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Concentrations of Radionuclides in Terrestrial Vegetation on the Hanford Site of Potential Interest to Native Americans

T. M. Poston

March 1995

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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SUMMARY

Concentrations of ^{90}Sr and ^{137}Cs in Carey's balsamroot (*Balsamorhiza careyana*) and Gray's desertparsley (*Lomatium grayi*) were similar to concentrations observed in other plants collected on the Hanford Site and from offsite locations surrounding the Site as part of annual Hanford Site surveillance. Observed concentrations may be attributed to historic fallout more than to Hanford Site emissions, although the observation that 200 Area plants had slightly higher concentrations of ^{137}Cs than 100 Area plants is consistent with other monitoring data of radioactivity in soil and vegetation collected onsite. The present concentrations of ^{90}Sr and ^{137}Cs in balsamroot and parsley fluctuate around background levels with some of the higher observed concentrations of ^{90}Sr found on the Fitzner/Eberhardt Arid Lands Ecology (ALE) Reserve. Analytical results and summary statistics by species and location are presented in the appendixes.

ACKNOWLEDGMENTS

The author expresses his appreciation to R. L. Dirkes, K. R. Price, P. R. Nickens, and associated staff of the Cultural Resources Group for critical reviews of this report. J. Dahl provided the initial screening and selection of plants and W. H. Rickard provided further consultation on sample selection and participated in sample collection with Radiation Protection Technologists. M. K. DeSmet provided editorial and publication assistance.

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INTRODUCTION

The U.S. Department of Energy's (DOE's) Hanford Site was established in 1943 in southeastern Washington State for nuclear materials production. Although the Site is quite large (1450 km^2 [560 mi^2]), only about 6% of the Site has been developed for industrial purposes (Woodruff et al. 1993). For the Site's first 45 years of existence, its principal mission was the production of plutonium for national defense and the management of resulting wastes. The Hanford Site is currently being remediated and cleaned up under the direction of the Hanford Federal Facility Agreement and Consent Order (1989 as amended), commonly referred to as the Tri-Party Agreement. As cleanup proceeds, more public access will be allowed onsite. The interest and potential use of the Site by regional Native American tribes is great, and their anticipated access to the Site warrants additional investigations.

BACKGROUND

Native Americans use many wild plants, some of which are found on the Hanford Site. They were used for food as well as for medicinal and religious practices. These species and their uses have been briefly summarized by Sackschewsky et al. (1992). This group of plants was reviewed with Hanford Site scientists and a staff botanist for the Yakama Indian Nation and pared down to eight species for sampling consideration (Table 1). Further review with Site botanists identified two plants most suitable for sampling because they were relatively large plants and were common on the Site; Carey's balsamroot (*Balsamorhiza careyana*) and two parsley species: Gray's desertparsley (*Lomatium grayi*) and turpentine springparsley (*Cymopteris terebinthinus*). The roots of parsley are very small and they were not sampled. While other species could have been sampled, for this preliminary sampling effort, this study focused on these species as generally representative of other terrestrial vegetation.

Additional information is available on radionuclide concentrations in other endemic Site vegetation in annual Site environmental monitoring reports produced by the Pacific Northwest Laboratory. Routine surveillance of Site vegetation has provided data on radionuclide concentrations in mixed samples of big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* sp.). Additionally, an extensive evaluation of radionuclide contamination in riparian vegetation was conducted from 1990 through 1992 (Antonio et al. 1993).

OBJECTIVE

The objective of this study was to obtain and report data on the concentrations of radionuclides in endemic plants on the Hanford Site that may be of interest to regional tribes, particularly species that have not normally been sampled. In April and May, 1994, two species of parsley and one species of balsamroot were collected from three distinct areas on the Hanford Site for analysis of gamma emitting radionuclides and ^{90}Sr.

Table 1. Terrestrial Plants on the Hanford Site of Potential Interest to Native Americans[a]

Plant (Common Name)	Part Used	Harvest Date	Location/Plant Associations
Allium macrum (rock onion)	bulb	spring	Scattered on rocky flats on top of Rattlesnake Ridge *Artemisia rigida-Poa*, loam *Eriogonum sphaerocephalum-Poa*, silt
Amelanchier alnifolia (western serviceberry)	fruit	autumn	Common in canyons and near springs of Rattlesnake/Umtanum Ridges *Crataegus douglasii-Symphoricarpus albus*
Balsamorhiza careyana (Carey's balsamroot)	stalk root	spring	Common and widespread in sandy areas, often with sagebrush *Artemisia rigida-Poa*, loam; *Eriogonum sphaerocephalum-Poa*, silt *Purshia tridentata-Festuca idahoensis* *Purshia-Stipa*
Lewisia rediviva (bitterroot)	bulb	spring	Local on rocky slopes Umtanum/Rattlesnake Ridges *Artemisia rigida-Poa*, Intermediates, *Eriogonum thymoides-Poa*, *Eriogonum douglasii-Poa*
Lomatium grayi (Gray's desertparsley)	root	spring	Common & widespread; rocky-silty soils along drainages, Rattlesnake Mountain, Snively Canyon *Artemisia rigida-Poa* *Eriogonum thymoides-Poa*
Perideridia gairdneri (Gairdner's yampah)	root	spring	White Bluffs & Rattlesnake Hills *Symphoricarpus* phase of *Festuca-Symphoricarpus*, *Artemisia tripartita-Agropyron spicatum* (might not be common)
Prunus virginiana (chokecherry)	fruit	summer autumn	Widespread in moist areas, e.g., Snively Canyon, Hanford Townsite *Festuca-idahoensis-Symphoricarpus*, *Purshia tridentata-Festuca idahoensis* *Crataegus douglasii-Heracleum lanatum*
Sambucus cerulea (blue elderberry)	fruit	autumn	Local in drainages of Rattlesnake Ridge *Crataegus douglasii-Heracleum lanatum*

(a) See Downs et al. (1993) and Daubenmire (1970) for more detailed descriptions of plant associations and associated soil types.

METHODS

The species collected were Carey's balsamroot and two species of parsley: Gray's desertparsley and turpentine springparsley. These species were chosen over other species of interest to Native Americans because of their great abundance on the Site. Balsamroot samples consisted of roots, or leaves and stems. Parsley samples consisted of leaves and stems only; the roots were too small to obtain sufficient sample mass for analysis. Each sample was a composite of multiple plants collected at each location. Samples were submitted to International Technology Laboratories (ITAS), Richland, Washington, for drying and radionuclide analysis. All results are reported as pCi/g dry weight. Results are reported for ^{7}Be, ^{40}K, ^{60}Co, ^{137}Cs, and ^{90}Sr.

Samples where collected from three general areas. The Fitzner-Eberhardt Arid Lands Ecology Reserve (ALE) along the 1200 Foot Road was sampled as an area generally upwind from the industrialized areas. Plants growing on land adjacent to two industrialized areas were also sampled; the 200 Area plateau in areas to the south and east of the 200-W and 200-E Areas, and the 100 Areas extending from east of 100-N to 100-F (Figure 1). The 200 Areas contain shutdown facilities that have processed irradiated fuel elements from the production reactors and currently store radioactive wastes. The 100 Areas include a series of 7 distinct areas located along the Columbia River where shutdown nuclear production reactors are located.

Data are graphically presented as scattergrams showing all data and box plots. The box plot shows the median, the 25th percentile (bottom of box), and 75th percentile (top of box) concentrations. Box figures with additional bars show the 10th and 90th percentiles and symbols above and below those bars show individual results outside of the 10th and 90th percentile concentrations when $N \geq 4$. Because of the limited number of samples collected, the box plots are of marginal value for depicting the distribution of the data, however it is assumed that the data follow a log-normal distribution and the median concentration provides a better estimate of central tendency than the mean. Summary statistics of radionuclide concentrations by location and individual analytical results for each species, sample portion, and location are found in the appendixes.

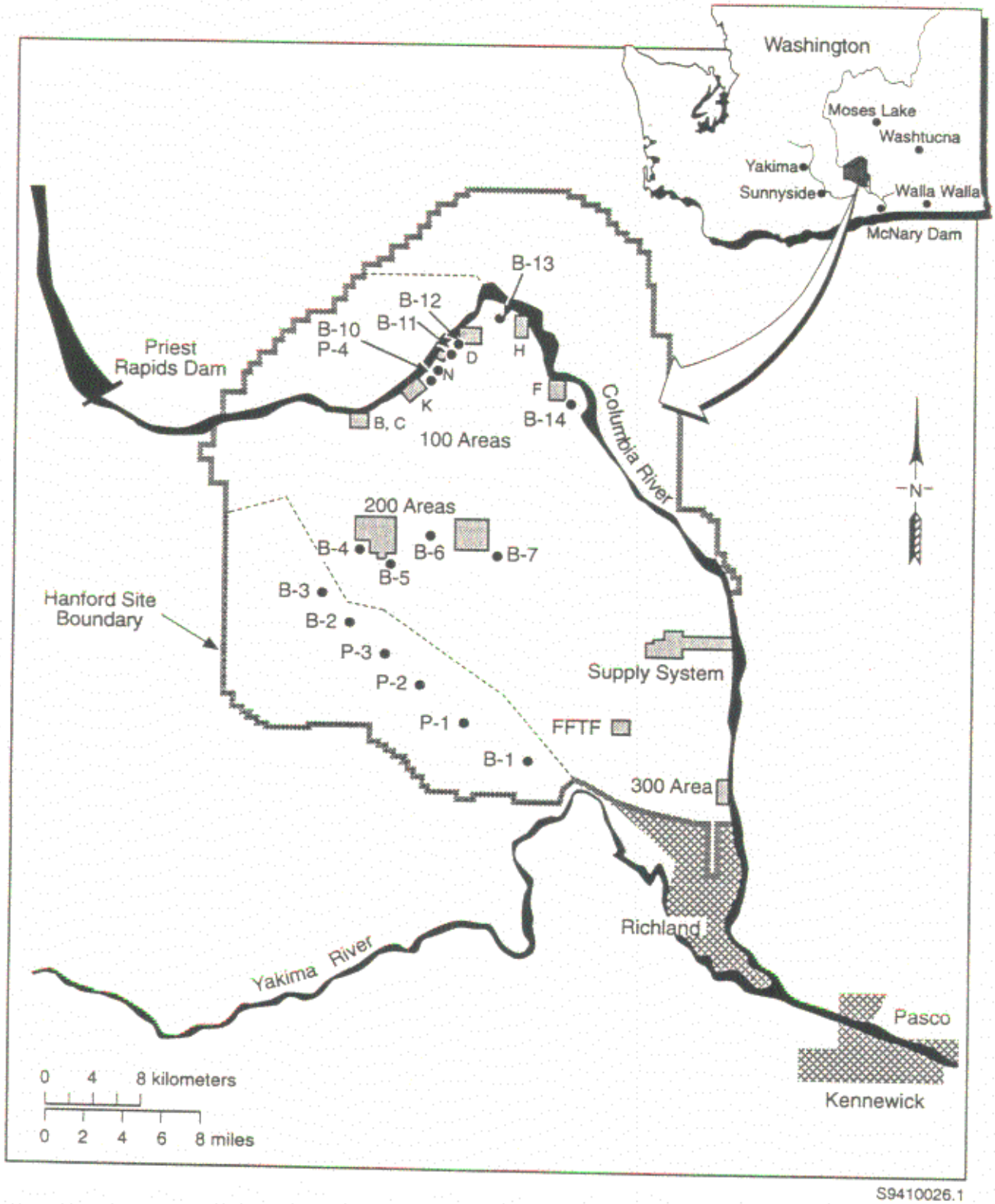

Figure 1. Sampling Locations of Balsamroot (B) and Parsley (P), April and May, 1994

RESULTS AND DISCUSSION

Both naturally occurring and manmade radionuclides were found in plant samples collected during this study. Natural radionuclides found in plant samples were ^{7}Be and ^{40}K; manmade radionuclides were ^{60}Co, ^{137}Cs, and ^{90}Sr.

NATURAL RADIONUCLIDES

Potassium-40 and ^{7}Be were routinely measured in plant samples. Both of these radionuclides occur naturally and their presence is not unexpected. Beryllium-7 is of atmospheric origin and has a relatively short half-life (53.6 d). It was found in leaves, but not the roots of plants indicating lack of translocation to roots from the leaves and little indication of uptake from soil. Potassium-40 was also found in higher concentrations in leaves than in roots. Median concentrations of ^{40}K ranged from 31 to 42 pCi/g in leaves and 5.9 to 8.2 pCi/g in roots. Concentrations of K vary between different species of plants and by season (Rickard and Vaughan 1988).

COBALT-60

The analyses in general show that ^{60}Co was not found in plants collected from the 200 Area plateau or ALE, however 3 balsamroot samples collected from the 100.Areas had detectable amounts in either the roots or leaves. These concentrations of ^{60}Co were near the detection limit of 0.02 pCi/g.

CESIUM-137

Cesium-137 was found only in balsamroot, and almost exclusively in the roots from all areas sampled (Figures 2 and 3). Two of fourteen balsamroot leaf samples contained ^{137}Cs at concentrations close to the detection limit of 0.02 pCi/g. The concentrations of ^{137}Cs in balsamroot roots collected from the 200 Areas were greater than concentrations observed in samples collected at ALE. This observation is consistent with observations of the distribution of ^{137}Cs in soil and desert vegetation samples (consisting of rabbitbrush and big sagebrush) collected onsite during routine surveillance and reported in annual Site surveillance reports. The maximum and median onsite concentration of ^{137}Cs in balsamroot leaves collected from the 200 Areas was 0.05 ($\pm$ 0.02 2σ counting error) and 0.02 pCi/g, respectively. The maximum and median onsite concentration (sampled outside of nuclear facilities boundaries) of ^{137}Cs in routinely monitored desert vegetation sampled onsite from 1985 through 1993 was 0.36 ($\pm$ 0.04) pCi/g in the 200 Areas and 0.03 pCi/g for 92 samples, respectively. The median concentrations provide a better basis for comparison. The maximum and median concentration of ^{137}Cs collected at distant locations was 0.98 ($\pm$ 0.05) pCi/g (at Washtucna), and 0.02 pCi/g for the 37 samples collected at Washtucna, Moses Lake, Walla Walla, McNary Dam, Sunnyside, and Yakima, respectively. Collectively, these results show that ^{137}Cs in the species collected do not indicate any mechanism of elevated accumulation or bioconcentration relative to other desert vegetation that have been historically monitored.

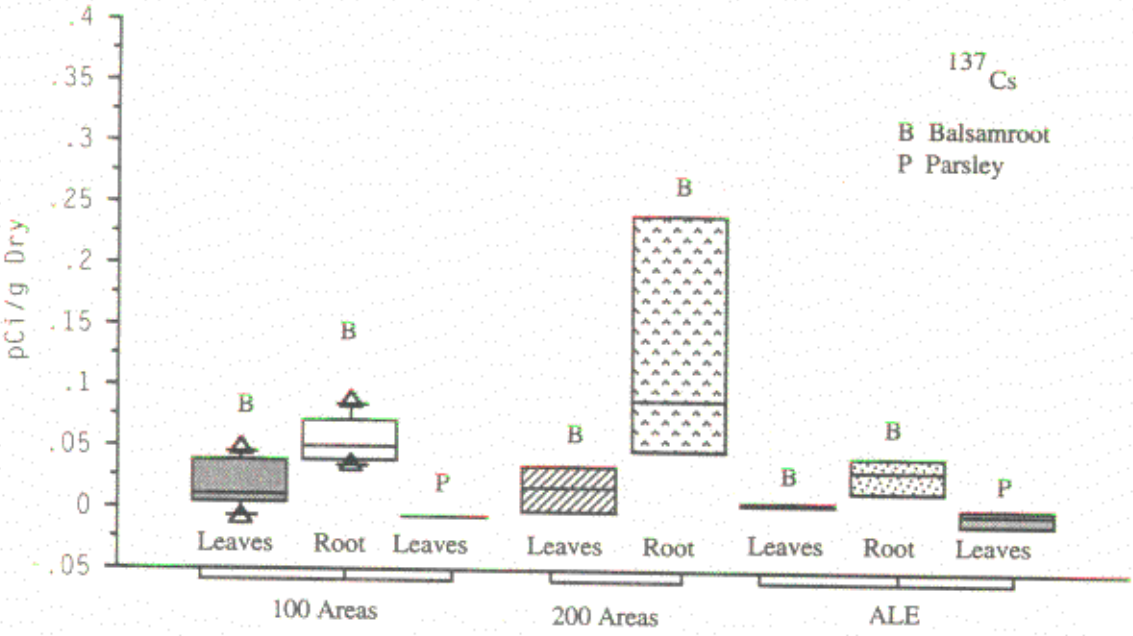

Figure 2. Box Plot of ^{137}Cs in Terrestrial Vegetation

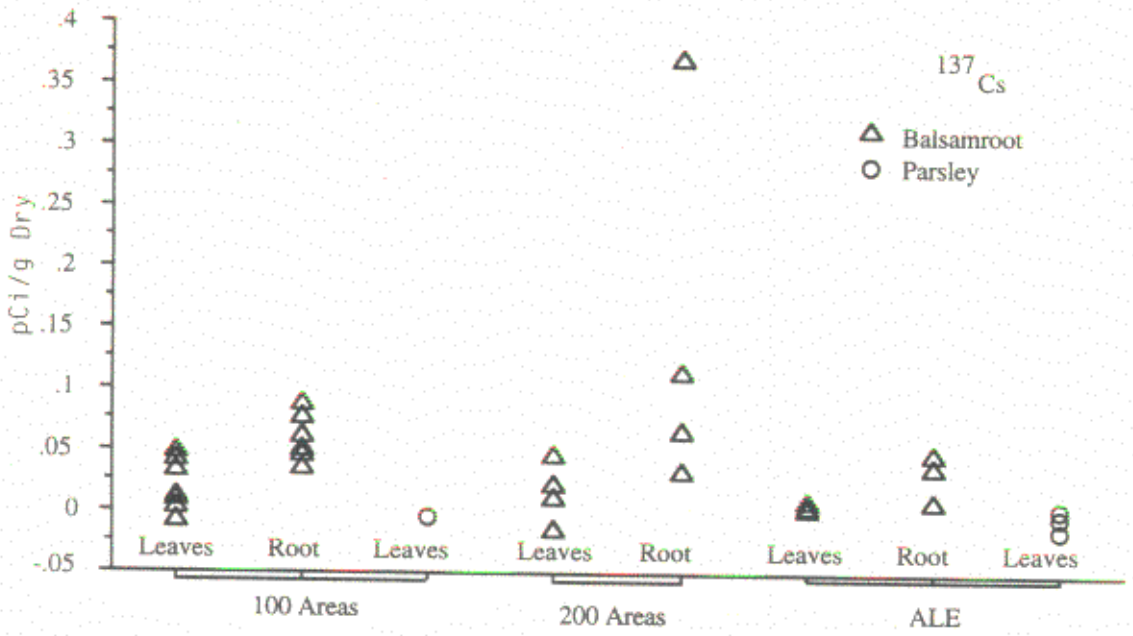

Figure 3. Scattergram of ^{137}Cs in Terrestrial Vegetation

STRONTIUM-90

Strontium-90 concentrations in terrestrial vegetation were highest in samples collected from ALE (Figures 4 and 5). As with ^{137}Cs, concentrations of ^{90}Sr were higher in root tissue relative to leafy portions. While the concentrations of ^{90}Sr were higher than concentrations of ^{137}Cs, the concentrations were within the range of ^{90}Sr associated with other offsite locations that are routinely monitored and reported in annual Site surveillance reports. The maximum and median onsite concentration of ^{90}Sr in terrestrial vegetation sampled onsite from 1985 through 1993 was 8.22 ($\pm$ 0.09) pCi/g (from the 200 Areas), and 0.087 pCi/g for 88 samples Sitewide, respectively. The maximum and median concentration of ^{90}Sr collected at distant locations was 0.74 ($\pm$ 0.02) pCi/g at Moses Lake, and 0.03 pCi/g for the 32 samples collected at Washtucna, Moses Lake, Walla Walla, McNary Dam, Sunnyside, and Yakima, respectively.

PERSPECTIVE ON RESULTS

These data provide an initial indication of concentrations of radionuclides expected in Site terrestrial vegetation of potential interest to Native American people. For ^{90}Sr and ^{137}Cs, the concentrations represent contributions from fallout associated with atmospheric weapons testing and possible Hanford Site activities, particularly in samples collected near the industrialized areas. This observation is supported by the similarity in concentrations reported in other natural vegetation collected onsite and offsite in the past. However, the concentrations reported here are very low and where contributions from fallout for ^{90}Sr were comparatively elevated in the ALE samples, elevated ^{137}Cs would also be expected.

No attempt has been made to evaluate the dose that might result from the use of these plants by humans, however, the concentrations are very low and the associated doses associated with plant use are expected to be immeasurable. Information on amounts used, for what purpose the plant is used, and specific parts used are needed to develop dose estimates and are beyond the scope of this initial study.

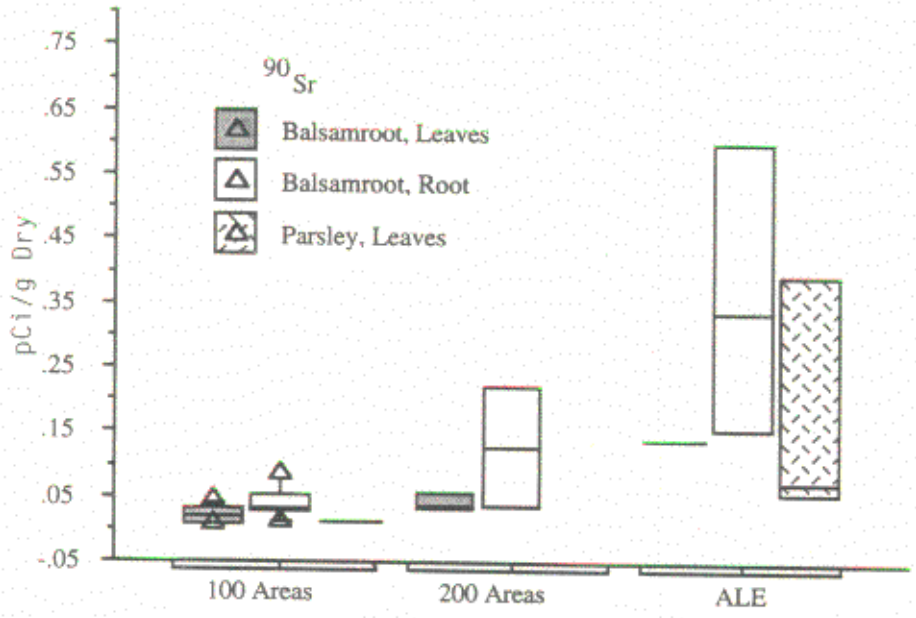

Figure 4. Box Plot of ^{90}Sr in Terrestrial Vegetation

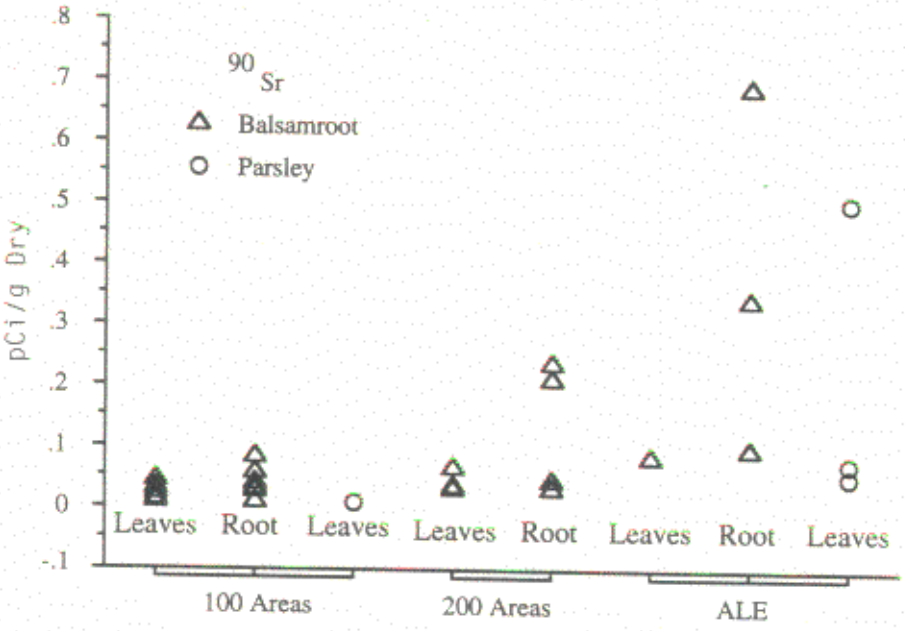

Figure 5. Scattergram of ^{90}Sr in Terrestrial Vegetation

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APPENDIX A

SUMMARY STATISTICS

Table A.1. Summary Statistics (pCi/g dry) for Terrestrial Vegetation Collected on the Hanford Site in 1994

Radionuclide	MDC	Location	Species	Portion	Median	Mean	Standard Deviation	Standard Error	Count	Minimum	Maximum	Variance	Coefficient of Variation	Geometric Mean
Be-7	0.23	100 Areas	Balsamroot	Leaves	2.2000	2.2771	0.8305	0.3139	7	1.3700	3.6700	0.6897	0.365	2.153
Be-7	0.23	100 Areas	Balsamroot	Root	0.0284	0.0891	0.1243	0.0470	7	-0.0434	0.2780	0.0155	1.395	NV
Be-7	0.23	100 Areas	Cymopterus	Leaves	4.0400	4.0400	NV	NV	1	4.0400	4.0400	NV	NV	4.040
Be-7	0.23	200 Areas	Balsamroot	Leaves	1.2950	1.2850	0.3361	0.1681	4	0.8900	1.6600	0.1130	0.262	1.251
Be-7	0.23	200 Areas	Balsamroot	Root	0.0591	0.0186	0.0886	0.0443	4	-0.1140	0.0702	0.0079	4.769	NV
Be-7	0.23	ALE	Balsamroot	Leaves	1.5200	1.8500	0.6243	0.3604	3	1.4600	2.5700	0.3897	0.337	1.787
Be-7	0.23	ALE	Balsamroot	Root	0.0347	0.0528	0.0680	0.0393	3	-0.0043	0.1280	0.0046	1.288	NV
Be-7	0.23	ALE	Lomatium	Leaves	3.2600	3.1300	0.3440	0.1986	3	2.7400	3.3900	0.1183	0.110	3.117
Co-60	0.03	100 Areas	Balsamroot	Leaves	0.0010	-0.0003	0.0278	0.0105	7	-0.0515	0.0438	0.0008	-100.366	NV
Co-60	0.03	100 Areas	Balsamroot	Root	0.0000	0.0086	0.0194	0.0074	7	-0.0093	0.0441	0.0004	2.257	NV
Co-60	0.03	100 Areas	Cymopterus	Leaves	0.0120	0.0120	NV	NV	1	0.0120	0.0120	NV	NV	0.012
Co-60	0.03	200 Areas	Balsamroot	Leaves	-0.0138	-0.0134	0.0063	0.0032	4	-0.0206	-0.0053	0.0000	-0.472	NV
Co-60	0.03	200 Areas	Balsamroot	Root	0.0012	0.0017	0.0039	0.0020	4	-0.0024	0.0069	0.0000	2.251	NV
Co-60	0.03	ALE	Balsamroot	Leaves	-0.0134	-0.0164	0.0127	0.0073	3	-0.0303	-0.0056	0.0002	-0.770	NV
Co-60	0.03	ALE	Balsamroot	Root	-0.0037	-0.0039	0.0085	0.0049	3	-0.0124	0.0045	0.0001	-2.175	NV
Co-60	0.03	ALE	Lomatium	Leaves	-0.0138	-0.0097	0.0079	0.0045	3	-0.0147	-0.0007	0.0001	-0.808	NV
Cs-137	0.03	100 Areas	Balsamroot	Leaves	0.0114	0.0193	0.0209	0.0079	7	-0.0078	0.0468	0.0004	1.082	NV
Cs-137	0.03	100 Areas	Balsamroot	Root	0.0503	0.0555	0.0200	0.0075	7	0.0340	0.0870	0.0004	0.360	0.053
Cs-137	0.03	100 Areas	Cymopterus	Leaves	-0.0037	-0.0037	NV	NV	1	-0.0037	-0.0037	NV	NV	NV
Cs-137	0.03	200 Areas	Balsamroot	Leaves	0.0166	0.0161	0.0253	0.0127	4	-0.0148	0.0459	0.0006	1.576	NV
Cs-137	0.03	200 Areas	Balsamroot	Root	0.0900	0.1451	0.1530	0.0765	4	0.0316	0.3690	0.0234	1.054	0.097
Cs-137	0.03	ALE	Balsamroot	Leaves	0.0047	0.0053	0.0027	0.0016	3	0.0029	0.0082	0.0000	0.508	0.005
Cs-137	0.03	ALE	Balsamroot	Root	0.0321	0.0299	0.0195	0.0112	3	0.0094	0.0481	0.0004	0.652	0.024
Cs-137	0.03	ALE	Lomatium	Leaves	-0.0020	-0.0041	0.0087	0.0050	3	-0.0136	0.0034	0.0001	-2.147	NV
K-40	0.53	100 Areas	Balsamroot	Leaves	34.8000	34.3000	3.8583	1.4583	7	28.3000	39.9000	14.8867	0.112	34.109
K-40	0.53	100 Areas	Balsamroot	Root	7.0500	7.4557	1.6179	0.6115	7	5.9000	10.9000	2.6177	0.217	7.328
K-40	0.53	100 Areas	Cymopterus	Leaves	32.8000	32.8000	NV	NV	1	32.8000	32.8000	NV	NV	32.800
K-40	0.53	200 Areas	Balsamroot	Leaves	42.1000	43.5750	3.3009	1.6504	4	41.6000	48.5000	10.8958	0.076	43.485
K-40	0.53	200 Areas	Balsamroot	Root	8.1850	8.1750	0.0889	0.0444	4	8.0600	8.2700	0.0079	0.011	8.175
K-40	0.53	ALE	Balsamroot	Leaves	30.9000	31.1667	4.5059	2.6015	3	26.8000	35.8000	20.3033	0.145	30.950
K-40	0.53	ALE	Balsamroot	Root	5.8800	5.6833	0.5046	0.2913	3	5.1100	6.0600	0.2546	0.089	5.668
K-40	0.53	ALE	Lomatium	Leaves	38.6000	41.2000	4.5902	2.6502	3	38.5000	46.5000	21.0700	0.111	41.036
Sr-90	0.005	100 Areas	Balsamroot	Leaves	0.0217	0.0218	0.0139	0.0053	7	0.0069	0.0444	0.0002	0.638	0.018
Sr-90	0.005	100 Areas	Balsamroot	Root	0.0317	0.0397	0.0244	0.0092	7	0.0097	0.0847	0.0006	0.615	0.033
Sr-90	0.005	100 Areas	Cymopterus	Leaves	0.0074	0.0074	NV	NV	1	0.0074	0.0074	NV	NV	0.007
Sr-90	0.005	200 Areas	Balsamroot	Leaves	0.0342	0.0426	0.0187	0.0108	3	0.0296	0.0641	0.0004	0.439	0.040
Sr-90	0.005	200 Areas	Balsamroot	Root	0.1261	0.1292	0.1068	0.0534	4	0.0296	0.2350	0.0114	0.827	0.090
Sr-90	0.005	ALE	Balsamroot	Leaves	0.0810	0.0810	NV	NV	1	0.0810	0.0810	NV	NV	0.081
Sr-90	0.005	ALE	Balsamroot	Root	0.3380	0.3740	0.2976	0.1718	3	0.0961	0.6880	0.0886	0.796	0.282
Sr-90	0.005	ALE	Lomatium	Leaves	0.0737	0.2082	0.2512	0.1450	3	0.0530	0.4980	0.0631	1.206	0.125

NV = No value.
Values good to two decimal places only for gamma spectroscopy results, three decimal places for Strontium-90 values.

APPENDIX B

ANALYTICAL RESULTS

Table B.1. Analytical Results (pCi/g dry) of Vegetation Samples

Sample Number	Plant ID	Location	Plant Species	Sample	Constituent	Date (Y/M/D)	Result	Counting Error	Overall Error	Analysis Size (g)
B0BW61	B-1	ALE	Balsamroot	Leaves	Be-7	940428	2.57E+00	3.84E-01	4.62E-01	161
B0BW61	B-1	ALE	Balsamroot	Leaves	Co-60	940428	-1.34E-02	3.72E-02	3.72E-02	161
B0BW61	B-1	ALE	Balsamroot	Leaves	Cs-137	940428	8.20E-03	2.83E-02	2.83E-02	161
B0BW61	B-1	ALE	Balsamroot	Leaves	K-40	940428	2.68E+01	1.27E+00	2.97E+00	161
B0BW61	B-1	ALE	Balsamroot	Leaves	Sr-90	940428	8.10E-02	1.20E-02	1.88E-02	104
B0BW62	B-1	ALE	Balsamroot	Root	Be-7	940428	1.28E-01	1.03E-01	1.04E-01	229
B0BW62	B-1	ALE	Balsamroot	Root	Co-60	940428	-1.24E-02	1.24E-02	1.25E-02	229
B0BW62	B-1	ALE	Balsamroot	Root	Cs-137	940428	4.81E-02	1.37E-02	1.45E-02	229
B0BW62	B-1	ALE	Balsamroot	Root	K-40	940428	6.06E+00	3.83E-01	7.17E-01	229
B0BW62	B-1	ALE	Balsamroot	Root	Sr-90	940428	6.88E-01	2.37E-02	1.27E-01	100
B0BW63	P-1	ALE	Lomation	Leaves	Be-7	940428	3.26E+00	5.48E-01	6.37E-01	133
B0BW63	P-1	ALE	Lomation	Leaves	Co-60	940428	-1.38E-02	4.32E-02	4.32E-02	133
B0BW63	P-1	ALE	Lomation	Leaves	Cs-137	940428	-1.36E-02	3.52E-02	3.53E-02	133
B0BW63	P-1	ALE	Lomation	Leaves	K-40	940428	3.86E+01	1.65E+00	4.20E+00	133
B0BW63	P-1	ALE	Lomation	Leaves	Sr-90	940428	4.98E-01	3.98E-02	9.82E-02	102
B0BW64	P-2	ALE	Lomation	Leaves	Be-7	940428	3.39E+00	3.90E-01	5.17E-01	138
B0BW64	P-2	ALE	Lomation	Leaves	Co-60	940428	-1.47E-02	2.26E-02	2.27E-02	138
B0BW64	P-2	ALE	Lomation	Leaves	Cs-137	940428	-1.99E-03	1.73E-02	1.73E-02	138
B0BW64	P-2	ALE	Lomation	Leaves	K-40	940428	4.65E+01	1.31E+00	4.83E+00	138
B0BW64	P-2	ALE	Lomation	Leaves	Sr-90	940428	7.37E-02	1.14E-02	1.79E-02	100
B0BW65	P-3	ALE	Lomation	Leaves	Be-7	940428	2.74E+00	2.55E-01	3.74E-01	173
B0BW65	P-3	ALE	Lomation	Leaves	Co-60	940428	-6.72E-04	2.24E-02	2.24E-02	173
B0BW65	P-3	ALE	Lomation	Leaves	Cs-137	940428	3.43E-03	1.60E-02	1.60E-02	173
B0BW65	P-3	ALE	Lomation	Leaves	K-40	940428	3.85E+01	1.05E+00	3.99E+00	173
B0BW65	P-3	ALE	Lomation	Leaves	Sr-90	940428	5.30E-02	8.37E-03	1.28E-02	100
B0BW66	B-2	ALE	Balsamroot	Root	Be-7	940428	-4.32E-03	7.26E-02	7.26E-02	321
B0BW66	B-2	ALE	Balsamroot	Root	Co-60	940428	-3.74E-03	8.38E-03	8.39E-03	321
B0BW66	B-2	ALE	Balsamroot	Root	Cs-137	940428	3.21E-02	1.10E-02	1.15E-02	321
B0BW66	B-2	ALE	Balsamroot	Root	K-40	940428	5.88E+00	3.57E-01	6.87E-01	321
B0BW66	B-2	ALE	Balsamroot	Root	Sr-90	940428	3.38E-01	2.17E-02	8.61E-02	106
B0BW67	B-2	ALE	Balsamroot	Leaves	Be-7	940428	1.46E+00	2.27E-01	2.70E-01	159
B0BW67	B-2	ALE	Balsamroot	Leaves	Co-60	940428	-3.03E-02	2.46E-02	2.48E-02	159
B0BW67	B-2	ALE	Balsamroot	Leaves	Cs-137	940428	2.92E-03	1.69E-02	1.70E-02	159
B0BW67	B-2	ALE	Balsamroot	Leaves	K-40	940428	3.09E+01	1.00E+00	3.25E+00	159
B0BW67	B-2	ALE	Balsamroot	Leaves	Sr-90	940428				
B0BW68	B-3	ALE	Balsamroot	Root	Be-7	940428	3.47E-02	7.35E-02	7.36E-02	296
B0BW68	B-3	ALE	Balsamroot	Root	Co-60	940428	4.49E-03	7.62E-03	7.64E-03	296
B0BW68	B-3	ALE	Balsamroot	Root	Cs-137	940428	9.37E-03	7.38E-03	7.44E-03	296
B0BW68	B-3	ALE	Balsamroot	Root	K-40	940428	5.11E+00	3.20E-01	6.03E-01	296
B0BW68	B-3	ALE	Balsamroot	Root	Sr-90	940428	9.61E-02	9.34E-03	2.44E-02	107
B0BW69	B-3	ALE	Balsamroot	Leaves	Be-7	940428	1.52E+00	2.92E-01	3.29E-01	199
B0BW69	B-3	ALE	Balsamroot	Leaves	Co-60	940428	-5.55E-03	1.90E-02	1.90E-02	199
B0BW69	B-3	ALE	Balsamroot	Leaves	Cs-137	940428	4.73E-03	1.29E-02	1.29E-02	199