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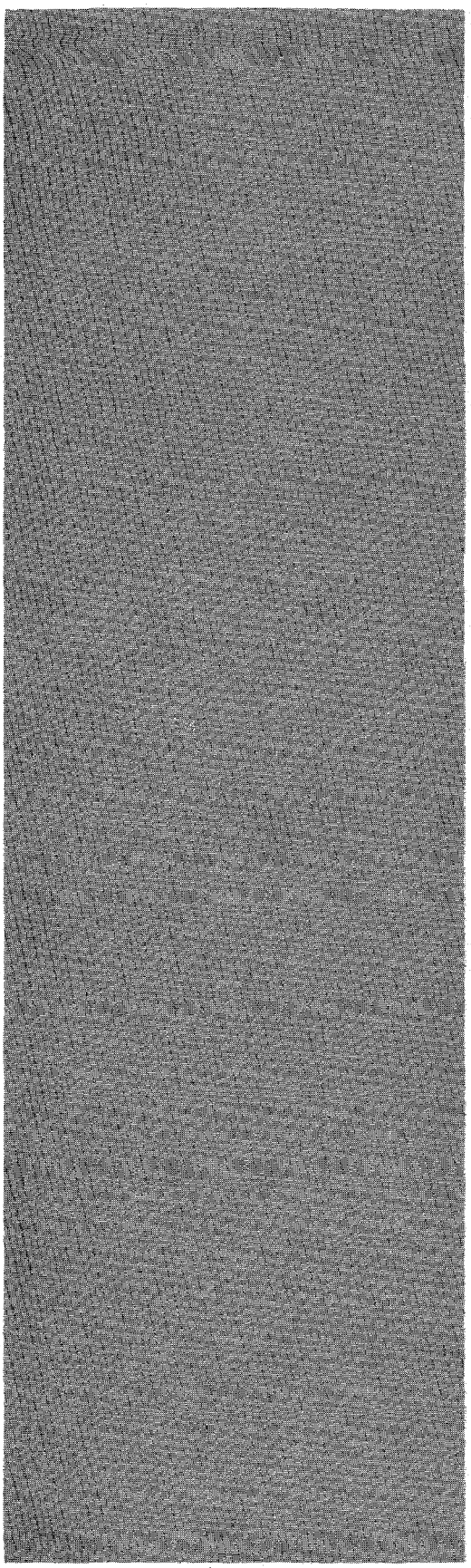

Radionuclide Contaminant Analysis of Small Mammals at Area G, Technical Area 54, 1996 (with cumulative summary for 1994–1996)

Los Alamos
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RADIONUCLIDE CONTAMINANT ANALYSIS OF SMALL MAMMALS AT AREA G, TECHNICAL AREA 54, 1996

(with cumulative summary 1994–96)

by
James R. Biggs, Kathryn D. Bennett, and P. R. Fresquez

ABSTRACT

Small mammals were sampled at two waste burial sites at Area G, Technical Area (TA) 54 and a control site within the proposed Area G expansion area in 1996 to (1) identify radionuclides that are present within rodent tissues at waste burial sites, (2) to compare the amount of radionuclide uptake by small mammals at waste burial sites to a control site, and (3) to identify the primary mode of contamination to small mammals, either through surface contact or ingestion/inhalation. Three composite samples of approximately five animals per sample were collected at each site. Pelts and carcasses of each animal were separated and analyzed independently. Samples were analyzed for ^{241}Am, ^{90}Sr, ^{238}Pu, ^{239}Pu, total U, ^{137}Cs, and ^{3}H. Higher levels of total U, ^{241}Am, ^{238}Pu, and ^{239}Pu were detected in pelts as compared to the carcasses of small mammals at TA-54. Concentrations of other measured radionuclides in carcasses were nearly equal to or exceeded the mean concentrations in the pelts. Due to low sample sizes in total number of animals captured, statistical analysis to compare site to site could not be conducted. However, mean concentrations of total U, ^{238}Pu, ^{239}Pu, and ^{137}Cs in rodent carcasses were higher at Site 1 than Site 2 or the Control Site and ^{241}Am was higher at Site 2 than Site 1 or the Control Site.

INTRODUCTION

A solid, low-level radioactive waste disposal facility has been operating at Area G, Technical Area (TA) 54 at Los Alamos National Laboratory (LANL) since 1957 and has been used to dispose of various wastes including tritium waste, transuranic waste, volatile organic compounds, and mixed waste. The collection and analysis of small mammals at TA-54, Area G, was initiated in 1994 as part of the Enhanced Environmental Annual Surveillance program at Area G by the Environment, Safety, and Health Division in collaboration with the Solid Waste Management

Group. The program is intended to provide data to aid in meeting requirements of DOE Order 5400.1, which specifies monitoring of existing operations at radioactive waste burial sites.

Five sites were selected for trapping in 1996 to correlate with vegetation samplng sites (Fresquez et al. 1997)(Table 1, Figure 1): Site 1, Site 2, Control Site (or Site 3), Open Active Pits, and Tritium Shafts. Sites 1 and 2 were also trapped in 1994 and 1995 and the Control Site was trapped in 1994. A background site, located on Frijoles Mesa on the southern edge of LANL, was trapped in 1995 instead of the Control Site. Trapping was planned for the background site (see Bennett et al. 1996) but due to very low captures at the control site, we did not attempt to trap the background site. This is the first year of trapping at the Open Active Pits and Tritium Shafts. A description of Sites 1 and 2 and the Control Site are provided in previous reports (Biggs et al. 1995, Bennett et al. 1996).

Table 1. A Correlation of Rodent Sampling Sites to Vegetation Sampling Sites.

Rodent Sampling Site Number	Year(s) Sampled	Veg. Sampling Site Number (Fresquez et al. 1997)	Year(s) Sampled
1	1994, '95, '96	5, 6	1994, '95, '96
2	1994, '95, '96	7	1996
Control Site (Site 3)	1994, '96	8	1996
Background (Site 4)	1995	9	1994, '95, '96
Tritium Shafts	1995, '96	1	1994, '95, '96
Open Active Pits	1995, '96	3	1994, '95, '96

A detailed description of methods used to trap, collect, and analyze rodents is also given in those reports. This report provides results of 1996 sampling and a cumulative summary from 1994–96.

RESULTS OF 1996 SAMPLING

Species Composition

Deer mouse (*Peromyscus maniculatus*) was the primary small mammal species captured at Site 1 and Site 2. One harvest mouse (*Riethrodontomys megalotis*) was also captured at Site 2. Collection of rodent samples was attempted at the Open Active Pits in the west portion of Area G and at the Tritium Shafts located along the south edge of Area G. Trapping success was very low

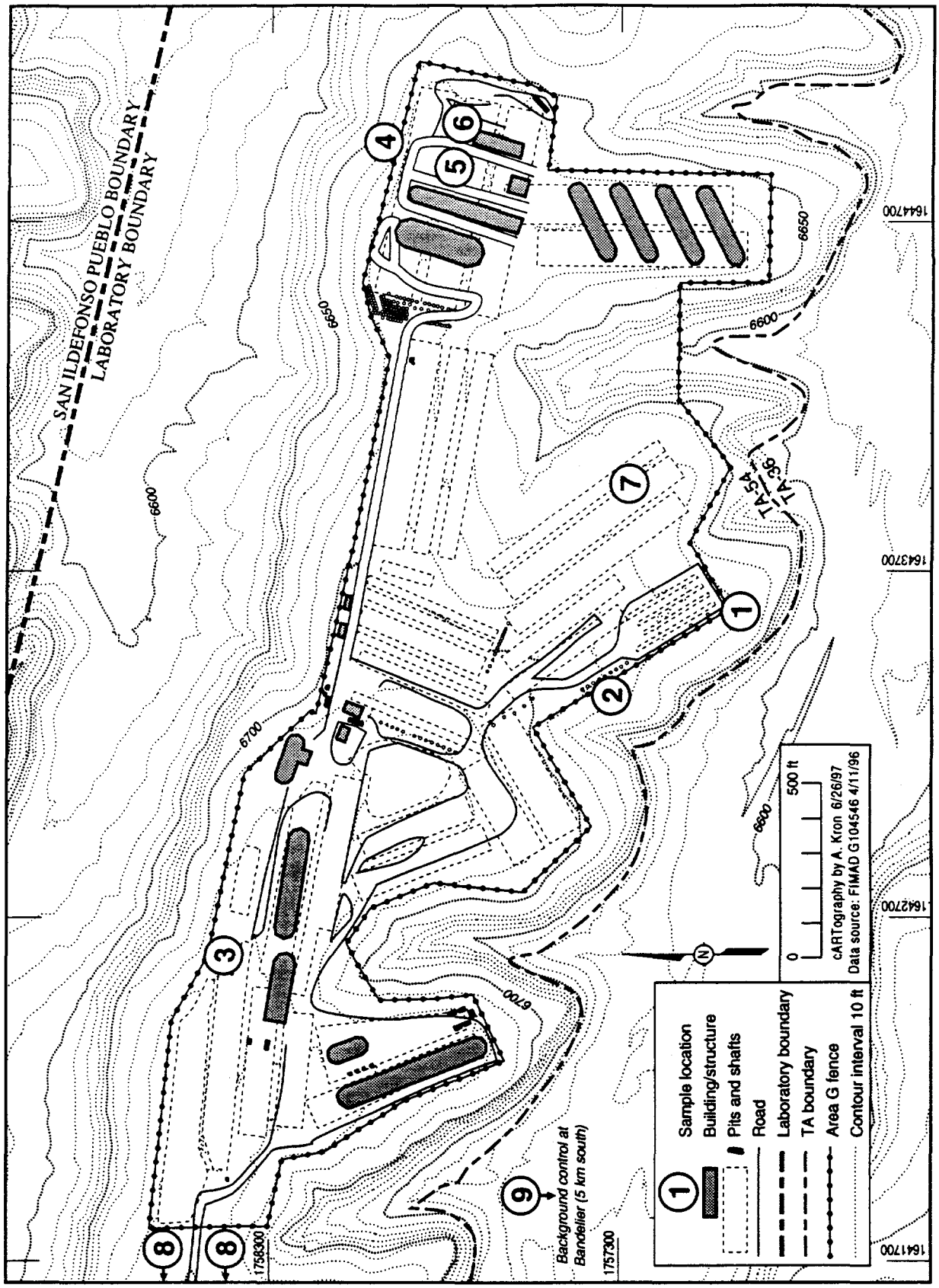


Figure 1. Site/sample locations of vegetation at Area G. Site #8 is located farther west and Site #9 is located farther south than what is shown here. Refer to Table 1 to correlate vegetation sampling sites to rodent sampling sites.

at both locations. Deer mouse was the only species captured around the Open Active Pits and deer mice and pinyon mice (*P. trueii*) were captured at the Tritium Shafts. A nearly equal number of deer mice and pinyon mice were captured in the control grids.

Density Estimates

Site 1 had the highest density of animals followed by Site 2 (Table 2). Density calculations could not be attempted on capture data for the Open Active Pits or the Tritium Shafts due to the low number of captures. The density of the trapping area for Sites 1 and 2 is based on a 100-m by 100-m grid with an additional 5-m boundary strip to help account for animals being drawn into the grid due to the bait. Therefore the total effective trapping area is approximately 1.21 ha. Because of the low capture rates at the Control Site, capture data from all three grids were pooled to estimate density. Since three grids were pooled to estimate density, the total effective trapping area is approximately 100 m by 100 m multiplied by three grids plus a 5-m boundary strip for each of the three grids. Therefore, the total effective trapping area is 3.63 ha. Table 2 gives the number of animals per hectare of each site sampled after adjustment for the total effective trapping area.

Species Weights (biomass)

The average weight of all species combined and a biomass estimate (average weight × density) was calculated for each site trapped (Table 3). No estimates are given for the Tritium Shafts and Open Active Pits due to low sample size.

Radionuclide Analysis

A summary of radionuclide analysis on pelt and carcass samples is given in Table 4. Only the major isotopes of concern are summarized. For most sites, the mean concentrations of radionuclides in carcasses were lower than the concentrations found in pelts for total U, ^{241}Am, ^{238}Pu, and ^{239}Pu. For the remaining radionuclides, concentrations in carcasses were usually nearly equal to or exceeded the mean concentrations in the pelts. To analyze data from previous years,

Table 2. Rodent Density Estimate of Area G (Sites 1 and 2) and Control Site (Site 3).

SITE 1	DAY	NO. OF CAPTURES	NO. OF TRAPS
	1	3	100
	2	3	100
	3	1	100
	4	3	100
	5	3	100
	6	1	100
DENSITY (# animals/ha)	23 se = 15.7		
95% CONFIDENCE INTERVAL	Lower 95% Limit = 0	Upper 95% Limit = 53.7	
SITE 2	**DAY**	**NO. OF CAPTURES**	**NO. OF TRAPS**
	1	2	100
	2	1	100
	3	2	100
	4	1	100
	5	1	100
	6	1	100
DENSITY (# animals/ha)	11.4 se = 4.5		
95% CONFIDENCE INTERVAL	Lower 95% Limit = 2.6	Upper 95% Limit = 20.2	
CONTROL SITE (3 grids)	**DAY**	**NO. OF CAPTURES**	**NO. OF TRAPS**
	1	2	300
	2	1	300
	3	1	300
DENSITY (# animals/ha)	1.5 se = 0.4		
95% CONFIDENCE INTERVAL	Lower 95% Limit = 0.7	Upper 95% Limit = 2.2	

Table 3. Average Weights, Densities, and Biomass Estimates for Sites 1 and 2 and the Control Site.

Sample Location	Average Weight (grams)	Density Estimate (#/ha)	Biomass Estimate (grams)
Site 1	19.43 (se = 1.05)	23	445
Site 2	17.06 (se = 1.68)	11.4	194
Control Site (3 grids pooled)	25.88 (se = 1.69)	1.5	39
Open Active Pits	20.33 (se = 0.44)	****	****
Tritium Shafts	****	****	****

**** Insufficient data to perform analysis.

an ANOVA test was used to determine if the mean radionuclide concentrations in carcasses were different between sites and Duncan's multiple range test was used to show where the differences occurred. However, due to low sample sizes for all sites except Site 1 during this year's trapping, statistical analysis could not be conducted to identify differences in radionuclide concentrations between sites. Mean concentrations of radionuclides in rodent carcasses are discussed in the

cumulative summary section of this report. Total U, ^{238}Pu, ^{239}Pu, and ^{137}Cs were higher at Site 1 compared to Site 2 and the Control Site. ^{241}Am was substantially higher at Site 2 than at Site 1 or the Control Site.

Table 4. Summary of Radionuclide Analysis of Small Mammal Pelts and Carcasses, 1996.

DATE	SAMPLE	SITE[1]	SAMPLE NUMBER[2]	U	AM241	PU238	PU239	CS137	H3
06/96	PELT	1	1	1.06 (0.11)[3]	0.1664 (0.0424)	0.057 (0.011)	0.1972 (0.0209)	5.95 (1.12)	24877 (66.3)
06/96	PELT	1	2	1.16 (0.12)	0.049 (0.031)	0.0747 (0.015)	0.1107 (0.0182)	2.71 (2.42)	1465.6 (2.0)
06/96	PELT	1	3	1.66 (0.17)	0.1834 (0.0519)	0.0587 (0.0149)	0.2044 (0.0267)	7.37 (6.55)	1187.8 (24.2)
06/96	PELT	2	1	1.54 (0.15)	0.6792 (0.1001)	0.174 (0.029)	1.401 (0.089)	6.93 (1.63)	985.7 (29.1)
06/96	PELT	2	2	0.96 (0.1)	0.6532 (0.0798)	0.0112 (0.009)	0.7414 (0.0605)	4.29 (3.82)	560.6 (1.8)
06/96	PELT	OAP	1	6.55 (0.66)	50.34 (2.61)	24.88 (0.93)	149.3 (5.0)	5.24 (1.38)	3002.2 (87.3)
06/96	PELT	TS	1	1.43 (0.14)	0.055 (0.033)	0.099 (0.050)	0.1105 (0.0535)	6.62 (5.92)	465.6 (1.6)
06/96	PELT	CNTL	1	3.87 (0.39)	0.087 (0.035)	0.0514 (0.0247)	0.0331 (0.0217)	23.5 (4.3)	0.01 (0.16)
06/96	PELT	CNTL	1	0.74 (0.07)	0.0615 (0.0326)	0.0034 (0.01)	0.0603 (0.0247)	5.5 (4.93)	1.568 (0.257)
06/96	CARCASS	1	1	0.24 (0.02)	0.0074 (0.0041)	0.0087 (0.0023)	0.0194 (0.0031)	1.34 (1.2)	1120.6 (20.3)
06/96	CARCASS	1	2	0.26 (0.03)	0.0059 (0.003)	0.0133 (0.0024)	0.0104 (0.0021)	1.9 (0.3)	4444.6 (32.8)
06/96	CARCASS	1	3	1.82 (0.18)	0.2658 (0.022)	0.234 (0.0107)	1.132 (0.032)	1.04 (0.21)	1121.1 (20.3)
06/96	CARCASS	2	1	0.45 (0.05)	1.1 (0.2)	0.0149 (0.0027)	0.0878 (0.0066)	1.25 (0.22)	908.2 (19.2)
06/96	CARCASS	2	2	0.28 (0.03)	0.097 (0.011)	0.0192 (0.0052)	0.4359 (0.0262)	0.83 (0.73)	413.1 (16.4)
06/96	CARCASS	OAP	1	0.49 (0.05)	0.1039 (0.018)	0.0316 (0.0046)	0.1021 (0.0085)	1.22 (1.09)	2601.6 (26.6)
06/96	CARCASS	TS	1	0.18 (0.02)	0.0099 (0.0028)	0.0018 (0.0036)	0.003 (0.001)	1.78 (0.37)	4140.3 (31.9)
06/96	CARCASS	CNTL	1	0.06 (0.01)	0.0139 (0.0025)	0.0156 (0.0034)	0.0058 (0.0022)	0.27 (1.07)	0.012 (0.141)
06/96	CARCASS	CNTL	1	0.16 (0.02)	0.0028 (0.0021)	0.0004 (0.0006)	0.0023 (0.0013)	0.49 (0.43)	0.416 (0.143)

[1] OAP = Open Active Pits, TS = Tritium Shafts, CNTL = Control Grid

[2] Only one composite pelt sample was analyzed for the OAP, TS, and CNTL (grids 1 & 2) due to low total ashed weight of combined samples.

[3] Analytical uncertainty (+/- 1SD) is shown in parentheses.

Only one sample was collected at the Open Active Pit (3 animals) and the Tritium Shafts (2 animals) due to the low capture rate. Athough not statistically analyzed, the pelt sample from the Open Active Pit had much higher concentrations of total U, ^{241}Am, ^{238}Pu, and ^{239}Pu compared to any other site, in either pelts or carcasses (Table 4).

CUMULATIVE SUMMARY

Species Composition

No large differences in species composition were observed from a comparison of year-to-year data from Sites 1 and 2 (Figure 2). However, the captures of two additional species (brush mouse, pocket mouse) occurred in 1995 at the Control Site. Species composition at the Control Site did not differ between 1994 and 1996. The different species composition may be explained by the fact that the 1995 Control Site had slightly different habitat characteristics.

Density and Biomass Estimates

Density estimations were made for each year of sampling using Leslie's regression method (Seber 1982). Confidence intervals were calculated at 95% using the general method (Seber 1982). Biomass estimates were estimated for each year of sampling by multiplying the density estimate by the mean weight. The biomass is a product of two random variables, therefore we selected Goodman's estimator for variance (Goodman 1960). We calculated confidence intervals of 95%.

There are only slight changes in the density (Figure 3) and biomass (Figure 4) of rodents at each of the sampled sites from year to year. However, the density and biomass of rodents remains greater from year to year at the Area G sampling locations compared to the Control Site. During other sampling efforts within Laboratory boundaries in 1996, we also found relatively lower densities of rodents on nondisturbed habitats (i.e., similar to our Control Site) compared to disturbed habitats (i.e., Area G).

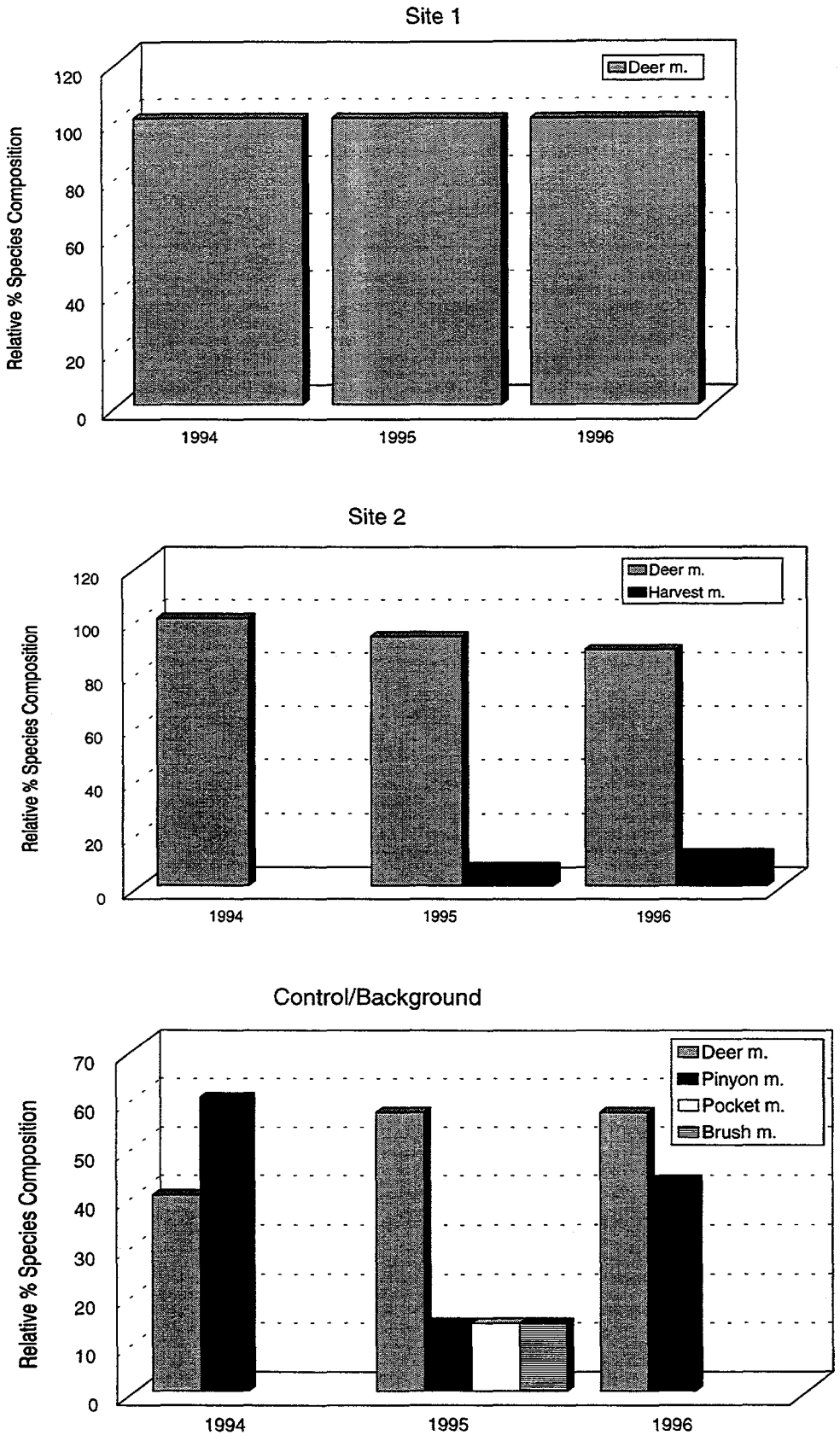
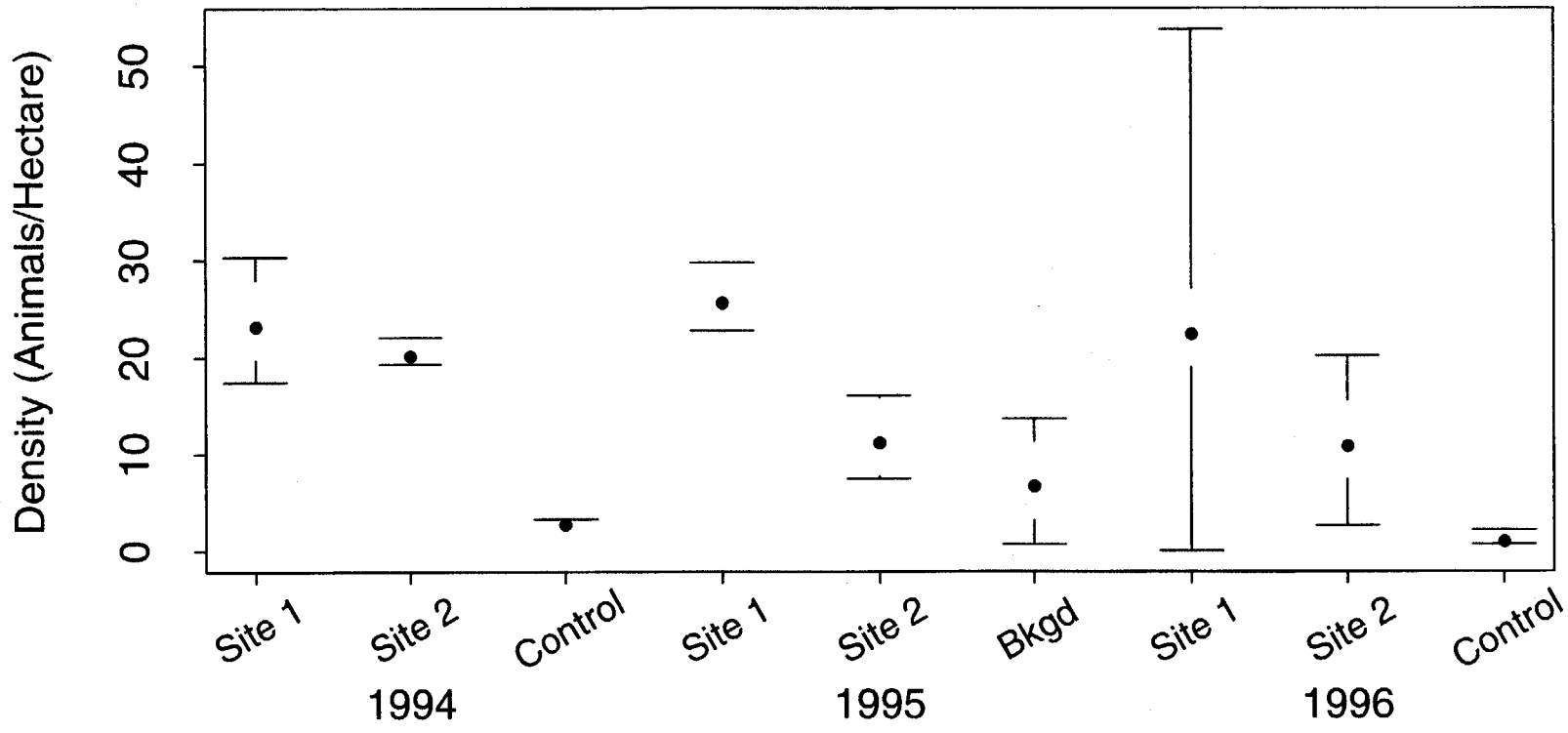
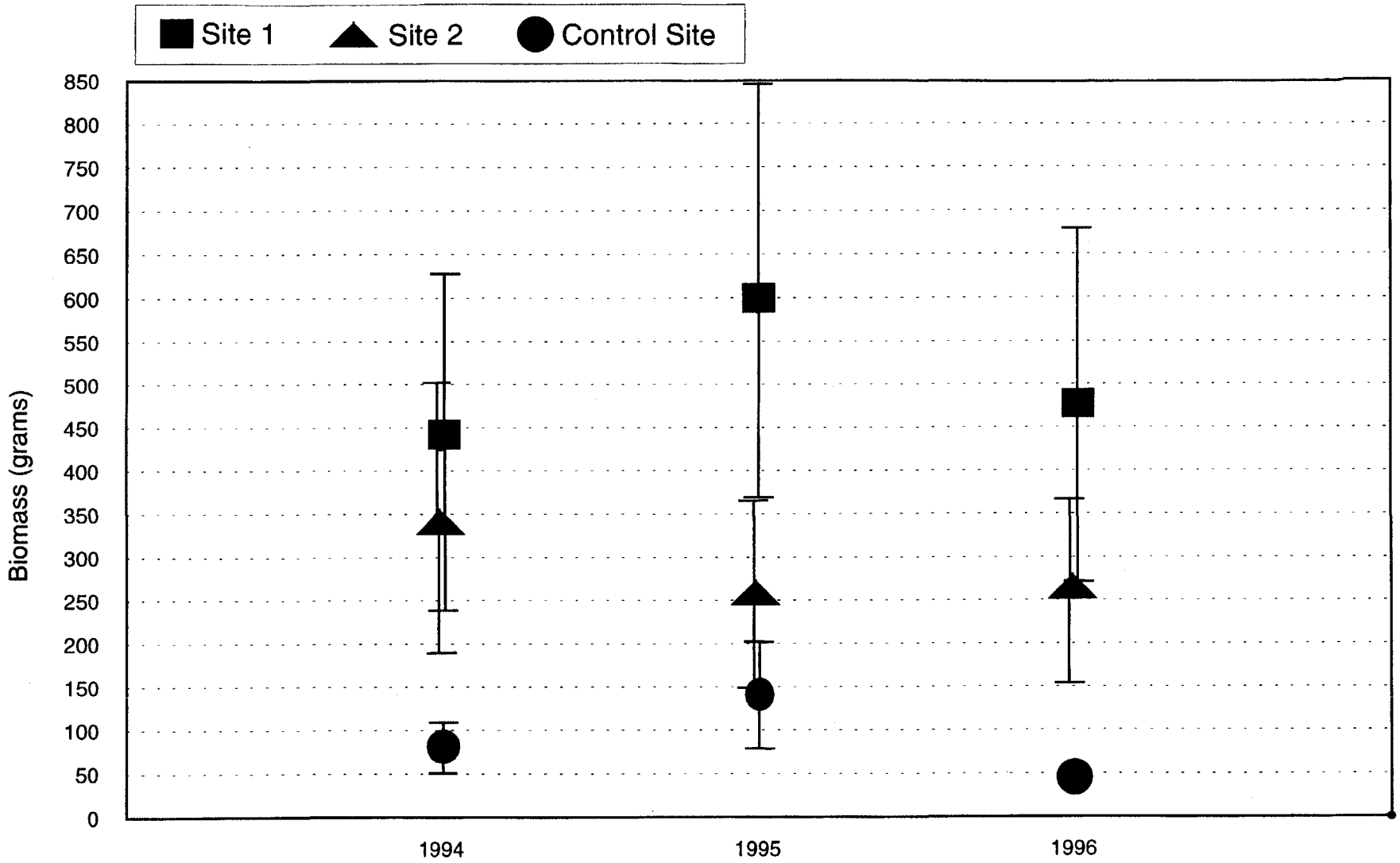


Figure 2. Relative Species Composition for Sites 1 and 2 and the Control Site, 1994–1996.



* Vertical and horizontal bars indicate 95% Confidence Interval.
Dots indicate the density estimate.

Figure 3. Rodent density by site and year.



* vertical and horizontal lines indicate 95% confidence interval

Figure 4. Biomass Estmates for Area G and Control Site, 1994-96.

Mean Radionuclide Concentrations for Carcasses

Of the major radionuclides analyzed, four have shown an increase in concentrations in rodent carcasses at Sites 1 and 2 from 1994 to 1996: ^{241}Am, ^{239}Pu, and ^{137}Cs (Figure 5). However, this report only includes three years of data and more data will be necessary to accurately identify trends in radionuclide concentrations. Tritium concentration in carcasses showed a sharp decrease from 1994 to 1996.

Mean Radionuclide Concentrations for Pelts

Concentrations of some radionuclides showing an increase in carcasses showed little or no increase, and in some cases, a decrease, in pelts (Figure 6). Both ^{241}Am and ^{239}Pu showed a decrease or only a slight increase in concentration. As with carcasses, ^{137}Cs increased in pelts from 1994 to 1996. Tritium also showed a sharp decrease in concentration similar to carcasses.

ACKNOWLEDGMENTS

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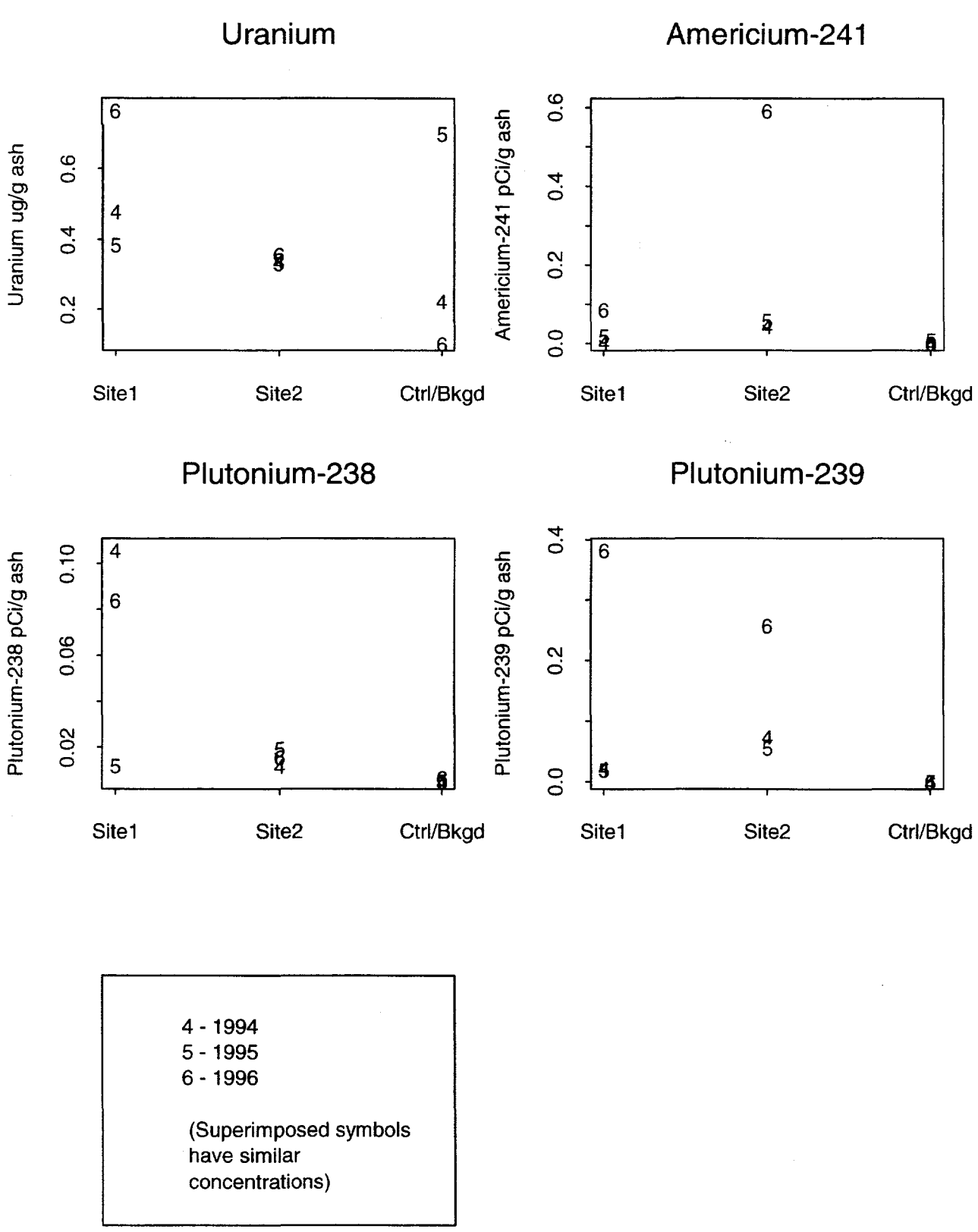

Figure 5. Radionuclide concentrations in rodent carcasses, 1994 – 1996.

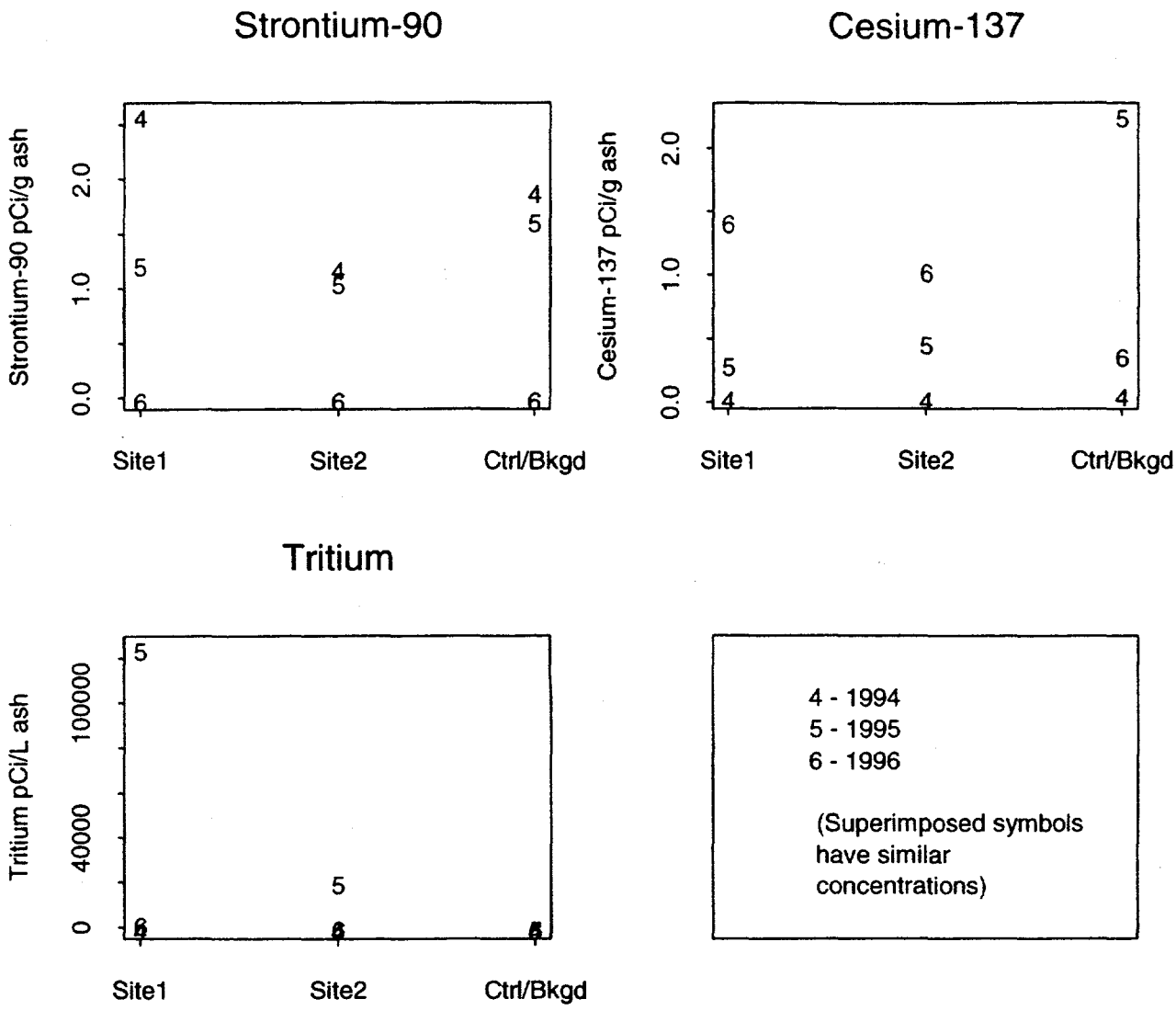

Figure 5 (cont.). Radionuclide concentrations in rodent carcasses, 1994 – 1996.

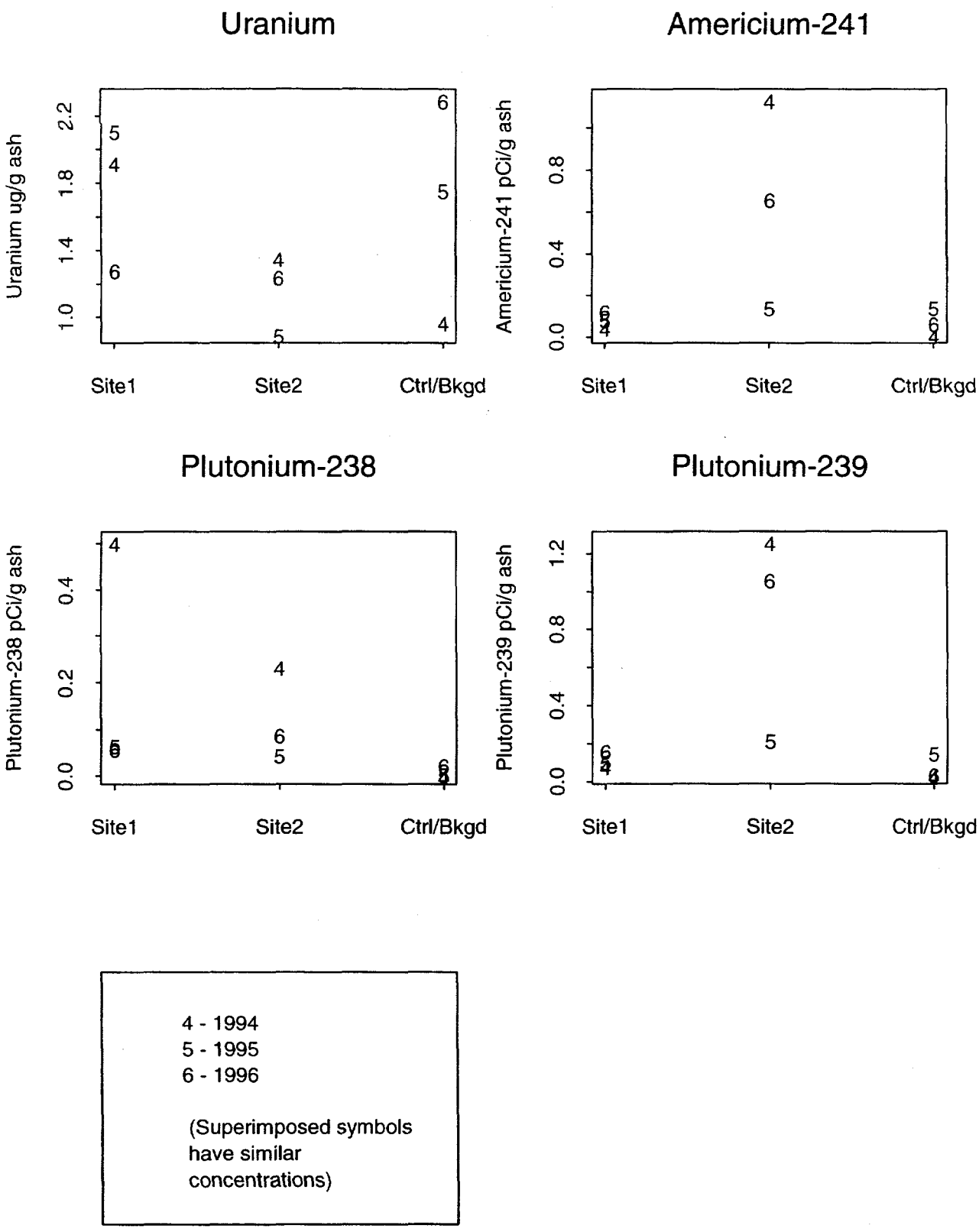

Figure 6. Radionuclide concentrations in rodent pelts, 1994 – 1996.

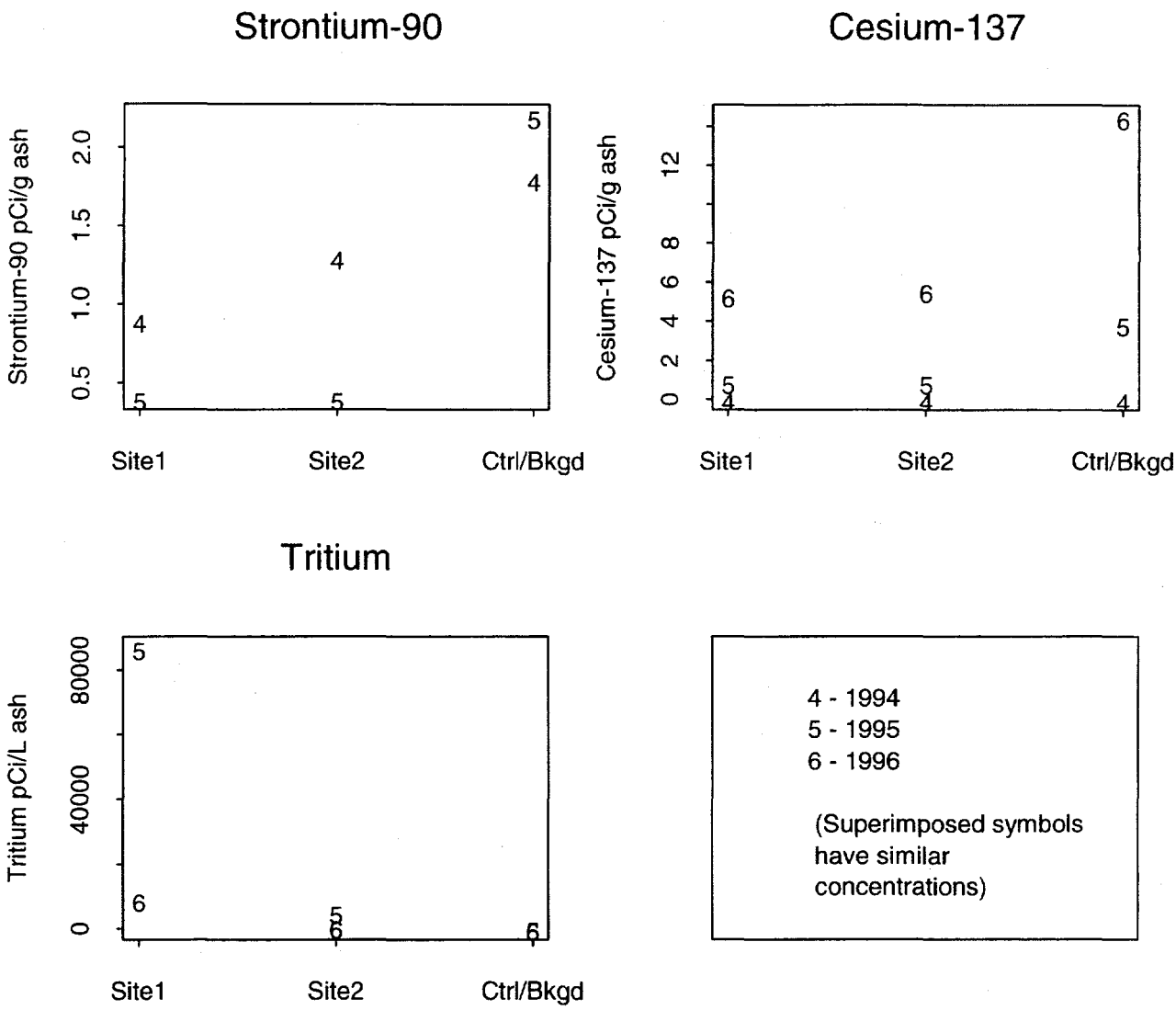

Figure 6 (cont.). Radionuclide concentrations in rodent pelts, 1994 – 1996.

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