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ES/ER/TM-219

**Development and Validation
of Bioaccumulation Models
for Small Mammals**

B. E. Sample
J. J. Beauchamp
R. A. Efroymsen
G. W. Suter, II

Date Issued February 1998

Prepared for the
U.S. Department of Energy
Office of Environmental Management
under budget and reporting code EW 20

LOCKHEED MARTIN ENERGY SYSTEMS, INC.
managing the
Environmental Management Activities at the
Oak Ridge East Tennessee Technology Park
Oak Ridge Y-12 Plant Oak Ridge National Laboratory
Paducah Gaseous Diffusion Plant Portsmouth Gaseous Diffusion Plant
under contract DE-AC05-84OR21400
for the
U.S. DEPARTMENT OF ENERGY



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**ENVIRONMENTAL
RESTORATION
PROGRAM**

ES/ER/TM-219

**Development and Validation
of Bioaccumulation Models
for Small Mammals**

MANAGED BY
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

LCN-17560 (S 8-95)

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ACKNOWLEDGMENTS

The authors would like to thank Ron Mellot and Rob Pastorok of PTI Environmental Services for their assistance in providing unpublished validation data. In addition, this report has benefitted from the review and comments of Sylvia Talmage and Chris Welsh.

PREFACE

While considerable data are available concerning chemical concentrations in small mammal tissues in relation to environmental contamination, models relating soil concentrations to whole-body concentrations have not been developed. The purpose of this document, then, was to develop a database of soil and whole-body small mammal concentrations for 9 inorganic chemicals, based on data from 22 studies from 4 countries and 9 states. This information will be used to evaluate risks to predatory wildlife on the Oak Ridge Reservation. Plant and earthworm data and models are presented in companion reports ES/ER/TM-218 and ES/ER/TM-220, respectively.

This work was performed under Work Breakdown Structure 1.4.12.2.3.04.05.02, Activity Data Sheet 8300 (CCADS-8323).

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ABBREVIATIONS

CEC	cation exchange capacity
DTPA	diethylenetriaminepentaacetic acid
GI	gastrointestinal
PD	proportional deviation
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzo-furan
UFs	uptake factors
UPL	upper prediction limit

EXECUTIVE SUMMARY

Whole-body contaminant concentrations in small mammals are needed to evaluate risks to predatory wildlife. Because these data are lacking for most contaminated sites, predators of small mammals are frequently not considered in ecological risk assessments. While considerable data are available concerning chemical concentrations in small mammal tissues in relation to environmental contamination, models relating soil concentrations to whole-body concentrations have not been developed. We developed a database of chemical concentrations in soil and whole bodies of small mammals for 14 inorganic (As, Ba, Cd, Co, Cr, Cu, F, Fe, Hg, Ni, Pb, Se, Tl, and Zn) and 2 organic chemicals [tetrachlorodibenzo-p-dioxin (TCDD) and tetrachlorodibenzo-furan (TCDF)] based on data from 20 studies from 4 countries and 8 U.S. states.

Small mammal species were segregated into insectivore, herbivore, and omnivore trophic groups based on diet. Uptake factors (UFs)—whole-body concentration/soil concentration and regression models of natural-log-transformed soil and whole-body concentrations— were developed for each analyte for all small mammals (e.g., generalized models) and for each trophic group. Models were developed using data from 18 studies and then were applied to data from the remaining two studies for validation purposes. Estimated and observed concentrations in small mammals from the validation dataset were compared using nonparametric Wilcoxon signed-rank tests. Relative accuracy and quality of different estimation methods were evaluated by calculating the proportional deviation (PD)—(measured - estimate)/measured — of the estimate from the measured value and the percentage of estimates that exceeded measured values.

Insufficient data ($n < 4$) were available in the model dataset to fit regression models for Ba, Co, Fe, and Tl. With the exception of F and Hg, significant general regression models were fit for each analyte for which adequate data were available. For Cr, Se, tetrachlorodibenzo-p-dioxin (TCDD), and tetrachlorodibenzo-furan (TCDF), sufficient data were available to fit only one trophic-group-specific model; in all cases, this was for omnivores. Data sufficient to fit > 1 trophic-group-specific model were available for As, Cd, Cu, Ni, Pb, and Zn. Significant differences among trophic-group models were observed for each analyte, except Ni. Data for model validation were available for both herbivores and omnivores for 11 inorganic chemicals (As, Ba, Cd, Co, Cr, Cu, Fe, Ni, Pb, Se, and Zn). No validation data were available for the insectivore trophic group or for F, Hg, TCDD, or TCDF.

Best (e.g., smallest median and range PD, % overestimates closest to 50%) general estimates were generated by regression models for 3 of 9 analytes for herbivores and 7 of 11 analytes for omnivores. Seventy percent (14 of 20) of the best general estimates did not differ significantly from measured values. The 90th percentile UF and the upper 95% prediction interval on the regressions were of equal utility for generating conservative estimates of bioaccumulation in small mammals.

1. INTRODUCTION

Whole-body contaminant concentrations in small mammals are needed to evaluate risks to predatory wildlife. In most assessments where risks to predators are a concern, small mammals are collected from the site and tissue residues determined. In the absence of site-specific data, risks to predators are frequently not considered.

While considerable data are available concerning chemical concentrations in small mammal tissues in relation to environmental contamination (Talmage and Walton 1991), models relating contaminant concentrations in soil to whole-body concentrations in small mammals have not been developed. In the only comparable research, Shore (1995) used data from published studies to develop models to predict concentrations of Cd and Pb in liver and kidneys of small mammals from soil concentrations. Because these models considered only organ concentrations and not whole-body concentrations, and consumers of small mammals generally consume their prey whole, they are of limited use in estimating potential exposure to predators of small mammals. However, because significant, linear relationships were identified for Cd and Pb in both liver and kidneys, the potential utility of predicting tissue concentrations from soil concentrations is indicated.

The purpose of this report was to assemble a database of soil and small mammal contaminant concentration data from published literature for a wide range of contaminants, develop uptake factors (UFs) and other bioaccumulation models from these data, and then evaluate the accuracy of the estimates using independent data that were not included in the model development. The validation step allows the reliability of the models to be determined. In this report, both UFs and regression models were developed and tested, because, while regression models are most likely to consistently provide the best estimate of small mammal body burdens, the use of UFs is required by some regulatory agencies. In addition, when no regression model fits the uptake data well, a conservative UF may be employed in screening assessments to determine if site-specific studies are needed. The models presented in this report will facilitate the more accurate estimation of contaminant exposure experienced by predatory wildlife on the Oak Ridge Reservation (ORR) and at other contaminated sites. Additional models for estimating contaminant bioaccumulation by sediment biota, plants, and earthworms are presented in Jones et al. (1997), Efrogmson et al. (1997), and Sample et al. (1998).

2. MATERIALS AND METHODS

2.1 DATABASE DEVELOPMENT

A literature search was performed for studies that reported chemical concentrations in co-located small mammal and soil samples. Data were restricted to only studies that reported whole-body or carcass (whole body minus selected organs or other tissues) concentrations. To ensure relevancy of UFs and models to field situations, only field studies in which resident small mammals were collected were considered. All small mammal tissue burdens were therefore assumed to be at equilibrium with soil concentrations.

To ensure comparability of data, only “total” chemical analyses of both soil and small mammals (i.e., resulting from extractions of metals using concentrated acids) were included. Data resulting from diethylenetriaminepentaacetic acid (DTPA), acetic acid, and other mild extraction methods were excluded. The mean (or composite) chemical concentration in soil and small mammals reported for each sampling location evaluated in each study was considered an observation. If data for multiple small mammal species were reported at a site, each was considered a separate observation. Soil and small mammal data in the database were reported as mg/kg dry weight. If studies reported small mammal concentrations in terms of wet weight, dry weight concentrations were estimated assuming a 68% water content (EPA 1993). Data concerning soil characteristics [e.g., soil pH, % organic matter, cation exchange capacity (CEC), soil texture, etc.] were rarely reported and therefore do not appear in the database.

Because chemical uptake was expected to vary according to small mammal diet preferences, each species was assigned to one of the three trophic groups: insectivore (diet consisting primarily of insects and other invertebrates), herbivore (diet consisting primarily of plant material), and omnivore (diet consisting of both animal and plant material). A summary of the small mammal species included in the database and the trophic groups to which they were assigned is presented in Table 1.

To validate the models developed from the literature-derived data, soil and small mammal data collected as part of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigations at sites in Oklahoma (PTI 1995) and Montana (LaTier et al. 1995) were acquired as a validation dataset. Small mammal species in this validation dataset, however, represented only the herbivore and omnivore trophic groups. Validation data for insectivores were unavailable. Summaries of the analytical methods, data presented, and assumptions made for each study included in the database are presented in Appendix A. The small mammal bioaccumulation database is presented in Appendix B.

Table 1. Summary of small mammal species and trophic groups included in bioaccumulation database

Species	Trophic Group
<i>Blarina brevicauda</i>	Insectivore
<i>Cryptotis parva</i>	Insectivore
<i>Parascalops breweri</i>	Insectivore
<i>Sorex araneus</i>	Insectivore

Table 1 (continued)

Species	Trophic Group
<i>Sorex cinereus</i>	Insectivore
<i>Sorex minutus</i>	Insectivore
<i>Apodemus sylvaticus</i>	Herbivore
<i>Clethrionomys glareolus</i>	Herbivore
<i>Microtus agrestis</i>	Herbivore
<i>Microtus arvalis</i>	Herbivore
<i>Microtus pennsylvanicus</i>	Herbivore
<i>Microtus pinetorum</i>	Herbivore
<i>Oryzomys palustris</i>	Herbivore
<i>Sigmodon hispidus</i>	Herbivore
<i>Glaucomyz volans</i>	Omnivore
<i>Mus musculus</i>	Omnivore
<i>Peromyscus leucopus</i>	Omnivore
<i>Peromyscus maniculatus</i>	Omnivore
<i>Reithrodontomys spp.</i>	Omnivore
<i>Rattus norvegicus</i>	Omnivore
<i>Zapus hudsonius</i>	Omnivore

2.2. MODEL DEVELOPMENT AND VALIDATION

UFs— contaminant concentration in small mammals/contaminant concentration in soil— were calculated for each observation and analyte in the literature-derived bioaccumulation dataset. Summary statistics were generated for each UF by analyte for all small mammals combined (i.e., general small mammal UF) and for each trophic group. The Shapiro-Wilk test (PROC UNIVARIATE; SAS Inst. Inc. 1988a) was applied to the untransformed and natural-log transformed UFs for each analyte to determine if the distribution of the UFs was normal or log-normal, respectively.

To evaluate the relationship between the contaminant concentration in soil and that in whole bodies of small mammals, simple linear regressions were performed using SAS PROC REG (SAS Inst. Inc. 1988b) for each analyte/trophic group combination with $n \geq 4$. Contaminant concentrations in both soil and small mammals were natural-log transformed prior to regression analyses. Because data concerning the number of individuals included in composites or means were not available for all observations, no weighting of observations was applied. Simple linear regression models of ln-small mammal concentration on ln-soil concentration were developed for each analyte for all species combined (i.e., general small mammal model) and for each trophic group. Regressions of the log-transformed data correspond to a non-linear model, the power model. That is, the untransformed relationship of concentrations in small mammals (y) to that in soil (x) is $y = a(x)^b$.

UFs and regression models were applied to the soil concentration data from the validation studies, and estimated contaminant concentrations in small mammals were generated. To evaluate the

appropriateness and accuracy of various methods for calculating general estimates, estimates were generated using the median UFs and simple regression models based on all the data (e.g. the general model) or only on trophic-level-specific data. Because conservative estimates are needed for some purposes (e.g., screening assessments), estimates were also generated using the 90th percentile UF and the upper 95% prediction limit (95% UPL) for the simple regression model for the general and trophic-level-specific data. The 95% UPL was calculated according to Dowdy and Wearden (1983).

For each analyte and estimation method (i.e., UF or model, general or trophic-level-specific), differences between estimated and measured concentrations in small mammals from the validation dataset were evaluated using Wilcoxon signed-rank tests (PROC UNIVARIATE; SAS Inst. Inc. 1988a). Differences were considered significant if $p(H_0=0) \leq 0.05$. Relative accuracy and quality of different estimation methods were evaluated by calculating the proportional deviation (PD) of the estimate from the measured value:

$$PD = (M_i - E_i) / M_i$$

where

- PD = proportional deviation
- M_i = measured concentration for chemical in small mammal at soil concentration (I)
- E_i = estimated concentration for chemical in small mammal at soil concentration (I)

Negative values for PD indicate overestimation while positive PD values indicate underestimation. The percentage of estimated values that exceeded their corresponding measured value was also tabulated for each chemical and estimation method. Relative quality of general estimation methods was evaluated by the following criteria:

1. median PD closest to 0 (indicates estimates center around measured values);
2. PD with narrowest range (indicates relative accuracy of method);
3. percentage overestimation closest to 50% (indicates estimates center around measured values);
4. difference between estimated and measured values not significantly different as determined by Wilcoxon signed-rank tests.

Relative quality of conservative estimation methods was evaluated by

1. smallest, negative median PD value (indicates method overestimates while to minimizing the degree of overestimation);
2. PD with narrowest range (to minimize the degree of overestimation);

In addition to evaluation of PD values, a graphical evaluation was performed by plotting measured and estimated concentrations in earthworms vs. the corresponding measured soil concentration.

Comparisons of trophic-level-specific linear regression models were performed for each analyte using the F-test procedure for comparing regression lines outlined in Draper and Smith (1981). If F-test results were significant ($p \leq 0.05$), pair-wise Z-tests (Dowdy and Wearden 1983) for differences in slopes and intercepts between trophic groups were performed. Differences were considered significant if $p \leq 0.05$.

Both general and trophic-level-specific linear regression models were also developed for the natural-log transformed small mammal and soil data from the validation studies. These models were

compared to the corresponding models developed from the literature-derived bioaccumulation dataset using F-tests (Draper and Smith 1981). Differences were considered significant if $p \leq 0.05$.

Following these validation analyses, all data were pooled, and UFs and regression models were recalculated. These results were reported as the final UF or model.

Data for additional analytes were present in the validation studies that were unrepresented in the literature-derived dataset. UFs were generated and summary statistics and distributions were determined for these analytes. Because these data represented few locations, regression models were not fit to these data. These data are presented in Appendix C.

3. RESULTS

3.1 MODELING RESULTS

A total of 20 studies were identified that contained data suitable for inclusion in the small mammal bioaccumulation database (Appendix A). These studies represented four countries and eight U.S. states.

General UFs were developed for 14 inorganic and 2 organic chemicals (Table 2). Fewer data were available for trophic-group-specific UFs. For most analytes for which sufficient observations were available, the distribution of UFs was best described by a log-normal distribution. With few exceptions, median UFs were <1 for all chemicals and all groups, indicating no bioconcentration (Table 2). Exceptions included the general UF for tetrachlorodibenzo-p-dioxin (TCDD), the insectivore UF for Cd, and the omnivore UF for Zn. [Note: the mean and standard deviation of the natural-log-transformed UFs are presented as parameters for describing the UF distributions for those analytes best fit by a log-normal distribution. While the untransformed UFs are best fit by a log-normal distribution, the natural-log-transformed UFs are normally distributed. These parameters may be used in two ways. They may be applied to normal distribution functions in Monte Carlo simulation software; however, the output from the sampling from this distribution must be back-transformed (i.e., e^y , where y =sampling result). Alternatively, they may be incorporated directly into appropriate lognormal functions such as the LOGNORM2 function in the @RISK Monte Carlo simulation software (Palisades Corp. 1994b). Use of the LOGNORM2 function requires no back-transformation. Comparable results are obtained using either approach.]

Data sufficient for regression analyses (i.e., $n \geq 4$) were available for 12 chemicals (Table 3). General models (i.e., models that included data for 2 or more trophic groups) were generated for 11 chemicals. Significant, general model fits were obtained for all analytes except F and Hg (Table 3). Slopes for all significant, general regression models were positive (Table 3; Figs. 1–8). Intercepts did not differ significantly from 0 for Cd, Ni, Pb, or TCDD; in all other general models, intercepts differing from 0 were observed (Table 3). r^2 values for the significant, general regression models ranged from 0.2 (Cu) to 0.92 (TCDD).

For Cr, Hg, Se, TCDD, and TCDF, sufficient data were available to fit only one trophic-group-specific model; in all cases, this was for omnivores. In general, the omnivore model was very similar to the general model (Figs. 3a, 6b, and 8a); however, significant fits were obtained only for Cr and Se (Table 3).

Data sufficient to fit >1 trophic-group-specific model were available for As, Cd, Cu, Ni, Pb, and Zn. F-test results indicated significant differences ($p < 0.001$) among trophic-group models for each analyte, except Ni ($p = 0.54$; Fig. 5b). While significant model fits for As were obtained for both herbivores and omnivores (Table 3), intercepts and slopes for these models differed significantly ($p < 0.05$; Fig. 1a). For Cd and Zn, significant model fits were obtained for all three trophic groups. While slopes of the insectivore and herbivore models differed significantly for both chemicals ($p < 0.05$), slopes for insectivore and omnivore, and omnivore and herbivore did not (Table 3, Figs. 2a and 7). Intercepts differed significantly among all three models for Cd while only among herbivores and omnivores for Zn. A significant trophic-group regression model for Cu was obtained only for insectivores; no linear relationship was observed for either herbivores or omnivores

Table 2. Summary statistics for literature-derived soil-small mammal UFs

Analyte	Trophic Group	N (Studies)	N (Observations)	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
As	General	4	46	0.0060	0.0061	0.0003	0.0038	0.0154	0.0217	-5.7047	1.19868	lognormal
Ba	General	1	2	0.0168	0.0024	0.0144	0.0168	0.0187	0.0192			uniform
Cd	General	7	73	2.6492	8.3023	0.0166	0.7568	4.0933	69.5606	-0.40852	1.66803	lognormal
Co	General	1	3	0.1089	0.0548	0.0466	0.1000	0.1640	0.1800			normal
Cr	General	2	26	0.1285	0.1877	0.0314	0.0605	0.2284	0.8000	-2.53972	0.83081	lognormal ^a
Cu	General	6	50	0.5482	0.4134	0.0044	0.5999	1.1123	1.3978	-1.22629	1.47424	lognormal ^a
F	General	1	4	0.1200	0.1470	0.0021	0.0579	0.2875	0.3620			normal
Fe	General	1	3	0.0186	0.0091	0.0105	0.0141	0.0278	0.0313			normal
Hg	General	1	18	0.1244	0.2277	0.0183	0.0543	0.1484	1.0457	-2.70075	0.94709	lognormal
Ni	General	3	31	0.3655	0.2606	0.0213	0.3524	0.6750	1.1429	-1.37501	1.02531	lognormal ^a
Pb	General	11	112	0.1920	0.3154	0.0031	0.1233	0.3032	2.6585	-2.27519	1.2067	lognormal
Se	General	2	24	0.3584	0.3330	0.0346	0.2107	0.7648	1.2632	-1.42642	0.93924	lognormal
TCDD	General	2	5	1.0552	0.6199	0.3680	1.0323	1.7714	2.0952			normal
TCDF	General	1	4	0.1214	0.0293	0.0804	0.1229	0.1522	0.1594			normal
Tl	General	1	2	0.1124	0.0104	0.1020	0.1124	0.1207	0.1227	-2.19019	0.13067	
Zn	General	8	77	1.5149	2.2003	0.0051	0.8984	2.7255	16.3636	-0.39458	1.56089	lognormal
As	Insectivore	1	1	0.0013								
Cd	Insectivore	5	38	4.8127	11.0702	0.2086	2.1050	6.8860	69.5606	0.79402	1.11395	lognormal
Cr	Insectivore	2	2	0.0815	0.0140	0.0675	0.0815	0.0927	0.0955			uniform
Cu	Insectivore	4	30	0.6857	0.3549	0.0121	0.7714	1.1123	1.1758	-0.6897	1.05494	lognormal ^a

∞

Table 2 (continued)

Analyte	Trophic Group	N (Studies)	N (Observations)	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
F	Insectivore	1	2	0.1821	0.1800	0.0021	0.1821	0.3261	0.3620			uniform
Hg	Insectivore	1	1	1.0457								
Ni	Insectivore	2	9	0.3487	0.1347	0.0667	0.3643	0.4722	0.5782			normal
Pb	Insectivore	9	54	0.2541	0.4140	0.0042	0.1601	0.3319	2.6585	-1.91202	1.03533	lognormal ^a
Se	Insectivore	2	2	0.7241	0.0892	0.6349	0.7241	0.7955	0.8133			uniform
Zn	Insectivore	5	37	1.4672	1.6063	0.0894	0.8328	2.7563	6.9610	-0.14855	1.11972	lognormal
As	Herbivore	3	23	0.0046	0.0056	0.0003	0.0020	0.0130	0.0194	-5.21855	0.94223	lognormal
Cd	Herbivore	4	21	0.2507	0.2402	0.0166	0.2059	0.3871	1.0000	-1.85937	1.09428	lognormal
Co	Herbivore	1	3	0.1089	0.0548	0.0466	0.1000	0.1640	0.1800			normal
Cr	Herbivore	2	2	0.0774	0.0461	0.0314	0.0774	0.1143	0.1235			uniform
Cu	Herbivore	4	11	0.3389	0.4914	0.0044	0.0525	1.2903	1.3978	-2.44521	1.93173	lognormal
F	Herbivore	1	2	0.0579	0.0557	0.0021	0.0579	0.1024	0.1136			uniform
Fe	Herbivore	1	3	0.0186	0.0091	0.0105	0.0141	0.0278	0.0313			normal
Hg	Herbivore	1	1	0.0239								
Ni	Herbivore	3	8	0.4666	0.3827	0.0307	0.3924	0.9716	1.1429	-1.3282	1.33763	lognormal ^a
Pb	Herbivore	9	33	0.0864	0.0780	0.0031	0.0750	0.1967	0.2867	-3.04376	1.30969	lognormal ^a
Se	Herbivore	1	1	0.1550								
TCDD	Herbivore	1	1	1.2857								
Zn	Herbivore	6	23	1.6527	3.3311	0.0051	0.8984	2.4829	16.3636	-0.98103	2.16623	lognormal

Table 2 (continued)

Analyte	Trophic Group	N (Studies)	N (Observations)	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
As	Omnivore	3	22	0.0078	0.0061	0.0007	0.0062	0.0159	0.0217	-6.12951	1.27579	lognormal
Cd	Omnivore	4	14	0.3745	0.4241	0.0321	0.2583	0.7200	1.7053	-1.4963	1.06492	lognormal
Cr	Omnivore	2	22	0.1374	0.2023	0.0323	0.0563	0.3105	0.8000	-2.51976	0.87656	lognormal ^a
Cu	Omnivore	3	9	0.3455	0.2767	0.0200	0.2113	0.7147	0.8667	-1.52513	1.17905	lognormal ^a
Hg	Omnivore	1	16	0.0731	0.0450	0.0183	0.0543	0.1225	0.1920	-2.8078	0.65634	lognormal
Ni	Omnivore	2	14	0.3186	0.2164	0.0213	0.3418	0.5518	0.8000			normal
Pb	Omnivore	6	25	0.1974	0.2108	0.0149	0.1274	0.3763	0.9949	-2.04511	0.95721	lognormal
Se	Omnivore	2	21	0.3333	0.3326	0.0346	0.2082	0.6515	1.2632	-1.50996	0.93593	lognormal ^a
TCDD	Omnivore	1	4	0.9976	0.6810	0.3680	0.7636	1.7763	2.0952			normal
TCDF	Omnivore	1	4	0.1214	0.0293	0.0804	0.1229	0.1522	0.1594			normal
Tl	Omnivore	1	2	0.1124	0.0104	0.1020	0.1124	0.1207	0.1227	-2.19019	0.13067	
Zn	Omnivore	4	17	1.4323	1.1236	0.0483	1.2027	2.7255	4.2967			normal

^a Data not fit well by either normal or lognormal distributions, however, closest fit provided by lognormal.

Table 3. Results of regression of ln whole-body small mammal on ln soil

Analyte	Group	N	B0±SE	B1±SE	r ²	P model fit
As	General	46	-4.5480±0.4627 ^c	0.6725±0.1223 ^c	0.41	0.0001
As	Herbivore	22	-5.6531±0.5333 ^c	1.1382±0.1570 ^c	0.72	0.0001
As	Omnivore	23	-3.8362±0.6428 ^c	0.4031±0.1581 ^a	0.23	0.019
Cd	General	73	-0.1811±0.2082 ^{NS}	0.6409±0.1406 ^c	0.23	0.0001
Cd	Insectivore	38	0.8150±0.2031 ^c	0.9638±0.1516 ^c	0.53	0.0001
Cd	Herbivore	21	-1.2112±0.1746 ^c	0.4075±0.0950 ^c	0.49	0.0004
Cd	Omnivore	14	-1.4557±0.2482 ^c	0.5380±0.2030 ^a	0.37	0.02
Cr	General	26	-1.7457±0.5454 ^b	0.7670±0.1531 ^c	0.51	0.0001
Cr	Omnivore	22	-1.6518±0.6963 ^a	0.7380±0.2027 ^b	0.40	0.0016
Cu	General	50	2.3393±0.0969 ^c	0.0793±0.0232 ^c	0.20	0.0013
Cu	Insectivore	30	2.1042±0.0550 ^c	0.1783±0.0152 ^c	0.83	0.0001
Cu	Herbivore	11	2.4311±0.2611 ^c	0.0296±0.0487 ^{NS}	0.04	0.56
Cu	Omnivore	9	1.9400±0.3359 ^b	0.1422±0.0794 ^{NS}	0.31	0.11
F	General	4	1.7549±0.7730 ^{NS}	0.3129±0.0875 ^{NS}	0.86	0.07
Hg	General	18	-4.8666±1.7959 ^a	-2.2764±2.6962 ^{NS}	0.04	0.41
Hg	Omnivore	16	-4.0341±1.4366 ^a	-0.8965±2.2069 ^{NS}	0.01	0.69
Ni	General	31	-0.2553±0.2104 ^{NS}	0.4830±0.0799 ^c	0.56	0.0001
Ni	Insectivore	9	-0.4266±0.1505 ^a	0.5444±0.0738 ^c	0.89	0.0002
Ni	Herbivore	8	0.3519±0.3781 ^{NS}	0.3741±0.1166 ^a	0.63	0.018
Ni	Omnivore	14	-0.4354±0.4343 ^{NS}	0.5035±0.1680 ^a	0.43	0.01
Pb	General	112	0.3420±0.1995 ^{NS}	0.4518±0.0392 ^c	0.55	0.0001
Pb	Insectivore	54	0.4819±0.3099 ^{NS}	0.4869±0.0633 ^c	0.53	0.0001
Pb	Herbivore	33	-0.1228±0.2547 ^{NS}	0.4696±0.0429 ^c	0.79	0.0001
Pb	Omnivore	25	0.1155±0.5913 ^{NS}	0.4655±0.1413 ^b	0.32	0.0032
Se	General	24	-0.5827±0.2479 ^a	0.4420±0.1326 ^b	0.34	0.003
Se	Omnivore	21	-0.6392±0.2830 ^a	0.4618±0.1446 ^b	0.35	0.005

Table 3 (continued)

Analyte	Group	N	B0±SE	B1±SE	r ²	P model fit
TCDD	General	5	0.8113±1.8493 ^{NS}	1.0993±0.1852 ^b	0.92	0.0096
TCDD	Omnivore	4	0.7044±12.7713 ^{NS}	1.0894±1.1826 ^{NS}	0.29	0.45
TCDF	Omnivore	4	3.8673±11.4833 ^{NS}	1.6191±1.1794 ^{NS}	0.49	0.31
Zn	General	77	4.3843±0.0902 ^c	0.0786±0.0166 ^c	0.23	0.0001
Zn	Insectivore	37	4.2479±0.1191 ^c	0.1324±0.0228 ^c	0.49	0.0001
Zn	Herbivore	23	4.4459±0.1080 ^c	0.0502±0.0176 ^b	0.28	0.0096
Zn	Omnivore	17	4.1220±0.2235 ^c	0.1001±0.0455 ^a	0.24	0.04

model: $\ln(\text{whole body}) = B_0 + B_1(\ln[\text{soil}])$

^{NS} Not Significant: $p > 0.05$.

^a $p < 0.05$.

^b $p < 0.01$.

^c $p < 0.001$.

(Table 3, Fig. 3b). Despite obtaining a significant F-test value for Pb ($p = 0.0003$) indicating significant differences among trophic-group regression models, pair-wise Z-test comparisons indicated no differences between slopes or intercepts for any group ($p > 0.05$ for all tests). Visual comparison of the slopes and intercepts (Table 3, Fig. 6a) supports the similarity of models among trophic groups.

3.2 VALIDATION RESULTS

Data for model validation were available for both herbivores and omnivores for 11 inorganic chemicals (As, Ba, Cd, Co, Cr, Cu, Fe, Ni, Pb, Se, and Zn). No validation data were available for the insectivore trophic group or for F, Hg, TCDD, or TCDF.

General regression models fit to the validation data differed significantly from those fit to the model dataset for all analytes except Ni (Table 4). F-tests indicated no significant differences among trophic-level-specific models fit to validation data and those fit to the model data for 8 of 13 comparisons; both herbivores and omnivores for Cd and Cr; omnivores only for Cu, Ni, and Se, and herbivores only for Zn (Table 4). Significant differences between model and validation regressions were observed for As and Zn among omnivores, for Cu among herbivores, and for Pb among both herbivores and omnivores (Table 4).

Arsenic was not detected in any sample of herbivores from the validation dataset. Consequently, all general and conservative estimation methods significantly overestimated As in herbivores (Tables 5 and 6). Because the concentrations of As in herbivores from the validation dataset are undefined, the accuracy of the various estimation methods cannot be determined, and therefore the models cannot be validated.

Among general estimation methods for As in omnivores, the median general UF generated the best estimates. While the range of PDs for the median general UF was larger than that for the other three estimation methods, the median general UF generated estimates that did not significantly differ

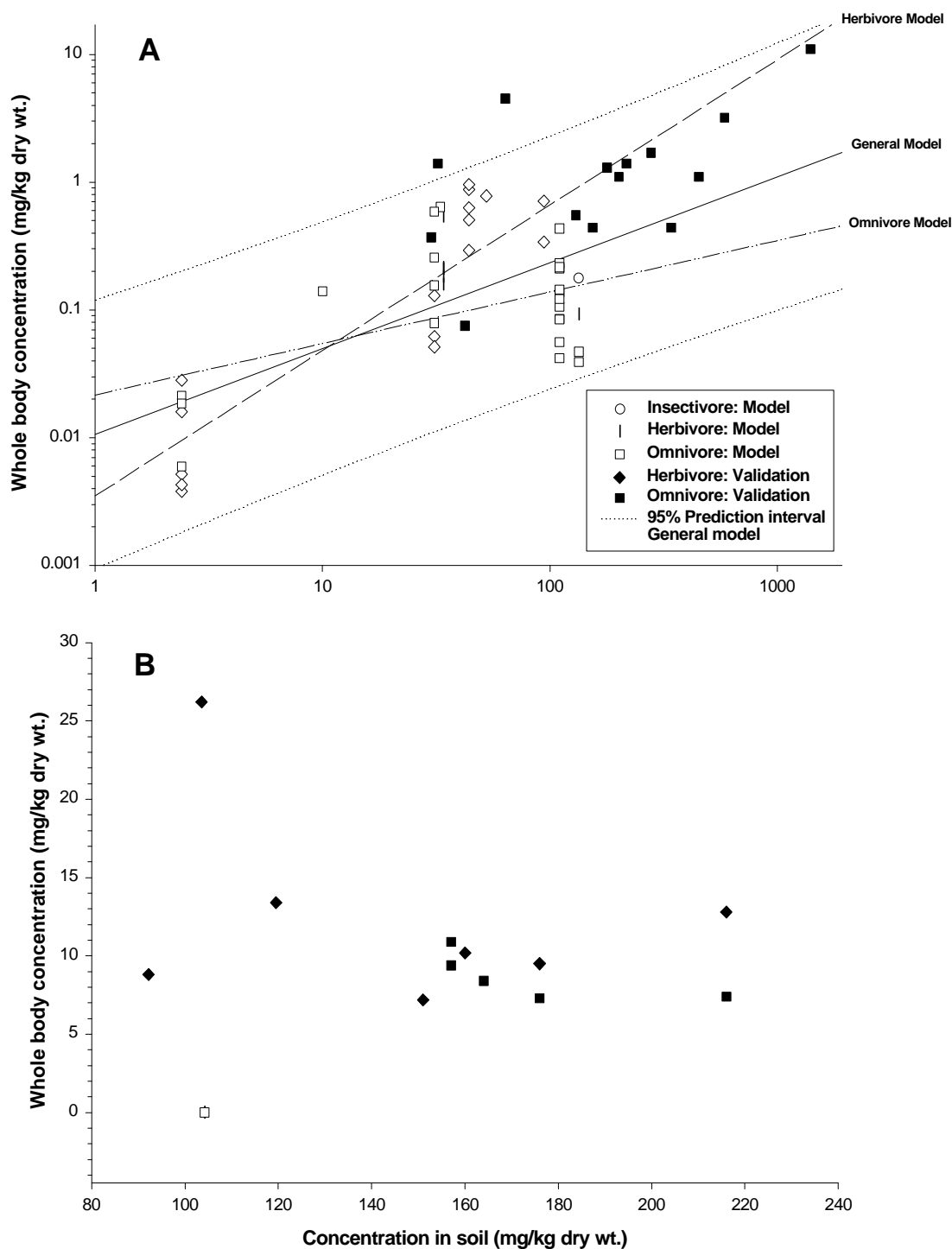


Fig. 1. Scatterplot of model and validation data for As (A) and Ba (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model. Regression lines not presented for Ba (B) due to insufficient number of observations.

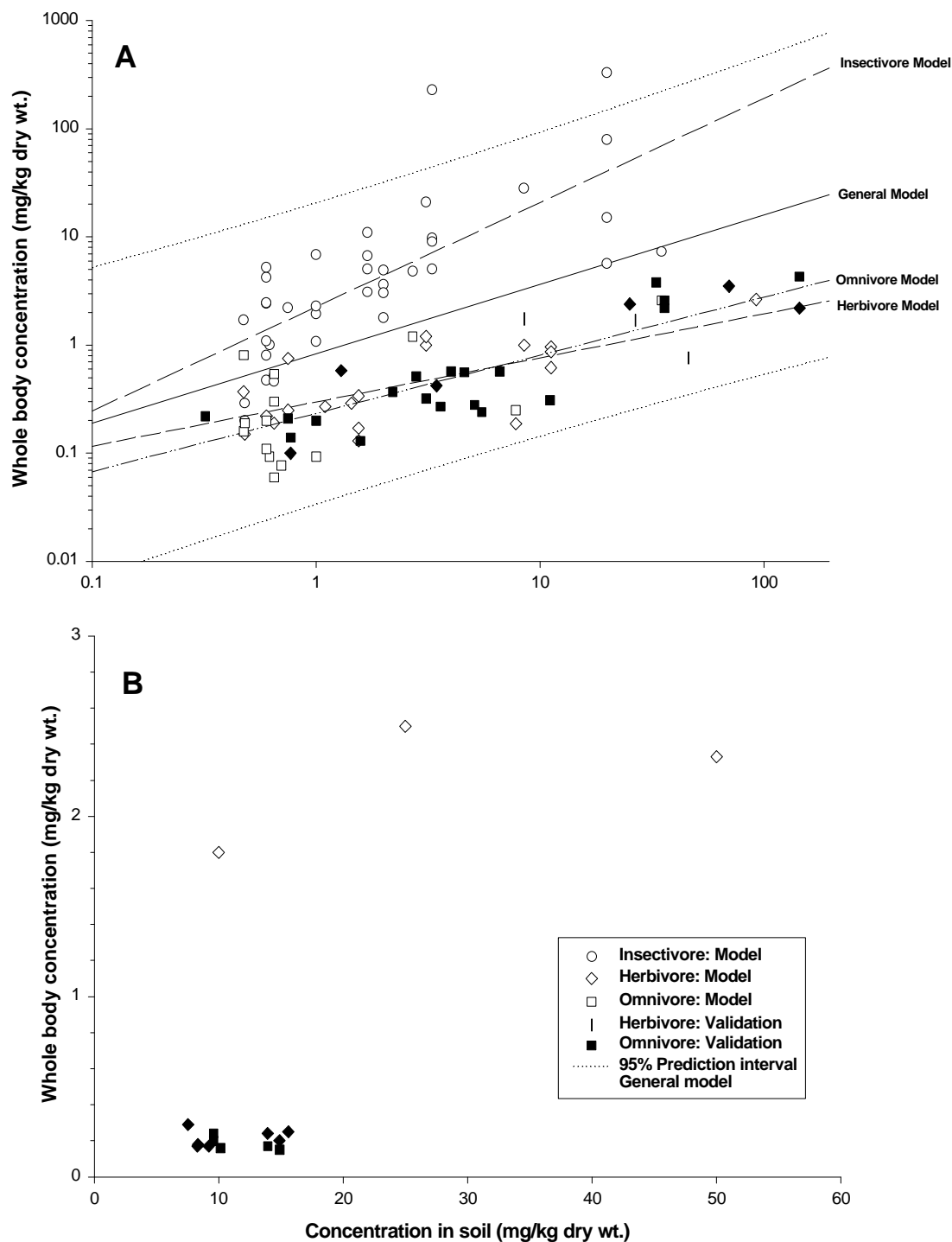


Fig. 2. Scatterplot of model and validation data for Cd (A) and Co (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model. Regression lines not presented for Co (B) due to insufficient number of observations.

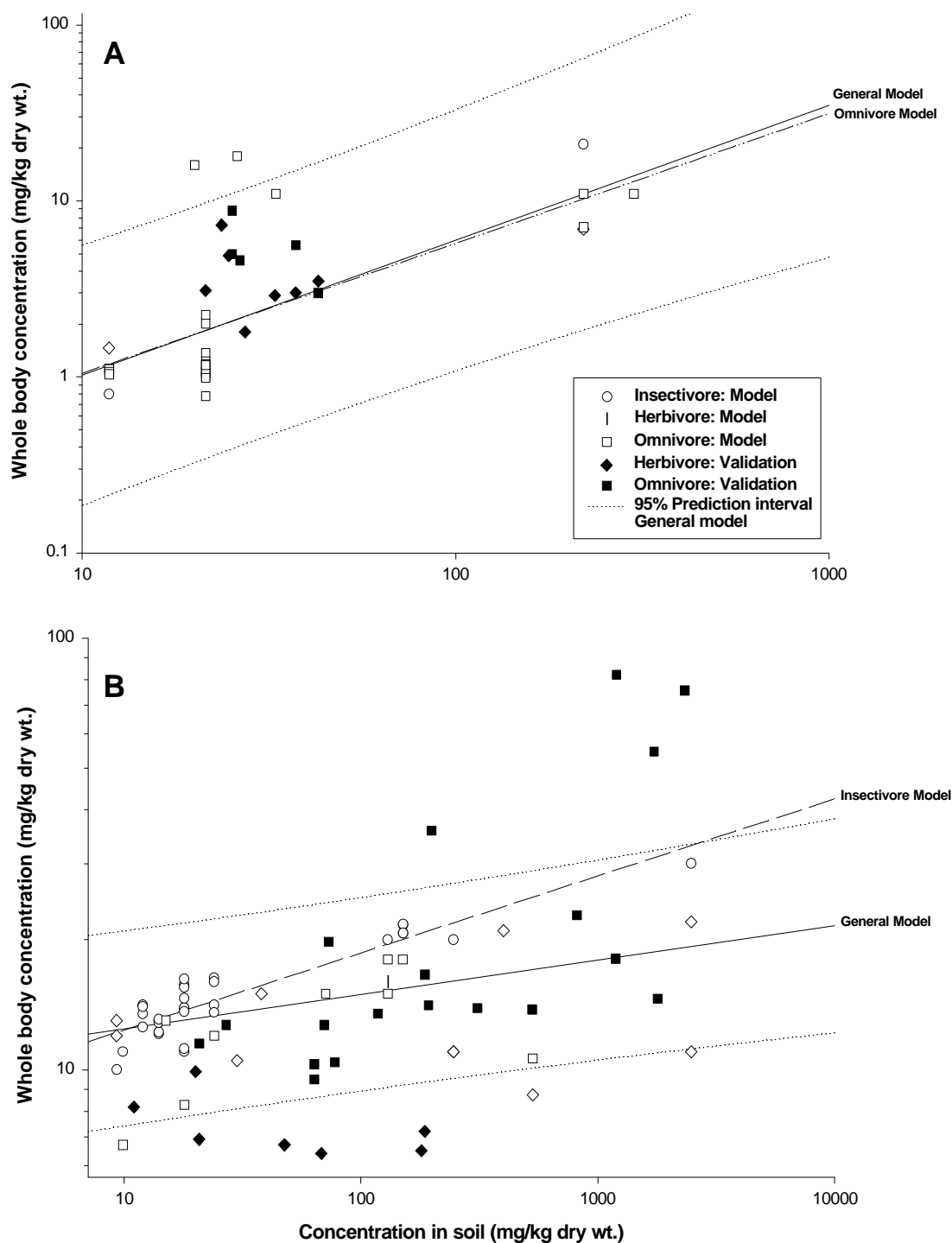


Fig. 3. Scatterplot of model and validation data for Cr (A) and Cu (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model.

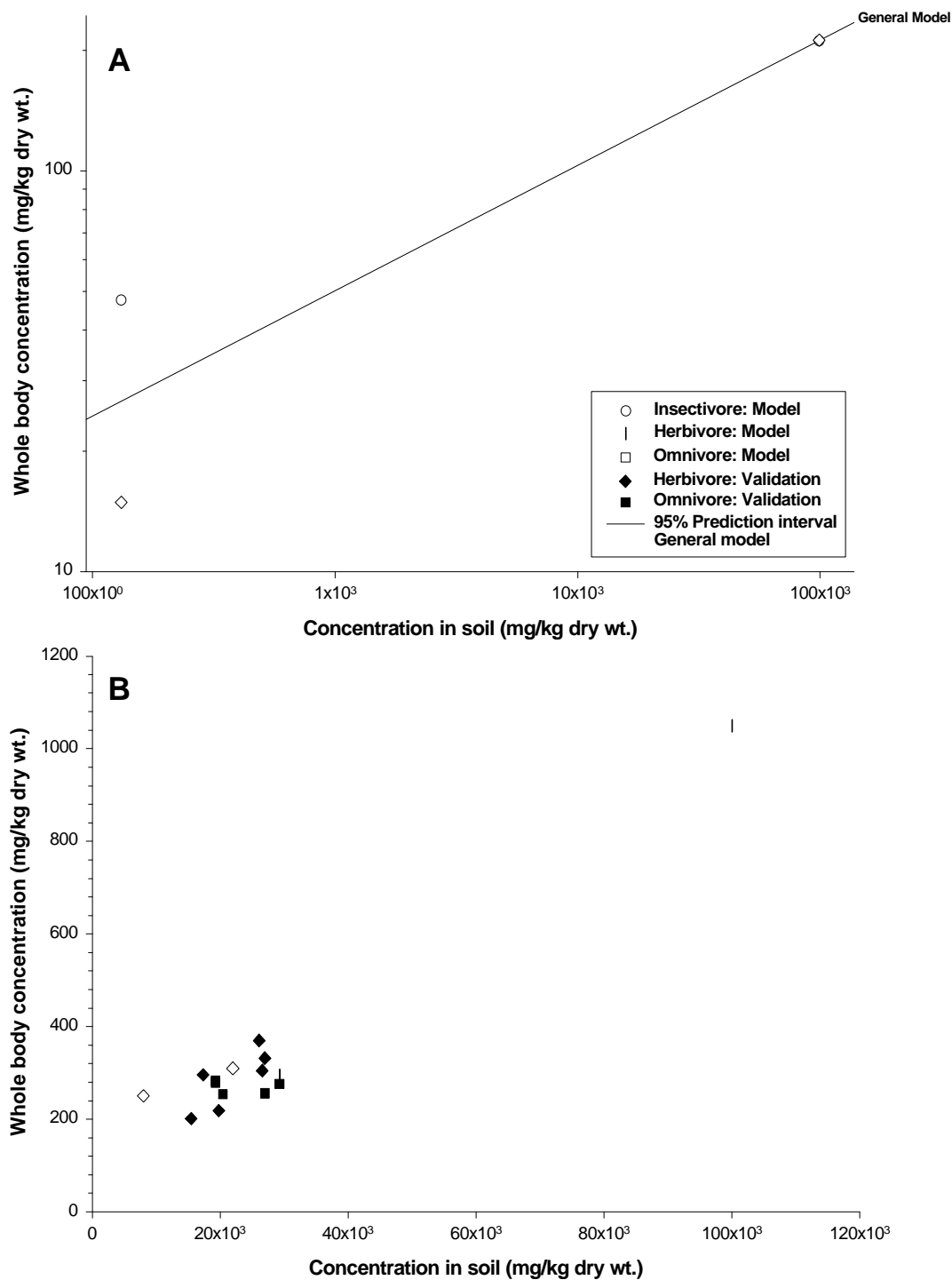


Fig. 4. Scatterplot of model and validation data for F (A) and Fe (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model. Regression lines not presented for Fe (B) due to insufficient number of observations.

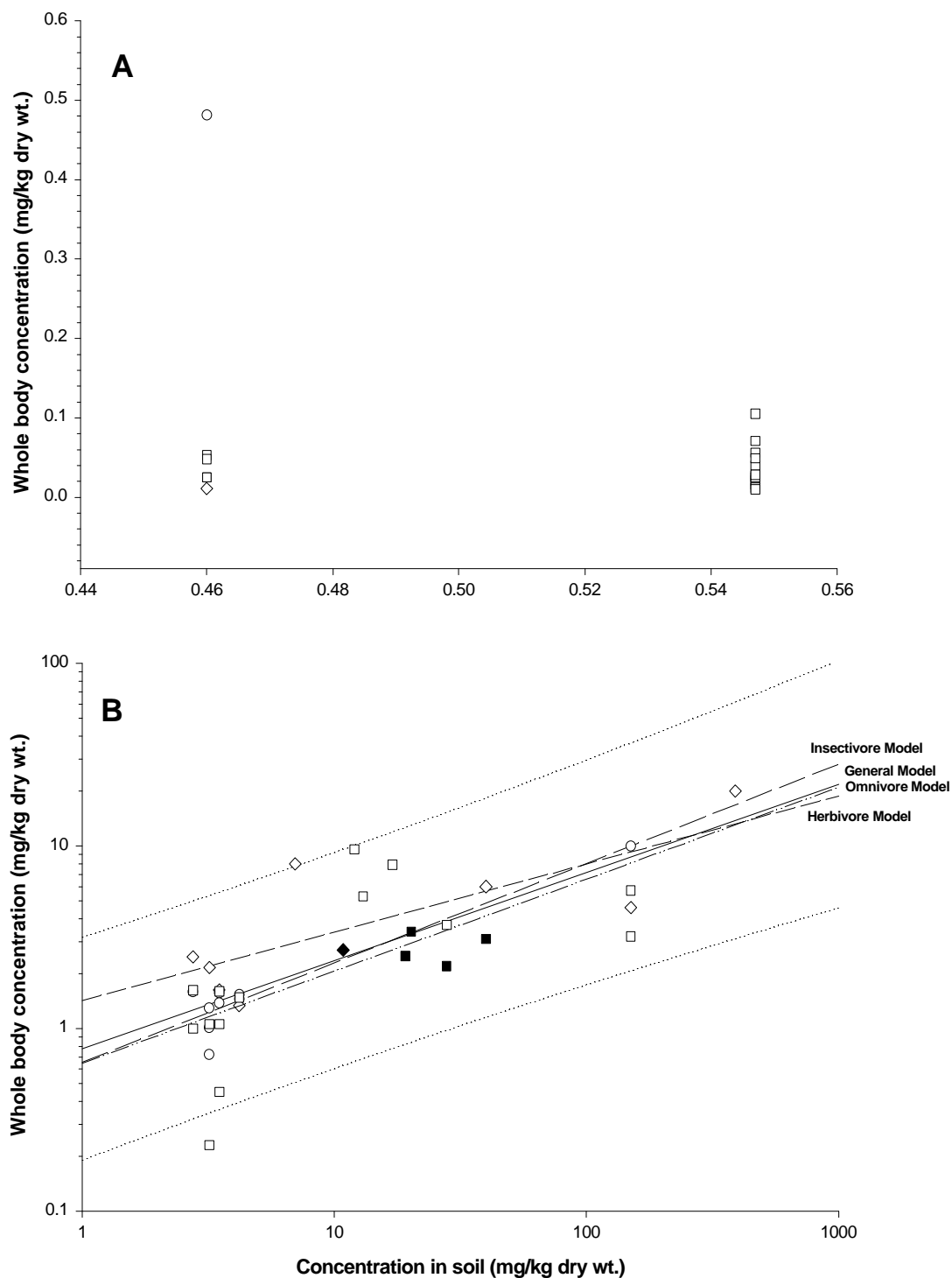


Fig. 5. Scatterplot of model and validation data for Hg (A) and Ni (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model. Regression lines not presented for Hg (A) due to lack of significant model fit.

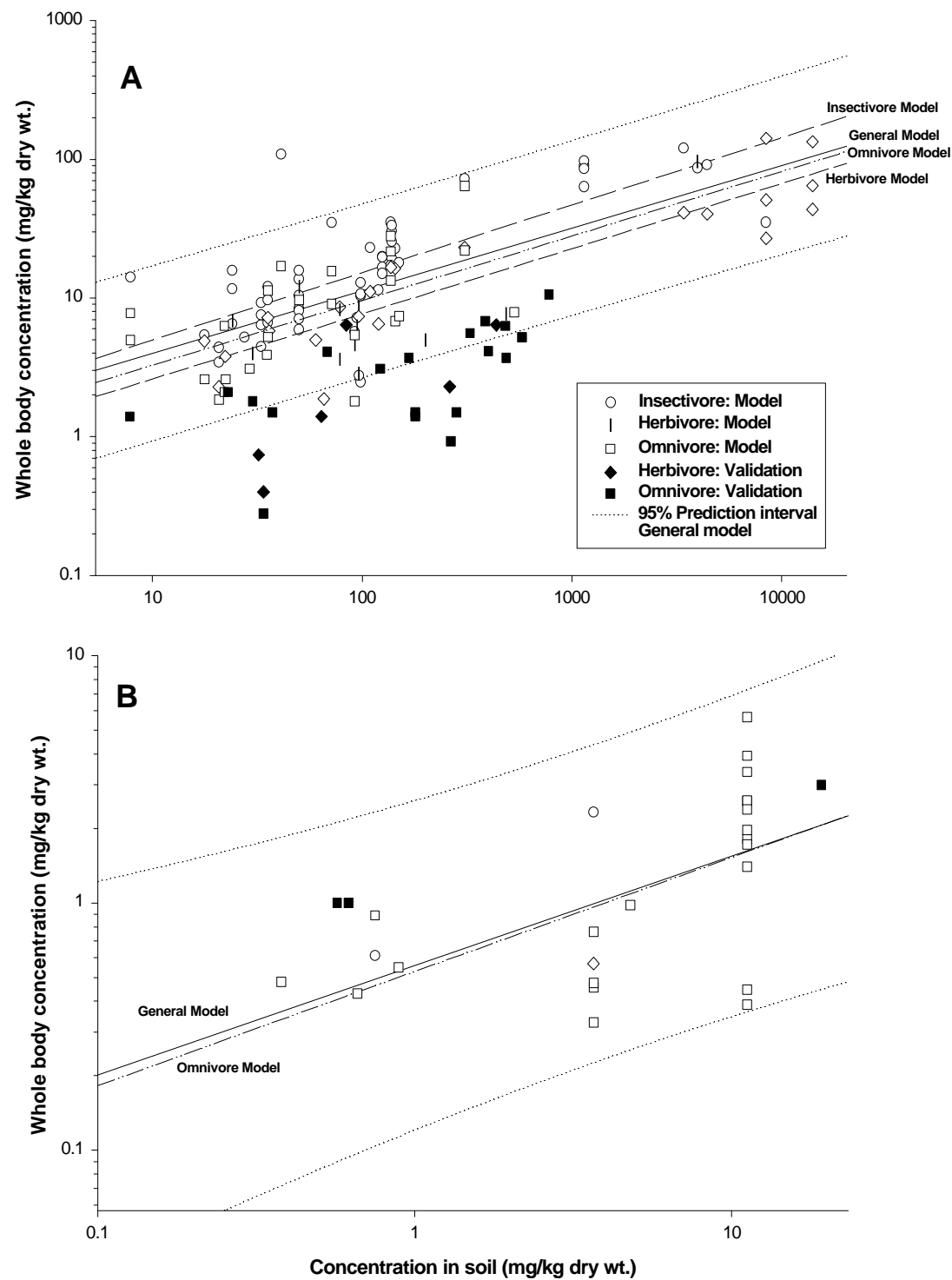


Fig. 6. Scatterplot of model and validation data for Pb (A) and Se (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model.

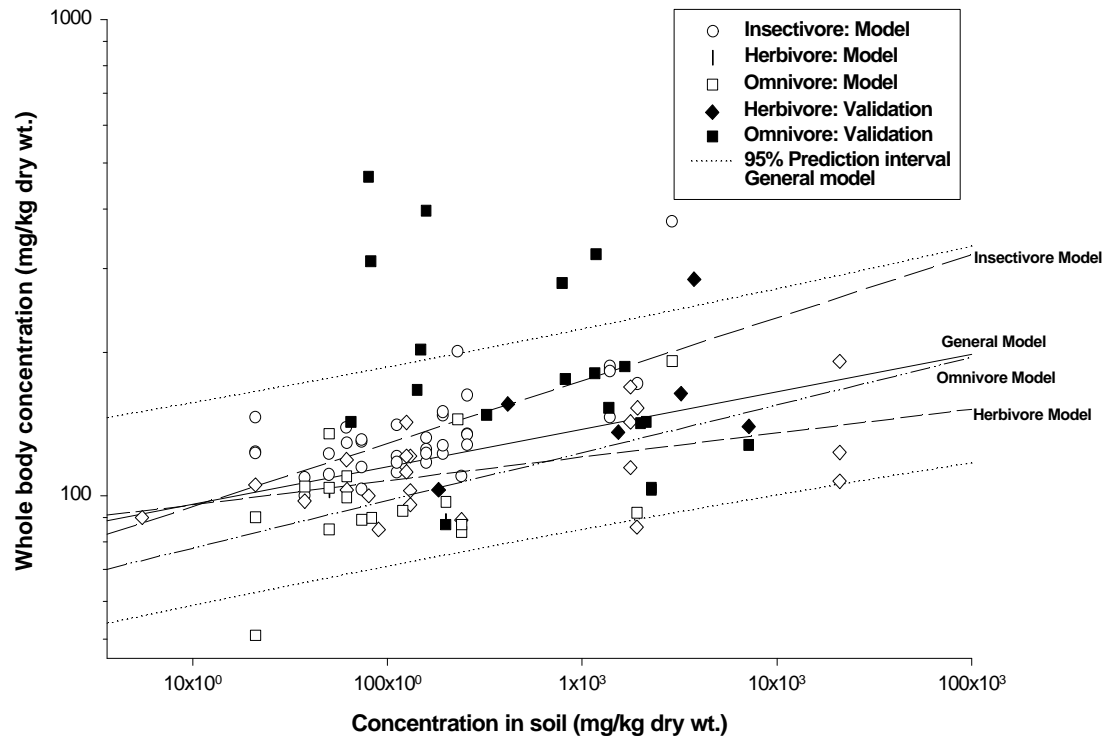


Fig. 7. Scatterplot of model and validation data for Zn by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model.

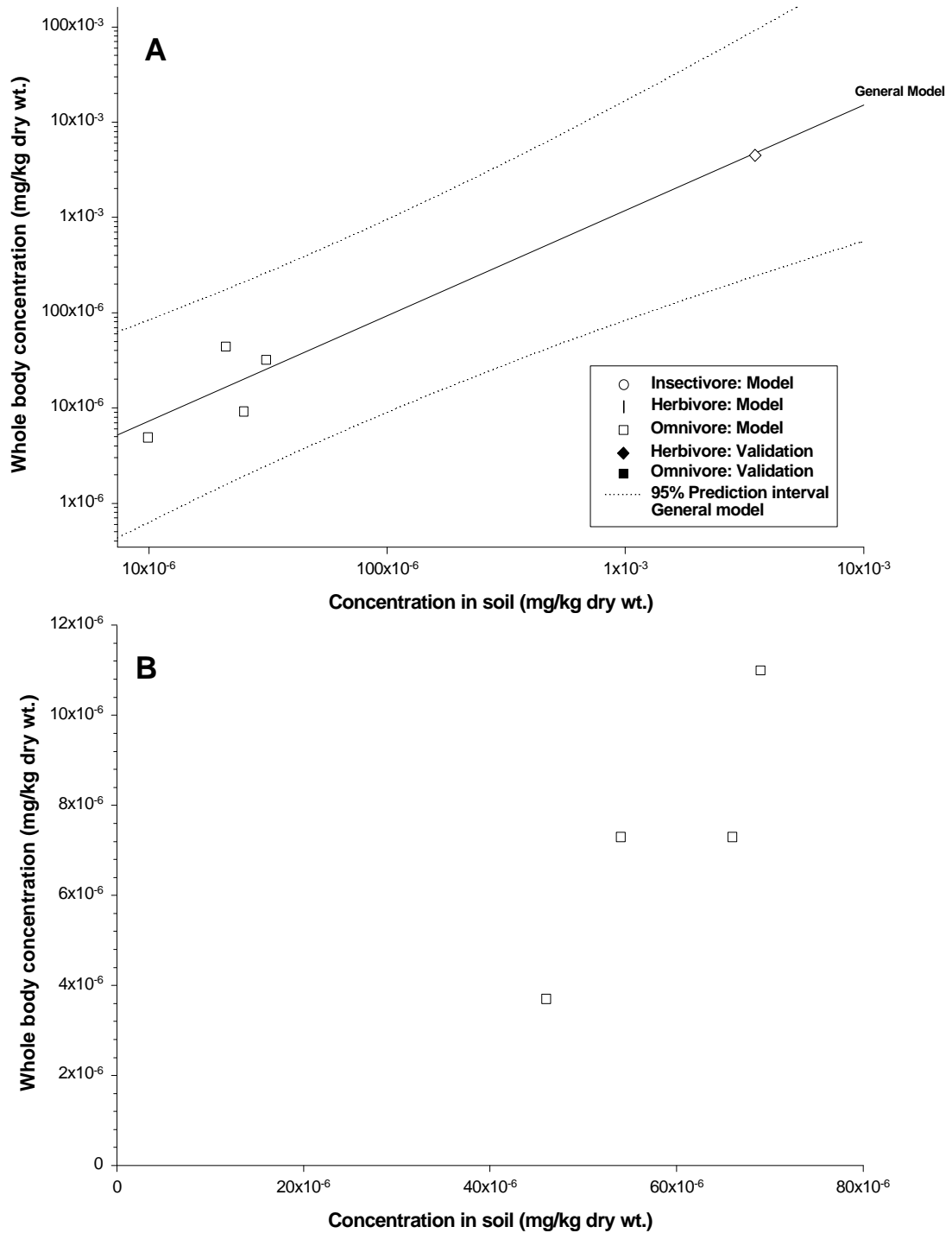


Fig. 8. Scatterplot of model and validation data for TCDD (A) and TCDF (B) by trophic group. Lines represent simple linear regression models of natural-log-transformed data from the model dataset for each trophic group and for all groups combined (e.g., General model). Only models for which significant fits were obtained are presented. Dotted lines represent 95% prediction interval for General model. Regression lines not presented for TCDF (B) due to lack of significant model fit.

from measured values, produced the lowest median PD values, and the percentage of overestimates that was closest to 50% (Table 5). For conservative estimation of As in omnivores, while the 95% UPL of the trophic-group regression produced the smallest median and range of PD values and generated estimates that did not significantly differ from measured values, the percent overestimation was only 58% (Table 6). Because the 90th percentile trophic-group UF generated the narrowest range of PD values and the highest percent of overestimates (tied with the 90th percentile general UF), the best conservative estimates were generated by this method (Table 6).

Table 4. Results of F-tests comparing regression models based on validation data and literature-derived dataset

Analyte	Models Compared	df	F	p
As	General	2,56	4.854	0.01
Cd	General	2,95	9.426	0.0002
Cr	General	2,34	3.479	0.04
Cu	General	2,72	9.952	0.0002
Ni	General	2,32	0.462	0.63
Pb	General	2,134	54.98	<0.0001
Zn	General	2,99	12.39	<0.0001
Cd	Herbivore	2,24	0.569	0.57
Cr	Herbivore	2,5	1.237	0.37
Cu	Herbivore	2,14	10.11	0.002
Pb	Herbivore	2,36	15.74	<0.0001
Zn	Herbivore	2,26	0.312	0.06
As	Omnivore	2,33	10.5	0.0003
Cd	Omnivore	2,29	0.276	0.76
Cr	Omnivore	2,23	2.307	0.12
Cu	Omnivore	2,24	0.714	0.5
Ni	Omnivore	2,14	0.127	0.88
Se	Omnivore	2,20	1.231	0.31
Pb	Omnivore	2,40	17.99	<0.0001
Zn	Omnivore	2,32	15.08	<0.0001

Ba in both herbivores and omnivores was underestimated by all methods; for herbivores, all differences were significant, while for omnivores, no differences were significant (Tables 5 and 6). Estimates generated by both general and trophic group UFs were comparable (Tables 5 and 6).

Trophic-group regression models generated the best general estimates of Cd in both herbivores and omnivores (Table 5). Estimates from these regression models did not significantly differ from

Table 5. Comparison of quality of general estimation methods as determined by the proportional deviation (PD) of the estimated values from measured values

PD = (measured-estimate)/measured. Negative PD values indicate overestimates while positive PD values indicate underestimates.

Analyte	Trophic Group	N	Median UF: General		Median UF: Trophic Group		Regression :General		Regression: Trophic Group	
			Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated
As	Herbivore	7 ^d	. . . ^a	100	. . . ^a	100	. . . ^a	100	. . . ^a	100
As	Omnivore	19 ^d	0.35 ^{NS} (-1.94 to 0.95)	47	0.66 ^b (-0.53 to 0.97)	37	0.72 ^b (-0.75 to 0.96)	37	0.85 ^b (-0.30 to 0.97)	32
Ba	Herbivore	7	0.74 ^a (0.65 to 0.93)	0	0.70 ^a (0.60 to 0.92)	0				
Ba	Omnivore	5	0.67 ^{NS} (0.51 to 0.76)	0	0.72 ^{NS} (0.58 to 0.79)	0				
Cd	Herbivore	7	-6.95 ^a (-48.53 to -0.69)	100	-1.16 ^{NS} (-12.48 to 0.54)	86	-3.02 ^a (-8.17 to -0.70)	100	0.33 ^{NS} (-1.68 to 0.54)	43
Cd	Omnivore	19	-6.33 ^c (-26.10 to -0.10)	100	-1.50 ^c (-8.25 to 0.62)	89	-3.17 ^c (-11.59 to -0.83)	100	0.04 ^{NS} (-1.75 to 0.60)	47
Co	Herbivore	7	-4.41 ^a (-6.45 to -1.60)	100	-4.41 ^a (-6.45 to -1.60)	100				
Co	Omnivore	5	-5.34 ^{NS} (-8.93 to -3.00)	100						
Cr	Herbivore	7	0.32 ^a (0.08 to 0.80)	0	0.12 ^{NS} (-0.17 to 0.75)	14				
Cr	Omnivore	5	0.65 ^{NS} (0.13 to 0.83)	0	0.68 ^{NS} (0.19 to 0.84)	0	0.53 ^{NS} (-0.04 to 0.76)	20	0.53 ^{NS} (-0.02 to 0.76)	20
Cu	Herbivore	7	-3.26 ^a (-15.61 to 0.20)	86	0.63 ^{NS} (-0.45 to 0.93)	29	-1.10 ^a (-1.41 to -0.33)	100		
Cu	Omnivore	19	-5.72 ^c (-72.55 to -0.08)	100	-1.37 ^b (-24.90 to 0.62)	84	-0.12 ^{NS} (-0.52 to 0.78)	63		
Fe	Herbivore	7	-0.15 ^{NS} (-0.40 to 0.17)	71	-0.15 ^{NS} (-0.40 to 0.17)	71				
Fe	Omnivore	5	-0.13 ^{NS} (-0.50 to 0.04)	60						

Table 5 (cont.)

Analyte	Trophic Group	N	Median UF: General		Median UF: Trophic Group		Regression :General		Regression: Trophic Group	
			Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated
Ni	Herbivore	7 ^d	-0.42 ^a (-0.42 to -0.42)	100	-0.58 ^a (-0.58 to -0.58)	100	0.09 ^a (0.09 to 0.09)	86	-0.28 ^a (-0.28 to -0.28)	100
Ni	Omnivore	5 ^d	-2.58 ^{NS} (-3.54 to -1.09)	100	-2.48 ^{NS} (-3.41 to -1.03)	100	-0.39 ^{NS} (-0.76 to 0.03)	80	-0.24 ^{NS} (-0.57 to 0.14)	80
Pb	Herbivore	7	-6.77 ^a (-12.99 to -0.62)	100	-3.73 ^a (-7.51 to 0.02)	86	-5.58 ^a (-16.27 to -0.63)	100	-3.45 ^a (-10.55 to -0.11)	100
Pb	Omnivore	19	-8.03 ^c (-34.14 to 0.31)	95	-8.32 ^c (-35.29 to 0.29)	95	-2.98 ^c (-23.67 to -1.31)	100	-2.39 ^c (-19.64 to -0.95)	100
Se	Herbivore	6 ^d	. . . ^a	100	. . . ^a	100	. . . ^a	100		
Se	Omnivore	5 ^d	0.87 ^{NS} (-0.35 to 0.88)	60	0.87 ^{NS} (-0.33 to 0.88)	60	0.55 ^{NS} (0.31 to 0.56)	40	0.58 ^{NS} (0.31 to 0.59)	40
Zn	Herbivore	7	-9.11 ^a (-45.01 to -0.60)	100	-9.11 ^a (-45.01 to -0.60)	100	-0.05 ^{NS} (-0.37 to 0.46)	57	0.09 ^{NS} (-0.25 to 0.55)	29
Zn	Omnivore	19	-2.29 ^b (-49.32 to 0.85)	68	-3.41 ^b (-66.37 to 0.79)	74	0.23 ^a (-0.43 to 0.76)	32	0.31 ^b (-0.30 to 0.80)	21

^{NS} Estimate not significantly different from measured as determined by Wilcoxon signed-rank test.

^a Estimate significantly different from measured as determined by Wilcoxon signed-rank test; p < 0.05.

^b Estimate significantly different from measured as determined by Wilcoxon signed-rank test; p < 0.01.

^c Estimate significantly different from measured as determined by Wilcoxon signed-rank test; p < 0.001.

^d Analyte below detection limits for some observations in validation dataset. PD values could therefore not be calculated for these observations. Number of nondetects by analyte and trophic group were: As in herbivores: 7; As in omnivores: 5; Ni in herbivores: 6; Ni in omnivores: 1; Se in herbivores: 6; and Se in omnivores: 2.

Table 6. Comparison of quality of conservative estimation methods as determined by the proportional deviation (PD) of the estimated values from measured values

PD = (measured-estimate)/measured. Negative PD values indicate overestimates while positive PD values indicate underestimates.

Analyte	Trophic Group	N	90th Percentile UF: General		90th Percentile UF: Trophic Group		Regression :General 95% UPL		Regression: Trophic Group 95% UPL	
			Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated
As	Herbivore	7 ^d	. . . ^a	100	. . . ^a	100	. . . ^a	100	. . . ^a	100
As	Omnivore	19 ^d	-1.77 ^b (-11.44 to 0.77)	89	-1.42 ^a (-9.88 to 0.80)	89	-0.90 ^a (-10.80 to 0.74)	84	0.12 ^{NS} (-6.65 to 0.85)	58
Ba	Herbivore	7	0.70 ^a (0.60 to 0.92)	0	0.70 ^a (0.60 to 0.92)	0				
Ba	Omnivore	5	0.63 ^{NS} (0.44 to 0.72)	0	0.72 ^{NS} (0.58 to 0.79)	0				
Cd	Herbivore	7	-42.05 ^a (-267.36 to -8.15)	100	-3.06 ^a (-24.34 to 0.14)	86	-40.23 ^a (-91.65 to -24.02)	100	-0.83 ^a (-6.97 to -0.13)	100
Cd	Omnivore	19	-38.72 ^c (-145.81 to -4.96)	100	-7.05 ^c (-28.75 to -0.21)	100	-55.50 ^c (-158.34 to -18.79)	100	-12.69 ^c (-910.01 to -4.69)	100
Co	Herbivore	7	-8.74 ^a (-12.41 to -3.69)	100	-8.74 ^a (-12.41 to -3.69)	100				
Co	Omnivore	5	-10.42 ^{NS} (-16.88 to -6.20)	100						
Cr	Herbivore	7	-2.77 ^a (-4.06 to -0.08)	100	-0.40 ^{NS} (-0.87 to 0.60)	57				
Cr	Omnivore	5	-0.92 ^{NS} (-3.77 to 0.05)	80	-0.92 ^{NS} (-3.77 to 0.05)	80	-0.92 ^{NS} (-3.26 to 0.03)	80	-1.14 ^{NS} (-3.69 to -0.08)	100
Cu	Herbivore	7	-6.93 ^a (-29.93 to -0.50)	100	-8.17 ^a (-34.73 to -0.73)	100	-2.24 ^a (-2.72 to -1.05)	100		
Cu	Omnivore	19	-11.51 ^c (-135.92 to -1.02)	100	-8.71 ^c (-105.26 to -0.56)	100	-0.72 ^{NS} (-1.34 to -0.66)	79		
Fe	Herbivore	7	-1.54 ^a (-2.11 to -0.83)	100	-1.54 ^a (-2.11 to -0.83)	100				
Fe	Omnivore	5	-1.52 ^{NS} (-2.32 to -1.13)	100						
Ni	Herbivore	7 ^d	-1.71 ^a (-1.71 to -1.71)	100	-3.59 ^a (-3.59 to -3.59)	100	-1.86 ^a (-1.86 to -1.86)	100	-3.42 ^a (-3.42 to -3.42)	100

Table 6 (continued)

Analyte	Trophic Group	N	90th Percentile UF: General		90th Percentile UF: Trophic Group		Regression :General 95% UPL		Regression: Trophic Group 95% UPL	
			Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated	Median PD (range)	% Over Estimated
Ni	Omnivore	5 ^d	-5.87 ^{NS} (-7.70 to -3.01)	100	-4.99 ^{NS} (-6.59 to -2.50)	100	-3.36 ^{NS} (-4.53 to -2.07)	100	-4.91 ^{NS} (-6.50 to -3.16)	100
Pb	Herbivore	7	-18.22 ^a (-33.62 to -3.00)	100	-11.79 ^a (-22.05 to -1.66)	100	-21.12 ^a (-57.03 to -4.47)	100	-10.39 ^a (-28.52 to -1.83)	100
Pb	Omnivore	19	-21.33 ^c (-85.93 to -0.70)	100	-29.35 ^c (-117.15 to -1.31)	100	-12.38 ^c (-81.90 to -6.77)	100	-11.95 ^c (-77.91 to -6.46)	100
Se	Herbivore	6 ^d	. . . ^a	100				100		
Se	Omnivore	5 ^d	0.50 ^{NS} (-4.21 to 0.54)	40	0.60 ^{NS} (-3.17 to 0.63)	60	-0.51 ^{NS} (-1.35 to -0.45)	100	-0.46 ^{NS} (-1.45 to -0.40)	100
Zn	Herbivore	7	-30.30 ^a (-141.49 to -3.94)	100	-28.18 ^a (-131.83 to -3.61)	100	-0.57 ^a (-1.05 to 0.20)	86	-0.26 ^{NS} (-0.75 to 0.37)	86
Zn	Omnivore	19	-9.20 ^c (-154.85 to 0.52)	89	-9.20 ^c (-154.85 to 0.52)	89	-0.16 ^{NS} (-1.14 to 0.64)	68	-0.08 ^{NS} (-1.03 to 0.68)	63

^{NS} Estimate not significantly different from measured as determined by Wilcoxon signed-rank test.

^a Estimate significantly different from measured as determined by Wilcoxon signed-rank test; p < 0.05.

^b Estimate significantly different from measured as determined by Wilcoxon signed-rank test; p < 0.01.

^c Estimate significantly different from measured as determined by Wilcoxon signed-rank test; p < 0.001.

^d Analyte below detection limits for some observations in validation dataset. PD values could therefore not be calculated for these observations. Number of nondetects by analyte and trophic group were: As in herbivores: 7; As in omnivores: 5; Ni in herbivores: 6; Ni in omnivores: 1; Se in herbivores: 6; and Se in omnivores: 2.

measured values. In addition, the trophic-group regressions produced the smallest median and range PD and the percent overestimation closest to 50% of all general estimation methods (Table 5). Among conservative methods, while the 95% UPL for the trophic group regression produced the best conservative estimates for herbivores, the 90th percentile trophic-group UF generated the best estimates for omnivores (Table 6).

All methods overestimated Co in both herbivores and omnivores, with all differences being significant for herbivores and none significant for omnivores (Table 5). The closest estimates were obtained from the median general UF.

The best general estimates of Cr in herbivorous small mammals were generated by the median trophic-group UF. While these estimates were more accurate than those generated by the median general UF, they were less than measured values 86% of the time (Table 5). Both regression models produced equivalent and better general estimates of Cr in omnivores as compared to either general UF (Table 5). Among conservative estimation methods, the 90th percentile general UF produced the best conservative estimates of Cr in herbivores, while the trophic-group regression model produced the best conservative estimates of Cr in omnivores (Table 6). Both conservative methods overestimated all validation observations.

For general estimation of Cu in small mammals, the median trophic-group UF and the general regression model generated the best estimates for herbivores and omnivores respectively (Table 5). Both methods produced estimates that did not differ from measured values, and generated the smallest median and range PD values of all general methods. Among conservative methods, the 95% UPL of the general regression model generated the best estimates for both trophic groups, overestimating 100% and 80% of observations for herbivores and omnivores, respectively (Table 6).

Only one estimation method, the general UF, was available for Fe. Estimates using the median UF, while generally exceeding measured values, did not differ significantly from measured values for either herbivores or omnivores (Table 5). Estimates using the 90th percentile UF exceeded all measured values for both trophic groups, with estimates differing from measured values for herbivores while not differing for omnivores (Table 6).

Validation data for Ni in herbivores was limited; Ni was detected in only 1 of 7 samples. Based on this single sample, the best general estimate was produced by the general regression model (Table 5), and the best conservative estimate was generated by the 90th percentile general UF (Table 6). Among omnivores, Ni was detected in 4 of 5 validation samples. No general or conservative estimate, generated by any method, differed significantly from measured values (Tables 5 and 6). The best general estimates for omnivores were generated by the trophic group regression (Table 5), while the best conservative estimates were generated by the 95% UPL for the general regression model (Table 6).

All general and conservative estimation methods significantly overestimated Pb in both herbivores and omnivores, with the percent of validation observations that were overestimated being $\geq 86\%$ for all methods (Table 5 and 6). The best general and conservative estimates for herbivores and omnivores were generated by the trophic-group UFs and trophic-group regression models, respectively (Table 5 and 6).

Similar to As, because Se was not detected in any herbivore sample from the validation dataset (Tables 5 and 6), general and conservative estimation methods cannot be validated. For omnivores,

Se was detected in 3 of 5 validation samples; based on these limited data, the best general and conservative estimates were generated by the regression models, with the general model producing estimates that were marginally better than the trophic-group models (Tables 5 and 6).

Compared to UFs, the regression models clearly produced the best general and conservative estimates of Zn in small mammals (Tables 5 and 6). For general estimates, the general regression model generated better estimates for both herbivores and omnivores than did the trophic group models (Table 5). For conservative estimates, both the general and trophic-group regression models generated comparable estimates for both herbivores and omnivores (Table 6).

3.3 FINAL UFs AND MODELS

Final UFs and regression models incorporating data from the validation studies were calculated for all analytes (Tables 7 and 8). UFs based on the combined dataset were, in general, similar to those based only on the original dataset. Distributions for most UFs were best fit by a lognormal distribution. Median UFs for all analytes and trophic groups were <1 except the general UF for TCDD, the insectivore UF for Cd and Hg, and the herbivore UF for TCDD (Table 7).

Similar to the UFs, regression models fit to the combined data were, in general, similar to those based only on the original dataset (Table 8). Inclusion of the additional data resulted in changes to some models. For example, sufficient data were available to fit general, herbivore, and omnivore models for Ba, Co, and Fe, and a model for Cr accumulation by herbivores. Significant model fits were not obtained for any group for Ba, for omnivores for Co and Fe, or for herbivores for Cr (Table 8). While significant general and herbivore models were fit for Co (Table 8), because the model and validation data have distinct and separate distributions (Fig. 2b), these models are unlikely to be valid. Significant general and herbivore model fits were also obtained for Fe (Table 8). In contrast to Co, the model and validation Fe data have overlapping distributions (Fig. 4b), suggesting the validity of the model. Other changes resulting from the inclusion of the validation data included obtaining a significant model fit for Cu in omnivores and losing significant linear relationships for the uptake of Pb and Zn by omnivores (Table 8). Inclusion of the validation data resulted in increased r^2 values for the general models for As and Cu; for the herbivore models for Cd, Cu, and Zn; and for the omnivore models for As and Cu (Table 8). r^2 values decreased following inclusion of the validation data for the general models for Cd, Cr, Pb, and Zn; for the herbivore model for Pb; and for the omnivore models for Cr, Pb, and Zn (Table 8).

In addition to the analytes represented in both the original and validation datasets, another 8 analytes were represented only in the validation dataset. Summary statistics for UFs for these analytes are presented in Appendix C, Table C-1. Scatterplots of concentrations of chemicals in small mammals versus those in soil are presented for chemicals with five or more observations in Figs. C-1 and C-2.

Table 7. Summary statistics for final soil-small mammal UFs following inclusion of validation data

Analyte	Trophic Group	N	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
As	General	72	0.0063	0.0105	0	0.0025	0.0149	0.071	-5.55414	1.2009	lognormal
Ba	General	14	0.0696	0.0588	0.0144	0.0566	0.1121	0.253	-2.90415	0.70504	lognormal
Cd	General	99	1.9902	7.2513	0.0153	0.3333	3.9905	69.561	-0.90973	1.71361	lognormal
Co	General	15	0.0371	0.0455	0.0101	0.0205	0.1	0.18	-3.68549	0.79542	lognormal ^a
Cr	General	38	0.1382	0.1661	0.0314	0.0846	0.3333	0.8	-2.36584	0.79454	lognormal ^a
Cu	General	76	0.42	0.3978	0.0044	0.1963	1.045	1.398	-1.60802	1.47025	lognormal ^a
F	General	4	0.12	0.1697	0.0021	0.0579	0.362	0.362	-3.87154	2.67022	normal ^b
Fe	General	15	0.0137	0.0053	0.0094	0.0124	0.0171	0.031	-4.34004	0.29831	lognormal ^a
Hg	General	18	0.1244	0.2343	0.0183	0.0543	0.192	1.046	-2.70075	0.94709	lognormal
Ni	General	43	0.2799	0.2672	0	0.2488	0.5891	1.143	-1.47029	0.99379	lognormal
Pb	General	138	0.1615	0.2927	0.0031	0.1054	0.2864	2.659	-2.60246	1.34442	lognormal
Se	General	35	0.3464	0.4617	0	0.1619	1.1867	1.754	-1.29816	1.03053	lognormal
TCDD	General	5	1.0698	0.7488	0.3067	1.0667	2.2	2.2	-0.15821	0.78578	normal ^b
TCDF	General	4	0.1204	0.0384	0.074	0.1251	0.1571	0.157	-2.15976	0.34561	normal ^b
Tl	General	2	0.1124	0.0146	0.102	0.1124	0.1227	0.123	-2.19019	0.13067	normal ^b
Zn	General	103	1.3352	2.0537	0.0051	0.7717	2.6878	16.364	-0.64685	1.62191	lognormal ^a
As	Insectivore	1	0.0013		0.0013	0.0013	0.001	0.001	-6.62945		
Cd	Insectivore	38	4.8127	11.2188	0.2086	2.105	7.017	69.561	0.79402	1.11395	lognormal
Cr	Insectivore	2	0.0815	0.0197	0.0675	0.0815	0.095	0.095	-2.52205	0.24458	uniform
Cu	Insectivore	30	0.6857	0.361	0.0121	0.7714	1.117	1.176	-0.6897	1.05494	lognormal ^a
F	Insectivore	2	0.1821	0.2545	0.0021	0.1821	0.362	0.362	-3.58288	3.63012	uniform
Hg	Insectivore	1	1.0457		1.0457	1.0457	1.046	1.046	0.04464		

Table 7 (continued)

Analyte	Trophic Group	N	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
Ni	Insectivore	9	0.3487	0.1429	0.0667	0.3643	0.578	0.578	-1.18015	0.62741	normal
Pb	Insectivore	54	0.2541	0.4179	0.0042	0.1601	0.339	2.659	-1.91202	1.03533	lognormal ^a
Se	Insectivore	2	0.7241	0.1262	0.6349	0.7241	0.813	0.813	-0.33047	0.17516	uniform
Zn	Insectivore	37	1.46716	1.62847	0.089351	0.83277	2.90106	6.961	-0.14855	1.11972	lognormal
As	Herbivore	29	0.0059	0.0064	0	0.0042	0.016	0.022	-5.21855	0.94223	lognormal
Ba	Herbivore	8	0.088	0.0725	0.0192	0.0615	0.253	0.253	-2.67578	0.74561	lognormal
Cd	Herbivore	28	0.221	0.2287	0.0153	0.1258	0.448	1	-2.00975	1.09269	lognormal
Co	Herbivore	10	0.0472	0.0534	0.0134	0.021	0.14	0.18	-3.45664	0.86467	lognormal
Cr	Herbivore	9	0.1249	0.0846	0.0314	0.0884	0.309	0.309	-2.27201	0.66518	normal ^b
Cu	Herbivore	18	0.3116	0.4279	0.0044	0.1086	1.29	1.398	-2.21637	1.67145	lognormal
F	Herbivore	2	0.0579	0.0788	0.0021	0.0579	0.114	0.114	-4.1602	2.80698	uniform
Fe	Herbivore	10	0.0145	0.0063	0.01	0.0126	0.024	0.031	-4.29297	0.33165	lognormal ^a
Hg	Herbivore	1	0.0239		0.0239	0.0239	0.024	0.024	-3.73333		
Ni	Herbivore	15	0.2654	0.3702	0	0.0513	0.898	1.143	-1.33517	1.25141	lognormal
Pb	Herbivore	40	0.0756	0.0761	0.0031	0.0522	0.187	0.287	-3.20343	1.26692	lognormal
Se	Herbivore	7	0.0221	0.0586	0	0	0.155	0.155	-1.86407		normal
TCDD	Herbivore	1	1.2857		1.2857	1.2857	1.286	1.286	0.25131		
Zn	Herbivore	30	1.32102	3.03062	0.00511	0.50429	2.31681	16.3636	-1.22783	2.02508	lognormal
As	Omnivore	42	0.0067	0.0127	0	0.0025	0.014	0.071	-5.72462	1.30952	lognormal
Ba	Omnivore	6	0.0451	0.0196	0.0144	0.0463	0.069	0.069	-3.20865	0.56515	normal ^b

Table 7 (continued)

Analyte	Trophic Group	N	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
Cd	Omnivore	33	0.2412	0.3232	0.0279	0.1217	0.462	1.705	-1.93828	0.97669	lognormal
Co	Omnivore	5	0.0168	0.0061	0.0101	0.0158	0.025	0.025	-4.14321	0.37334	normal ^b
Cr	Omnivore	27	0.1468	0.1914	0.0323	0.0699	0.349	0.8	-2.38555	0.86868	lognormal ^a
Cu	Omnivore	28	0.2051	0.2241	0.0082	0.1272	0.554	0.867	-2.20087	1.22553	lognormal
Fe	Omnivore	5	0.0121	0.0026	0.0094	0.0124	0.015	0.015	-4.43416	0.21765	normal ^b
Hg	Omnivore	16	0.0731	0.0465	0.0183	0.0543	0.13	0.192	-2.8078	0.65634	normal ^b
Ni	Omnivore	19	0.2587	0.2189	0	0.1683	0.589	0.8	-1.68292	1.00451	normal ^b
Pb	Omnivore	44	0.1258	0.183	0.0035	0.0659	0.286	0.995	-2.90347	1.39799	lognormal
Se	Omnivore	26	0.4047	0.494	0	0.2062	1.263	1.754	-1.35522	1.04902	lognormal
TCDD	Omnivore	4	1.0158	0.8533	0.3067	0.7783	2.2	2.2	-0.26059	0.86798	normal ^b
TCDF	Omnivore	4	0.1204	0.0384	0.074	0.1251	0.157	0.157	-2.15976	0.34561	normal ^b
TI	Omnivore	2	0.1124	0.0146	0.102	0.1124	0.123	0.123	-2.19019	0.13067	uniform
Zn	Omnivore	36	1.2113	1.38532	0.017852	0.55772	2.78218	5.85	-0.67485	1.55762	lognormal

^a Data not fit by either normal or lognormal distributions, however, closest fit provided by lognormal.

^b Data fit acceptably by both normal and lognormal distributions; closest fit provided by normal.

Table 8. Results of regression of ln whole-body small mammal concentration on ln soil concentration following inclusion of validation data

Analyte	Group	N	B0±SE	B1±SE	r ²	P model fit
As	General	60	-4.8471±0.4347 ^c	0.8188±0.1043 ^c	0.52	0.0001
As	Herbivore	22	-5.6531±0.5333 ^c	1.1382±0.1570 ^c	0.72	0.0001
As	Omnivore	37	-4.5796±0.6845 ^c	0.7354±0.1506 ^c	0.41	0.0001
Ba	General	14	-1.4120±3.6196 ^{NS}	0.7000±0.7266 ^{NS}	0.07	0.35
Ba	Herbivore	8	0.3361±4.8292 ^{NS}	0.3859±0.9831 ^{NS}	0.025	0.71
Ba	Omnivore	6	-10.0552±4.9417 ^{NS}	2.3511±0.9743 ^{NS}	0.59	0.07
Cd	General	99	-0.4306±0.1809 ^a	0.4865±0.1016 ^c	0.19	0.0001
Cd	Insectivore	38	0.8150±0.2031 ^c	0.9638±0.1516 ^c	0.53	0.0001
Cd	Herbivore	28	-1.2571±0.1541 ^c	0.4723±0.0698 ^c	0.64	0.0001
Cd	Omnivore	33	-1.5383±0.1418 ^c	0.5660±0.0780 ^c	0.63	0.0001
Co	General	15	-4.4669±1.1308 ^b	1.3070±0.4367 ^a	0.41	0.01
Co	Herbivore	10	-4.2614±1.3393 ^b	1.3096±0.5035 ^b	0.46	0.03
Co	Omnivore	5	-0.2028±0.8884 ^{NS}	-0.6179±0.3636 ^{NS}	0.49	0.19
Cr	General	38	-1.4599±0.5053 ^b	0.7338±0.1439 ^c	0.42	0.0001
Cr	Herbivore	9	-0.1347±0.7556 ^{NS}	0.3887±0.2112 ^{NS}	0.33	0.11
Cr	Omnivore	27	-1.4945±0.6846 ^b	0.7326±0.1994 ^b	0.35	0.001
Cu	General	76	2.0420±0.1301 ^c	0.1444±0.0285 ^c	0.26	0.0001
Cu	Insectivore	30	2.1042±0.0550 ^c	0.1783±0.0152 ^c	0.83	0.0001
Cu	Herbivore	18	2.0423±0.2538 ^c	0.0675±0.0521 ^{NS}	0.1	0.21
Cu	Omnivore	28	1.4592±0.2861 ^c	0.2681±0.0547 ^c	0.48	0.0001
F	General	4	1.7549±0.7730 ^{NS}	0.3129±0.0875 ^{NS}	0.87	0.07
Fe	General	15	-0.2879±1.1312 ^{NS}	0.5969±0.1124 ^c	0.68	0.0001
Fe	Herbivore	10	-0.4758±1.2717 ^{NS}	0.6207±0.1261 ^b	0.75	0.0012
Fe	Omnivore	5	6.2403±1.4278 ^a	-0.0643±0.1423 ^{NS}	0.06	0.68
Hg	General	18	-4.8666±1.7959 ^a	-2.2764±2.6962 ^{NS}	0.04	0.41
Hg	Omnivore	16	-4.0341±1.4366 ^a	-0.8965±2.2069 ^{NS}	0.01	0.69
Ni	General	36	-0.2462±0.1970 ^{NS}	0.4658±0.0729 ^c	0.55	0.0001
Ni	Insectivore	9	-0.4266±0.1505 ^a	0.5444±0.0738 ^c	0.89	0.0002
Ni	Herbivore	9	0.3174±0.3449 ^{NS}	0.3766±0.1092 ^a	0.63	0.01
Ni	Omnivore	18	-0.4140±0.3797 ^{NS}	0.4780±0.1381 ^b	0.43	0.003
Pb	General	138	0.0761±0.2524 ^{NS}	0.4422±0.0497 ^c	0.37	0.0001

Table 8 (continued)

Analyte	Group	N	B0±SE	B1±SE	r ²	P model fit
Pb	Insectivore	54	0.4819±0.3099 ^{NS}	0.4869±0.0633 ^c	0.53	0.0001
Pb	Herbivore	40	-0.6114±0.3356 ^{NS}	0.5181±0.0582 ^c	0.68	0.0001
Pb	Omnivore	44	0.5669±0.5550 ^{NS}	0.2194±0.1202 ^{NS}	0.07	0.07
Se	General	27	-0.4158±0.2090 ^{NS}	0.3764±0.1125 ^b	0.31	0.0026
Se	Omnivore	24	-0.4260±0.2315 ^{NS}	0.3786±0.1197 ^b	0.31	0.0045
TCDD	General	5	0.8113±1.8493 ^{NS}	1.0993±0.1852 ^b	0.92	0.0096
TCDD	Omnivore	4	0.7044±12.7713 ^{NS}	1.0894±1.1826 ^{NS}	0.29	0.45
TCDF	General	4	3.8673±11.4833 ^{NS}	1.6191±1.1794 ^{NS}	0.49	0.3
Zn	General	103	4.4713±0.1122 ^c	0.0738±0.0194 ^c	0.13	0.0002
Zn	Insectivore	37	4.2479±0.1191 ^c	0.1324±0.0228 ^c	0.49	0.0001
Zn	Herbivore	30	4.3632±0.1261 ^c	0.0706±0.0198 ^b	0.31	0.0013
Zn	Omnivore	36	4.4987±0.2955 ^c	0.0745±0.0509 ^{NS}	0.06	0.15

model: $\ln(\text{whole body}) = B0 + B1(\ln[\text{soil}])$

^{NS} Not Significant: $p > 0.05$.

^a $p < 0.05$.

^b $p < 0.01$.

^c $p < 0.001$

4. DISCUSSION

Like Shore (1995), we found significant ln-ln linear relationships between chemical concentrations in soils and those in the tissues of small mammals. In the current study, we fit significant regression models of ln whole-body concentration on ln soil concentration for all small mammals (9 of 12 chemicals), insectivores (5 of 5 chemicals), herbivores (5 of 6 chemicals), and omnivores (7 of 11 chemicals).

Our regression models indicate that bioaccumulation for many chemicals varies according to the trophic level, with accumulation based on the soil concentration greatest for insectivores and least for herbivores. Similar observations have been made by other researchers (Hunter, Johnson, and Thompson 1987; Ma, Denneman, and Faber 1991; Talmage and Walton 1991). Talmage and Walton attribute the higher accumulation seen in insectivores to food chain accumulation (consumption of herbivorous and predatory invertebrates). Higher accumulation by some insectivores may also be related to greater soil ingestion. For example, Talmage and Walton (1993) report soil consumption for short-tailed shrews (*Blarina brevicauda*) to be 13% of food consumption. In contrast, soil consumption for the omnivorous white-footed mouse (*Peromyscus leucopus*) was 1% of food ingestion.

The UFs and regression methods developed in this study, while useful for estimation purposes, do not accurately reflect the exposure pathways experienced by small mammals. Conceptually, the model for uptake by small mammals is: soil-food-small mammal. While incidental ingestion of soil by small mammals does occur (Garten 1980; Beyer, Conner, and Gerould 1994), the volume of soil consumed is small relative to the volume of food consumed. Our models bypass this intermediate, diet-mediated step in bioaccumulation. It is possible that improved models could be developed by considering diet-small mammal relationships. While significant model fits may be obtained for diet-based models, their predictive utility may be limited because of the temporal and spatial variability in diets consumed both by individual small mammals and within species of small mammals.

Because soil parameters such as soil pH and soil Ca concentration are known to influence chemical uptake in earthworms (Beyer, Hensler, and Moore 1987; Ma 1982; Morgan and Morgan 1991), soil chemistry may also influence bioavailability and uptake of contaminants by small mammals. It has been suggested that uptake of contaminants by small mammals may be affected by antagonism between co-occurring contaminants in the soil, such as Cd and Zn (Hunter, Johnson, and Thompson 1987; Talmage and Walton 1991). Additional parameters that may influence uptake of contaminants by small mammals include age, sex, and season of year (Talmage and Walton 1991). For example, Hunter, Johnson, and Thompson (1989) observed that Cd accumulation in common shrews (*Sorex araneus*) increased with age. Inclusion of these parameters in future analyses may further reduce the uncertainty associated with these models and increase their accuracy for generating site-specific estimates.

An additional source of uncertainty with our UFs and models is the preparation of small mammal samples prior to analysis. Whole-body concentrations may be biased due to chemicals retained in the stomach contents or by soil retained externally in the hair. While stomach contents were removed in some studies (Scanlon 1987) and some samples were washed (DOE 1995) or skinned (Beyer et al. 1985), most data included in models consisted of whole, unwashed specimens with stomach contents intact. The influence of these biases on the final analyses is not known.

5. RECOMMENDATIONS

In an ecological risk assessment context, the best data to estimate bioaccumulation of contaminants in soil by small mammals will always be site-specific data. Ideally, small mammals should be collected from multiple areas within the contaminated site and from reference areas (preferable at locations where soil samples are also collected) and analyses for contaminants of concern in whole-body or carcass tissue should be performed. In the absence of site-specific data, UFs or models should be used.

Because the available data indicate that bioaccumulation by small mammals is generally non-linear, decreasing as soil concentration increases, and UFs implicitly assume that accumulation is linear and constant across all soil concentrations, the use of log-linear regression models to estimate bioaccumulation by small mammals is recommended. For applications where conservative estimates are desired, such as screening ecological risk assessments, the 95% UPL for the trophic-group regression models are recommended (methods and parameters for calculating the 95% UPL are presented in Appendix D). If trophic-group models are not available, the general models should be used. In general, because they are based on a larger, more robust dataset, the regression models and UFs from the combined datasets (Tables 7 and 8) should be used. Due to the uncertainties associated with the models, it is highly recommended that users perform uncertainty analyses. It should be noted that because the models incorporate data from multiple sites and species, as well as multiple studies, these calculated uncertainties would represent variances among combinations of species and sites and not simply lack of knowledge (i.e., true uncertainty). Contaminant-specific recommendations and justifications are outlined in Table 9.

Table 9. Recommended application of bioaccumulation models
(all recommendations are from the combined validation dataset unless otherwise noted)

Analyte	Trophic Group	For General Estimates	For Conservative Estimates
As	Insectivore	general regression ^a	95% UPL for general regression ^a
	Herbivore	trophic-group regression	95% UPL for trophic-group regression
	Omnivore	trophic-group regression ^b	95% UPL for trophic-group regression ^b
Ba	All	median general UF ^c	90th percentile general UF ^c
Cd	All	trophic-group regression	95% UPL for trophic-group regression
Co	All	median general UF ^d	90th percentile general UF ^d
Cr	Insectivore	general regression ^a	95% UPL for general regression ^a
	Herbivore	median trophic group UF	90th percentile general UF

Table 9 (continued)

Analyte	Trophic Group	For General Estimates	For Conservative Estimates
	Omnivore	general or trophic-group regression	95% UPL for trophic-group regression
Cu	Insectivore	trophic-group regression	95% UPL for trophic-group regression
	Herbivore	median trophic-group UF	95% UPL for trophic-group regression
	Omnivore	trophic-group regression ^b	95% UPL for trophic-group regression
F	All	median general UF	90th percentile general UF
Fe	Insectivore	general regression ^a	95% UPL for general regression ^a
	Herbivore	trophic-group regression ^e	95% UPL for trophic-group regression ^e
	Omnivore	general regression ^f	95% UPL for general regression ^f
Hg	All	median general UF ^g	90th percentile general UF ^g
Ni	All	general regression ^h	95% UPL for general regression ^h
Pb	Insectivore	trophic-group regression	95% UPL for trophic-group regression
	Herbivore	trophic-group regression ⁱ	95% UPL for trophic-group regression ⁱ
	Omnivore	general regression ^j	95% UPL for general regression ^j
Se	Insectivore	general regression ^a	95% UPL for general regression ^a
	Herbivore	general regression	95% UPL for general regression
	Omnivore	general regression	95% UPL for general regression
Tl	All	median general UF	90th percentile general UF
Zn	All	general regression	95% UPL for general regression
TCDD	All	general regression	95% UPL for general regression

Table 9 (continued)

Analyte	Trophic Group	For General Estimates	For Conservative Estimates
TCDF	All	median general UF	90th percentile general UF
Analytes in Appendix C	All	median trophic-group UF ^d	90th percentile trophic-group UF ^d

^a Recommended because data not available for trophic-group model.

^b Recommended because addition of validation data resulted in better regression model fit (greater r^2 , lower p-value).

^c Recommended because significant regression model fits were not obtained and because trophic-group UFs were similar (Table 7).

^d Recommended because despite significant regression model fits (Table 8), distributions of model and validation data were disjoint (Fig. 2b) and because trophic-group UFs were similar (Table 7).

^e Recommended because addition of validation data resulted in significant regression model fit.

^f Recommended because addition of validation data resulted in significant general regression model fit but not trophic group model fit (Table 8).

^g Recommended because significant regression model fits were not obtained and because data for insectivore and omnivore UFs were limited (Table 7).

^h Recommended because trophic-group regression models were not significantly different.

ⁱ Recommended because while addition of validation data reduced r^2 , the combined dataset is more robust than the model data alone.

^j Recommended because addition of validation data resulted in non-significant trophic-group model.

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APPENDIX A

**SUMMARY OF STUDIES
INCLUDED IN THE SMALL MAMMAL
BIOACCUMULATION DATABASE**

A. MODEL DATA

Reference: Andrews et al. 1984

Analytes Considered: Cd

Species: *Microtus*, *Sorex*

Geographic Location of Study: Great Britain

Exposure Duration: resident

Type of Tissue Analyzed: liver, kidney, bone, whole body

Type of Source Media Analyzed: diet (plants, macro invertebrates)

Analytical Method: AA spectrometry

Soil Extraction Method: nitric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate food chain transfer of Cd metals at an abandoned mine

Notes:

Reference: Andrews et al. 1989a

Analytes Considered: Pb

Species: *Sorex*, *Microtus*

Geographic Location of Study: Great Britain

Exposure Duration: Resident

Type of Tissue Analyzed: whole body, liver, kidney, and other tissues

Type of Source Media Analyzed: soil, plants, insects, earthworms

Analytical Method: AA spectrometry

Soil Extraction Method: nitric perchloric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.): no

Purpose of Study: To evaluate uptake of Pb in association with a mine tailings site

Notes: used mean plant and insect concentrations in analyses.

Reference: Andrews et al. 1989b

Analytes Considered: Zn

Species: *Sorex*, *Microtus*

Geographic Location of Study: Great Britain

Exposure Duration: Resident

Type of Tissue Analyzed: whole body, liver, kidney, and other tissues

Type of Source Media Analyzed: soil, plants, insects, earthworms

Analytical Method: AA spectrometry

Soil Extraction Method: nitric perchloric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of metals in association with a mine tailings site

Notes: used mean plant and insect concentrations in analyses.

Reference: Andrews et al. 1989c

Analytes Considered: F

Species: *Sorex*, *Microtus*

Geographic Location of Study: Great Britain

Exposure Duration: Resident

Type of Tissue Analyzed: whole body, liver, kidney, and other tissues

Type of Source Media Analyzed: soil, plants, insects, earthworms

Analytical Method: Fluoride ion-selective electrode
Soil Extraction Method: nitric perchloric acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no
Purpose of Study: To evaluate uptake of F in association with a mine tailings site
Notes: used mean plant and insect concentrations in analyses.

Reference: Beyer et al. 1985
Analytes Considered: Pb, Zn, Cd, Cu
Species: *Blarina*, *Peromyscus*
Geographic Location of Study: Pennsylvania
Exposure Duration: Resident
Type of Tissue Analyzed: carcass (skin, feet, tails, GI tract removed)
Type of Source Media Analyzed: soil (a1 horizon), earthworms (mean of 2 species), insects (gypsy moth larvae), plants (acorns and fruit)
Analytical Method: AA spectrometry
Soil Extraction Method: acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: yes
Purpose of Study: To evaluate uptake of metals in association with a smelting site
Notes: The authors note that carcass concentrations were comparable to that in the carcass and external parts combined.

Reference: Beyer et al. 1990
Analytes Considered: Pb, Cu, Zn, Ni, Cd, Cr, As, Se
Species: *Mus*, *Blarina*, *Peromyscus*, *Microtus*
Geographic Location of Study: Maryland, Pennsylvania, New Jersey
Exposure Duration: resident
Type of Tissue Analyzed: carcass (tail and skin removed)
Type of Source Media Analyzed: dredged sediment
Analytical Method: AA spectrometry
Soil Extraction Method: acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: yes
Purpose of Study: To evaluate heavy metal transfer to biota using dredge spoil sites
Notes:

Reference: Cloutier et al. 1985
Analytes Considered: Cu, Ni, Fe, Co, Zn, Pb, and Ra-226
Species: *Microtus*
Geographic Location of Study: Ontario
Exposure Duration: Resident
Type of Tissue Analyzed: GI tract, skin, muscle, bone, liver, kidney; weighted sum to whole body
Type of Source Media Analyzed: soil, ground-level vegetation
Analytical Method: AA spectroscopy
Soil Extraction Method: acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no
Purpose of Study: To evaluate uptake of heavy metals at nickel and uranium mine-tailings site
Notes: All data values extracted from histograms of summary statistics

Reference: DOE 1995

Analytes Considered: As, Cd, Cr, Pb, Hg, Se, and Tl

Species: *Microtus*, *Peromyscus*, *Blarina*, *Reithrodontomys*

Geographic Location of Study: Tennessee

Exposure Duration: Resident

Type of Tissue Analyzed: whole body with including stomach contents

Analytical Method: AA spectroscopy

Soil Extraction Method: nitric and perchloric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of heavy metals at a coal ash disposal site.

Notes:

Reference: Elfving et al. 1979

Analytes Considered: As

Species: *Peromyscus*, *Microtus*

Geographic Location of Study: New York

Exposure Duration: Resident

Type of Tissue Analyzed: Whole body

Type of Source Media Analyzed: soil

Analytical Method: spectrometry using silver diethyldithiocarbamate procedure

Soil Extraction Method: hydrochloric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of As in old orchards

Notes:

Reference: ERT 1987

Analytes Considered: 2,3,7,8 TCDD and 2,3,7,8 TCDF

Species: *Peromyscus*

Geographic Location of Study: Wisconsin

Exposure Duration: Resident

Type of Tissue Analyzed: whole body

Type of Source Media Analyzed: soil

Analytical Method: Mass spectroscopy

Soil Extraction Method:

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate the uptake of TCDD by small mammals in forests treated with paper mill sludge.

Notes:

Reference: Fanelli et al. 1980

Analytes Considered: TCDD

Species: *Microtus*

Geographic Location of Study: Italy

Exposure Duration: Resident

Type of Tissue Analyzed: whole body

Type of Source Media Analyzed: soil

Analytical Method: GC MS

Soil Extraction Method:

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of TCDD in vicinity of Seveso

Notes:

Reference: Goldsmith and Scanlon 1977

Analytes Considered: Pb

Species: *Blarina*, *Microtus*, *Peromyscus*, *Cryptotis*, *Glaucomys*, *Sorex*, *Tamias*, *Zapus*, *Parascalops*

Geographic Location of Study: Virginia

Exposure Duration: Resident

Type of Tissue Analyzed: Whole body

Type of Source Media Analyzed: soil, earthworms, plants

Analytical Method: AA spectrometry

Soil Extraction Method: nitric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of metals in association with highway traffic

Notes: soil and plant data reported in Goldsmith et al. 1976. Plant concentrations represent mean on grass, forb, herb, and shrub measurements to 0-18 m from road. Soil value represents mean concentration 0-18 m from roads.

Reference: Hope et al. 1996

Analytes Considered: Ba

Species: *Peromyscus*, *Sigmodon*

Geographic Location of Study: Virginia

Exposure Duration: Resident

Type of Tissue Analyzed: Whole body

Type of Source Media Analyzed: soil, ground-dwelling invertebrates, vegetation

Analytical Method: not stated

Soil Extraction Method: not stated

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of barium at a contaminated site

Notes:

Reference: Hunter and Johnson 1982

Analytes Considered: Cd, Cu

Species: *Microtus*, *Sorex*, *Apodemus*

Geographic Location of Study: Great Britain

Exposure Duration: resident

Type of Tissue Analyzed: liver, kidney, bone, whole body

Type of Source Media Analyzed: soil, plants, invertebrates

Analytical Method: AA spectrometry

Soil Extraction Method: nitric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate food chain transfer of Cd and Cu at a smelting site

Notes: Whole-body concentrations interpolated from figures; organ, soil, plant, and invertebrate concentrations reported in tables. Concentrations in detritivore invertebrates used as earthworms. Insect concentration represented by mean for carnivore and herbivore invertebrates. Plant concentrations represented by mean of grass and ground cover.

Reference: Johnson et al. 1978

Analytes Considered: Cd, Pb, Zn

Species: *Apodemus*, *Microtus*, *Clethrionomys*

Geographic Location of Study: Wales, Great Britain

Exposure Duration: Resident
Type of Tissue Analyzed: Whole body, bone, liver, kidney, brain, muscle
Type of Source Media Analyzed: soil
Analytical Method: AA spectrometry
Soil Extraction Method: nitric and perchloric acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no
Purpose of Study: To evaluate uptake of metals associated with mining and smelting sites
Notes:

Reference: Pascoe et al. 1994, Pascoe et al. 1996
Analytes Considered: As, Cd, Cu, Pb, Zn
Species: *Peromyscus*, *Microtus*
Geographic Location of Study: Montana
Exposure Duration: Resident
Type of Tissue Analyzed: liver, kidney, testes, carcass
Type of Source Media Analyzed: soil, vegetation, earthworms, grasshoppers
Analytical Method: not stated
Soil Extraction Method: not stated
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no
Purpose of Study: To evaluate uptake of metals at a contaminated site
Notes: small mammals were skinned and dissected before analyses. Plant data represents mean of above ground grasses and forbs. Small mammal concentrations reported in wet weight; dry weight estimated by assuming a water content of 68% (EPA 1993).

Reference: Quarles et al. 1974
Analytes Considered: Pb
Species: *Peromyscus*, *Microtus*, *Blarina*
Geographic Location of Study: Virginia
Exposure Duration: Resident
Type of Tissue Analyzed: Whole body
Type of Source Media Analyzed: soil, ground-level vegetation
Analytical Method: AA spectrometry
Soil Extraction Method: nitric and perchloric acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: yes, pH and soil type
Purpose of Study: To evaluate uptake of lead adjacent to highways
Notes:

Reference: Read and Martin 1993
Analytes Considered: Cd, Cu, Pb, Zn
Species: *Sorex araneus*, *Sorex minutus*
Geographic Location of Study: Great Britain
Exposure Duration: resident
Type of Tissue Analyzed: liver, kidney, carcass, whole body
Type of Source Media Analyzed: surface litter
Analytical Method: AA spectrometry
Soil Extraction Method: nitric acid
Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no
Purpose of Study: To evaluate uptake and transfer of metals in the vicinity of a smelting site

Notes: Surface litter concentration assumed representative of surface soil

Reference: Roberts et al. 1978

Analytes Considered: Pb

Species: *Sorex*, *Apodemus*, *Microtus*, *Clethrionomys*

Geographic Location of Study: Great Britain

Exposure Duration: Resident

Type of Tissue Analyzed: whole body, liver, kidney

Type of Source Media Analyzed: soil, plants, insects, earthworms

Analytical Method: AA spectrometry

Soil Extraction Method: nitric perchloric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of Pb in association with a mine tailings site

Notes: Body burdens reported in wet weight. Dry weight concentrations estimated assuming a 68% water content for small mammals (EPA 1993).

Reference: Scanlon 1987

Analytes Considered: Cd, Pb, Ni, and Zn

Species: *Microtus*, *Peromyscus*, *Blarina*, *Mus*, *Cryptotis*, *Rattus*, *Sorex*

Geographic Location of Study: Virginia

Exposure Duration: Resident

Type of Tissue Analyzed: whole body with stomach contents removed

Type of Source Media Analyzed: soil, earthworms (depurated, data only for Pb and Zn)

Analytical Method: AA spectroscopy

Soil Extraction Method: nitric and hydrochloric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: no

Purpose of Study: To evaluate uptake of heavy metals along roadways in relation to traffic density.

Notes: Soil data not reported in study. Contacted P.F. Scanlon and was directed to another publication (Scanlon 1991) in which soil data were reported.

B. Validation Data

Reference: LaTier et al. 1995

Analytes Considered: As, Cd, Cu, Pb, and Zn

Species: *Peromyscus*

Geographic Location of Study: Clark Fork River Superfund Site, Montana

Exposure Duration: Resident

Type of Tissue Analyzed: whole body

Type of Source Media Analyzed: soil, arthropods, plants

Analytical Method: ICP/MS

Soil Extraction Method: nitric acid

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: yes

Purpose of Study: To evaluate uptake of contaminants associated with a contaminated watershed.

Notes: Small mammal analyzed as composites of 3 individuals/sampling location

Reference: PTI 1995.

Analytes Considered: 24 inorganics

Species: *Peromyscus*, *Sigmodon*

Geographic Location of Study: Bartlesville, Oklahoma

Exposure Duration: Resident

Type of Tissue Analyzed: whole body

Type of Source Media Analyzed: soil, earthworms, plants

Analytical Method: not specifically report; AA assumed

Soil Extraction Method: not specifically report; strong acids assumed

Soil Characteristics (pH, CEC, % OM, % Clay, etc.) Presented: yes

Purpose of Study: To evaluate uptake of contaminants associated with National Zinc Site.

Notes: Small mammal analyzed as composites of up to 12 individuals/sampling location

APPENDIX B

**SMALL MAMMAL
BIOACCUMULATION DATABASE**

Table B.1. Small mammal bioaccumulation database.

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
As	Tennessee	Blarina brevicauda	Carnivore	0.177	134	0.00132	model	DOE 1995
As	Tennessee	Microtus pinetorum	Herbivore	0.093	134	0.00069	model	DOE 1995
As	Montana	Microtus pennsylvanicus	Herbivore	0.781	52.5	0.01488	model	Pascoe et al. 1994, 1996
As	MD,PA,NJ	Mus musculus	Omnivore	0.64	33	0.01939	model	Beyer et al. 1990
As	Tennessee	Peromyscus leucopus	Omnivore	0.047	134	0.00035	model	DOE 1995
As	MD,PA,NJ	Mus musculus	Omnivore	0.14	10	0.01400	model	Beyer et al. 1990
As	Tennessee	Reithrodontomys	Omnivore	0.144	110	0.00131	model	DOE 1995
As	Tennessee	Reithrodontomys	Omnivore	0.056	110	0.00051	model	DOE 1995
As	Tennessee	Reithrodontomys	Omnivore	0.216	110	0.00196	model	DOE 1995
As	Tennessee	Reithrodontomys	Omnivore	0.137	110	0.00125	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.232	110	0.00211	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.042	110	0.00038	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.434	110	0.00395	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.039	134	0.00029	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.106	110	0.00096	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.211	110	0.00192	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.084	110	0.00076	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.085	110	0.00077	model	DOE 1995
As	Tennessee	Peromyscus leucopus	Omnivore	0.122	110	0.00111	model	DOE 1995
As	NewYork	Microtus pinetorum	Herbivore	0.712	94	0.00758	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.544	34	0.01600	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.16	34	0.00471	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.876	44	0.01991	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.340	94	0.00362	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.004	2.4	0.00158	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.028	2.4	0.01170	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.211	34	0.00619	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.183	34	0.00538	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.005	2.4	0.00216	model	Elfving et al. 1979

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
As	NewYork	Microtus pinetorum	Herbivore	0.016	2.4	0.00664	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.507	44	0.01153	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.004	2.4	0.00179	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.062	31	0.00199	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.293	44	0.00666	model	Elfving et al. 1979
As	NewYork	Microtus pinetorum	Herbivore	0.956	44	0.02172	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.129	31	0.00416	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.214	34	0.00630	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.051	31	0.00166	model	Elfving et al. 1979
As	NewYork	Microtus pennsylvanicus	Herbivore	0.630	44	0.01433	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.257	31	0.00829	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.589	31	0.01900	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.019	2.4	0.00772	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.021	2.4	0.00887	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.006	2.4	0.00248	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.156	31	0.00503	model	Elfving et al. 1979
As	NewYork	Peromyscus leucopus	Omnivore	0.079	31	0.00255	model	Elfving et al. 1979
Ba	Virginia	Sigmodon hispidus	Herbivore	2	104.2	0.01919	model	Hope et al. 1996
Ba	Virginia	Peromyscus leucopus	Omnivore	1.5	104.2	0.01440	model	Hope et al. 1996
Cd	Virginia	Blarina brevicauda	Carnivore	0.29	0.48	0.60417	model	Scanlon 1987
Cd	GreatBritain	Sorex minutus (immature)	Carnivore	5.06	3.3	1.53333	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (immature)	Carnivore	1.79	2	0.89500	model	Read and Martin 1993
Cd	Pennsylvania	Blarina brevicauda	Carnivore	4.8	2.7	1.77778	model	Beyer et al. 1985
Cd	GreatBritain	Sorex minutus (adult)	Carnivore	4.21	0.6	7.01667	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (immature)	Carnivore	2.46	0.6	4.10000	model	Read and Martin 1993
Cd	Pennsylvania	Blarina brevicauda	Carnivore	7.3	35	0.20857	model	Beyer et al. 1985
Cd	GreatBritain	Sorex minutus (adult)	Carnivore	9.03	3.3	2.73636	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (adult)	Carnivore	330.67	19.9	16.61658	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (immature)	Carnivore	1.08	1	1.08000	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (adult)	Carnivore	15.06	19.9	0.75678	model	Read and Martin 1993

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cd	GreatBritain	Sorex araneus (adult)	Carnivore	5.2	0.6	8.66667	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (adult)	Carnivore	4.92	2	2.46000	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (immature)	Carnivore	5.66	19.9	0.28442	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (immature)	Carnivore	3.09	1.7	1.81765	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (immature)	Carnivore	1.93	1	1.93000	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (immature)	Carnivore	5.05	1.7	2.97059	model	Read and Martin 1993
Cd	Virginia	Blarina brevicauda	Carnivore	0.47	0.6	0.78333	model	Scanlon 1987
Cd	GreatBritain	Sorex araneus (adult)	Carnivore	10.92	1.7	6.42353	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (adult)	Carnivore	3.62	2	1.81000	model	Read and Martin 1993
Cd	GreatBritain	Sorex minutus (adult)	Carnivore	2.28	1	2.28000	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (adult)	Carnivore	6.83	1	6.83000	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (immature)	Carnivore	9.78	3.3	2.96364	model	Read and Martin 1993
Cd	Virginia	Cryptotis parva	Carnivore	0.2	0.48	0.41667	model	Scanlon 1987
Cd	Virginia	Cryptotis parva	Carnivore	0.52	0.65	0.80000	model	Scanlon 1987
Cd	MD,PA,NJ	Blarina brevicauda	Carnivore	1	0.62	1.61290	model	Beyer et al. 1990
Cd	Virginia	Cryptotis parva	Carnivore	0.8	0.6	1.33333	model	Scanlon 1987
Cd	Virginia	Sorex cinereus	Carnivore	1.09	0.6	1.81667	model	Scanlon 1987
Cd	GreatBritain	Sorex minutus (adult)	Carnivore	6.66	1.7	3.91765	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus	Carnivore	2.2	0.75	2.93333	model	Hunter and Johnson 1982
Cd	GreatBritain	Sorex araneus (adult)	Carnivore	229.55	3.3	69.56061	model	Read and Martin 1993
Cd	Virginia	Blarina brevicauda	Carnivore	0.46	0.65	0.70769	model	Scanlon 1987
Cd	GreatBritain	Sorex araneus	Carnivore	21	3.1	6.77419	model	Hunter and Johnson 1982
Cd	GreatBritain	Sorex araneus (immature)	Carnivore	79.41	19.9	3.99045	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus (immature)	Carnivore	2.44	0.6	4.06667	model	Read and Martin 1993
Cd	GreatBritain	Sorex araneus	Carnivore	28	8.5	3.29412	model	Hunter and Johnson 1982
Cd	GreatBritain	Sorex araneus (immature)	Carnivore	3.03	2	1.51500	model	Read and Martin 1993
Cd	Virginia	Blarina brevicauda	Carnivore	1.71	0.475	3.60000	model	Scanlon 1987
Cd	GreatBritain	Clethrionomys glareolus	Herbivore	0.87	11.2	0.07768	model	Johnson et al. 1978
Cd	GreatBritain	Microtus agrestis	Herbivore	0.62	11.2	0.05536	model	Johnson et al. 1978
Cd	GreatBritain	Microtus agrestis	Herbivore	0.13	1.55	0.08387	model	Johnson et al. 1978

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cd	GreatBritain	Clethrionomys glareolus	Herbivore	0.17	1.55	0.10968	model	Johnson et al. 1978
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	0.96	11.2	0.08571	model	Johnson et al. 1978
Cd	GreatBritain	Microtus agrestis	Herbivore	1.2	3.1	0.38710	model	Hunter and Johnson 1982
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	0.76	45.9	0.01656	model	Johnson et al. 1978
Cd	Virginia	Microtus pennsylvanicus	Herbivore	0.22	0.6	0.36667	model	Scanlon 1987
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	0.75	0.75	1.00000	model	Hunter and Johnson 1982
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	1	3.1	0.32258	model	Hunter and Johnson 1982
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	1	8.5	0.11765	model	Hunter and Johnson 1982
Cd	GreatBritain	Microtus agrestis	Herbivore	0.25	0.75	0.33333	model	Hunter and Johnson 1982
Cd	GreatBritain	Microtus agrestis	Herbivore	1.75	8.5	0.20588	model	Hunter and Johnson 1982
Cd	Montana	Microtus pennsylvanicus	Herbivore	0.1875	7.8	0.02404	model	Pascoe et al. 1994, 1996
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	0.29	1.44	0.20139	model	Johnson et al. 1978
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	2.64	92.2	0.02863	model	Johnson et al. 1978
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	0.34	1.55	0.21935	model	Johnson et al. 1978
Cd	GreatBritain	Apodemus sylvaticus	Herbivore	0.27	1.1	0.24545	model	Johnson et al. 1978
Cd	Virginia	Microtus pennsylvanicus	Herbivore	0.19	0.65	0.29231	model	Scanlon 1987
Cd	Virginia	Microtus pennsylvanicus	Herbivore	0.37	0.475	0.77895	model	Scanlon 1987
Cd	Virginia	Microtus pennsylvanicus	Herbivore	0.15	0.48	0.31250	model	Scanlon 1987
Cd	Virginia	Mus musculus	Omnivore	0.11	0.6	0.18333	model	Scanlon 1987
Cd	Virginia	Mus musculus	Omnivore	0.06	0.65	0.09231	model	Scanlon 1987
Cd	Virginia	Peromyscus leucopus	Omnivore	0.81	0.475	1.70526	model	Scanlon 1987
Cd	Virginia	Mus musculus	Omnivore	0.16	0.475	0.33684	model	Scanlon 1987
Cd	Virginia	Peromyscus leucopus	Omnivore	0.3	0.65	0.46154	model	Scanlon 1987
Cd	Virginia	Peromyscus leucopus	Omnivore	0.19	0.48	0.39583	model	Scanlon 1987
Cd	Virginia	Peromyscus leucopus	Omnivore	0.2	0.6	0.33333	model	Scanlon 1987
Cd	Pennsylvania	Peromyscus leucopus	Omnivore	2.6	35	0.07429	model	Beyer et al. 1985
Cd	Pennsylvania	Peromyscus leucopus	Omnivore	1.2	2.7	0.44444	model	Beyer et al. 1985
Cd	Virginia	Rattus norvegicus	Omnivore	0.54	0.65	0.83077	model	Scanlon 1987
Cd	MD,PA,NJ	Mus musculus	Omnivore	0.077	0.7	0.11000	model	Beyer et al. 1990
Cd	MD,PA,NJ	Mus musculus	Omnivore	0.093	0.62	0.15000	model	Beyer et al. 1990

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cd	Montana	Peromyscus maniculatus	Omnivore	0.25	7.8	0.03205	model	Pascoe et al. 1994, 1996
Cd	MD,PA,NJ	Mus musculus	Omnivore	0.093	1	0.09300	model	Beyer et al. 1990
Co	Ontario	Microtus pennsylvanicus	Herbivore	2.33	50	0.04660	model	Cloutier et al. 1985
Co	Ontario	Microtus pennsylvanicus	Herbivore	1.8	10	0.18000	model	Cloutier et al. 1985
Co	Ontario	Microtus pennsylvanicus	Herbivore	2.5	25	0.10000	model	Cloutier et al. 1985
Cr	MD,PA,NJ	Blarina brevicauda	Carnivore	21	220	0.09545	model	Beyer et al. 1990
Cr	Tennessee	Blarina brevicauda	Carnivore	0.797	11.8	0.06754	model	DOE 1995
Cr	MD,PA,NJ	Microtus pennsylvanicus	Herbivore	6.9	220	0.03136	model	Beyer et al. 1990
Cr	Tennessee	Microtus pinetorum	Herbivore	1.457	11.8	0.12347	model	DOE 1995
Cr	Tennessee	Reithrodontomys	Omnivore	0.778	21.4	0.03636	model	DOE 1995
Cr	MD,PA,NJ	Mus musculus	Omnivore	11	33	0.33333	model	Beyer et al. 1990
Cr	MD,PA,NJ	Mus musculus	Omnivore	11	300	0.03667	model	Beyer et al. 1990
Cr	Tennessee	Reithrodontomys	Omnivore	1.004	21.4	0.04692	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.363	21.4	0.06369	model	DOE 1995
Cr	Tennessee	Reithrodontomys	Omnivore	1.227	21.4	0.05734	model	DOE 1995
Cr	MD,PA,NJ	Peromyscus leucopus	Omnivore	7.1	220	0.03227	model	Beyer et al. 1990
Cr	Tennessee	Peromyscus leucopus	Omnivore	2.253	21.4	0.10528	model	DOE 1995
Cr	Tennessee	Reithrodontomys	Omnivore	1.082	21.4	0.05056	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	2.013	21.4	0.09407	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	0.987	21.4	0.04612	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.092	21.4	0.05103	model	DOE 1995
Cr	MD,PA,NJ	Mus musculus	Omnivore	18	26	0.69231	model	Beyer et al. 1990
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.11	11.8	0.09407	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.184	21.4	0.05533	model	DOE 1995
Cr	MD,PA,NJ	Mus musculus	Omnivore	11	220	0.05000	model	Beyer et al. 1990
Cr	MD,PA,NJ	Mus musculus	Omnivore	16	20	0.80000	model	Beyer et al. 1990
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.051	21.4	0.04911	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.07	11.8	0.09068	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.117	11.8	0.09466	model	DOE 1995
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.167	21.4	0.05453	model	DOE 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cr	Tennessee	Peromyscus leucopus	Omnivore	1.035	11.8	0.08771	model	DOE 1995
Cu	GreatBritain	Sorex araneus (immature)	Carnivore	21.66	151	0.14344	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (adult)	Carnivore	13.47	12	1.12250	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus	Carnivore	20	246	0.08130	model	Hunter and Johnson 1982
Cu	GreatBritain	Sorex araneus	Carnivore	30	2480	0.01210	model	Hunter and Johnson 1982
Cu	GreatBritain	Sorex araneus (immature)	Carnivore	13.57	24	0.56542	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (adult)	Carnivore	11.18	18	0.62111	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (immature)	Carnivore	12.12	14	0.86571	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (immature)	Carnivore	13.61	18	0.75611	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus	Carnivore	10	9.3	1.07527	model	Hunter and Johnson 1982
Cu	MD,PA,NJ	Blarina brevicauda	Carnivore	20	130	0.15385	model	Beyer et al. 1990
Cu	GreatBritain	Sorex araneus (immature)	Carnivore	12.54	12	1.04500	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (immature)	Carnivore	15.75	18	0.87500	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (adult)	Carnivore	12.84	14	0.91714	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (immature)	Carnivore	13.93	18	0.77389	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (immature)	Carnivore	14.13	24	0.58875	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (immature)	Carnivore	13.99	12	1.16583	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (adult)	Carnivore	15.96	24	0.66500	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (adult)	Carnivore	15.51	18	0.86167	model	Read and Martin 1993
Cu	Pennsylvania	Blarina brevicauda	Carnivore	11	18	0.61111	model	Beyer et al. 1985
Cu	GreatBritain	Sorex minutus (adult)	Carnivore	16.22	18	0.90111	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (immature)	Carnivore	13.84	18	0.76889	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (adult)	Carnivore	20.73	151	0.13728	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (adult)	Carnivore	14.61	18	0.81167	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (immature)	Carnivore	20.72	151	0.13722	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (adult)	Carnivore	13.07	14	0.93357	model	Read and Martin 1993
Cu	Pennsylvania	Blarina brevicauda	Carnivore	11	9.9	1.11111	model	Beyer et al. 1985
Cu	GreatBritain	Sorex minutus (immature)	Carnivore	12.2	14	0.87143	model	Read and Martin 1993
Cu	GreatBritain	Sorex minutus (adult)	Carnivore	14.11	12	1.17583	model	Read and Martin 1993
Cu	GreatBritain	Sorex araneus (adult)	Carnivore	21.71	151	0.14377	model	Read and Martin 1993

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cu	GreatBritain	Sorex minutus (adult)	Carnivore	16.3	24	0.67917	model	Read and Martin 1993
Cu	Ontario	Microtus pennsylvanicus	Herbivore	15	38	0.39474	model	Cloutier et al. 1985
Cu	Montana	Microtus pennsylvanicus	Herbivore	8.75	532.2	0.01644	model	Pascoe et al. 1994, 1996
Cu	Ontario	Microtus pennsylvanicus	Herbivore	10.5	30	0.35000	model	Cloutier et al. 1985
Cu	Ontario	Microtus pennsylvanicus	Herbivore	21	400	0.05250	model	Cloutier et al. 1985
Cu	MD,PA,NJ	Microtus pennsylvanicus	Herbivore	16	130	0.12308	model	Beyer et al. 1990
Cu	GreatBritain	Microtus agrestis	Herbivore	11	246	0.04472	model	Hunter and Johnson 1982
Cu	GreatBritain	Microtus agrestis	Herbivore	22	2480	0.00887	model	Hunter and Johnson 1982
Cu	GreatBritain	Apodemus sylvaticus	Herbivore	12	9.3	1.29032	model	Hunter and Johnson 1982
Cu	GreatBritain	Apodemus sylvaticus	Herbivore	11	2480	0.00444	model	Hunter and Johnson 1982
Cu	GreatBritain	Apodemus sylvaticus	Herbivore	11	246	0.04472	model	Hunter and Johnson 1982
Cu	GreatBritain	Microtus agrestis	Herbivore	13	9.3	1.39785	model	Hunter and Johnson 1982
Cu	MD,PA,NJ	Mus musculus	Omnivore	18	130	0.13846	model	Beyer et al. 1990
Cu	MD,PA,NJ	Peromyscus leucopus	Omnivore	15	130	0.11538	model	Beyer et al. 1990
Cu	Pennsylvania	Peromyscus leucopus	Omnivore	8.3	18	0.46111	model	Beyer et al. 1985
Cu	MD,PA,NJ	Mus musculus	Omnivore	12	24	0.50000	model	Beyer et al. 1990
Cu	MD,PA,NJ	Mus musculus	Omnivore	18	150	0.12000	model	Beyer et al. 1990
Cu	MD,PA,NJ	Mus musculus	Omnivore	15	71	0.21127	model	Beyer et al. 1990
Cu	Montana	Peromyscus maniculatus	Omnivore	10.625	532.2	0.01996	model	Pascoe et al. 1994, 1996
Cu	Pennsylvania	Peromyscus leucopus	Omnivore	6.7	9.9	0.67677	model	Beyer et al. 1985
Cu	MD,PA,NJ	Mus musculus	Omnivore	13	15	0.86667	model	Beyer et al. 1990
F	GreatBritain	Sorex araneus	Carnivore	47.5	131.2	0.36204	model	Andrews et al. 1989c
F	GreatBritain	Sorex araneus	Carnivore	211	98876	0.00213	model	Andrews et al. 1989c
F	GreatBritain	Microtus agrestis	Herbivore	14.9	131.2	0.11357	model	Andrews et al. 1989c
F	GreatBritain	Microtus agrestis	Herbivore	212	98876	0.00214	model	Andrews et al. 1989c
Fe	Ontario	Microtus pennsylvanicus	Herbivore	1050	100000	0.01050	model	Cloutier et al. 1985
Fe	Ontario	Microtus pennsylvanicus	Herbivore	250	8000	0.03125	model	Cloutier et al. 1985
Fe	Ontario	Microtus pennsylvanicus	Herbivore	310	22000	0.01409	model	Cloutier et al. 1985
Hg	Tennessee	Blarina brevicauda	Carnivore	0.481	0.46	1.04565	model	DOE 1995
Hg	Tennessee	Microtus pinetorum	Herbivore	0.011	0.46	0.02391	model	DOE 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.027	0.547	0.04936	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.016	0.547	0.02925	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.053	0.46	0.11522	model	DOE 1995
Hg	Tennessee	Reithrodontomys	Omnivore	0.071	0.547	0.12980	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.021	0.547	0.03839	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.04	0.547	0.07313	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.025	0.46	0.05435	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.025	0.46	0.05435	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.056	0.547	0.10238	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.025	0.547	0.04570	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.049	0.547	0.08958	model	DOE 1995
Hg	Tennessee	Reithrodontomys	Omnivore	0.012	0.547	0.02194	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.048	0.46	0.10435	model	DOE 1995
Hg	Tennessee	Peromyscus leucopus	Omnivore	0.028	0.547	0.05119	model	DOE 1995
Hg	Tennessee	Reithrodontomys	Omnivore	0.105	0.547	0.19196	model	DOE 1995
Hg	Tennessee	Reithrodontomys	Omnivore	0.01	0.547	0.01828	model	DOE 1995
Ni	Virginia	Blarina brevicauda	Carnivore	1.59	2.75	0.57818	model	Scanlon 1987
Ni	Virginia	Sorex cinereus	Carnivore	0.72	3.2	0.22500	model	Scanlon 1987
Ni	Virginia	Cryptotis parva	Carnivore	1.38	3.5	0.39429	model	Scanlon 1987
Ni	MD,PA,NJ	Blarina brevicauda	Carnivore	10	150	0.06667	model	Beyer et al. 1990
Ni	Virginia	Cryptotis parva	Carnivore	1.29	3.2	0.40312	model	Scanlon 1987
Ni	Virginia	Blarina brevicauda	Carnivore	1.01	3.2	0.31562	model	Scanlon 1987
Ni	Virginia	Blarina brevicauda	Carnivore	1.56	3.5	0.44571	model	Scanlon 1987
Ni	Virginia	Blarina brevicauda	Carnivore	1.53	4.2	0.36429	model	Scanlon 1987
Ni	Virginia	Cryptotis parva	Carnivore	1.45	4.2	0.34524	model	Scanlon 1987
Ni	Ontario	Microtus pennsylvanicus	Herbivore	6	40	0.15000	model	Cloutier et al. 1985
Ni	Virginia	Microtus pennsylvanicus	Herbivore	2.16	3.2	0.67500	model	Scanlon 1987
Ni	Virginia	Microtus pennsylvanicus	Herbivore	1.63	3.5	0.46571	model	Scanlon 1987
Ni	Virginia	Microtus pennsylvanicus	Herbivore	1.34	4.2	0.31905	model	Scanlon 1987
Ni	MD,PA,NJ	Microtus pennsylvanicus	Herbivore	4.6	150	0.03067	model	Beyer et al. 1990

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Ni	Ontario	<i>Microtus pennsylvanicus</i>	Herbivore	20	390	0.05128	model	Cloutier et al. 1985
Ni	Ontario	<i>Microtus pennsylvanicus</i>	Herbivore	8	7	1.14286	model	Cloutier et al. 1985
Ni	Virginia	<i>Microtus pennsylvanicus</i>	Herbivore	2.47	2.75	0.89818	model	Scanlon 1987
Ni	Virginia	<i>Peromyscus leucopus</i>	Omnivore	1.06	3.2	0.33125	model	Scanlon 1987
Ni	Virginia	<i>Peromyscus leucopus</i>	Omnivore	1.06	3.5	0.30286	model	Scanlon 1987
Ni	Virginia	<i>Mus musculus</i>	Omnivore	0.23	3.2	0.07187	model	Scanlon 1987
Ni	Virginia	<i>Mus musculus</i>	Omnivore	1.62	2.75	0.58909	model	Scanlon 1987
Ni	Virginia	<i>Peromyscus leucopus</i>	Omnivore	1	2.75	0.36364	model	Scanlon 1987
Ni	Virginia	<i>Peromyscus leucopus</i>	Omnivore	1.48	4.2	0.35238	model	Scanlon 1987
Ni	Virginia	<i>Mus musculus</i>	Omnivore	0.45	3.5	0.12857	model	Scanlon 1987
Ni	Virginia	<i>Rattus norvegicus</i>	Omnivore	1.6	3.5	0.45714	model	Scanlon 1987
Ni	MD,PA,NJ	<i>Mus musculus</i>	Omnivore	7.9	17	0.46471	model	Beyer et al. 1990
Ni	MD,PA,NJ	<i>Mus musculus</i>	Omnivore	5.3	13	0.40769	model	Beyer et al. 1990
Ni	MD,PA,NJ	<i>Peromyscus leucopus</i>	Omnivore	3.2	150	0.02133	model	Beyer et al. 1990
Ni	MD,PA,NJ	<i>Mus musculus</i>	Omnivore	9.6	12	0.80000	model	Beyer et al. 1990
Ni	MD,PA,NJ	<i>Mus musculus</i>	Omnivore	3.7	28	0.13214	model	Beyer et al. 1990
Ni	MD,PA,NJ	<i>Mus musculus</i>	Omnivore	5.7	150	0.03800	model	Beyer et al. 1990
Pb	GreatBritain	<i>Sorex araneus</i> (immature)	Carnivore	10.3	98	0.10510	model	Read and Martin 1993
Pb	GreatBritain	<i>Sorex araneus</i> (adult)	Carnivore	2.48	98	0.02531	model	Read and Martin 1993
Pb	Virginia	<i>Blarina brevicauda</i>	Carnivore	35.13	137	0.25642	model	Scanlon 1987
Pb	Virginia	<i>Blarina brevicauda</i>	Carnivore	5.2	27.4	0.18978	model	Quarles et al. 1974
Pb	GreatBritain	<i>Sorex araneus</i> (adult)	Carnivore	6.37	33	0.19303	model	Read and Martin 1993
Pb	Virginia	<i>Blarina brevicauda</i>	Carnivore	72.56	307.5	0.23597	model	Scanlon 1987
Pb	GreatBritain	<i>Sorex araneus</i> (immature)	Carnivore	16.62	125	0.13296	model	Read and Martin 1993
Pb	Virginia	<i>Blarina brevicauda</i>	Carnivore	5.4	17.7	0.30508	model	Quarles et al. 1974
Pb	Virginia	<i>Blarina brevicauda</i>	Carnivore	22.7	143.4	0.15830	model	Quarles et al. 1974
Pb	GreatBritain	<i>Sorex araneus</i> (immature)	Carnivore	4.46	33	0.13515	model	Read and Martin 1993
Pb	Virginia	<i>Blarina brevicauda</i>	Carnivore	12.03	35.5	0.33887	model	Scanlon 1987
Pb	GreatBritain	<i>Sorex minutus</i> (adult)	Carnivore	9.21	33	0.27909	model	Read and Martin 1993
Pb	GreatBritain	<i>Sorex minutus</i> (adult)	Carnivore	8.44	50	0.16880	model	Read and Martin 1993

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Pb	GreatBritain	Sorex minutus (adult)	Carnivore	30.39	138	0.22022	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus (immature)	Carnivore	19.3	138	0.13986	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus (adult)	Carnivore	90	1142	0.07881	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (adult)	Carnivore	97.41	1142	0.08530	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (adult)	Carnivore	19.86	125	0.15888	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (immature)	Carnivore	85.45	1142	0.07482	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (immature)	Carnivore	8.07	50	0.16140	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (immature)	Carnivore	25.53	138	0.18500	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (immature)	Carnivore	10.68	98	0.10898	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus	Carnivore	35	8430	0.00415	model	Roberts et al. 1978
Pb	GreatBritain	Sorex araneus (immature)	Carnivore	5.9	50	0.11800	model	Read and Martin 1993
Pb	GreatBritain	Sorex minutus (immature)	Carnivore	15.02	125	0.12016	model	Read and Martin 1993
Pb	Virginia	Sorex cinereus	Carnivore	9.65	35.5	0.27183	model	Scanlon 1987
Pb	GreatBritain	Sorex araneus	Carnivore	2.75	96.3	0.02856	model	Roberts et al. 1978
Pb	Virginia	Cryptotis parva	Carnivore	6.66	35.5	0.18761	model	Scanlon 1987
Pb	GreatBritain	Sorex minutus (immature)	Carnivore	7.54	33	0.22848	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus (adult)	Carnivore	19.69	125	0.15752	model	Read and Martin 1993
Pb	Virginia	Cryptotis parva	Carnivore	3.44	20.75	0.16578	model	Scanlon 1987
Pb	Virginia	Cryptotis parva	Carnivore	17.16	137	0.12526	model	Scanlon 1987
Pb	GreatBritain	Sorex minutus (adult)	Carnivore	12.91	98	0.13173	model	Read and Martin 1993
Pb	Virginia	Blarina brevicauda	Carnivore	4.4	20.75	0.21205	model	Scanlon 1987
Pb	GreatBritain	Sorex araneus (adult)	Carnivore	7.06	50	0.14120	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus (adult)	Carnivore	33.4	138	0.24203	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus (immature)	Carnivore	63.43	1142	0.05554	model	Read and Martin 1993
Pb	GreatBritain	Sorex araneus	Carnivore	90.9	4413	0.02060	model	Andrews et al. 1989a
Pb	Virginia	Sorex cinereus	Carnivore	13.7	50.07	0.27362	model	Goldsmith and Scanlon 1977
Pb	Virginia	Cryptotis parva	Carnivore	10.4	50.07	0.20771	model	Goldsmith and Scanlon 1977
Pb	Virginia	Blarina brevicauda	Carnivore	15.8	50.07	0.31556	model	Goldsmith and Scanlon 1977
Pb	Virginia	Cryptotis parva	Carnivore	6.5	24.07	0.27005	model	Goldsmith and Scanlon 1977
Pb	Pennsylvania	Blarina brevicauda	Carnivore	109	41	2.65854	model	Beyer et al. 1985

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Pb	Virginia	Parascalops breweri	Carnivore	15.8	24.07	0.65642	model	Goldsmith and Scanlon 1977
Pb	Virginia	Blarina brevicauda	Carnivore	14.1	7.84	1.79847	model	Goldsmith and Scanlon 1977
Pb	Pennsylvania	Blarina brevicauda	Carnivore	18	150	0.12000	model	Beyer et al. 1985
Pb	MD,PA,NJ	Blarina brevicauda	Carnivore	5.7	92	0.06196	model	Beyer et al. 1990
Pb	Virginia	Blarina brevicauda	Carnivore	34.8	71.45	0.48705	model	Goldsmith and Scanlon 1977
Pb	GreatBritain	Sorex araneus	Carnivore	11.4	119.6	0.09532	model	Andrews et al. 1989a
Pb	Virginia	Blarina brevicauda	Carnivore	11.6	24.07	0.48193	model	Goldsmith and Scanlon 1977
Pb	GreatBritain	Sorex araneus	Carnivore	86.7	3960	0.02189	model	Andrews et al. 1989a
Pb	GreatBritain	Sorex araneus	Carnivore	23.1	108.9	0.21212	model	Andrews et al. 1989a
Pb	Tennessee	Blarina brevicauda	Carnivore	0.677	15.3	0.04425	model	DOE 1995
Pb	GreatBritain	Sorex araneus	Carnivore	7.2	94.3	0.07635	model	Andrews et al. 1989a
Pb	GreatBritain	Sorex araneus	Carnivore	120	3411	0.03518	model	Andrews et al. 1989a
Pb	Tennessee	Microtus pinetorum	Herbivore	0.476	15.3	0.03111	model	DOE 1995
Pb	Virginia	Microtus pennsylvanicus	Herbivore	7.21	35.5	0.20310	model	Scanlon 1987
Pb	GreatBritain	Microtus agrestis	Herbivore	8.625	78	0.11058	model	Roberts et al. 1978
Pb	GreatBritain	Microtus agrestis	Herbivore	8.625	96.3	0.08956	model	Roberts et al. 1978
Pb	Virginia	Microtus pennsylvanicus	Herbivore	6.9	24.07	0.28666	model	Goldsmith and Scanlon 1977
Pb	GreatBritain	Microtus agrestis	Herbivore	133.75	14010	0.00955	model	Roberts et al. 1978
Pb	Virginia	Microtus pennsylvanicus	Herbivore	12.1	50.07	0.24166	model	Goldsmith and Scanlon 1977
Pb	Ontario	Microtus pennsylvanicus	Herbivore	4	30	0.13333	model	Cloutier et al. 1985
Pb	GreatBritain	Microtus agrestis	Herbivore	141.563	8430	0.01679	model	Roberts et al. 1978
Pb	GreatBritain	Clethrionomys glareolus	Herbivore	50.938	8430	0.00604	model	Roberts et al. 1978
Pb	Ontario	Microtus pennsylvanicus	Herbivore	5	60	0.08333	model	Cloutier et al. 1985
Pb	Ontario	Microtus pennsylvanicus	Herbivore	5	200	0.02500	model	Cloutier et al. 1985
Pb	MD,PA,NJ	Microtus pennsylvanicus	Herbivore	4.6	92	0.05000	model	Beyer et al. 1990
Pb	Virginia	Microtus pennsylvanicus	Herbivore	23.07	307.5	0.07502	model	Scanlon 1987
Pb	GreatBritain	Clethrionomys glareolus	Herbivore	8.25	78	0.10577	model	Roberts et al. 1978
Pb	GreatBritain	Apodemus sylvaticus	Herbivore	3.625	78	0.04647	model	Roberts et al. 1978
Pb	GreatBritain	Microtus agrestis	Herbivore	11.1	108.9	0.10193	model	Andrews et al. 1989a
Pb	GreatBritain	Microtus agrestis	Herbivore	96.7	3960	0.02442	model	Andrews et al. 1989a

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Pb	Virginia	Microtus pennsylvanicus	Herbivore	16.3	143.4	0.11367	model	Quarles et al. 1974
Pb	Virginia	Microtus pennsylvanicus	Herbivore	3.8	22.2	0.17117	model	Quarles et al. 1974
Pb	Virginia	Microtus pennsylvanicus	Herbivore	4.9	17.7	0.27684	model	Quarles et al. 1974
Pb	Virginia	Microtus pennsylvanicus	Herbivore	5.8	36	0.16111	model	Quarles et al. 1974
Pb	GreatBritain	Apodemus sylvaticus	Herbivore	43.4375	14010	0.00310	model	Roberts et al. 1978
Pb	GreatBritain	Apodemus sylvaticus	Herbivore	2.875	96.3	0.02985	model	Roberts et al. 1978
Pb	Montana	Microtus pennsylvanicus	Herbivore	1.875	65.7	0.02854	model	Pascoe et al. 1994, 1996
Pb	GreatBritain	Microtus agrestis	Herbivore	40.3	4413	0.00913	model	Andrews et al. 1989a
Pb	GreatBritain	Microtus agrestis	Herbivore	6.5	119.6	0.05435	model	Andrews et al. 1989a
Pb	Virginia	Microtus pennsylvanicus	Herbivore	16.63	137	0.12139	model	Scanlon 1987
Pb	GreatBritain	Clethrionomys glareolus	Herbivore	7.375	96.3	0.07658	model	Roberts et al. 1978
Pb	GreatBritain	Clethrionomys glareolus	Herbivore	64.6875	14010	0.00462	model	Roberts et al. 1978
Pb	GreatBritain	Microtus agrestis	Herbivore	41.2	3411	0.01208	model	Andrews et al. 1989a
Pb	GreatBritain	Apodemus sylvaticus	Herbivore	26.875	8430	0.00319	model	Roberts et al. 1978
Pb	Virginia	Microtus pennsylvanicus	Herbivore	2.29	20.75	0.11036	model	Scanlon 1987
Pb	GreatBritain	Microtus agrestis	Herbivore	6.3	94.3	0.06681	model	Andrews et al. 1989a
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.271	15.3	0.01771	model	DOE 1995
Pb	Virginia	Peromyscus leucopus	Omnivore	13.38	137	0.09766	model	Scanlon 1987
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.139	16	0.00869	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.967	16	0.06044	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.172	16	0.01075	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.338	16	0.02112	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	1.453	16	0.09081	model	DOE 1995
Pb	Virginia	Peromyscus leucopus	Omnivore	1.85	20.75	0.08916	model	Scanlon 1987
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.821	15.3	0.05366	model	DOE 1995
Pb	MD,PA,NJ	Mus musculus	Omnivore	5.4	92	0.05870	model	Beyer et al. 1990
Pb	Virginia	Peromyscus leucopus	Omnivore	3.9	35.1	0.11111	model	Quarles et al. 1974
Pb	Virginia	Peromyscus leucopus	Omnivore	2.6	22.3	0.11659	model	Quarles et al. 1974
Pb	Virginia	Peromyscus leucopus	Omnivore	2.6	17.7	0.14689	model	Quarles et al. 1974
Pb	Virginia	Peromyscus leucopus	Omnivore	6.8	143.4	0.04742	model	Quarles et al. 1974

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Pb	Pennsylvania	Peromyscus leucopus	Omnivore	7.4	150	0.04933	model	Beyer et al. 1985
Pb	Pennsylvania	Peromyscus leucopus	Omnivore	17	41	0.41463	model	Beyer et al. 1985
Pb	Virginia	Rattus norvegicus	Omnivore	27.95	137	0.20401	model	Scanlon 1987
Pb	MD,PA,NJ	Mus musculus	Omnivore	2.1	22	0.09545	model	Beyer et al. 1990
Pb	MD,PA,NJ	Mus musculus	Omnivore	7.9	530	0.01491	model	Beyer et al. 1990
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.285	16	0.01781	model	DOE 1995
Pb	MD,PA,NJ	Mus musculus	Omnivore	6.3	22	0.28636	model	Beyer et al. 1990
Pb	Tennessee	Reithrodontomys	Omnivore	10.267	16	0.64169	model	DOE 1995
Pb	MD,PA,NJ	Mus musculus	Omnivore	3.1	29	0.10690	model	Beyer et al. 1990
Pb	MD,PA,NJ	Peromyscus leucopus	Omnivore	1.8	92	0.01957	model	Beyer et al. 1990
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.492	15.3	0.03216	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.195	16	0.01219	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.647	15.3	0.04229	model	DOE 1995
Pb	Tennessee	Peromyscus leucopus	Omnivore	0.611	16	0.03819	model	DOE 1995
Pb	Virginia	Peromyscus leucopus	Omnivore	9.7	50.07	0.19373	model	Goldsmith and Scanlon 1977
Pb	Tennessee	Reithrodontomys	Omnivore	0.151	16	0.00944	model	DOE 1995
Pb	Tennessee	Reithrodontomys	Omnivore	0.056	16	0.00350	model	DOE 1995
Pb	Virginia	Peromyscus leucopus	Omnivore	5.24	35.5	0.14761	model	Scanlon 1987
Pb	Virginia	Zapus hudsonius	Omnivore	9.1	71.45	0.12736	model	Goldsmith and Scanlon 1977
Pb	Virginia	Peromyscus leucopus	Omnivore	21.96	307.5	0.07141	model	Scanlon 1987
Pb	Tennessee	Reithrodontomys	Omnivore	0.137	16	0.00856	model	DOE 1995
Pb	Virginia	Peromyscus leucopus	Omnivore	15.6	71.45	0.21833	model	Goldsmith and Scanlon 1977
Pb	Virginia	Peromyscus leucopus	Omnivore	5	7.84	0.63776	model	Goldsmith and Scanlon 1977
Pb	Virginia	Mus musculus	Omnivore	64.25	307.5	0.20894	model	Scanlon 1987
Pb	Virginia	Mus musculus	Omnivore	11.32	35.5	0.31887	model	Scanlon 1987
Pb	Virginia	Mus musculus	Omnivore	21.73	137	0.15861	model	Scanlon 1987
Pb	Virginia	Glaucomys volans	Omnivore	7.8	7.84	0.99490	model	Goldsmith and Scanlon 1977
Se	MD,PA,NJ	Blarina brevicauda	Carnivore	0.61	0.75	0.81333	model	Beyer et al. 1990
Se	Tennessee	Blarina brevicauda	Carnivore	2.33	3.67	0.63488	model	DOE 1995
Se	Tennessee	Microtus pinetorum	Herbivore	0.569	3.67	0.15504	model	DOE 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Se	Tennessee	Peromyscus leucopus	Omnivore	1.722	11.2	0.15375	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	1.813	11.2	0.16188	model	DOE 1995
Se	MD,PA,NJ	Mus musculus	Omnivore	0.89	0.75	1.18667	model	Beyer et al. 1990
Se	MD,PA,NJ	Mus musculus	Omnivore	0.98	4.8	0.20417	model	Beyer et al. 1990
Se	MD,PA,NJ	Mus musculus	Omnivore	0.48	0.38	1.26316	model	Beyer et al. 1990
Se	MD,PA,NJ	Mus musculus	Omnivore	0.55	0.89	0.61798	model	Beyer et al. 1990
Se	Tennessee	Reithrodontomys	Omnivore	1.4	11.2	0.12500	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	0.329	3.67	0.08965	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	2.583	11.2	0.23062	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	0.764	3.67	0.20817	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	0.446	11.2	0.03982	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	3.937	11.2	0.35152	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	0.455	3.67	0.12398	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	5.64	11.2	0.50357	model	DOE 1995
Se	Tennessee	Reithrodontomys	Omnivore	0.387	11.2	0.03455	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	1.973	11.2	0.17616	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	0.474	3.67	0.12916	model	DOE 1995
Se	Tennessee	Reithrodontomys	Omnivore	3.387	11.2	0.30241	model	DOE 1995
Se	Tennessee	Reithrodontomys	Omnivore	2.597	11.2	0.23188	model	DOE 1995
Se	Tennessee	Peromyscus leucopus	Omnivore	2.387	11.2	0.21312	model	DOE 1995
Se	MD,PA,NJ	Mus musculus	Omnivore	0.43	0.66	0.65152	model	Beyer et al. 1990
TCDD	Italy	Microtus arvalis	Herbivore	0.0045	0.0035	1.28571	model	Fanelli et al. 1980
TCDD	Wisconsin	Peromyscus maniculatus	Omnivore	0.000009	0.000025	0.36800	model	ERT 1987
TCDD	Wisconsin	Peromyscus maniculatus	Omnivore	0.000044	0.000021	2.09524	model	ERT 1987
TCDD	Wisconsin	Peromyscus maniculatus	Omnivore	0.000005	0.00001	0.49495	model	ERT 1987
TCDD	Wisconsin	Peromyscus maniculatus	Omnivore	0.000032	0.000031	1.03226	model	ERT 1987
TCDF	Wisconsin	Peromyscus maniculatus	Omnivore	0.000011	0.000069	0.15942	model	ERT 1987
TCDF	Wisconsin	Peromyscus maniculatus	Omnivore	0.000004	0.000046	0.08043	model	ERT 1987
TCDF	Wisconsin	Peromyscus maniculatus	Omnivore	0.000007	0.000066	0.11061	model	ERT 1987
TCDF	Wisconsin	Peromyscus maniculatus	Omnivore	0.000007	0.000054	0.13519	model	ERT 1987

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Tl	Tennessee	Peromyscus leucopus	Omnivore	0.243	1.98	0.12273	model	DOE 1995
Tl	Tennessee	Reithrodontomys	Omnivore	0.202	1.98	0.10202	model	DOE 1995
Zn	GreatBritain	Sorex araneus (adult)	Carnivore	129.92	74	1.75568	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (adult)	Carnivore	184.26	1389	0.13266	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (adult)	Carnivore	117.46	159	0.73874	model	Read and Martin 1993
Zn	Virginia	Sorex cinereus	Carnivore	146.18	21	6.96095	model	Scanlon 1987
Zn	GreatBritain	Sorex araneus (adult)	Carnivore	140.8	112	1.25714	model	Read and Martin 1993
Zn	MD,PA,NJ	Blarina brevicauda	Carnivore	110	240	0.45833	model	Beyer et al. 1990
Zn	GreatBritain	Sorex araneus (immature)	Carnivore	182.47	1389	0.13137	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (adult)	Carnivore	149.99	193	0.77715	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus	Carnivore	129	61.9	2.08401	model	Andrews et al. 1989b
Zn	Pennsylvania	Blarina brevicauda	Carnivore	377	2900	0.13000	model	Beyer et al. 1985
Zn	GreatBritain	Sorex araneus (adult)	Carnivore	162.54	257	0.63245	model	Read and Martin 1993
Zn	Pennsylvania	Blarina brevicauda	Carnivore	201	230	0.87391	model	Beyer et al. 1985
Zn	GreatBritain	Sorex araneus	Carnivore	172	1925	0.08935	model	Andrews et al. 1989b
Zn	GreatBritain	Sorex araneus (immature)	Carnivore	147.34	193	0.76342	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (immature)	Carnivore	134.96	257	0.52514	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (adult)	Carnivore	134.34	257	0.52272	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (adult)	Carnivore	122.47	193	0.63456	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (adult)	Carnivore	187.15	1389	0.13474	model	Read and Martin 1993
Zn	Virginia	Blarina brevicauda	Carnivore	122.45	50.25	2.43682	model	Scanlon 1987
Zn	GreatBritain	Sorex minutus (adult)	Carnivore	117.51	112	1.04920	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (adult)	Carnivore	122.7	159	0.77170	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (immature)	Carnivore	127.84	257	0.49743	model	Read and Martin 1993
Zn	Virginia	Blarina brevicauda	Carnivore	100.01	37.6	2.65984	model	Scanlon 1987
Zn	GreatBritain	Sorex minutus (immature)	Carnivore	127.36	193	0.65990	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (immature)	Carnivore	131.08	74	1.77135	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (immature)	Carnivore	111.81	112	0.99830	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (immature)	Carnivore	125.19	159	0.78736	model	Read and Martin 1993
Zn	Virginia	Blarina brevicauda	Carnivore	139.2	61.75	2.25425	model	Scanlon 1987

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Zn	Virginia	Blarina brevicauda	Carnivore	122.88	21	5.85143	model	Scanlon 1987
Zn	GreatBritain	Sorex minutus (adult)	Carnivore	103.14	74	1.39378	model	Read and Martin 1993
Zn	GreatBritain	Sorex minutus (immature)	Carnivore	146.02	1389	0.10513	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (immature)	Carnivore	120.92	112	1.07964	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (immature)	Carnivore	114.74	74	1.55054	model	Read and Martin 1993
Zn	GreatBritain	Sorex araneus (immature)	Carnivore	132.41	159	0.83277	model	Read and Martin 1993
Zn	Virginia	Cryptotis parva	Carnivore	110.71	50.25	2.20318	model	Scanlon 1987
Zn	Virginia	Cryptotis parva	Carnivore	123.46	21	5.87905	model	Scanlon 1987
Zn	Virginia	Cryptotis parva	Carnivore	109.08	37.6	2.90106	model	Scanlon 1987
Zn	GreatBritain	Clethrionomys glareolus	Herbivore	102.6	131	0.78321	model	Johnson et al. 1978
Zn	GreatBritain	Clethrionomys glareolus	Herbivore	142.7	125	1.14160	model	Johnson et al. 1978
Zn	GreatBritain	Microtus agrestis	Herbivore	121.2	131	0.92519	model	Johnson et al. 1978
Zn	GreatBritain	Microtus agrestis	Herbivore	191.6	21000	0.00912	model	Johnson et al. 1978
Zn	Virginia	Microtus pennsylvanicus	Herbivore	97.52	37.6	2.59362	model	Scanlon 1987
Zn	GreatBritain	Microtus agrestis	Herbivore	121.2	125	0.96960	model	Johnson et al. 1978
Zn	GreatBritain	Microtus agrestis	Herbivore	169.3	1766	0.09587	model	Johnson et al. 1978
Zn	Montana	Microtus pennsylvanicus	Herbivore	85.9375	1908.9	0.04502	model	Pascoe et al. 1994, 1996
Zn	GreatBritain	Clethrionomys glareolus	Herbivore	123.4	21000	0.00588	model	Johnson et al. 1978
Zn	GreatBritain	Clethrionomys glareolus	Herbivore	142.9	1766	0.08092	model	Johnson et al. 1978
Zn	GreatBritain	Apodemus sylvaticus	Herbivore	112.3	125	0.89840	model	Johnson et al. 1978
Zn	GreatBritain	Apodemus sylvaticus	Herbivore	95.8	131	0.73130	model	Johnson et al. 1978
Zn	Virginia	Microtus pennsylvanicus	Herbivore	119.03	61.75	1.92761	model	Scanlon 1987
Zn	Ontario	Microtus pennsylvanicus	Herbivore	100	80	1.25000	model	Cloutier et al. 1985
Zn	GreatBritain	Apodemus sylvaticus	Herbivore	114.6	1766	0.06489	model	Johnson et al. 1978
Zn	Ontario	Microtus pennsylvanicus	Herbivore	90	5.5	16.36364	model	Cloutier et al. 1985
Zn	GreatBritain	Apodemus sylvaticus	Herbivore	107.3	21000	0.00511	model	Johnson et al. 1978
Zn	Ontario	Microtus pennsylvanicus	Herbivore	85	90	0.94444	model	Cloutier et al. 1985
Zn	MD,PA,NJ	Microtus pennsylvanicus	Herbivore	89	240	0.37083	model	Beyer et al. 1990
Zn	Virginia	Microtus pennsylvanicus	Herbivore	105.46	21	5.02190	model	Scanlon 1987
Zn	GreatBritain	Microtus agrestis	Herbivore	103	61.9	1.66397	model	Andrews et al. 1989b

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Zn	GreatBritain	Microtus agrestis	Herbivore	153	1925	0.07948	model	Andrews et al. 1989b
Zn	Virginia	Microtus pennsylvanicus	Herbivore	102.51	50.25	2.04000	model	Scanlon 1987
Zn	Virginia	Mus musculus	Omnivore	50.94	21	2.42571	model	Scanlon 1987
Zn	Montana	Peromyscus maniculatus	Omnivore	92.1875	1908.9	0.04829	model	Pascoe et al. 1994, 1996
Zn	Virginia	Mus musculus	Omnivore	84.98	50.25	1.69114	model	Scanlon 1987
Zn	Virginia	Peromyscus leucopus	Omnivore	109.99	61.75	1.78121	model	Scanlon 1987
Zn	Virginia	Mus musculus	Omnivore	99.26	61.75	1.60745	model	Scanlon 1987
Zn	Virginia	Peromyscus leucopus	Omnivore	104.61	37.6	2.78218	model	Scanlon 1987
Zn	Virginia	Peromyscus leucopus	Omnivore	90.23	21	4.29667	model	Scanlon 1987
Zn	Virginia	Peromyscus leucopus	Omnivore	104.12	50.25	2.07204	model	Scanlon 1987
Zn	Virginia	Rattus norvegicus	Omnivore	135.06	50.25	2.68776	model	Scanlon 1987
Zn	Pennsylvania	Peromyscus leucopus	Omnivore	145	230	0.63043	model	Beyer et al. 1985
Zn	MD,PA,NJ	Mus musculus	Omnivore	89	74	1.20270	model	Beyer et al. 1990
Zn	MD,PA,NJ	Mus musculus	Omnivore	90	83	1.08434	model	Beyer et al. 1990
Zn	MD,PA,NJ	Mus musculus	Omnivore	97	200	0.48500	model	Beyer et al. 1990
Zn	MD,PA,NJ	Mus musculus	Omnivore	87	240	0.36250	model	Beyer et al. 1990
Zn	Pennsylvania	Peromyscus leucopus	Omnivore	192	2900	0.06621	model	Beyer et al. 1985
Zn	MD,PA,NJ	Mus musculus	Omnivore	93	120	0.77500	model	Beyer et al. 1990
Zn	MD,PA,NJ	Peromyscus leucopus	Omnivore	84	240	0.35000	model	Beyer et al. 1990
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0	0	ERR	validation	PTI 1995
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0	0.445	0.00000	validation	PTI 1995
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0	1	0.00000	validation	PTI 1995
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0	0.76	0.00000	validation	PTI 1995
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0.04	5.4	0.00741	validation	PTI 1995
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0.03	6.9	0.00435	validation	PTI 1995
Ag	Oklahoma	Sigmodon hispidus	Herbivore	0	3	0.00000	validation	PTI 1995
Ag	Oklahoma	Peromyscus leucopus	Omnivore	1.7	2.1	0.80952	validation	PTI 1995
Ag	Oklahoma	Peromyscus leucopus	Omnivore	0.56	2.9	0.19310	validation	PTI 1995
Ag	Oklahoma	Peromyscus leucopus	Omnivore	0	0	ERR	validation	PTI 1995
Ag	Oklahoma	Peromyscus leucopus	Omnivore	0.02	5.4	0.00370	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Ag	Oklahoma	Peromyscus leucopus	Omnivore	0.23	2.1	0.10952	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	93.6	14700	0.00637	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	300	13750	0.02182	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	138	12200	0.01131	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	280	16400	0.01707	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	508	16500	0.03079	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	279	16100	0.01733	validation	PTI 1995
Al	Oklahoma	Sigmodon hispidus	Herbivore	327	21050	0.01553	validation	PTI 1995
Al	Oklahoma	Peromyscus leucopus	Omnivore	1540	21050	0.07316	validation	PTI 1995
Al	Oklahoma	Peromyscus leucopus	Omnivore	1260	13600	0.09265	validation	PTI 1995
Al	Oklahoma	Peromyscus leucopus	Omnivore	840	13600	0.06176	validation	PTI 1995
Al	Oklahoma	Peromyscus leucopus	Omnivore	694	14550	0.04770	validation	PTI 1995
Al	Oklahoma	Peromyscus leucopus	Omnivore	688	16100	0.04273	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	15.4	0.00000	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	20.8	0.00000	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	38.8	0.00000	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	7.55	0.00000	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	6.2	0.00000	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	4.9	0.00000	validation	PTI 1995
As	Oklahoma	Sigmodon hispidus	Herbivore	0	5.7	0.00000	validation	PTI 1995
As	Montana	Peromyscus maniculatus	Omnivore	1.3	178	0.00730	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	0.37	30	0.01233	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	1.7	278	0.00612	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	0.44	154	0.00286	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	1.1	201	0.00547	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	0.44	342	0.00129	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	4.5	63.7	0.07064	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	11	1400	0.00786	validation	LaTier et al. 1995
As	Oklahoma	Peromyscus leucopus	Omnivore	0	7.9	0.00000	validation	PTI 1995
As	Montana	Peromyscus maniculatus	Omnivore	3.2	586	0.00546	validation	LaTier et al. 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
As	Montana	Peromyscus maniculatus	Omnivore	1.4	32.1	0.04361	validation	LaTier et al. 1995
As	Oklahoma	Peromyscus leucopus	Omnivore	0	7.9	0.00000	validation	PTI 1995
As	Oklahoma	Peromyscus leucopus	Omnivore	0	17	0.00000	validation	PTI 1995
As	Montana	Peromyscus maniculatus	Omnivore	1.4	217	0.00645	validation	LaTier et al. 1995
As	Oklahoma	Peromyscus leucopus	Omnivore	0	38.8	0.00000	validation	PTI 1995
As	Oklahoma	Peromyscus leucopus	Omnivore	0	7.55	0.00000	validation	PTI 1995
As	Montana	Peromyscus maniculatus	Omnivore	0.075	42.2	0.00178	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	0.55	130	0.00423	validation	LaTier et al. 1995
As	Montana	Peromyscus maniculatus	Omnivore	1.1	452	0.00243	validation	LaTier et al. 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	9.5	176	0.05398	validation	PTI 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	8.8	92.2	0.09544	validation	PTI 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	13.4	119.5	0.11213	validation	PTI 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	26.2	103.6	0.25290	validation	PTI 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	12.8	216	0.05926	validation	PTI 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	7.2	151	0.04768	validation	PTI 1995
Ba	Oklahoma	Sigmodon hispidus	Herbivore	10.2	160	0.06375	validation	PTI 1995
Ba	Oklahoma	Peromyscus leucopus	Omnivore	9.4	157	0.05987	validation	PTI 1995
Ba	Oklahoma	Peromyscus leucopus	Omnivore	10.9	157	0.06943	validation	PTI 1995
Ba	Oklahoma	Peromyscus leucopus	Omnivore	8.4	164	0.05122	validation	PTI 1995
Ba	Oklahoma	Peromyscus leucopus	Omnivore	7.4	216	0.03426	validation	PTI 1995
Ba	Oklahoma	Peromyscus leucopus	Omnivore	7.3	176	0.04148	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	0.95	0.00000	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	1.15	0.00000	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	1.2	0.00000	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	0.63	0.00000	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	1.3	0.00000	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	1.07	0.00000	validation	PTI 1995
Be	Oklahoma	Sigmodon hispidus	Herbivore	0	0.84	0.00000	validation	PTI 1995
Be	Oklahoma	Peromyscus leucopus	Omnivore	0	0.87	0.00000	validation	PTI 1995
Be	Oklahoma	Peromyscus leucopus	Omnivore	0	0.95	0.00000	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Be	Oklahoma	Peromyscus leucopus	Omnivore	0	0.87	0.00000	validation	PTI 1995
Be	Oklahoma	Peromyscus leucopus	Omnivore	0	1.15	0.00000	validation	PTI 1995
Be	Oklahoma	Peromyscus leucopus	Omnivore	0	1.3	0.00000	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	32200	8380	3.84248	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	33800	1950	17.33333	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	29600	2195	13.48519	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	39000	35770	1.09030	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	27800	2500	11.12000	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	27800	1790	15.53073	validation	PTI 1995
Ca	Oklahoma	Sigmodon hispidus	Herbivore	39200	13000	3.01538	validation	PTI 1995
Ca	Oklahoma	Peromyscus leucopus	Omnivore	39300	4110	9.56204	validation	PTI 1995
Ca	Oklahoma	Peromyscus leucopus	Omnivore	31900	35770	0.89181	validation	PTI 1995
Ca	Oklahoma	Peromyscus leucopus	Omnivore	35000	8380	4.17661	validation	PTI 1995
Ca	Oklahoma	Peromyscus leucopus	Omnivore	35000	4110	8.51582	validation	PTI 1995
Ca	Oklahoma	Peromyscus leucopus	Omnivore	36100	3715	9.71736	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	0.42	3.45	0.12174	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	2.4	25.2	0.09524	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	1.7	26.6	0.06391	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	0.58	1.295	0.44788	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	2.2	144	0.01528	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	0.1	0.77	0.12987	validation	PTI 1995
Cd	Oklahoma	Sigmodon hispidus	Herbivore	3.5	69.8	0.05014	validation	PTI 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.22	0.32	0.68750	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.57	4	0.14250	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.13	1.58	0.08228	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.37	2.2	0.16818	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.513	2.8	0.18321	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.24	5.5	0.04364	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.32	3.1	0.10323	validation	LaTier et al. 1995
Cd	Oklahoma	Peromyscus leucopus	Omnivore	3.8	33.1	0.11480	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cd	Montana	Peromyscus maniculatus	Omnivore	0.28	5.1	0.05490	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.31	11.1	0.02793	validation	LaTier et al. 1995
Cd	Oklahoma	Peromyscus leucopus	Omnivore	2.6	36	0.07222	validation	PTI 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.57	6.6	0.08636	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.56	4.6	0.12174	validation	LaTier et al. 1995
Cd	Oklahoma	Peromyscus leucopus	Omnivore	0.14	0.77	0.18182	validation	PTI 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.2	1	0.20000	validation	LaTier et al. 1995
Cd	Oklahoma	Peromyscus leucopus	Omnivore	4.3	144	0.02986	validation	PTI 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.27	3.6	0.07500	validation	LaTier et al. 1995
Cd	Montana	Peromyscus maniculatus	Omnivore	0.21	0.75	0.28000	validation	LaTier et al. 1995
Cd	Oklahoma	Peromyscus leucopus	Omnivore	2.2	36	0.06111	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.25	15.6	0.01603	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.24	13.95	0.01720	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.2	14.9	0.01342	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.17	8.3	0.02048	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.29	7.55	0.03841	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.18	8.35	0.02156	validation	PTI 1995
Co	Oklahoma	Sigmodon hispidus	Herbivore	0.17	9.2	0.01848	validation	PTI 1995
Co	Oklahoma	Peromyscus leucopus	Omnivore	0.17	13.95	0.01219	validation	PTI 1995
Co	Oklahoma	Peromyscus leucopus	Omnivore	0.16	10.15	0.01576	validation	PTI 1995
Co	Oklahoma	Peromyscus leucopus	Omnivore	0.24	9.6	0.02500	validation	PTI 1995
Co	Oklahoma	Peromyscus leucopus	Omnivore	0.15	14.9	0.01007	validation	PTI 1995
Co	Oklahoma	Peromyscus leucopus	Omnivore	0.2	9.6	0.02083	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	3.1	21.4	0.14486	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	7.3	23.6	0.30932	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	2.9	32.8	0.08841	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	3.5	42.9	0.08159	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	1.8	27.3	0.06593	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	3	37.3	0.08043	validation	PTI 1995
Cr	Oklahoma	Sigmodon hispidus	Herbivore	4.9	24.7	0.19838	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cr	Oklahoma	Peromyscus leucopus	Omnivore	5.6	37.3	0.15013	validation	PTI 1995
Cr	Oklahoma	Peromyscus leucopus	Omnivore	8.8	25.2	0.34921	validation	PTI 1995
Cr	Oklahoma	Peromyscus leucopus	Omnivore	4.6	26.45	0.17391	validation	PTI 1995
Cr	Oklahoma	Peromyscus leucopus	Omnivore	3	42.9	0.06993	validation	PTI 1995
Cr	Oklahoma	Peromyscus leucopus	Omnivore	5	25.2	0.19841	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	6.9	20.75	0.33253	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	8.2	11	0.74545	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	6.5	180	0.03611	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	6.4	68	0.09412	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	9.9	20.05	0.49377	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	6.7	47.6	0.14076	validation	PTI 1995
Cu	Oklahoma	Sigmodon hispidus	Herbivore	7.2	186	0.03871	validation	PTI 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	75.6	2329	0.03246	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	22.8	817	0.02791	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	19.8	73.1	0.27086	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	14.1	193	0.07306	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	12.7	27	0.47037	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	54.6	1730	0.03156	validation	LaTier et al. 1995
Cu	Oklahoma	Peromyscus leucopus	Omnivore	10.4	77.4	0.13437	validation	PTI 1995
Cu	Oklahoma	Peromyscus leucopus	Omnivore	9.5	63.7	0.14914	validation	PTI 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	13.8	529	0.02609	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	12.7	70	0.18143	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	35.8	199	0.17990	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	13.5	118	0.11441	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	14.6	1790	0.00816	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	13.9	311	0.04469	validation	LaTier et al. 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	18.1	1190	0.01521	validation	LaTier et al. 1995
Cu	Oklahoma	Peromyscus leucopus	Omnivore	10.3	63.7	0.16170	validation	PTI 1995
Cu	Montana	Peromyscus maniculatus	Omnivore	82.2	1200	0.06850	validation	LaTier et al. 1995
Cu	Oklahoma	Peromyscus leucopus	Omnivore	11.5	20.75	0.55422	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Cu	Oklahoma	Peromyscus leucopus	Omnivore	16.6	186	0.08925	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	305	26600	0.01147	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	294	29300	0.01003	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	370	26100	0.01418	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	296	17350	0.01706	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	219	19800	0.01106	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	332	27000	0.01230	validation	PTI 1995
Fe	Oklahoma	Sigmodon hispidus	Herbivore	201	15500	0.01297	validation	PTI 1995
Fe	Oklahoma	Peromyscus leucopus	Omnivore	276	29300	0.00942	validation	PTI 1995
Fe	Oklahoma	Peromyscus leucopus	Omnivore	256	27000	0.00948	validation	PTI 1995
Fe	Oklahoma	Peromyscus leucopus	Omnivore	254	20450	0.01242	validation	PTI 1995
Fe	Oklahoma	Peromyscus leucopus	Omnivore	279	19300	0.01446	validation	PTI 1995
Fe	Oklahoma	Peromyscus leucopus	Omnivore	283	19300	0.01466	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	11700	1845	6.34146	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	11300	1980	5.70707	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	11300	1850	6.10811	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	11400	3735	3.05221	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	10600	1560	6.79487	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	10800	1400	7.71429	validation	PTI 1995
K	Oklahoma	Sigmodon hispidus	Herbivore	10900	1410	7.73050	validation	PTI 1995
K	Oklahoma	Peromyscus leucopus	Omnivore	10400	2320	4.48276	validation	PTI 1995
K	Oklahoma	Peromyscus leucopus	Omnivore	10500	3735	2.81124	validation	PTI 1995
K	Oklahoma	Peromyscus leucopus	Omnivore	10300	2320	4.43966	validation	PTI 1995
K	Oklahoma	Peromyscus leucopus	Omnivore	11000	2325	4.73118	validation	PTI 1995
K	Oklahoma	Peromyscus leucopus	Omnivore	10400	1980	5.25253	validation	PTI 1995
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1570	2530	0.62055	validation	PTI 1995
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1330	1340	0.99254	validation	PTI 1995
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1680	3505	0.47932	validation	PTI 1995
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1640	2850	0.57544	validation	PTI 1995
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1630	1420	1.14789	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1540	1750	0.88000	validation	PTI 1995
Mg	Oklahoma	Sigmodon hispidus	Herbivore	1500	1950	0.76923	validation	PTI 1995
Mg	Oklahoma	Peromyscus leucopus	Omnivore	1290	3505	0.36805	validation	PTI 1995
Mg	Oklahoma	Peromyscus leucopus	Omnivore	1400	2530	0.55336	validation	PTI 1995
Mg	Oklahoma	Peromyscus leucopus	Omnivore	1590	2140	0.74299	validation	PTI 1995
Mg	Oklahoma	Peromyscus leucopus	Omnivore	1400	2140	0.65421	validation	PTI 1995
Mg	Oklahoma	Peromyscus leucopus	Omnivore	1500	2120	0.70755	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	9.6	615	0.01561	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	7.5	455	0.01648	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	14.9	254	0.05866	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	8.6	578	0.01488	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	13.1	1145	0.01144	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	6.9	486	0.01420	validation	PTI 1995
Mn	Oklahoma	Sigmodon hispidus	Herbivore	17.4	219.5	0.07927	validation	PTI 1995
Mn	Oklahoma	Peromyscus leucopus	Omnivore	19	615	0.03089	validation	PTI 1995
Mn	Oklahoma	Peromyscus leucopus	Omnivore	12.6	583	0.02161	validation	PTI 1995
Mn	Oklahoma	Peromyscus leucopus	Omnivore	16.5	524	0.03149	validation	PTI 1995
Mn	Oklahoma	Peromyscus leucopus	Omnivore	19.4	524	0.03702	validation	PTI 1995
Mn	Oklahoma	Peromyscus leucopus	Omnivore	22.3	1145	0.01948	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4230	69.05	61.25996	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4040	49.3	81.94726	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4140	148	27.97297	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4490	395	11.36709	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4170	41.6	100.24038	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4450	71.8	61.97772	validation	PTI 1995
Na	Oklahoma	Sigmodon hispidus	Herbivore	4280	86.2	49.65197	validation	PTI 1995
Na	Oklahoma	Peromyscus leucopus	Omnivore	4670	61.4	76.05863	validation	PTI 1995
Na	Oklahoma	Peromyscus leucopus	Omnivore	4340	57.3	75.74171	validation	PTI 1995
Na	Oklahoma	Peromyscus leucopus	Omnivore	4370	395	11.06329	validation	PTI 1995
Na	Oklahoma	Peromyscus leucopus	Omnivore	4430	71.8	61.69916	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Na	Oklahoma	Peromyscus leucopus	Omnivore	4590	57.3	80.10471	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	0	39.95	0.00000	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	0	26	0.00000	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	0	10.2	0.00000	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	2.7	10.85	0.24885	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	0	27.9	0.00000	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	0	14.1	0.00000	validation	PTI 1995
Ni	Oklahoma	Sigmodon hispidus	Herbivore	0	17.5	0.00000	validation	PTI 1995
Ni	Oklahoma	Peromyscus leucopus	Omnivore	2.5	19.15	0.13055	validation	PTI 1995
Ni	Oklahoma	Peromyscus leucopus	Omnivore	3.4	20.2	0.16832	validation	PTI 1995
Ni	Oklahoma	Peromyscus leucopus	Omnivore	3.1	39.95	0.07760	validation	PTI 1995
Ni	Oklahoma	Peromyscus leucopus	Omnivore	2.2	27.9	0.07885	validation	PTI 1995
Ni	Oklahoma	Peromyscus leucopus	Omnivore	0	20.2	0.00000	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	1.4	63.9	0.02191	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	0.4	33.8	0.01183	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	2.3	261	0.00881	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	0.74	32.05	0.02309	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	6.4	83.9	0.07628	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	7.7	485	0.01588	validation	PTI 1995
Pb	Oklahoma	Sigmodon hispidus	Herbivore	6.4	435	0.01471	validation	PTI 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	6.3	481	0.01310	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	3.1	122	0.02541	validation	LaTier et al. 1995
Pb	Oklahoma	Peromyscus leucopus	Omnivore	3.7	485	0.00763	validation	PTI 1995
Pb	Oklahoma	Peromyscus leucopus	Omnivore	1.5	179	0.00838	validation	PTI 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	3.7	167	0.02216	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	5.6	326	0.01718	validation	LaTier et al. 1995
Pb	Oklahoma	Peromyscus leucopus	Omnivore	1.4	179	0.00782	validation	PTI 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	5.2	577	0.00901	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	4.13	399	0.01035	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	1.4	7.8	0.17949	validation	LaTier et al. 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Pb	Oklahoma	Peromyscus leucopus	Omnivore	0.28	33.8	0.00828	validation	PTI 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	6.8	386	0.01762	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	1.8	30	0.06000	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	2.1	22.9	0.09170	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	1.5	37.3	0.04021	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	10.6	776	0.01366	validation	LaTier et al. 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	0.93	265	0.00351	validation	LaTier et al. 1995
Pb	Oklahoma	Peromyscus leucopus	Omnivore	1.5	281.5	0.00533	validation	PTI 1995
Pb	Montana	Peromyscus maniculatus	Omnivore	4.1	68	0.06029	validation	LaTier et al. 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0	0	ERR	validation	PTI 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0	4.4	0.00000	validation	PTI 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0	3.25	0.00000	validation	PTI 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0.04	0	ERR	validation	PTI 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0.03	0	ERR	validation	PTI 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0	3.3	0.00000	validation	PTI 1995
Sb	Oklahoma	Sigmodon hispidus	Herbivore	0.04	0	ERR	validation	PTI 1995
Sb	Oklahoma	Peromyscus leucopus	Omnivore	0	0	ERR	validation	PTI 1995
Sb	Oklahoma	Peromyscus leucopus	Omnivore	0	3.25	0.00000	validation	PTI 1995
Sb	Oklahoma	Peromyscus leucopus	Omnivore	0.02	0	ERR	validation	PTI 1995
Sb	Oklahoma	Peromyscus leucopus	Omnivore	0	0	ERR	validation	PTI 1995
Sb	Oklahoma	Peromyscus leucopus	Omnivore	0.07	0	ERR	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	0.265	0.00000	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	0	ERR	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	0.94	0.00000	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	0.27	0.00000	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	0.53	0.00000	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	0.25	0.00000	validation	PTI 1995
Se	Oklahoma	Sigmodon hispidus	Herbivore	0	19.2	0.00000	validation	PTI 1995
Se	Oklahoma	Peromyscus leucopus	Omnivore	0	0.265	0.00000	validation	PTI 1995
Se	Oklahoma	Peromyscus leucopus	Omnivore	1	0.57	1.75439	validation	PTI 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Se	Oklahoma	Peromyscus leucopus	Omnivore	0	0.57	0.00000	validation	PTI 1995
Se	Oklahoma	Peromyscus leucopus	Omnivore	3	19.2	0.15625	validation	PTI 1995
Se	Oklahoma	Peromyscus leucopus	Omnivore	1	0.62	1.61290	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.37	28.6	0.01294	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.48	57.9	0.00829	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.36	30.4	0.01184	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.55	28.25	0.01947	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.55	30.7	0.01792	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.56	39.65	0.01412	validation	PTI 1995
V	Oklahoma	Sigmodon hispidus	Herbivore	0.46	41.2	0.01117	validation	PTI 1995
V	Oklahoma	Peromyscus leucopus	Omnivore	0.36	28.4	0.01268	validation	PTI 1995
V	Oklahoma	Peromyscus leucopus	Omnivore	0.52	39.65	0.01311	validation	PTI 1995
V	Oklahoma	Peromyscus leucopus	Omnivore	0.2	28.4	0.00704	validation	PTI 1995
V	Oklahoma	Peromyscus leucopus	Omnivore	0.3	57.9	0.00518	validation	PTI 1995
V	Oklahoma	Peromyscus leucopus	Omnivore	0.32	30.85	0.01037	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	285	3750	0.07600	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	88.7	199	0.44573	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	164	3210	0.05109	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	140	7170	0.01953	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	103	183	0.56284	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	156	416	0.37500	validation	PTI 1995
Zn	Oklahoma	Sigmodon hispidus	Herbivore	136	1530	0.08889	validation	PTI 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	322	1180	0.27288	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	311	82.2	3.78345	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	176	817	0.21542	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	397	158	2.51266	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	148	322	0.45963	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	187	1659	0.11272	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	468	80	5.85000	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	153	1370	0.11168	validation	LaTier et al. 1995

Table B.1 (cont.)

Analyte	Study Location	Species	Trophic Group	Tissue Concentration mg/kg dry wt.	Soil Concentration mg/kg dry wt.	Uptake Factor	Portion of Dataset	Reference
Zn	Montana	Peromyscus maniculatus	Omnivore	143	65.1	2.19662	validation	LaTier et al. 1995
Zn	Oklahoma	Peromyscus leucopus	Omnivore	128	7170	0.01785	validation	PTI 1995
Zn	Oklahoma	Peromyscus leucopus	Omnivore	87	199	0.43719	validation	PTI 1995
Zn	Oklahoma	Peromyscus leucopus	Omnivore	143	2135	0.06698	validation	PTI 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	280	788	0.35533	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	167	142	1.17606	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	203	148	1.37162	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	181	1164	0.15550	validation	LaTier et al. 1995
Zn	Montana	Peromyscus maniculatus	Omnivore	142	1992	0.07129	validation	LaTier et al. 1995
Zn	Oklahoma	Peromyscus leucopus	Omnivore	104	2270	0.04581	validation	PTI 1995
Zn	Oklahoma	Peromyscus leucopus	Omnivore	103	2270	0.04537	validation	PTI 1995

APPENDIX C

**SUPPLEMENTAL SMALL MAMMAL BIOACCUMULATION
DATA FROM THE VALIDATION STUDIES**

Table C.1. Summary statistics for soil-small mammal UFs derived from validation data

Analyte	Trophic Group	N	Mean	Standard Deviation	Minimum	Median	90th Percentile	Maximum	Mean of Natural Log-transformed values	Standard Deviation of Natural Log-transformed values	Distribution
Ag	General	10	0.1128	0.2533	0	0.004	0.5013	0.81	-3.33487	2.27547	lognormal
Al	General	12	0.0365	0.0274	0.0064	0.0263	0.0732	0.093	-3.59239	0.81728	normal ^b
Ca	General	12	8.1901	5.5913	0.8918	9.0389	15.5307	17.333	1.76089	0.99875	normal ^b
K	General	12	5.4305	1.6139	2.8112	5.4798	7.7143	7.73	1.64634	0.32703	normal ^b
Mg	General	12	0.7076	0.2193	0.368	0.6809	0.9925	1.148	-0.3903	0.31441	normal ^b
Mn	General	12	0.0293	0.0206	0.0114	0.0205	0.0587	0.079	-3.71448	0.60173	lognormal
Na	General	12	58.2571	28.4054	11.0633	61.8384	81.9473	100.24	3.87422	0.75195	normal
V	General	12	0.012	0.0041	0.0052	0.0123	0.0179	0.019	-4.48179	0.37525	normal ^b
Ag	Herbivore	6	0.002	0.0032	0	0	0.007	0.007	-5.17168	0.37675	lognormal
Al	Herbivore	7	0.0172	0.0078	0.0064	0.0171	0.031	0.031	-4.16207	0.50004	normal ^b
Ca	Herbivore	7	9.3453	6.5936	1.0903	11.12	17.333	17.333	1.87744	1.04842	normal ^b
K	Herbivore	7	6.2069	1.59	3.0522	6.3415	7.73	7.73	1.78839	0.31767	normal
Mg	Herbivore	7	0.7807	0.2409	0.4793	0.7692	1.148	1.148	-0.28928	0.31421	normal ^b
Mn	Herbivore	7	0.0301	0.0273	0.0114	0.0156	0.079	0.079	-3.79559	0.77192	lognormal ^a
Na	Herbivore	7	56.3453	30.3066	11.3671	61.26	100.24	100.24	3.84608	0.74346	normal ^b
V	Herbivore	7	0.0137	0.0039	0.0083	0.0129	0.019	0.019	-4.32748	0.29025	normal ^b
Ag	Omnivore	4	0.279	0.3621	0.0037	0.1513	0.81	0.81	-2.41647	2.28221	normal ^b
Al	Omnivore	5	0.0636	0.0202	0.0427	0.0618	0.093	0.093	-2.79483	0.31425	normal ^b
Ca	Omnivore	5	6.5727	3.8928	0.8918	8.5158	9.717	9.717	1.59773	1.01847	normal
K	Omnivore	5	4.3435	0.9156	2.8112	4.4828	5.253	5.253	1.44747	0.24079	normal
Mg	Omnivore	5	0.6052	0.1507	0.368	0.6542	0.743	0.743	-0.53173	0.28442	normal
Mn	Omnivore	5	0.0281	0.0073	0.0195	0.0309	0.037	0.037	-3.60092	0.27254	normal ^b
Na	Omnivore	5	60.9335	28.7368	11.0633	75.7417	80.105	80.105	3.91361	0.85	lognormal ^a
V	Omnivore	5	0.00968	0.00348	0.005181	0.01037	0.01311	0.0131	-4.69783	0.40108	normal ^b

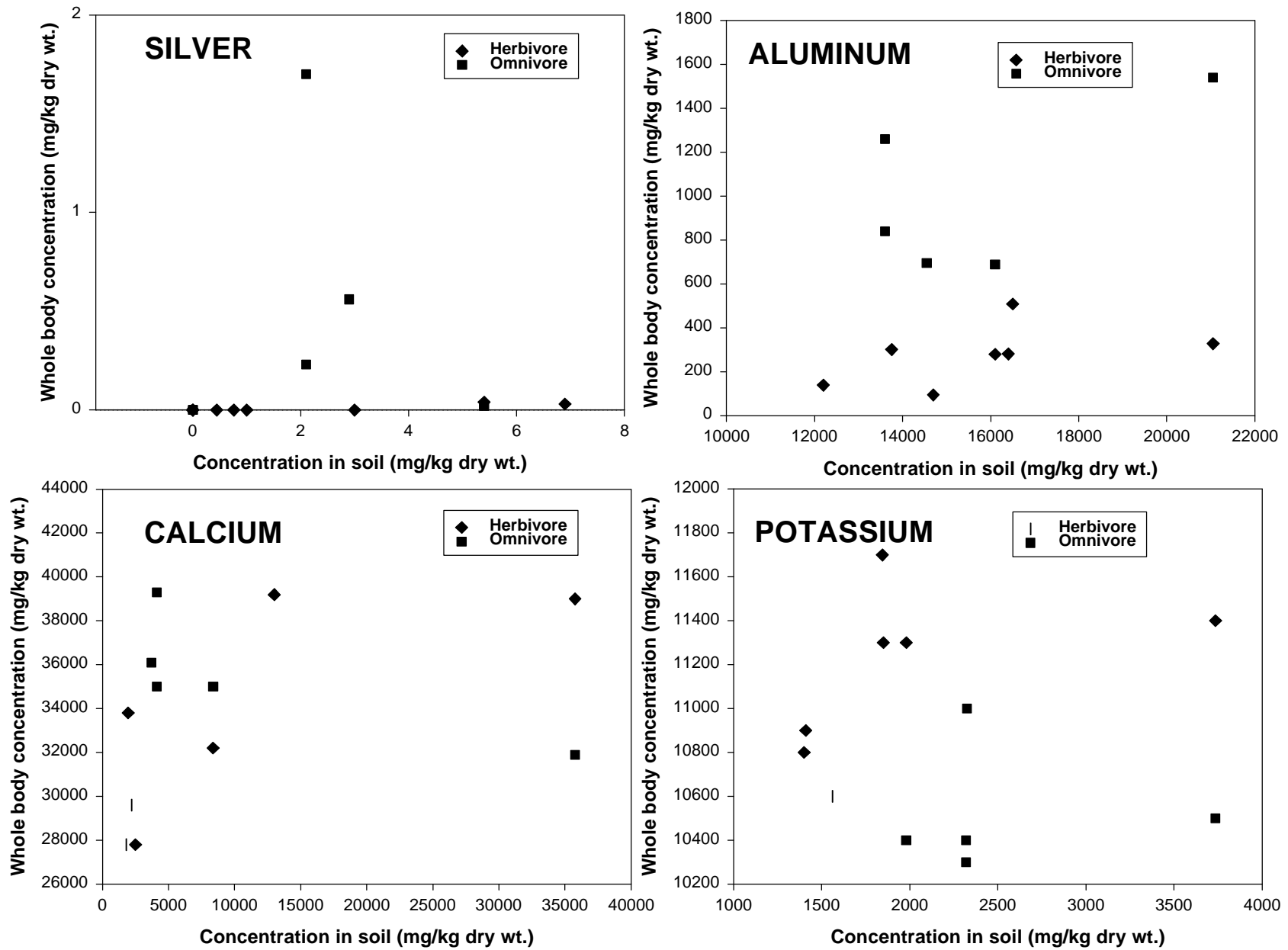


Fig. C.1. Scatterplot of concentration of Ag, Al, Ca, and K in small mammals vs that in soil reported in PTI (1995).

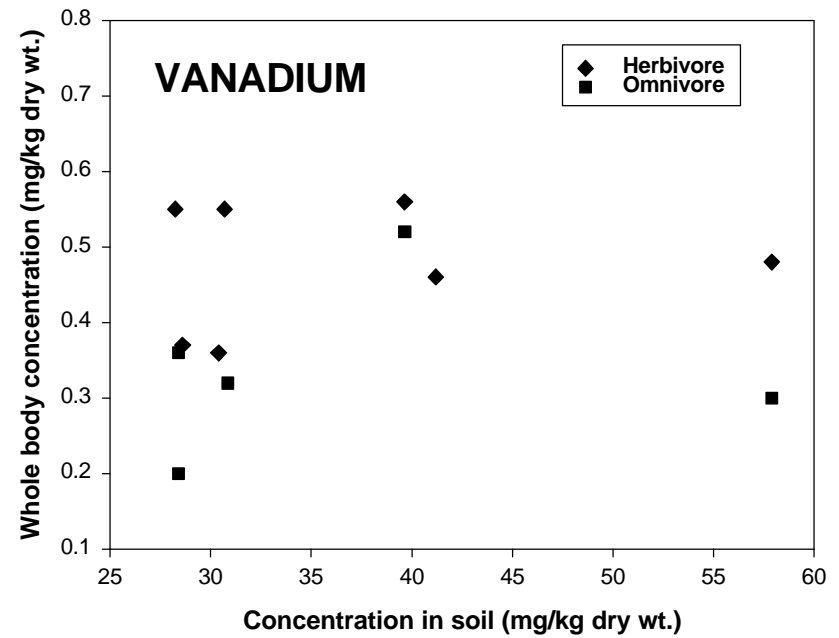
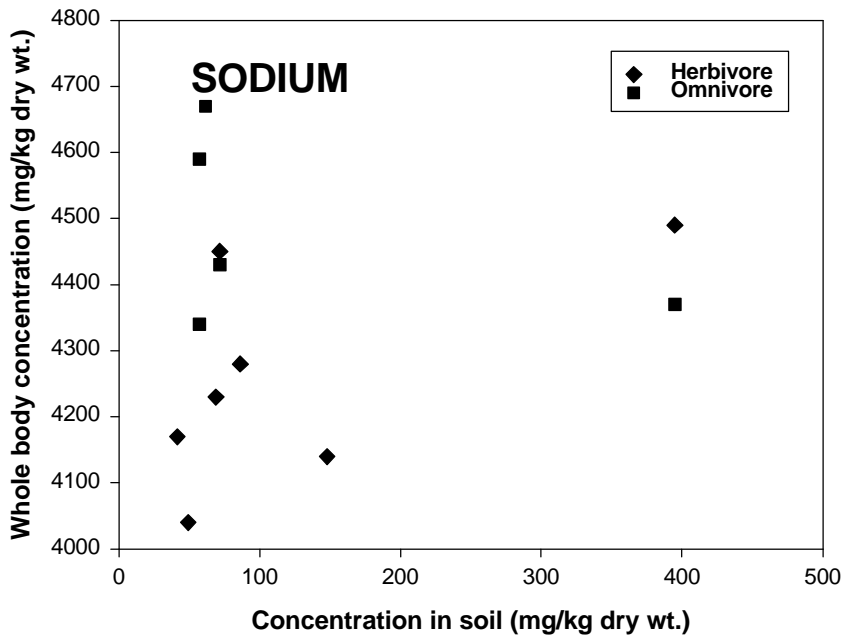
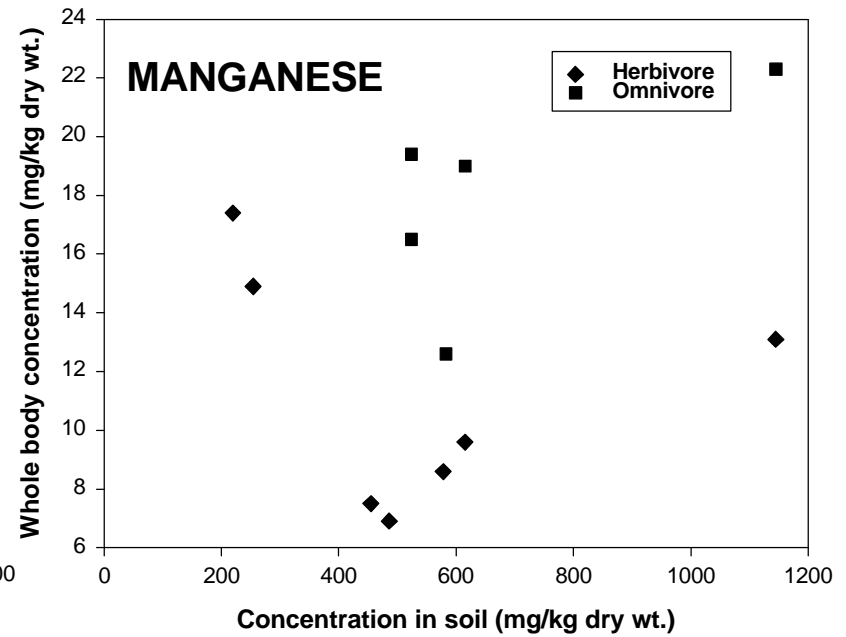
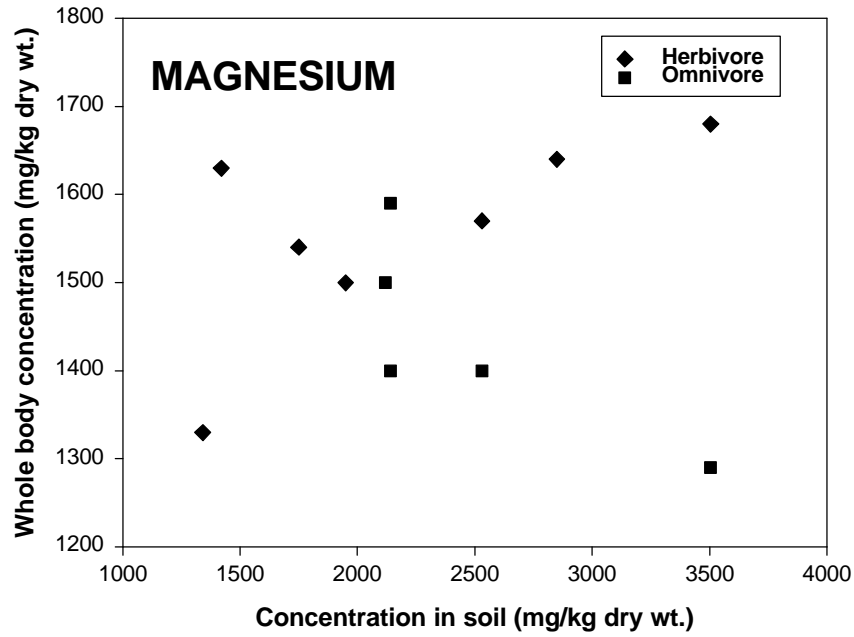


Fig. C.2. Scatterplot of concentration of Mg, Mn, Na, and V in small mammals vs that in soil reported in PTI (1995).

APPENDIX D

PROCEDURE FOR CALCULATING PREDICTION LIMITS FOR ESTIMATES GENERATED BY THE SIMPLE REGRESSION MODELS

Prediction limits for estimates generated by the regression models presented in Table 8 may be calculated using the following equation (Dowdy and Wearden 1983):

$$\text{Prediction Limit} = \hat{y} \pm t_{\alpha=0.05, df=n-2} * RMSE * \sqrt{1 + \frac{1}{n} + \frac{(x^* - \bar{x})^2}{Sxx}}$$

- \hat{y} = ln-transformed concentration of analyte in earthworm tissue estimated using regression models from Table 8.
- t_{α} = 0.05, df=n-2 = t-statistic for 95% one-tailed limits or 90% two-tailed intervals with n-2 degrees of freedom. (Presented in Table D-1).
- n = Sample size for regression model. (Presented in Table D-1).
- RMSE = Root mean square error for regression model. (Presented in Table D-1).
- x^* = ln-transformed soil concentration for which earthworm concentrations are being estimated. (Site specific).
- \bar{x} = Mean soil concentration from regression model. (Presented in Table D-1).
- Sxx = Variance of soil concentrations from regression model. $Sxx = \sum x^2 - \sum x / n$. (Presented in Table D-1).

The procedure for calculating an upper 95% prediction limit for an estimate (\hat{y}_{UPL}) is as follows:

1. Use regression model from Table 8 and estimate the ln-transformed concentration of analyte in earthworm tissue (\hat{y}) from the ln-transformed soil concentration of the analyte of concern (x^*).
2. Obtain values for t, n, RMSE, \bar{x} , and Sxx from Table D-1.
3. Apply the values from step 2 along with x^* to the equation outlined above and add the product to \hat{y} to generate the upper 95% prediction limit for \hat{y} (\hat{y}_{UPL}).
4. \hat{y}_{UPL} as calculated by the above equation is ln-transformed and must be back-transformed. Back-transform \hat{y}_{UPL} as follows: $e^{\hat{y}_{UPL}}$, where $e = 2.7182818$.

A lower 95% prediction limit (\hat{y}_{LPL}) can be calculated by subtracting the product from step 3 from \hat{y} , then back transforming the result. The 90% prediction interval (PI) is calculated if both the UPL and LPL are calculated. In application, 95% of all estimates are expected to fall below or above the UPL and LPL, respectively, and 90% of all estimates are expected to fall between the UPL and LPL.

Table D.1. Values for estimating upper and lower prediction limits for estimates generated by simple regression models.

All models based on the combined model and validation datasets (Table 8).

Analyte	Trophic Group	n	$\sum x$	\bar{x}	$\sum x^2$	Root Mean Square Error (RMSE)	Sxx	t statistic ($\alpha = 0.05$, df = n-2)
As	all	60	234.1678	3.9028	1042.0794	1.18089	-896.5413	1.6716
As	Herbivore	22	69.1773	3.1444	253.9455	0.94732	-205.9797	1.7247
As	Omnivore	37	160.0927	4.3268	764.1451	1.27314	-672.0413	1.6896
Cd	all	99	92.9788	0.9392	313.6895	1.53246	-84.1552	1.6607
Cd	Insectivore	38	22.0383	0.5800	68.1551	1.12842	-10.9877	1.6883
Cd	Herbivore	28	39.9333	1.4262	136.5506	0.62238	-52.0756	1.7056
Cd	Omnivore	33	30.4073	0.9214	108.9838	0.70189	-24.7158	1.6955
Cr	all	38	129.3113	3.4029	468.6595	0.76973	-427.7040	1.6883
Cr	Omnivore	27	89.9813	3.3326	318.2877	0.85565	-288.0869	1.7081
Cu	all	76	324.2293	4.2662	1587.9345	0.40722	-1362.3251	1.6657
Cu	Insectivore	30	102.0019	3.4001	394.1586	0.10431	-333.6743	1.7011
Cu	Omnivore	28	140.0202	5.0007	766.3043	0.44466	-672.8340	1.7056
Fe	all	15	150.7999	10.0533	1519.8568	0.21947	-1414.7169	1.7709
Fe	Herbivore	10	100.6496	10.0650	1016.6856	0.24102	-911.3656	1.8595
Ni	all	36	82.4994	2.2917	263.2776	0.62756	-181.7465	1.6909
Ni	Insectivore	9	14.8874	1.6542	37.4463	0.2641	-20.4654	1.8946
Ni	Herbivore	9	23.8583	2.6509	89.7852	0.56246	-53.2704	1.8946
Ni	Omnivore	18	43.7537	2.4308	136.0461	0.75261	-98.7967	1.7459
Pb	all	138	662.6961	4.8021	3565.3320	0.97193	-3156.5275	1.6561
Pb	Insectivore	54	251.9468	4.6657	1296.0365	0.69447	-1151.5028	1.6747
Pb	Herbivore	40	215.1331	5.3783	1330.4867	0.76632	-1123.7941	1.6860
Se	all	27	38.2005	1.4148	93.2072	0.70378	-50.5952	1.7081
Se	Omnivore	21	33.973	1.6178	80.4674	0.73017	-51.1284	1.7291
TCDD	all	5	-48.8163	-9.7633	498.5098	0.86676	-376.9043	2.3534
Zn	all	103	569.1873	5.5261	3444.9022	0.33578	-3111.9348	1.6601
Zn	Insectivore	37	187.4824	5.0671	1008.5309	0.17453	-922.7330	1.6896
Zn	Herbivore	30	180.4658	6.0155	1221.5471	0.23049	-1044.8786	1.7011

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