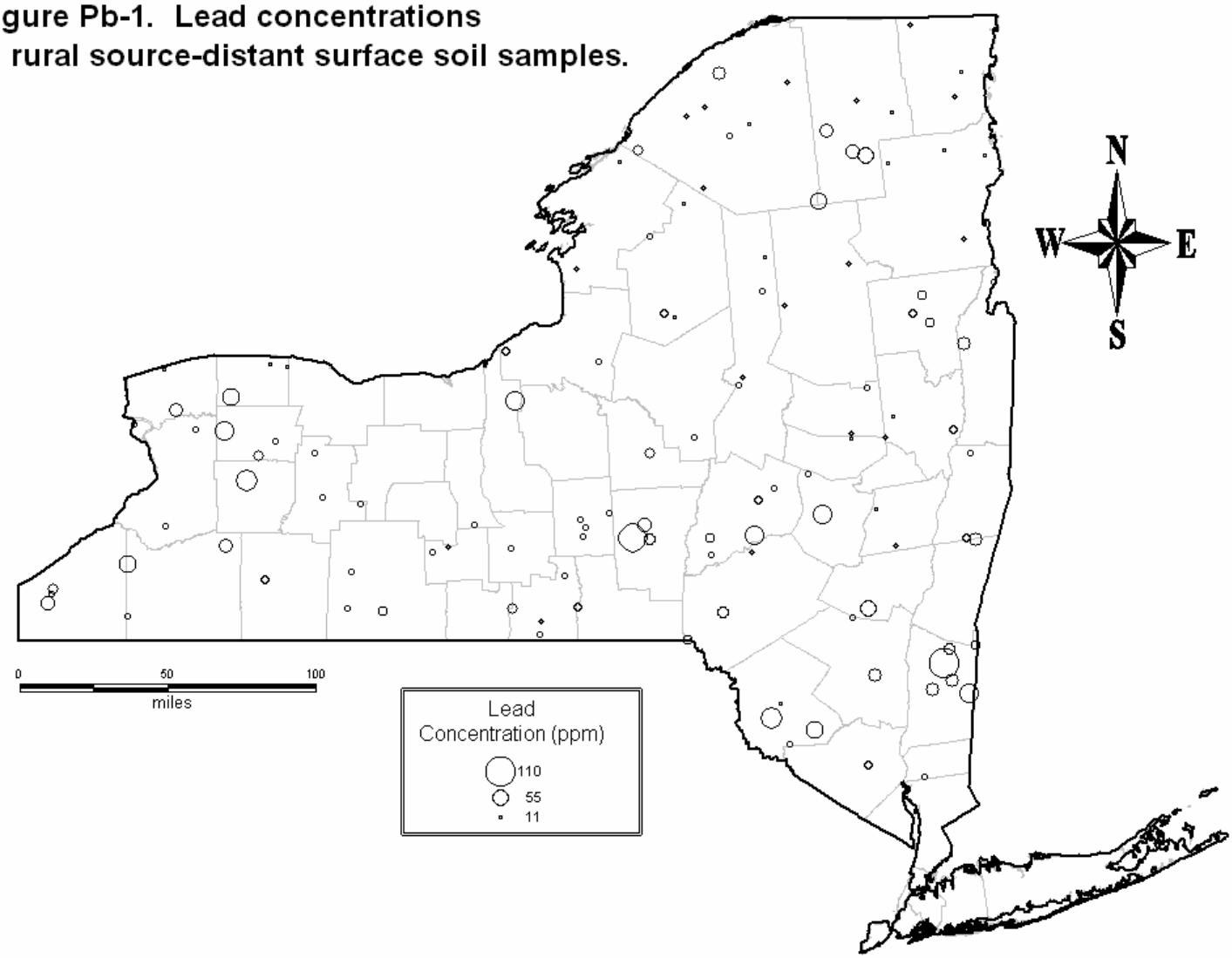

Figure Pb-2. Lead concentrations in rural habitat surface soil samples.

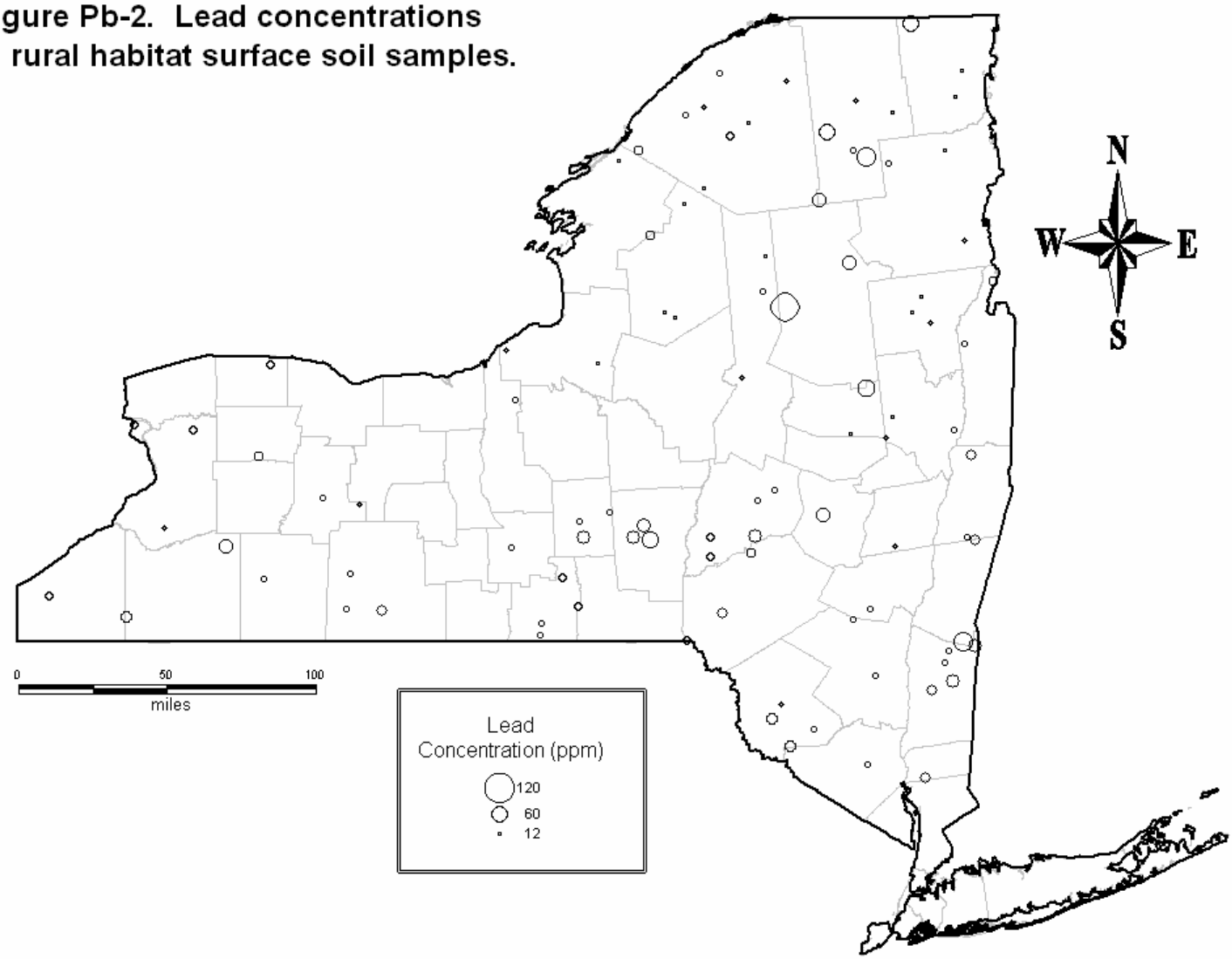

Figure Se-1. Selenium concentrations in rural source-distant surface soil samples.

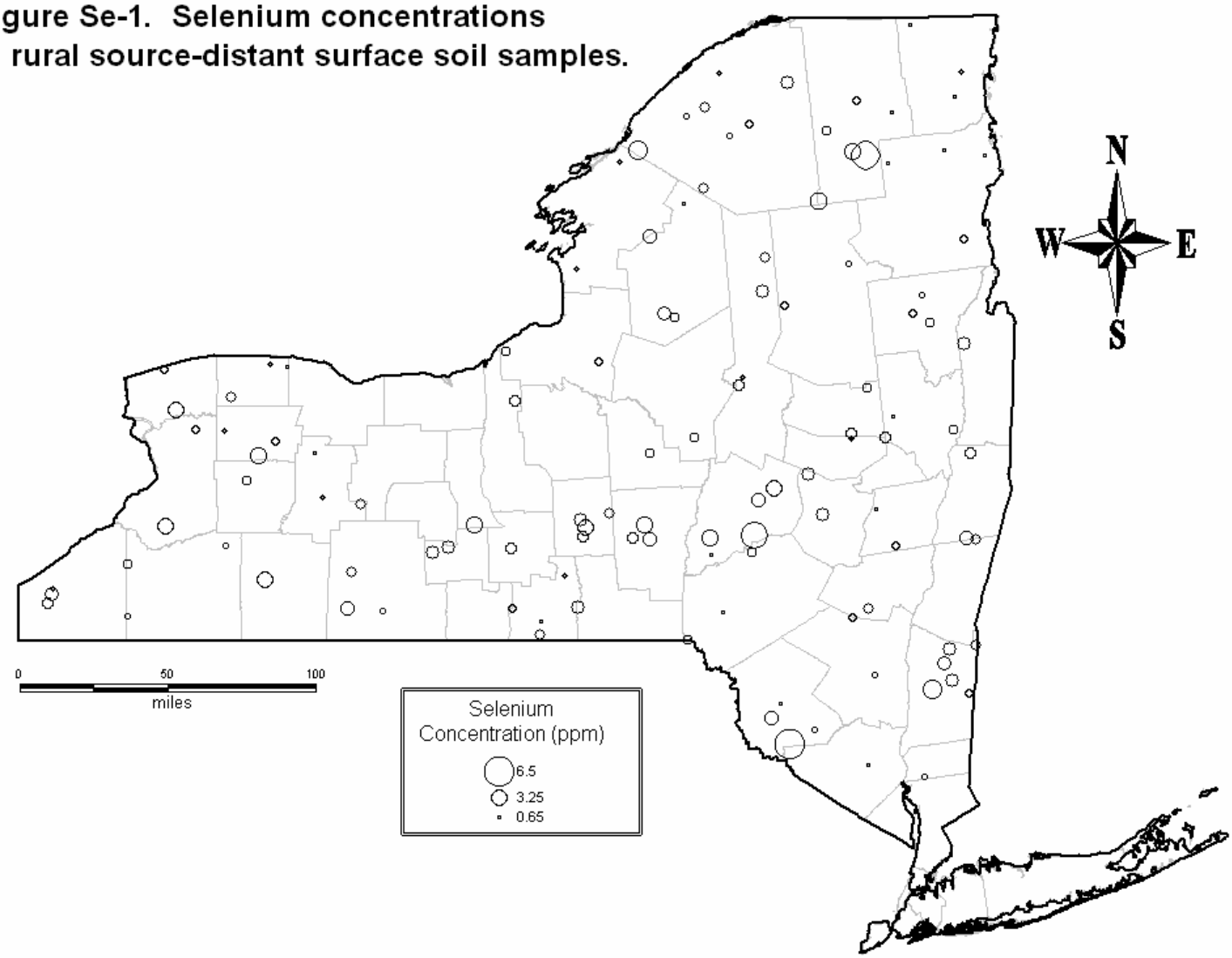

Figure Se-2. Selenium concentrations in rural habitat surface soil samples.

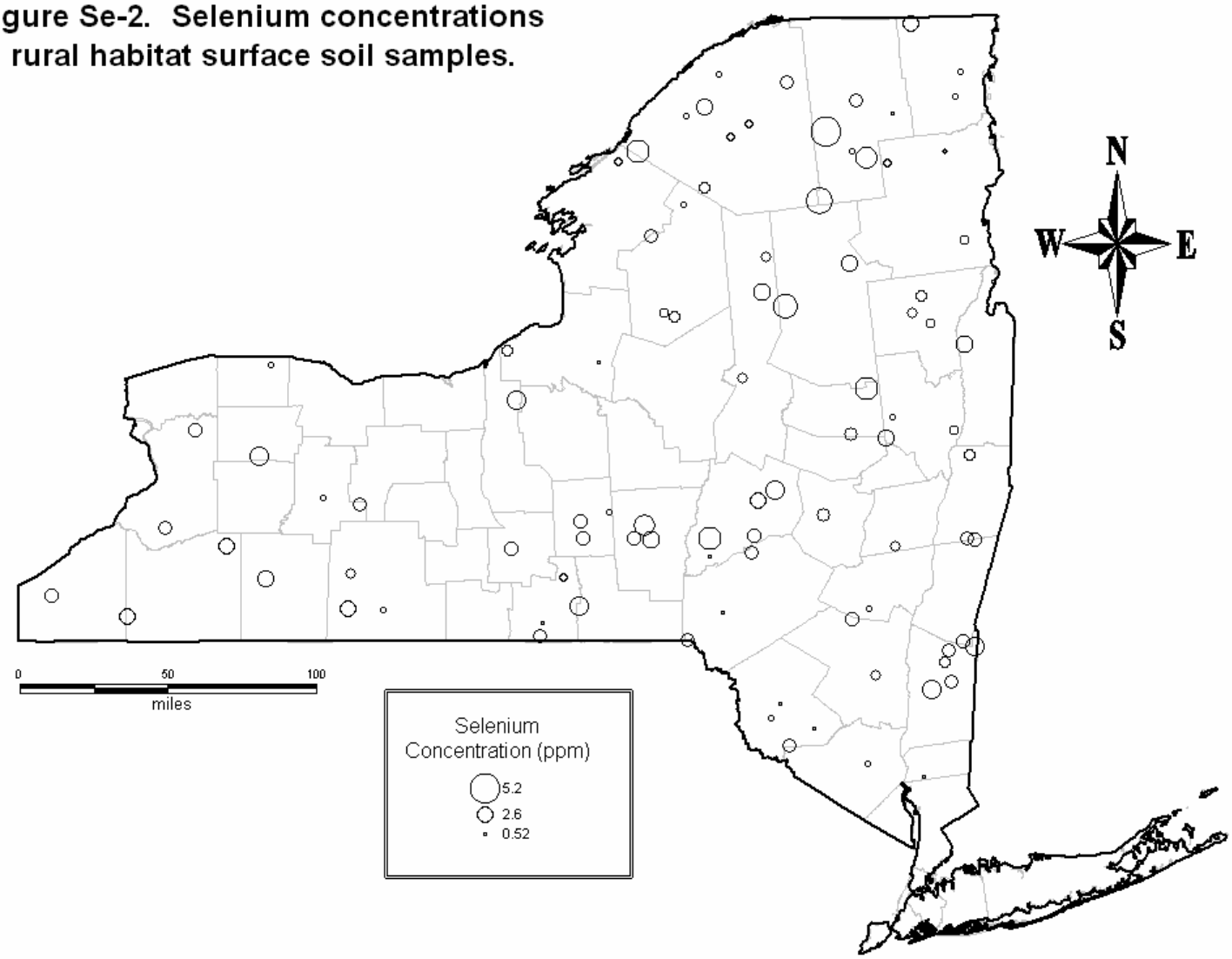

Figure V-1. Vanadium concentrations in rural source-distant surface soil samples.

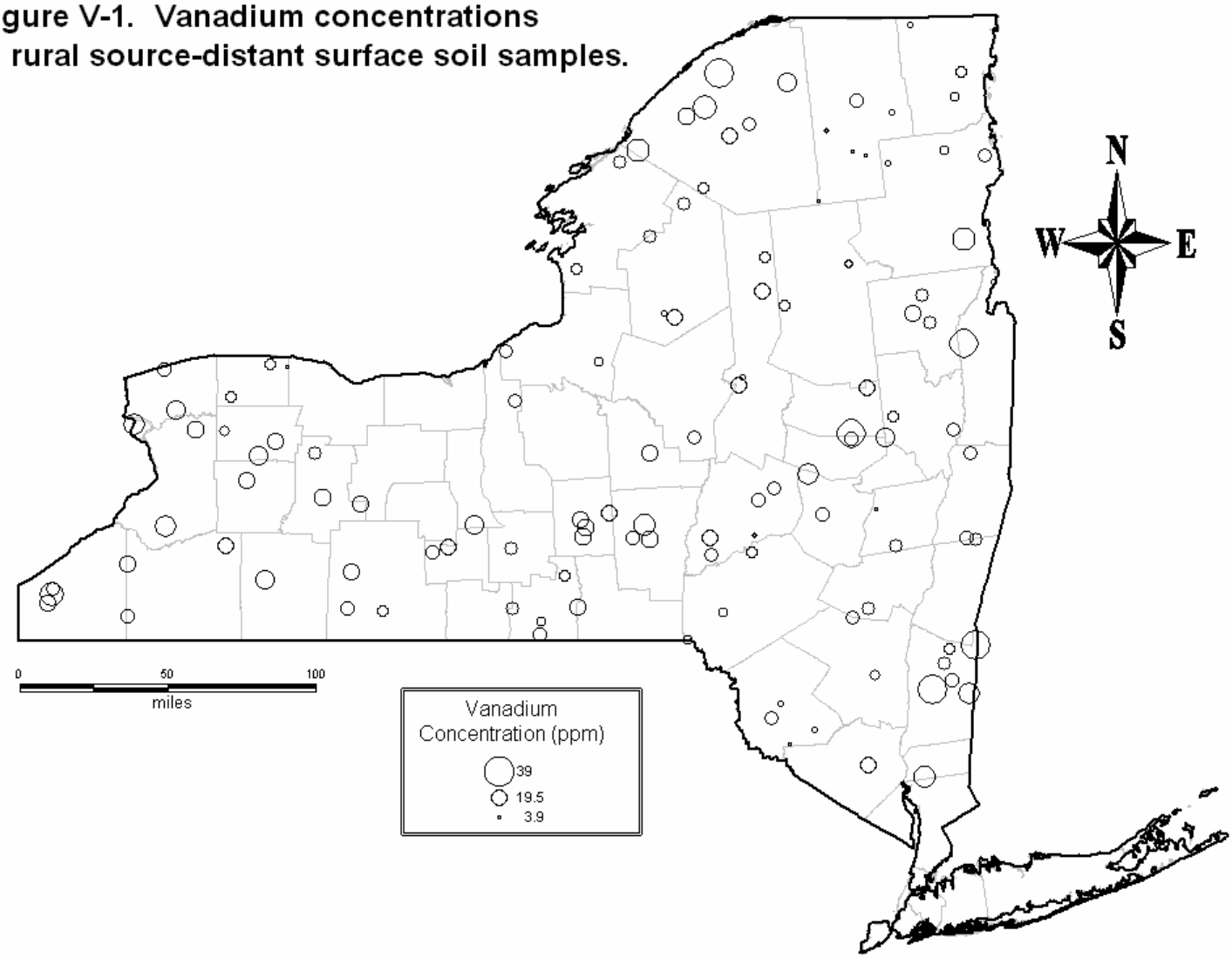

Figure V-2. Vanadium concentrations in rural habitat surface soil samples.

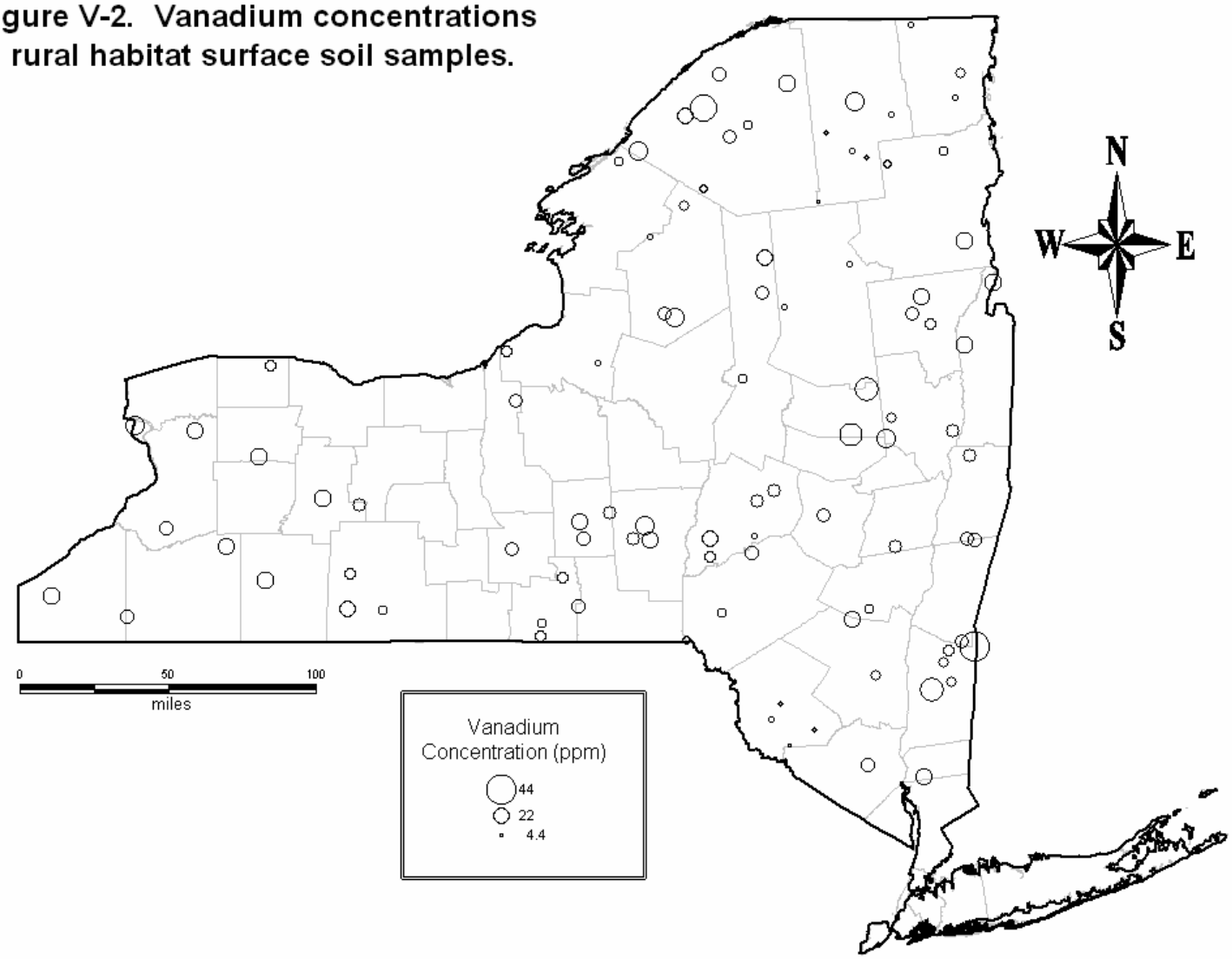

Figure Zn-1. Zinc concentrations in rural source-distant surface soil samples.

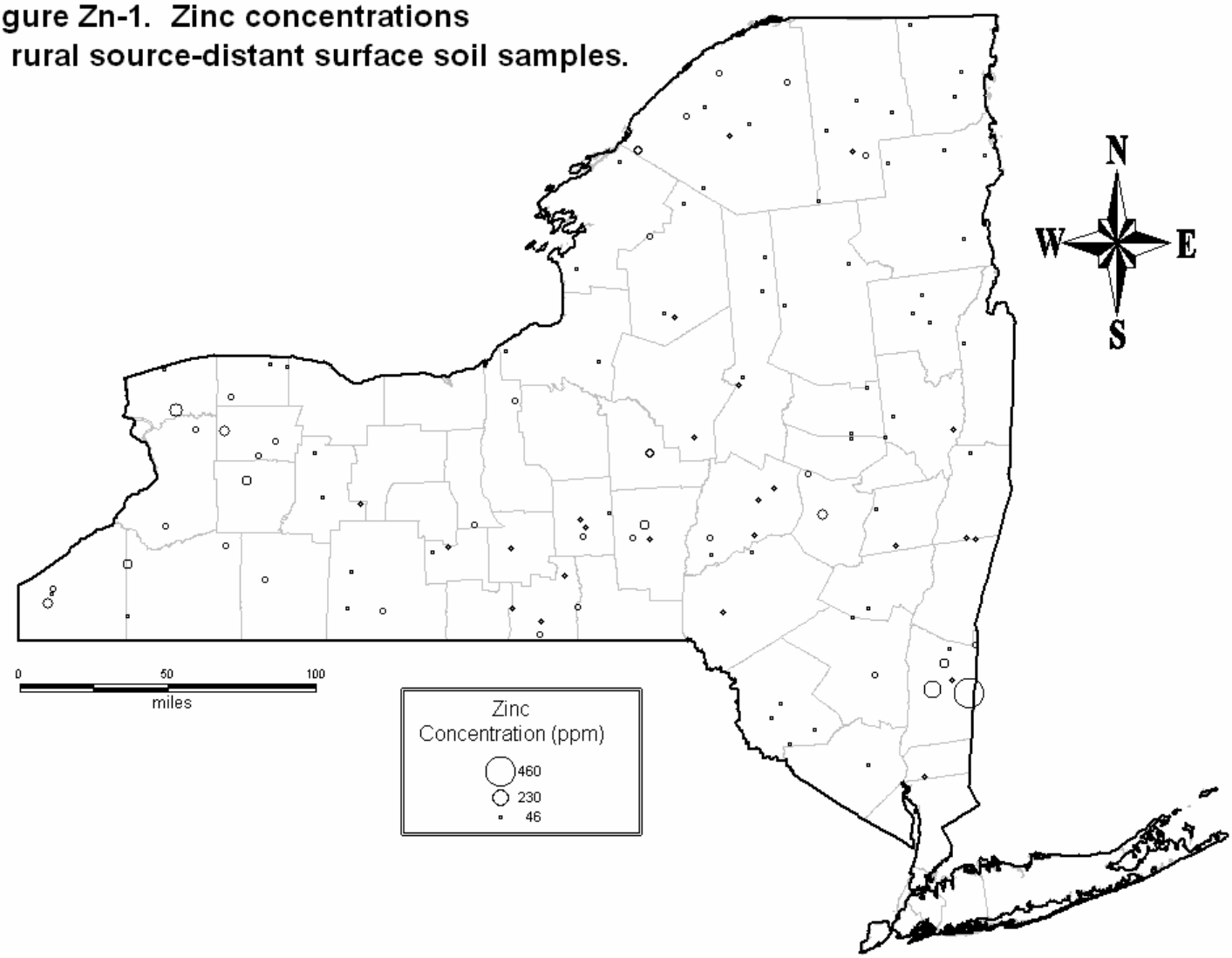

Figure Zn-2. Zinc concentrations in rural habitat surface soil samples.

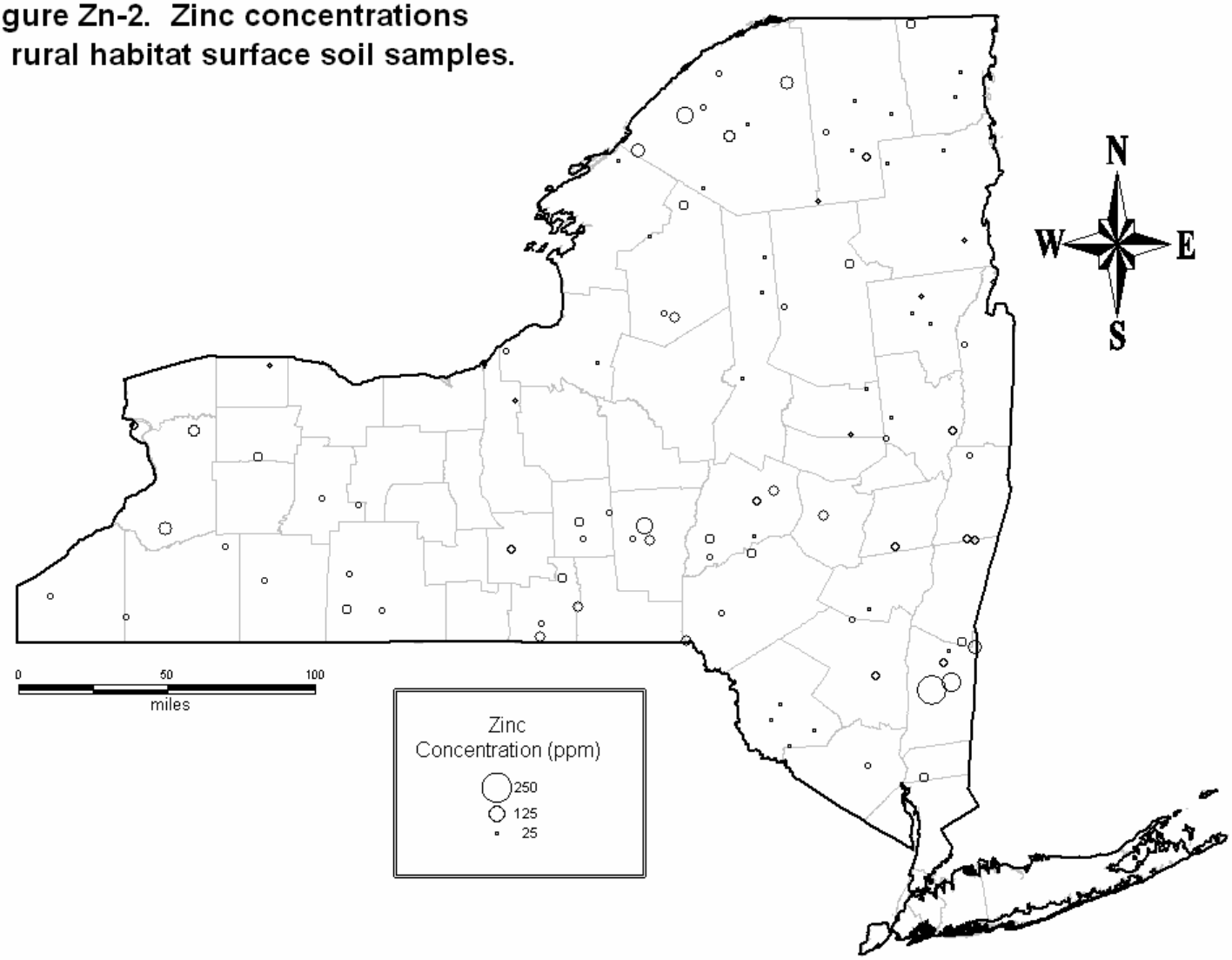

Table 1. Results of protocol conformance and missing data evaluations.

SOURCE-DISTANT DATA SET		
Sample Number	**Reason for Elimination or Absence**	**Source of Determination**
35D	Owner stated property was formerly an orchard. Protocol prohibited sampling at orchards.	sampling notes
56D	Data not received from the lab	
60D	Data not received from the lab	
65D	Data not received from the lab	
70D	Data not received from the lab	
75D	Data not received from the lab	
101D	Owner stated property was formerly an orchard. Protocol prohibited sampling at orchards.	sampling notes

NEAR SOURCE DATA SET		
Sample Number	**Reason for Elimination or Absence**	**Source of Determination**
16N	Data not received from the lab	
56N	Data not received from the lab	
75N	Data not received from the lab	

HABITAT DATA SET		
Sample Number	**Reason for Elimination or Absence**	**Source of Determination**
5H	Sample located in lawn	collection photograph sampling notes
26H	Sample taken in treed area surrounded by active agriculture and not large enough to meet habitat requirement	aerial photograph sampling notes
27H	Sample taken in residential area surrounded by active agriculture, no habitat area	aerial photograph sampling notes
29H	Sample taken within active lawn area at the edge of habitat area	sampling notes
30H	Sample taken in treed area surrounded by residential area and active agricultural, no habitat area available on property	sampling notes aerial photograph
31H	Sample taken in hedgerow at the edge of property, no habitat area available on property	sampling notes

HABITAT DATA SET (continued)		
Sample Number	**Reason for Elimination or Absence**	**Source of Determination**
34H	Sample taken in active agriculture field	aerial photograph sampling notes
35H	Sample taken on a property that was a converted orchard, no habitat area available on property	sampling notes
37H	Sample taken in recently active agriculture field	sampling notes aerial photograph
41H	No habitat area available on property	sampling notes aerial photograph
42H	Sample taken on a residential property surrounded by active agriculture, no habitat area available	sampling notes aerial photograph
43H	No habitat area available on property and no sampling data collected	aerial photograph
59H	No habitat area available on property	sampling notes aerial photograph
60H	Data not received from the lab	
65H	Data not received from the lab	
70H	Data not received from the lab	
75H	Data not received from the lab	
79H	No habitat area available on property	sampling notes aerial photograph
81H	Sample taken within active agriculture field on the edge of habitat areas	collection photograph sampling notes
85H	Sample taken in area too close to active agriculture	sampling notes aerial photograph
87H	Sample taken in area of active agriculture	sampling notes aerial photograph
88H	Sample taken in hedgerow between active agriculture fiel	sampling notes
90H	Sample taken in active agricultural field, no habitat area available on property	sampling notes aerial photograph
93H	Sample taken in close proximity to active agriculture	sampling notes aerial photograph
101H	Sample taken in area that was converted orchard	sampling notes
106H	Sample taken in active agricultural field	sampling notes
114H	Sample taken in active agriculture field	collection photograph sampling notes
115H	Sample taken in recently active agriculture field	sampling notes
124H	Sample taken in area that is managed either for agriculture or recreational area	sampling notes aerial photograph

Table 2. Counties where rural soil samples were collected (by sample type).

County	Source-distant	Near source	Habitat	Total
Albany	1	0	1	2
Alleganey	1	0	1	2
Broome	1	0	1	2
Cattaraugus	3	0	2	5
Cayuga	1	0	1	2
Chautauqua	3	1	1	5
Chenango	3	1	3	7
Clinton	3	0	3	6
Columbia	1	0	2	3
Cortland	4	1	3	8
Delaware	3	2	3	8
Dutchess	6	1	5	12
Erie	3	0	3	6
Essex	4	2	3	9
Franklin	5	3	5	13
Fulton	2	1	2	5
Genessee	3	1	1	5
Greene	2	0	2	4
Hamilton	2	0	2	4
Herkimer	4	2	3	9
Jefferson	2	0	1	3
Lewis	4	1	4	9
Livingston	3	1	2	6
Madison	1	0	0	1
Montgomery	1	1	0	2
Niagara	2	0	0	2
Oneida	1	0	0	1
Orange	1	0	1	2
Orleans	2	1	1	4
Oswego	2	1	2	5
Otsego	5	1	5	11
Putnam	1	0	1	2
Rensselaer	2	1	2	5
Saratoga	3	0	3	6
Schoharie	2	0	1	3
Schuyler	2	0	0	2
Seneca	1	0	0	1
St. Lawrence	9	0	9	18
Steuben	3	2	3	8
Sullivan	4	0	4	8
Tioga	4	2	3	9
Tompkins	1	0	1	2
Ulster	1	1	1	3
Warren	3	1	3	7
Washington	2	0	2	4
Wyoming	1	0	0	1
TOTAL	**118**	**28**	**96**	**242**

Table 3. Average (mean) relative percent differences for field duplicate samples of selected PAHs and metals.

	METALS																				PAHs				
Sample Pair	**Aluminum**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Calcium**	**Chromium (Total)**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Magnesium**	**Manganese**	**Mercury**	**Nickel**	**Potassium**	**Selenium**	**Sodium**	**Vanadium**	**Zinc**	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(g,h,i)perylene**	**Benzo(k)fluoranthene**
2D, 2DD	3		6	2	2	8	19	47	1	6	36	2	15	0	43	22	29		34	2					
3H, 3HD	3		27	5		22	15	41	37	22	0	24	2	22	31	14	26		66	4					
5N, 5ND	22	28	22	7		39	20	12	25	32	1	14	32	0	12	26	77	4	26	9					
9H, 9HD	**65**		15	44		34	**67**	22	28	**60**	13	**75**	**71**	46	**86**	46	46		5	16					
10D, 10DD	12	**93**	10	15	27	15	11	6	14	6	8	20	2	0	13	11	21	3	8	25					
20D, 20DD	15	9	6	6	14	4	10	15	11	15	30	19	3	15	10	5	26	0	9	6	9	9	21	7	2
29H, 29HD	18	**60**	10	10	22	12	13	12	8	12	9	10	8	22	12	28	5	16	12	15					
30D, 30DD	1	2	0	6	1	1	2	3	2	0	0	4	11	13	3	3	25	17	1	2					
39H, 39HD	5	15	1	10	33	19	3	17	10	8	20	0	24	24	5	4	25		3	2					
40D, 40DD	10	12	10	15	32	8	8	13	8	10	12	9	13	0	7	8	32	12	8	8					
49H, 49HD	3	20	0	5	11	25	0	12	7	5	10	5	19	22	4	13	13	23	0	1					
50D, 50DD	2	10	5	8	3	6	3	15	4	8	7	5	28	**67**	2	6	11	40	8	5					
59H, 59HD	3	18	6	3	11	6	1	1	5	0	1	3	2	29	2	7	4		1	6					
79H, 79HD	2	10	5	6	29	4	5	5	7	0	4	2	2	0	17	6	9	**71**	4	0					
80D, 80DD	3	7	1	3	19	0	2	1	1	2	1	0	11	15	4	10	5	0	2	3					
89H, 89HD	8	6	7	4	19	30	7	14	5	9	4	12	3	5	12	7	19		1	1					
90D, 90DD	1	1	4	4	41	9	4	17	6	11	10	11	17	**67**	6	12	10	2	2	1					
100D, 100DD	2	18	6	8	7	0	1	11	4	6	12	4	22	0	1	14	22	42	1	4		20	25		
109H, 109HD	4	20	**56**	6		10	22	49	2	24	5	11	24	0	23	10	39	18	17	9					
110D, 110DD	34	20	7	31	**90**	3	36	21	36	15	2	**58**	42	40	**66**	17	22	**63**	11	10					
119H, 119HD	19	2	9	9	26	8	13	10	0	9	8	11	10	25	9	10	24		14	9					
120D, 120DD	1	3	2	5	2	17	10	23	12	1	4	4	11	29	27	20	12		11	9					
123N, 123ND	12	33	17	29	16	33	5	6	0	5	12	8	15	33	6	27	40	18	18	8					
125N, 125ND	21		5	26	**65**	26	1	7	20	4	2	24	2	40	22	4	**100**	5	8	2					
N	24	20	24	24	20	24	24	24	24	24	24	24	24	24	24	24	24	16	24	24	1	2	2	1	1
Mean RPD	11	19	10	11	24	14	11	16	11	11	9	14	16	21	18	14	27	21	11	7	9	15	23	7	2

NOTE: Only pairs for which both the sample and the duplicate had detected values were used in this analysis. Bold type indicates RPDs that are above the QAPP criterion of +/- 50 percent.

Table 4. Representation of rural New York State soil orders in the Rural Survey database (Rural Survey, 2005).

Soil Order	***Percentage of NYS***	***Percentage of Rural NYS***	***Percentage of Source-Distant Samples (n=120)***	***Percentage of Remote Samples (n=121)***	***Percentage of Near Source Samples (n=28)***
Alfisols	20%	20%	22%	22%	18%
Entisols	1.8%	1.4%	0%	0%	0%
Histosols	1.7%	1.8%	0%	0%	0%
Inceptisols	48%	49%	55%	55%	57%
Mollisols	0%	0%	0%	0%	0%
Spodosols	22%	24%	23%	22%	25%
Utilisols	0.8%	0.8%	0%	0%	0%
Unknown	5.7%	3%	1%	1%	0%

Table 5a. MDL ranges for analytes not detected in the source-distant data set.

Organics (ppb)

ANALYTE	N	MIN	MAX
Aldrin	118	1.1	5.0
Aroclor-1221	118	3.6	17.0
Aroclor-1232	118	2.5	11.0
Aroclor-1242	118	3.2	15.0
Aroclor-1248	118	3.7	17.0
Aroclor-1254	118	1.4	6.3
Aroclor-1260	118	3.0	14.0
Benzene	118	0.21	0.96
alpha-BHC	118	1.1	5.3
beta-BHC	118	1.2	5.4
delta-BHC	39	0.4	4.2
gamma-BHC	118	1.2	5.8
bis(2-Chloroethoxy)methane	118	16	72
bis(2-Chloroethyl)ether	118	17	78
Bromochloromethane	118	0.5	2.1
Bromoform	118	0.3	1.4
Bromomethane	118	0.7	3.4
4-Bromophenyl-phenylether	118	9	41
Tert butyl alcohol	118	15	70
sec-Butylbenzene	118	0.3	1.1
tert-Butylbenzene	118	0.3	1.3
Carbon Disulfide	118	0.11	0.48
Carbon Tetrachloride	118	0.3	1.4
4-Chloroaniline	118	130	580
Chlorobenzene	118	0.4	1.7

ANALYTE	N	MIN	MAX
Chloroethane	118	0.6	2.5
Chloromethane	118	0.3	1.6
4-Chloro-3-methylphenol	118	10	47
2-Chloronaphthalene	118	7	33
2-Chlorophenol	118	15	68
4-Chlorophenyl-phenylether	118	9	39
4,4-DDE	118	1.3	6.1
4,4-DDT	118	1.9	8.8
Dibromochloromethane	118	0.3	1.4
1,2-Dibromo-3-Chloropropane	118	0.7	3.2
1,2-Dibromoethane	118	0.4	2.0
1,2-Dichlorobenzene	118	0.4	1.9
1,3-Dichlorobenzene	118	0.2	1.0
1,4-Dichlorobenzene	118	0.4	1.7
3,3-Dichlorobenzidine	118	55	340
Dichlorodifluoromethane	118	1.3	5.9
1,1-Dichloroethane	118	0.4	1.7
1,2-Dichloroethane	118	3.2	15.0
1,1-Dichloroethene	118	0.2	1.0
cis-1,2-Dichloroethene	118	0.4	1.7
trans-1,2-Dichloroethene	118	0.4	1.8
2,4-Dichlorophenol	118	12	55
1,2-Dichloropropane	118	0.4	1.6
cis-1,3-Dichloropropene	118	0.20	0.92
t-1,3-Dichloropropene	118	0.3	1.2

ANALYTE	N	MIN	MAX
Dieldrin	118	1.0	4.8
Diethylphthalate	118	11	49
2,4-Dimethylphenol	118	18	85
Dimethylphthalate	118	8	38
4,6-Dinitro-2-methylphenol	118	20	91
2,4-Dinitrophenol	118	15	69
2,4-Dinitrotoluene	118	7	31
2,6-Dinitrotoluene	118	15	67
Endosulfan II	118	1.4	6.3
Endosulfan Sulfate	118	1.5	7.1
Endrin	118	1.9	8.7
Endrin aldehyde	118	1.6	7.3
Endrin ketone	118	1.3	6.2
Ethyl Benzene	118	0.3	1.2
Heptachlor	118	1.3	6.3
Hexachlorobenzene	118	6	30
Hexachlorobutadiene	118	12	55
Hexachlorocyclopentadiene	118	9	39
Hexachloroethane	118	16	75
2-Hexanone	118	3.3	15.0
Isophorone	118	13	59
Isopropylbenzene	118	0.4	1.8
Methoxychlor	118	1.3	6.0
Methyl tert-butyl Ether	118	0.2	1.1
Methyl Acetate	118	1.3	6.1
Methylcyclohexane	118	0.2	1.7
4-Methyl-2-Pentanone	118	2.5	11.0
2-Nitroaniline	118	12	57
3-Nitroaniline	118	55	250

ANALYTE	N	MIN	MAX
4-Nitroaniline	118	27	120
Nitrobenzene	118	17	80
2-Nitrophenol	118	14	63
4-Nitrophenol	118	33	150
N-Nitrosodiphenylamine	118	9	40
N-Nitroso-di-n-propylamine	118	15	69
2,2-oxybis(1-Chloropropane)	118	18	85
Pentachlorophenol	118	11	49
Styrene	118	0.3	1.5
1,1,2,2-Tetrachloroethane	118	0.6	2.5
Toxaphene	118	3.1	14.0
1,1,1-Trichloroethane	118	0.3	1.3
1,1,2-Trichloroethane	118	0.5	2.4
Trichloroethene	118	0.3	1.5
2,4,5-Trichlorophenol	118	23	100
2,4,6-Trichlorophenol	118	12	57
1,1,2-Trichlorotrifluoroethane	118	0.5	2.2
1,2,4-Trimethylbenzene	118	0.4	1.9
1,3,5-Trimethylbenzene	118	0.3	1.4
Vinyl Chloride	118	0.2	1.1
Total Endrins	NA	4.8	22.2

Inorganics (ppm)

ANALYTE	N	MIN	MAX
Cyanide	118	0.1	2.4
Cyanide-Amenable	118	0.5	2.4
Thallium	118	0.0	1.6

NA= Not applicable.

Table 5b. MDL ranges for analytes not detected in the habitat data set.

Organics (ppb)

ANALYTE	N	MIN	MAX
Aldrin	96	1.1	5.0
Aroclor-1016	96	6	24
Aroclor-1221	96	3.7	17.0
Aroclor-1232	96	2.5	11.0
Aroclor-1242	96	3.2	14.0
Aroclor-1248	96	3.8	17.0
Aroclor-1254	96	1.4	6.3
Benzene	96	0.21	0.96
alpha-BHC	96	1.2	5.3
beta-BHC	96	1.2	5.4
delta-BHC	34	0.4	4.2
gamma-BHC	96	1.3	5.7
bis(2-Chloroethoxy)methane	95	16	120
bis(2-Chloroethyl)ether	95	17	130
Bromochloromethane	96	0.5	2.1
Bromoform	96	0.3	1.4
Bromomethane	96	0.8	3.4
4-Bromophenyl-phenylether	95	9	70
Tert butyl alcohol	96	15	70
n-Butylbenzene	96	0.4	2.0
sec-Butylbenzene	96	0.3	1.1
tert-Butylbenzene	96	0.3	1.3
Carbon Disulfide	96	0.11	0.48
Carbon Tetrachloride	96	0.3	1.4
alpha-Chlordane	96	1.6	7.0
gamma-Chlordane	96	1.6	7.0

ANALYTE	N	MIN	MAX
4-Chloroaniline	95	130	980
Chlorobenzene	96	0.4	1.7
Chloroethane	96	0.6	2.5
Chloromethane	96	0.4	1.6
4-Chloro-3-methylphenol	95	10	78
2-Chloronaphthalene	95	7	55
2-Chlorophenol	95	15	110
4-Chlorophenyl-phenylether	95	9	66
4,4-DDD	96	1.1	4.8
4,4-DDE	96	1.3	6.1
4,4-DDT	96	1.9	8.7
Dibenz(a,h)anthracene	95	10	78
Dibenzofuran	95	11	87
Dibromochloromethane	96	0.3	1.4
1,2-Dibromo-3-Chloropropane	96	0.7	3.2
1,2-Dibromoethane	96	0.4	2.0
1,2-Dichlorobenzene	96	0.4	1.9
1,3-Dichlorobenzene	96	0.2	1.0
1,4-Dichlorobenzene	96	0.4	1.7
3,3-Dichlorobenzidine	95	56	420
Dichlorodifluoromethane	96	1.3	5.9
1,1-Dichloroethane	96	0.4	1.7
1,2-Dichloroethane	96	3.2	15.0
1,1-Dichloroethene	96	0.2	1.0
cis-1,2-Dichloroethene	96	0.4	1.7
trans-1,2-Dichloroethene	96	0.4	1.8

ANALYTE	N	MIN	MAX
2,4-Dichlorophenol	95	12	93
1,2-Dichloropropane	96	0.4	1.6
cis-1,3-Dichloropropene	96	0.20	0.92
t-1,3-Dichloropropene	96	0.3	1.2
Dieldrin	96	1.1	4.8
Diethylphthalate	95	11	83
Dimethylphthalate	95	8	63
4,6-Dinitro-2-methylphenol	95	20	150
2,4-Dinitrophenol	95	15	120
2,4-Dinitrotoluene	95	7	53
Di-n-octyl phthalate	95	8	63
Endosulfan I	96	1.5	6.9
Endosulfan II	96	1.4	6.3
Endosulfan Sulfate	96	1.6	7.0
Endrin	96	1.9	8.7
Endrin aldehyde	96	1.6	7.2
Endrin ketone	96	1.4	6.2
Heptachlor	96	1.4	6.2
Heptachlor epoxide	96	1.3	6.0
Hexachlorobenzene	95	7	50
Hexachlorobutadiene	95	12	93
Hexachlorocyclopentadiene	95	9	66
Hexachloroethane	95	17	130
2-Hexanone	96	3.4	15.0
Isophorone	95	13	98
Isopropylbenzene	96	0.4	1.8
p-Isopropyltoluene	96	0.6	2.8
Methoxychlor	96	1.3	6.0
Methyl tert-butyl Ether	96	0.3	1.1

ANALYTE	N	MIN	MAX
Methyl Acetate	96	1.3	6.1
Methylcyclohexane	96	0.2	1.7
2-Methylnaphthalene	95	6	46
4-Methyl-2-Pentanone	96	2.5	11.0
2-Methylphenol	95	22	170
3-Nitroaniline	95	56	430
4-Nitroaniline	95	27	210
Nitrobenzene	95	18	130
2-Nitrophenol	95	14	110
4-Nitrophenol	95	34	260
N-Nitrosodiphenylamine	95	9	67
N-Nitroso-di-n-propylamine	95	15	120
2,2-oxybis(1-Chloropropane)	95	19	140
Pentachlorophenol	95	11	82
Styrene	96	0.3	1.5
1,1,2,2-Tetrachloroethane	96	0.6	2.5
Toluene	96	0.3	1.2
Toxaphene	96	3.2	14.0
1,1,1-Trichloroethane	96	0.3	1.3
1,1,2-Trichloroethane	96	0.5	2.4
Trichloroethene	96	0.3	1.5
2,4,5-Trichlorophenol	95	23	180
2,4,6-Trichlorophenol	95	13	96
1,1,2-Trichlorotrifluoroethane	96	0.5	2.2
1,3,5-Trimethylbenzene	96	0.3	1.4
Vinyl Chloride	96	0.3	1.1
Total Chlordanes	NA	3.2	14.0
Total Endosulfans	NA	4.5	20.2
Total Endrins	NA	4.9	22.1

Inorganics (ppm)

ANALYTE	N	MIN	MAX
Cyanide	96	0.1	2.4
Cyanide-Amenable	96	0.5	2.4
Thallium	96	0.3	1.6

NA= Not applicable.

Table 5c. MDL ranges for analytes not detected in the near source data set.

Organics (ppb)

ANALYTE	N	MIN	MAX
Aldrin	28	1.2	2.7
Aroclor-1016	28	5.9	13.0
Aroclor-1221	28	4.0	9.0
Aroclor-1232	28	2.7	6.1
Aroclor-1242	28	3.5	7.8
Aroclor-1248	28	4.1	9.3
Aroclor-1254	28	1.5	3.4
Benzene	28	0.23	0.52
alpha-BHC	28	1.2	2.8
beta-BHC	28	1.3	2.9
delta-BHC	10	0.4	2.2
gamma-BHC	28	1.4	3.1
bis(2-Chloroethoxy)methane	28	17	170
bis(2-Chloroethyl)ether	28	18	190
Bromochloromethane	28	0.5	1.1
Bromoform	28	0.34	0.77
Bromomethane	28	0.8	1.8
4-Bromophenyl-phenylether	28	10	100
Tert butyl alcohol	28	17	37
sec-Butylbenzene	28	0.27	0.62
tert-Butylbenzene	28	0.31	0.71
Carbon Disulfide	28	0.11	0.26
Carbon Tetrachloride	28	0.34	0.76
alpha-Chlordane	28	1.7	3.8
gamma-Chlordane	28	1.7	3.8
4-Chloroaniline	28	140	1,400
Chlorobenzene	28	0.4	0.9

ANALYTE	N	MIN	MAX
Chloroethane	28	0.6	1.3
Chloromethane	28	0.38	0.85
4-Chloro-3-methylphenol	28	11	110
2-Chloronaphthalene	28	8	80
2-Chlorophenol	28	16	170
4-Chlorophenyl-phenylether	28	9	95
4,4-DDD	28	1.1	2.6
4,4-DDE	28	1.4	3.3
4,4-DDT	28	2.1	4.7
Dibenz(a,h)anthracene	28	11	110
Dibromochloromethane	28	0.33	0.75
1,2-Dibromo-3-Chloropropane	28	0.8	1.7
1,2-Dibromoethane	28	0.5	1.1
1,2-Dichlorobenzene	28	0.5	1.0
1,3-Dichlorobenzene	28	0.24	0.54
1,4-Dichlorobenzene	28	0.40	0.90
3,3-Dichlorobenzidine	28	59	620
Dichlorodifluoromethane	28	1.4	3.2
1,1-Dichloroethane	28	0.40	0.91
1,2-Dichloroethane	28	3.5	7.9
1,1-Dichloroethene	28	0.24	0.55
cis-1,2-Dichloroethene	28	0.40	0.90
trans-1,2-Dichloroethene	28	0.42	0.95
2,4-Dichlorophenol	28	13	130
1,2-Dichloropropane	28	0.38	0.86
cis-1,3-Dichloropropene	28	0.22	0.50
t-1,3-Dichloropropene	28	0.29	0.66

ANALYTE	N	MIN	MAX
Dieldrin	28	1.1	2.6
2,4-Dimethylphenol	28	20	210
4,6-Dinitro-2-methylphenol	28	21	220
2,4-Dinitrophenol	28	16	170
2,4-Dinitrotoluene	28	7	76
2,6-Dinitrotoluene	28	16	160
Di-n-octyl phthalate	28	9	92
Endosulfan I	28	1.6	3.7
Endosulfan II	28	1.5	3.4
Endosulfan Sulfate	28	1.7	3.8
Endrin	28	2.0	4.6
Endrin aldehyde	28	1.7	3.9
Endrin ketone	28	1.5	3.3
Ethyl Benzene	28	0.28	0.64
Heptachlor	28	1.5	3.3
Heptachlor epoxide	28	1.4	3.2
Hexachlorobenzene	28	7	72
Hexachlorobutadiene	28	13	130
Hexachlorocyclopentadiene	28	9	96
Hexachloroethane	28	18	180
2-Hexanone	28	3.6	8.2
Isophorone	28	14	140
Isopropylbenzene	28	0.42	0.95
Methoxychlor	28	1.4	3.2
Methyl tert-butyl Ether	28	0.26	0.59
Methyl Acetate	28	1.4	3.3
Methylcyclohexane	28	0.26	0.91
2-Methylnaphthalene	28	6	66
4-Methyl-2-Pentanone	28	2.7	6.2
2-Methylphenol	28	23	240

ANALYTE	N	MIN	MAX
2-Nitroaniline	28	13	140
3-Nitroaniline	28	60	620
4-Nitroaniline	28	29	300
Nitrobenzene	28	19	190
2-Nitrophenol	28	15	150
4-Nitrophenol	28	36	370
N-Nitrosodiphenylamine	28	9	97
N-Nitroso-di-n-propylamine	28	16	170
2,2-oxybis(1-Chloropropane)	28	20	210
Pentachlorophenol	28	12	120
Styrene	28	0.36	0.80
1,1,2,2-Tetrachloroethane	28	0.6	1.4
Toluene	28	0.29	0.66
Toxaphene	28	3.4	7.6
1,1,1-Trichloroethane	28	0.31	0.69
1,1,2-Trichloroethane	28	0.6	1.3
Trichloroethene	28	0.36	0.82
2,4,5-Trichlorophenol	28	24	250
2,4,6-Trichlorophenol	28	13	140
1,1,2-Trichlorotrifluoroethane	28	0.5	1.2
1,3,5-Trimethylbenzene	28	0.32	0.73
Vinyl Chloride	28	0.27	0.60
Total Chlordanes	NA	3.4	7.6
Total Endosulfans	NA	4.8	10.9
Total Endrins	NA	5.2	11.8

Inorganics (ppm)

ANALYTE	N	MIN	MAX
Antimony	28	0.6	1.5
Cyanide	28	0.1	1.3
Cyanide-Amenable	28	0.6	1.3
Thallium	28	0.37	0.85

NA= Not applicable.

Table 6a. Distribution-free percentile values for detected analytes in the source-distant data set (outliers included).

Organics (ppb)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Acenaphthene	118	1.7	<8	<9	<10	<11	<20	<33	<35	110
Acenaphthylene	118	4.2	<10	<13	<14	<16	<36	46*	110	590
Anthracene	118	6.8	<8	<10	<11	<13	<35	97	120	150
Aroclor-1016	118	0.8	<5	<7	<7	<8	<10	<18	<24	72
Benzo(a)anthracene	118	10.2	<5	<7	<7	<10	72	160	500	2,600
Benzo(a)pyrene	118	10.2	<6	<7	<8	<12	41	120	470	3,400
Benzo(b)fluoranthene	118	13.6	<18	<23	<26	<38	110	360	590	4,600
Benzo(k)fluoranthene	118	10.2	<12	<15	<16	<23	<54***	100	330	1,700
Benzo(g,h,i)perylene	118	7.6	<15	<19	<21	<25	<62***	70	200	1,500
n-Butylbenzene	118	2.5	<0.4	<0.5	<0.6	<0.6	<0.9	<1.9	2.1	5.6
Carbazole	118	4.2	<8	<9	<10	<12	<26	<35	80	150
gamma-Chlordane	118	0.8	<1.5	<1.9	<2.0	<2.2	<2.8	5.1*	<6.7	<7.1
alpha-Chlordane	118	0.8	<1.5	<1.8	<2.0	<2.2	<2.7	<5.2	<7.0	10.0
Chrysene	118	12.7	<11	<14	<15	<23	100	230	610	2,400
4,4-DDD	118	0.8	<1.0	<1.3	<1.4	<1.5	<1.9	<3.6	<4.9	8.3
Dibenz(a,h)anthracene	118	1.7	<10	<12	<14	<15	<27	<44	<46	230
Dibenzofuran	118	2.5	<11	<14	<16	<18	<31	<51	53	93
Di-n-octyl phthalate	118	0.8	<8	<10	<11	<12	<22	<34	<37	65
1,4-Dioxane	117	1.7	<21	<25	<28	<30	<41	79*	<91	<95
Endosulfan I	118	0.8	<1.5	<1.8	<2.0	<2.2	<2.7	<5.2	<7.0	15.0
Fluoranthene	118	21.2	<5	<6	<7	<20	130	630	1,200	1,800
Fluorene	118	3.4	<10	<12	<13	<15	<33	<45	87	130
Heptachlor epoxide	118	0.8	<1.3	<1.6	<1.8	<1.9	<2.4	4.3*	<5.8	<6.1
Indeno(1,2,3-cd)pyrene	118	5.9	<8	<10	<11	<14	<34	76	180	1,400

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
p-Isopropyltoluene	118	2.5	<0.6	<0.7	<0.8	<0.9	<1.2	<2.5	2.9	8.6
2-Methylnaphthalene	118	0.8	<6	<7	<8	<9	<16	<25	<27	53
2-Methylphenol	118	0.8	<22	<26	<29	<32	<57	<90	<99	300
Naphthalene	118	43.2	<0.3	<0.4	<0.5	3.9	12.0	19.0	24.0	26.0
Phenanthrene	118	14.4	<8	<10	<11	<17	72	350	770	1,100
Pyrene	118	25.4	<6	<8	<9	39	170	640	1,100	2,900
Toluene	116	1.7	<0.3	<0.3	<0.4	<0.4	<0.5	<1.0	<1.2	13.0
m/p-Xylenes	118	2.5	<0.5	<0.7	<0.7	<0.8	<1.1	2.2*	2.4	4.5
o-Xylene	118	0.8	<0.5	<0.6	<0.6	<0.7	<0.8	<1.5	<2.0***	<2.1***
Total Chlordanes	NA	NA	3.0	3.7	4.0	4.4	5.5	10.4	14.1	15.1
Total Endosulfans	NA	NA	4.4	5.3	5.8	6.4	7.9	15.1	19.3	20.4
Total PAHs**	NA	NA	73	96	109	220	847	3,375	6,389	23,452
Total Carcinogenic PAHs**	NA	NA	35	44	50	80	431	956	2,847	16,330
BaP TEQs**	NA	NA	10	12	13	19	52	185	652	4,509

Inorganics (ppm)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Aluminum	118	100.0	561	6,900	9,855	12,200	14,000	15,800	17,000	20,000
Antimony	118	5.1	<0.6	<0.7	<0.8	<0.9	<1.2***	<2.4***	<2.7***	5.0
Arsenic	118	91.5	<0.2	2	5	7	10	12	14	69
Barium	118	100.0	4	46	67	98	126	165	312	743
Beryllium	118	100.0	0.1	0.4	0.5	0.7	0.9	1.0	1.1	2.5
Cadmium	118	78.0	<0.05	<0.2***	0.4	0.9	1.9	2.4	2.7	4.2
Calcium	118	100.0	245	1,140	2,125	3,600	7,010	9,190	46,400	74,500
Chromium (Total)	118	100.0	1	6	11	14	17	20	22	36
Cobalt	118	98.3	0.3*	4.0	6.5	8.6	11.0	13.3	14.8	15.1

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Copper	118	100.0	2	6	12	19	26	32	61	98
Iron	118	100.0	783	10,200	15,350	20,100	22,400	25,600	27,600	29,500
Lead	118	100.0	3	17	23	38	63	72	75	110
Magnesium	118	100.0	177	1,080	2,305	3,150	4,110	5,130	7,790	46,000
Manganese	118	100.0	13	241	466	748	1,030	1,610	1,760	4,550
Mercury	118	99.2	0.01*	0.03	0.05	0.09	0.14	0.20	0.27	0.34
Nickel	118	100.0	0	6	11	17	22	25	26	49
Potassium	118	100.0	116	424	787	1,100	1,480	1,890	2,180	2,440
Selenium	118	95.8	<0.4	1.1	1.9	2.6	3.3	3.7	5.7	6.5
Silver	118	18.6	<0.1	<0.1	<0.1	<0.2***	0.4*	0.6	1.3	1.6
Sodium	118	78.0	<39	<57***	79	117	<179***	211	269	422
Vanadium	118	100.0	2	14	17	21	26	31	38	38
Zinc	118	100.0	10	38	58	79	115	140	180	454

The "%" column indicates the perentage of the samples that had deteted values.
The less-than symbol ("<") signifies the method detection limit (MDL) for a non-detected value.
Percentile values computed as an average of a detect and a non-detect are recorded as detected values.
***Actual detected value; other non-detected readings had higher values.**
****Calculated using half the MDL for non-detected values.**
*****Actual non-detected value; other detected readings had lower values.**
NA= Not applicable.

Table 6b. Distribution-free percentile values for detected analytes in the habitat data set (outliers included).

Organics (ppb)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Acenaphthene	95	1.1	<7.7	<9.4	<10	<12	<19	<26	<58	120
Acenaphthylene	95	1.1	<10	<13	<14	<16	<26	<35	<79	500
Anthracene	95	1.1	<8	<10	<11	<13	<21	<28	<63	510
Aroclor-1260	96	1.0	<3	<4	<4	<5	<6	<9	<14	47
Benzo(a)anthracene	95	5.3	<5	<7	<7	<9	<17	62	150	1,500
Benzo(a)pyrene	95	4.2	<6	<7	<8	<10	<18	<46	110	1,100
Benzo(b)fluoranthene	95	5.3	<18	<23	<25	<31	<58	96	150	1,300
Benzo(k)fluoranthene	95	5.3	<12	<15	<16	<20	<37	66	<90***	590
Benzo(g,h,i)perylene	95	4.2	<15	<19	<20	<25	<46	<68***	<120***	400
2-Butanone	96	1.0	<2	<3	<3	<4	<5	<7	<11	31
Carbazole	95	1.1	<8	<9	<10	<12	<19	<26	<58	150
Chrysene	95	5.3	<11	<14	<15	<19	<35	71	190	1,900
1,4-Dioxane	96	1.0	<21	<26	<28	<31	<39	<50	<71***	<95***
2,4-Dimethylphenol	95	1.1	<19	<23	<25	<31	<49	<63	<140	270
2,6-Dinitrotoluene	95	1.1	<15	<18	<20	<24	<39	<50	<110	310
Ethyl Benzene	96	1.0	<0.3	<0.3	<0.4	<0.4	<0.5	<0.8	<1.0***	<1.2***
Fluoranthene	95	13.7	<5	<6	<7	<11	69	87	330	3,200
Fluorene	95	1.1	<10	<12	<13	<16	<25	<33	<75	310
Indeno(1,2,3-cd)pyrene	95	4.2	<8	<10	<11	<14	<26	54	75	270
Naphthalene	96	33.3	<0.3	<0.4	<0.5	5	10	14	18	<45***
2-Nitroaniline	95	1.1	<13	<15	<17	<21	<33	<43	62*	<96
Phenanthrene	95	6.3	<8	<10	<10	<13	<25	75	240	2,700
Phenol	95	1.1	<14	<18	<20	<23	<38	<49	<110	170

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Pyrene	95	18.9	<6	<8	<9	<17	76	170	320	4,600
1,2,4-Trimethylbenzene	96	1.0	<0.4	<0.5	<0.6	<0.7	<0.8	1.2*	<1.6	<1.9
m/p-Xylenes	96	3.1	<0.5	<0.7	<0.7	<0.8	<1.1	<2.1	3.6	5.6
o-Xylene	96	3.1	<0.5	<0.6	<0.6	<0.7	<0.9	<1.5***	<2.1***	2.3
Total PAHs**	NA	NA	0	94	109	171	330	667	1,699	19,027
Total Carcinogenic PAHs**	NA	NA	0	44	48	65	112	271	707	6,674
BaP TEQs**	NA	NA	0	12	13	16	30	75	153	1,428

Inorganics (ppm)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Aluminum	96	100.0	906	5,950	9,840	12,750	15,100	16,400	21,400	21,800
Antimony	96	2.1	<0.6	<0.7	<0.8	<0.9	<1.1	<2.0	3.3	5.8
Arsenic	96	89.6	<0.3	1.7	4.2	7.4	11.1	13.0	16.7	28.1
Barium	96	100.0	6	37	57	87	129	176	254	278
Beryllium	96	100.0	0.1	0.4	0.5	0.7	1.0	1.1	1.3	3.8
Cadmium	96	72.9	<0.05	0.1*	0.4	0.8	1.9	2.1	2.8	3.6
Calcium	96	100.0	113	743	1,265	2,820	4,810	6,100	14,800	19,800
Chromium (Total)	96	100.0	1.3	5.0	10.7	13.5	16.3	19.1	24.3	24.4
Cobalt	96	100.0	0.5	3.2	6.0	8.5	11.6	12.8	13.4	16.9
Copper	96	100.0	2	6	11	15	25	33	53	101
Iron	96	100.0	1,190	8,770	15,050	19,800	24,500	26,200	29,500	29,800
Lead	96	100.0	3	17	26	37	54	63	77	112
Magnesium	96	100.0	105	954	1,940	2,925	3,920	5,150	7,930	10,100
Manganese	96	100.0	17	147	397	650	1,130	1,600	1,940	4,140
Mercury	96	100.0	0.01	0.05	0.07	0.10	0.15	0.18	0.28	0.30
Nickel	96	100.0	1	4	11	17	22	25	37	50

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Potassium	96	100.0	126	286	599	949	1,310	1,700	2,230	2,440
Selenium	96	95.8	0.4*	1.2	2.1	2.6	3.3	3.9	4.4	5.1
Silver	96	18.8	<0.1	<0.1	<0.2***	<0.2***	0.5*	0.7	1.0	1.2
Sodium	96	74.0	<39	57*	75*	111*	203	251	282	627
Vanadium	96	100.0	3	12	18	23	26	33	39	44
Zinc	96	100.0	11	30	51	70	88	109	157	242

The "%" column indicates the perentage of the samples that had deteted values.
The less-than symbol ("<") signifies the method detection limit (MDL) for a non-detected value.
Percentile values computed as an average of a detect and a non-detect are recorded as detected values.
***Actual detected value; other non-detected readings had higher values.**
****Calculated using half the MDL for non-detected values.**
*****Actual non-detected value; other detected readings had lower values.**
NA= Not applicable.

Table 6c. Distribution-free percentile values for detected analytes in the near source data set (outliers included).

Organics (ppb)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Acenaphthene	28	7.1	<8	<9	<10	<19	<85	100	150	150
Acenaphthylene	28	10.7	<11	<13	<15	<25	98*	<110	500	500
Anthracene	28	17.9	<9	<10	<12	<22	180	310	620	620
Aroclor-1260	28	7.1	<3	<4	<4	<5	<8	20	32	32
Benzo(a)anthracene	28	35.7	<6	<7	<11	210	1,200	1,200	2,900	2,900
Benzo(a)pyrene	28	32.1	<7	<7	<10	150	630	1,100	2,400	2,400
Benzo(b)fluoranthene	28	42.9	<20	<24	41*	305	850	1,200	3,300	3,300
Benzo(k)fluoranthene	28	25.0	<13	<15	<17	160	360	740	1,500	1,500
Benzo(g,h,i)perylene	28	21.4	<17	<19	<22	74	290	550	630	630
n-Butylbenzene	28	7.1	<0.5	<0.5	<0.5	<0.6	<1.1	2.1	3.4	3.4
Carbazole	28	10.7	<8	<9	<11	<19	110	230	680	680
Chrysene	28	39.3	<12	<14	<25	210	540	630	1,300	1,300
Dibenzofuran	28	7.1	<13	<14	<16	<27	<50***	<130***	180	180
Diethylphthalate	28	3.6	<12	<13	<15	<25	<48	<120	130	130
Dimethylphthalate	28	3.6	<9	<10	<11	<20	<36	<92	580	580
1,4-Dioxane	28	3.6	<23*	<24	<26	<29	<35	<48	<51	<51
Fluoranthene	28	46.4	<5	<6	<26	320	2,000	2,800	7,400	7,400
Fluorene	28	10.7	<11	<12	<14	<25	120	160	580	580
Indeno(1,2,3-cd)pyrene	28	21.4	<9	<10	<12	<57	260	620	660	660
p-Isopropyltoluene	28	3.6	<0.7	<0.7	<0.8	<0.9	<1.4	<1.5	14.0	14.0
Naphthalene	28	39.3	<0.3	<0.4	<0.5	4.7	15.0	16.0	17.0	17.0
Phenanthrene	28	42.9	<9	<10	<19	110	950	1,600	8,500	8,500
Pyrene	28	50.0	<7	<8	53*	370	1,600	2,800	8,700	8,700

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
1,2,4-Trimethylbenzene	28	3.6	<0.5	<0.5	<0.5	<0.6	<1.0	<1.0	3.0	3.0
m/p-Xylenes	28	7.1	<0.6	<0.6	<0.7	<0.8	<1.3	2.7	6.8	6.8
o-Xylene	28	7.1	<0.5	<0.5	<0.6	<0.7	1.0*	<1.1	2.4	2.4
Total PAHs**	NA	NA	162	204	358	2,239	9,054	14,554	38,215	38,215
Total Carcinogenic PAHs**	NA	NA	78	93	155	1,212	3,965	6,182	11,114	11,114
BaP TEQs**	NA	NA	21	25	37	274	909	1,433	3,135	3,135

Inorganics (ppm)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Aluminum	28	100.0	1,860	5,235	8,550	11,500	13,700	13,700	14,400	14,400
Arsenic	28	96.4	<0.3	2.3	3.2	6.9	8.0	12.8	14.1	14.1
Barium	28	100.0	11	32	63	78	156	156	188	188
Beryllium	28	100.0	0.2	0.4	0.4	0.6	0.9	1.0	1.3	1.3
Cadmium	28	75.0	<0.1	<0.1***	0.4	0.7	1.5	2.1	2.3	2.3
Calcium	28	100.0	465	2,030	3,300	6,925	38,800	53,900	56,500	56,500
Chromium (Total)	28	100.0	1.3	5.8	11.1	14.6	15.8	16.0	17.5	17.5
Cobalt	28	96.4	<0.2	3.7	5.6	9.3	13.2	13.4	24.1	24.1
Copper	28	100.0	3.4	8.6	15.5	19.4	23.9	25.9	29.6	29.6
Iron	28	100.0	3,090	10,030	13,300	19,550	22,800	23,200	25,700	25,700
Lead	28	100.0	9	17	26	48	61	84	133	133
Magnesium	28	100.0	220	1,345	2,680	3,415	6,480	13,700	31,400	31,400
Manganese	28	100.0	17	236	426	690	1,160	1,290	1,560	1,560
Mercury	28	96.4	<0.01	0.03	0.04	0.07	0.14	0.19	0.28	0.28
Nickel	28	100.0	1.2	5.2	11.2	17.2	22.3	24.9	29.5	29.5
Potassium	28	100.0	122	510	800	1,150	1,460	1,560	1,660	1,660

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Selenium	28	89.3	<0.4	1.1	1.7	2.5	3.5	4.2	4.4	4.4
Silver	28	17.9	<0.12	<0.13	<0.14	<0.18***	<0.27***	0.37	0.40	0.40
Sodium	28	92.9	53*	100	131	185	221	295	806	806
Vanadium	28	100.0	4.0	10.8	15.3	18.6	21.4	22.7	25.9	25.9
Zinc	28	100.0	15	43	58	73	91	107	109	109

The "%" column indicates the perentage of the samples that had deteted values.
The less-than symbol ("<") signifies the method detection limit (MDL) for a non-detected value.
Percentile values computed as an average of a detect and a non-detect are recorded as detected values.
***Actual detected value; other non-detected readings had higher values.**
****Calculated using half the MDL for non-detected values.**
*****Actual non-detected value; other detected readings had lower values.**
NA= Not applicable.

Table D-1. Final data set for analytes detected in habitat areas.

Organics (ppb)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Fluoranthene	95	13.7	<DL	<DL	<DL	<DL	69	87	330	3200
Naphthalene	96	33.3	<DL	<DL	<DL	5	10	14	18	1
Pyrene	95	18.9	<DL	<DL	<DL	<DL	76	170	320	4600

Inorganics (ppm)

ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Aluminum	96	100.0	906	5950	9840	12750	15100	16400	21400	21800
Arsenic	96	89.6	<DL	1.7	4.2	7.4	11.1	13.0	16.7	28.1
Barium	96	100.0	6	37	57	87	129	176	254	278
Beryllium	96	100.0	0.1	0.4	0.5	0.7	1.0	1.1	1.3	3.8
Cadmium	96	72.9	<DL	0.1	0.4	0.8	1.9	2.1	2.8	3.6
Calcium	96	100.0	113	743	1265	2820	4810	6100	14800	19800
Chromium (Total)	96	100.0	1.3	5.0	10.7	13.5	16.3	19.1	24.3	24.4
Cobalt	96	100.0	0.5	3.2	6.0	8.5	11.6	12.8	13.4	16.9
Copper	96	100.0	2	6	11	15	25	33	53	101
Iron	96	100.0	1190	8770	15050	19800	24500	26200	29500	29800
Lead	96	100.0	3	17	26	37	54	63	77	112

Magnesium	96	100.0	105	954	1940	2925	3920	5150	7930	10100
Manganese	96	100.0	17	147	397	650	1130	1600	1940	4140
Mercury	96	100.0	0.01	0.05	0.07	0.10	0.15	0.18	0.28	0.30
Nickel	96	100.0	1	4	11	17	22	25	37	50
Potassium	96	100.0	126	286	599	949	1310	1700	2230	2440
ANALYTE	N	%	MIN	PERCENTILE VALUES						MAX
				25	50	75	90	95	98	
Selenium	96	95.8	0.4	1.2	2.1	2.6	3.3	3.9	4.4	5.1
Silver	96	18.8	<DL	<DL	<DL	<DL	0.5	0.7	1.0	1.2
Sodium	96	74.0	<DL	57	75	111	203	251	282	627
Vanadium	96	100.0	3	12	18	23	26	33	39	44
Zinc	96	100.0	11	30	51	70	88	109	157	242

The "%" column indicates the percentage of the samples that had detected values.
<DL = less than detection limit; not detected

Appendix E

Approaches for Modifying SCOs for a Track 3 Cleanup or Developing SCOs for Contaminants Not Included in the Track 1 or 2 Tables

This Appendix is a brief guide to the resources in the Technical Support Document (TSD) for developing soil cleanup objectives (SCOs) for: (1) Applicants to the Brownfield Cleanup Program (BCP) program intending to pursue Track 3 and modify the SCOs using site-specific data, or (2) Track 1 or 2 cleanups where NYS DEC or NYS DOH determines that a SCO needs to be developed for a compound not included in Tables 375-3.8 (a) or 375-3.8 (b). For sites being remediated under Track 3 of the Brownfield Cleanup Program, SCOs included in the regulation may be re-calculated in consideration of certain site-specific parameters, as described in this Appendix. For site contaminants for which SCOs are not included in the regulation, SCOs should be developed according to the methods outlined in the sections of the TSD to which this Appendix refers, unless other technically defensible approaches can be documented.

1) Track 3: Site contaminants for which SCOs are presented in the regulation

For sites that are being remediated under Track 3 of the regulation, certain site-specific information may be used to alter some of the parameter values used in the calculation of SCOs. As described below, the parameter values that may be altered using site-specific information are those used in the calculation of SCOs for inhalation and groundwater, and for protection of ecological resources from bioaccumulative contaminants. Changes to these parameter values are subject to approval by the Department.

(A) <u>Protection of Public Health SCOs:</u>

For the inhalation pathway, the parameters that may be modified using site-specific information are identified below (also see Sections 5.2.2.2 and 5.3 of the TSD).

<u>Particulate Inhalation Pathway</u>

Q/C = dispersion term (the inverse of the mean air concentration at the center of square 0.5-acre area source, g/m^2-s per kg/m^3)
R = respirable fraction emission rate (g/m^2-hr)
V = fraction of vegetative cover (unitless)
Um = mean annual wind speed (meters per second)
Ut = equivalent threshold value of the wind speed at 7-meters (meters per second)
F(x) = function dependent on Um/Ut (unitless)

Volatile Inhalation Pathway

Q/C = dispersion term (the inverse of the mean air concentration at the center of square 0.5-acre area source, g/m^2-s per kg/m^3)
T = average duration of volatilization (years)
ρb = dry soil bulk density (mg/m^3)
ds = depth of contamination (meters)

If any or all of the above parameters are modified using site-specific information, the procedures described in the next section of this Appendix (and the TSD) should be followed to determine the final SCO for the site.

(B) Protection of Groundwater SCOs:

For groundwater SCOs (described in Section 7.0 of the TSD), site-specific information may be used to identify a site-specific value for the fraction of organic carbon (f_{oc}) parameter used in the SCO calculation. In order to adjust the SCO for site-specific f_{oc}, the measured value has to be representative of the strata where the contamination exists. The groundwater SCO values should then be re-calculated, following the methods presented in Section 7.0 of the TSD.

(C) Protection of Ecological Resources SCOs:

SCOs for protection of ecological resources are based on three exposure scenarios: direct toxicity to plants, direct toxicity to earthworms, and toxicity to wildlife through food chain bioaccumulation. There are no site-specific conditions that can be used to modify SCOs based on direct toxicity to plants and earthworms. For SCO values based on food chain bioaccumulation, the generic value may be modified by substituting site-specific measurements of soil organic carbon into the formula shown as equation 2 in Section 8.2.3. This equation calculates the uptake of the contaminant from soil by earthworms (earthworm BAF or

bioaccumulation factor), and is used to estimate dietary exposure to birds or mammals at a higher trophic level. The calculated earthworm BAF from equation 2 is incorporated into variable B_i in equation 10 of Section 8.2.3. Variable B_i is an estimate of the concentration of the contaminant in the biota type, in this case, the earthworm. The B_i for the earthworm is calculated by multiplying the earthworm BAF by the concentration in the soil. Equation 10 is then solved using information from the simplified food chain table in Section 8.2.3 and Toxic Reference Values (TRVs) from Sample et al. 1996. A sample calculation is provided in Section 8.4. An electronic copy of the DEC ESCO calculation model, along with necessary TRV information, will be provided upon request.

2) Tracks 1 or 2: Site contaminants for which no SCOs are presented in the regulation

All information and methods used by applicants to derive SCOs for chemicals not included in the regulation are subject to approval by the NYS DOH for the health based SCOs and the NYS DEC for the groundwater and ecological resources SCOs.

(A) Protection of Public Health SCOs:

Section 5.0 of the TSD (and all its subsections) outlines the process for developing health-based SCOs. The section begins with a description of contaminant toxicity assessment and continues through exposure assessment and equations for combining the two assessments for calculating SCOs.

A toxicity assessment for the contaminant must be performed. This consists of checking authoritative bodies (recognized state, national or international health agencies), such as those listed in Table 5.1.1-1, for cancer and non-cancer chronic toxicity values and evaluating the values according to the processes outlined in Section 5.1.1. Alternatively, or in the absence of available toxicity values from these sources, toxicity values may be derived from dose-response assessments performed according to the approaches described in Section 5.1.1. Non-cancer chronic reference doses (RfDs) and reference concentrations should be adjusted, as described in Section 5.2.3, to account for potential non-site exposures. This adjustment may employ a factor

of five as described in Section 5.2.3 of the TSD. Alternatively, a literature review can be conducted to determine an adjustment factor to account for non-site exposure to the contaminant.

Section 5.2 of the TSD describes the exposure scenarios, exposure pathways and data used in exposure assessment. These data, and the toxicity values described above, are used to calculate chronic health-based SCOs according the methods presented in Section 5.3 of the TSD. These SCOs should be calculated for the relevant land use(s) (described in Section 3.0 of the TSD). Chronic health-based SCOs should be calculated for each exposure pathway, each health endpoint (i.e., cancer effects and non-cancer effects), and appropriate receptors (e.g., child, adult and adolescent) as described in the TSD. The pathway-, endpoint-, and receptor-specific SCOs are then combined, as described in Section 5.3 of the TSD, to account for exposure by multiple pathways.

Prior to calculation of combined pathway chronic health-based SCOs, a determination should be made of whether non-cancer inhalation and oral toxicity values are based on local or systemic effects (see Section 5.1.2 of the TSD). For chemicals for which both the inhalation and oral non-cancer toxicity values are based on systemic effects, pathway-specific SCOs can be combined as shown in the equation presented in Section 5.3.5 to calculate final chronic health-based multi-pathway SCOs for each appropriate receptor and health endpoint. For chemicals for which one or both of the non-cancer toxicity values is based on local effects, consideration should be given to whether or not to combine the pathways. The lower of the combined pathway or single pathway SCOs (based on local effects) is the chronic-health based SCO for that receptor and health endpoint. The lowest chronic health-based SCO of those calculated for each receptor and health endpoint should be considered the final chronic health-based SCO. If pathways are not combined for chemicals whose oral and inhalation toxicity values are based on systemic effects, defensible scientific evidence should be presented that indicates the effects are highly dependent on the route of exposure.

The acute toxicity of the chemical also should be considered. The approach outlined in Section 5.1.3 of the TSD should be followed. An acute health-based SCO should be calculated

according to the equation and parameter values presented in Section 5.4 of the TSD, unless another technically defensible approach is used and documented.

If the chemical for which the SCO is to be derived is either a semi-volatile organic compound (SVOC), or a metal or metalloid, the potential for non-allergic irritant contact dermatitis should be considered. The approach outlined in Section 5.1.4 of the TSD, and detailed in Appendix C-1 of the TSD should be followed. SCOs based on irritant contact dermatitis should be calculated according to the equation and parameter values presented in Section 5.5 of the TSD, unless another technically defensible approach is used and documented.

Some chemicals for which SCOs need to be derived may be components of mixtures (see Section 5.1.5 of the TSD). In these instances, the approaches described in Section 5.1.5 of the TSD should be considered.

The final health-based SCO must next be determined. This final value is the lowest of the SCOs based on chronic health effects, acute toxicity (if derived), and irritant contact dermatitis (if derived). Next, a comparison may be made between this final health-based SCO and the level of the contaminant that is representative of the concentration of the contaminant in rural soils of New York State. This rural background soil concentration value may be obtained from information presented in Appendix D or by other means as approved by the Department. If this rural background soil concentration is higher than the final health-based SCO, it may be substituted for the final health-based SCO.

(B) Protection of Groundwater SCOs:

SCOs for the protection of groundwater are calculated using the soil water partitioning theory. Information needed to calculate a groundwater SCO includes the groundwater standard or guidance value and the soil water partitioning coefficient for organic chemicals or the soil water distribution coefficient for inorganic chemicals. The procedure assumes a soil organic compound of 1%, which may be modified based upon site-specific data that are representative of

the contaminated soil. The specific procedure is specified in Section 7.0 of the TSD. Briefly the SCOs are calculated using the following expressions:

Allowable Soil Concentration Cs = f x Koc x Cw, or

Allowable Soil Concentration Cs = Kd x Cw

where:
f = fraction of organic carbon of the natural soil medium
Koc = the soil water partitioning coefficient
Kd = the soil water distribution coefficient
Cw = the groundwater standard or guidance value.

The allowable soil concentration is increased by a dilution attenuation factor of 100 which accounts for the mechanisms that prevent leachate from contaminated soil from actually reaching groundwater.

(C) Protection of Ecological Resources SCOs:

SCOs for protection of ecological resources are based on three exposure scenarios: direct toxicity to plants, direct toxicity to earthworms, and toxicity to wildlife through food chain bioaccumulation.

As discussed in section 8.2.1, risk thresholds for plant uptake of additional contaminants can be estimated using the same methodology used by Efroymson et al., (1997) to derive toxicity benchmarks. That methodology is summarized as follows:

1. Collect (or conduct) studies of the toxicity of the chemical of interest to plants. Efroymson et al., (1997) defined a significant effect as a greater than 20% reduction in plant growth or yield. Thus, a LOEC would be defined as the lowest chemical concentration tested that caused a greater than 20% reduction in growth or yield.

2. An LC50 is defined as the concentration that is lethal to 50% of the exposed organisms. If a study reported a plant LC50, the LC50 was divided by 5 to estimate a LOEC based on a 20% effect concentration from a concentration that caused a 50% decrease in survival.

3. If ten or more suitable studies were identified, the LOECs were organized in rank order, and the concentration equivalent to the 10th percentile of the range of LOECs was selected as the toxicity benchmark for that chemical. If less than 10 studies were available, the lowest LOEC was selected as the risk threshold.

If no plant toxicity data are available for a particular chemical, a toxicity assessment will be needed to develop risk thresholds for that chemical. Any required soil toxicity testing for such an assessment should be based on at least three toxicity tests using different plant species native to New York. Plant species used should be species that would be expected to grow in the type of soil, hydrology, and climatic conditions similar to that of the site being evaluated, or plant species used in standard phytotoxicity test methodologies as approved by the Department.

As discussed in Section 8.2.2, risk thresholds for earthworms exposed to other contaminants via direct uptake from the soil can be determined using the same methodology used by Efroymson et al., (1997a) to derive toxicity benchmarks. That methodology is summarized as follows:

1. Collect (or conduct) studies of the toxicity of the contaminant of interest to earthworms. Earthworm toxicity studies typically evaluate effects such as survival, growth, reproduction, or changes in behavior. Efroymson et al., (1997a) defined a LOEC as the lowest chemical concentration tested that caused a greater than 20% effect.

2. An LC_{50} is defined as the concentration that is lethal to 50% of the exposed organisms. If a study reported an earthworm LC_{50}, the LC_{50} was divided by 5 to estimate a LOEC based on a 20% effect concentration from a concentration that caused a 50% decrease in survival.

3. If ten or more suitable studies were identified, the LOECs were organized in rank order, and the concentration equivalent to the 10th percentile of the range of LOECs was selected as the toxicity benchmark for that chemical. If less than 10 studies were available, the lowest LOEC was selected as the risk threshold.

If no earthworm toxicity information is available for a particular chemical of concern, a toxicity

assessment will be needed to develop new risk thresholds. Any required soil toxicity testing for such an assessment should be based on at least three replicate toxicity tests, or tests with different species of earthworms that are native to New York using standard earthworm test protocols as approved by the Department.

ESCO values for toxicity through food chain exposure can be derived for additional contaminants by following the methods outlined in Section 8.2.3. The required elements of information for a nonpolar organic chemical of interest are its K_{OW} and an appropriate TRV derived experimentally or from the literature. For inorganic chemicals, appropriate plant and earthworm uptake factors (BAFs or uptake regression equation variables) derived either experimentally or from the literature are needed instead of a K_{OW}. Experimentally derived uptake factors must be based on standard plant and earthworm uptake test protocols as approved by the Department. An example of the calculation for a food chain based ESCO value is included in Section 8.4. An electronic copy of the DEC ESCO calculation model, along with necessary TRV information, will be provided upon request.

P:\Bureau\BROWNFIELDS SOIL CLEANUP OBJECTIVES\Final Draft TSD and App for DEC\Appendix E.doc