EMSL-LV-0539-14

ANIMAL INVESTIGATION PROGRAM 1975 ANNUAL REPORT: NEVADA TEST SITE AND VICINITY

Monitoring Systems Research and Development Division
Environmental Monitoring and Support Laboratory
U.S. ENVIRONMENTAL PROTECTION AGENCY
Las Vegas, NV 89114

Published February 1978

This study was performed under a Memorandum
of Understanding No. EY-76-A-08-0539
for the
DEPARTMENT OF ENERGY

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PRICE: PAPER COPY $6.00 MICROFICHE $3.00

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by
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ABSTRACT

Data are presented from the radioanalysis of tissues collected from cattle, deer, desert bighorn sheep, and other wildife that resided on or near the Nevada Test Site during 1975. Routine activities and special investigations of the Animal Investigation Program are also discussed.

Other than the naturally occurring potassium-40, gamma-emitting radionuclides are detected infrequently. Tritium concentrations in the tissues from most of the animals sampled are at background levels.

Strontium-90 levels in bones from deer and cattle are slightly lower than those reported for the preceding year while levels in desert bighorn sheep bones were elevated. A graph depicts the average levels found in the bones of the three species from 1956 through 1975.

The appendices of this report list actinide concentrations (plutonium-238, plutonium-239, uranium-234, uranium-235, and uranium-238) found in the tissues of all animals sampled. Graphs compare the plutonium-239 levels in lungs, livers, and femurs from Nevada Test Site cattle for the years 1971 through 1975. Levels reported appear to be relatively constant for these years with bone and lung data being nearly identical each year. Concentrations in liver are generally a factor of 2 or 3 lower than values for bone and lung.

Hypothetical dose estimates to man are calculated on the basis of the daily consumption of 0.5 kilogram of liver or muscle from Nevada Test Site animals that contained peak activity levels. The highest postulated dose is

2.2 millirems from plutonium-239 in liver from a mule deer. All postulated doses from other radionuclides are less than 1 millirem, except for cesium-137 in muscle from a mule deer. All of these postulated doses are less than 1 percent of the 500 millirems/year guide for radiation doses to the general population.

A deer migration study was initiated with the successful capture of eight mule deer which were outfitted with radiotransmitter-equipped collars, then released, and their movements followed on a weekly basis.

A number of Nevada Test Site springs were renovated to provide cleaner and more dependable water sources for wildlife.

The dietary habits of desert bighorn sheep were determined through the botanical analysis of rumen contents and are discussed according to the geographical locations of the animals at time of collections. In general, grasses made up about 50 percent of the diet with approximately 45 percent provided by shrubs and the remainder coming from forbs.

The gross and microscopic lesions found in necropsied animals are discussed. In general, these lesions are consistent with the physical condition of the animal and type of population sampled. No gross or microscopic lesions were detected that could be directly attributed to the effects of ionizing radiation.

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INTRODUCTION

During 1975, the operation of the Animal Investigation Program continued to be the responsibility of the U.S. Environmental Protection Agency's Environmental Monitoring and Support Laboratory-Las Vegas. The responsibilities assigned to the Animal Investigation Program by the U.S. Energy Research and Development Administration's* Nevada Operations Office include the following:

1. To conduct surveillance of domestic and wild animals on and around the Nevada Test Site and to assess the radionuclide burden present in their tissues and to detect any pathological effects from these burdens.
2. To investigate alleged damage to domestic animals and wildlife resulting from the activities of the Nevada Operations Office of the U.S. Energy Research and Development Administration*.
3. To maintain public relations through education and veterinary advice to the off-site population.
4. To conduct special ad hoc investigations.

The progress in achieving these responsibilities and summaries of the data collected during 1975 are presented in this report. The history, evolution, and accomplishments of the Animal Investigation Program from its inception in 1957 through 1975 have been published previously (Fountain 1961; Smith and Giles 1970, 1974, and 1975; and Smith et al., 1976, 1977a, and 1977b).

*Effective October 1, 1977, the U.S. Energy Research and Development Administration was designated the Department of Energy.

SAMPLE COLLECTION

The animals sampled during 1975 included beef cattle, mule deer, rabbits, and a coyote from the Nevada Test Site, and desert bighorn sheep that range the mountainous areas to the south and east of the Nevada Test Site. The animals sampled included those that were collected through the cooperation of licensed hunters, and those that died from natural causes or by accident, as well as those that were sacrificed as part of the routine sampling activities of the program.

The sacrificed animals were killed either by rifle or shotgun fire, were necropsied immediately after death, and any gross pathological changes were noted. Animals collected by other means were also necropsied if a prosector was available. If advanced postmortem changes had not occurred, the adrenals, eyes, heart, kidneys, liver, lungs, muscle, spleen, thyroid, gonads, and lesions (if any) were sampled and prepared for histopathological evaluation. Tissues collected for radioanalysis included rumen or stomach contents, liver, lung, tracheobronchial lymph nodes, muscle, thyroids, blood or urine, kidney, fetus (if present), and bone (femurs or hock). Rumen contents from desert bighorn sheep were collected for botanical analysis. If fresh blood was available, samples were collected and heparinized for hematological examination.

Thirteen animals from the Nevada Test Site beef herd were sacrificed and sampled during the year. The vital statistics of all the Nevada Test Site cattle sampled during 1975 are presented in table 1. Each animal sampled spent its entire life grazing on the Area 18 range of the Nevada Test Site.

TABLE 1. VITAL STATISTICS OF NEVADA TEST SITE CATTLE SAMPLED DURING 1975

Animal No.	Sex	Age (yrs)	Breed	Weight (kg)	Date Sampled	Remarks
1	F	4	Hereford	327	05/22/75	Cow, barren, fair condition.
2	F	13	Hereford	445	05/22/75	Cow, barren, excellent condition.
3	M	1	Hereford	227	05/22/75	Steer, fair condition.
4	M	2	Hereford	430	05/22/75	Steer, excellent condition.
5	M	1	Hereford	240	05/22/75	Steer good condition.
6	M	5	Hereford	661	05/22/75	Steer, excellent condition.
7	F	1-2	Hereford	200	07/29/75	Killed by motor vehicle, Pahute Mesa Road, near Camp 17.
8	M	0.3-0.5	Hereford	170	10/16/75	Calf, excellent condition.
9	M	0.3-0.5	Hereford	153	10/16/75	Calf, excellent condition.
10	M	0.3-0.5	Hereford	95	10/16/75	Calf, excellent condtion.
11	F	6-7	Hereford	454	10/16/75	Cow, excellent condition, barren.
12	F	9.5	Hereford	452	10/16/75	Cow, fair condition, squamous cell carcinoma of left eye and orbital tissue.
13	F	5.8	Hereford	520	10/15/75	Cow, fair condition.

Figure 1 shows the locations of the herds and facilities. The management of the beef herd and soil and range surveys of the Area 18 grazing area have been published previously (Smith 1970 , Leavitt 1970, and Brown and Mason 1968).

Tissue samples were collected from eight Nevada Test Site mule deer during 1975. (See table 2 for vital statistics.) Seven of the deer were collected after being struck by a motor vehicle, and one died during a capture attempt. Collection locations are noted on figure 1.

Other Nevada Test Site animals sampled included six cottontail rabbits (*Sylvilagus audubonii*) collected at the Area 15 farm. A coyote (*Canis latrans*) was also collected at the Area 15 farm.

Through the cooperation of State and Federal wildlife officials and participating hunters, tissue and/or rumen ingesta samples were collected from 25 mature desert bighorn sheep (*Ovis canadensis nelsoni*) rams during the annual hunt. The vital statistics of these animals are presented in table 3 and the collection sites are shown in figure 2. Most of the animals were collected from Clark County in southern Nevada with 13 coming from the Desert National Wildlife Range or the Nellis Air Force Range which are contiguous to the Nevada Test Site. One ram was collected from west-central Nevada near Lone Mountain in Esmeralda County.

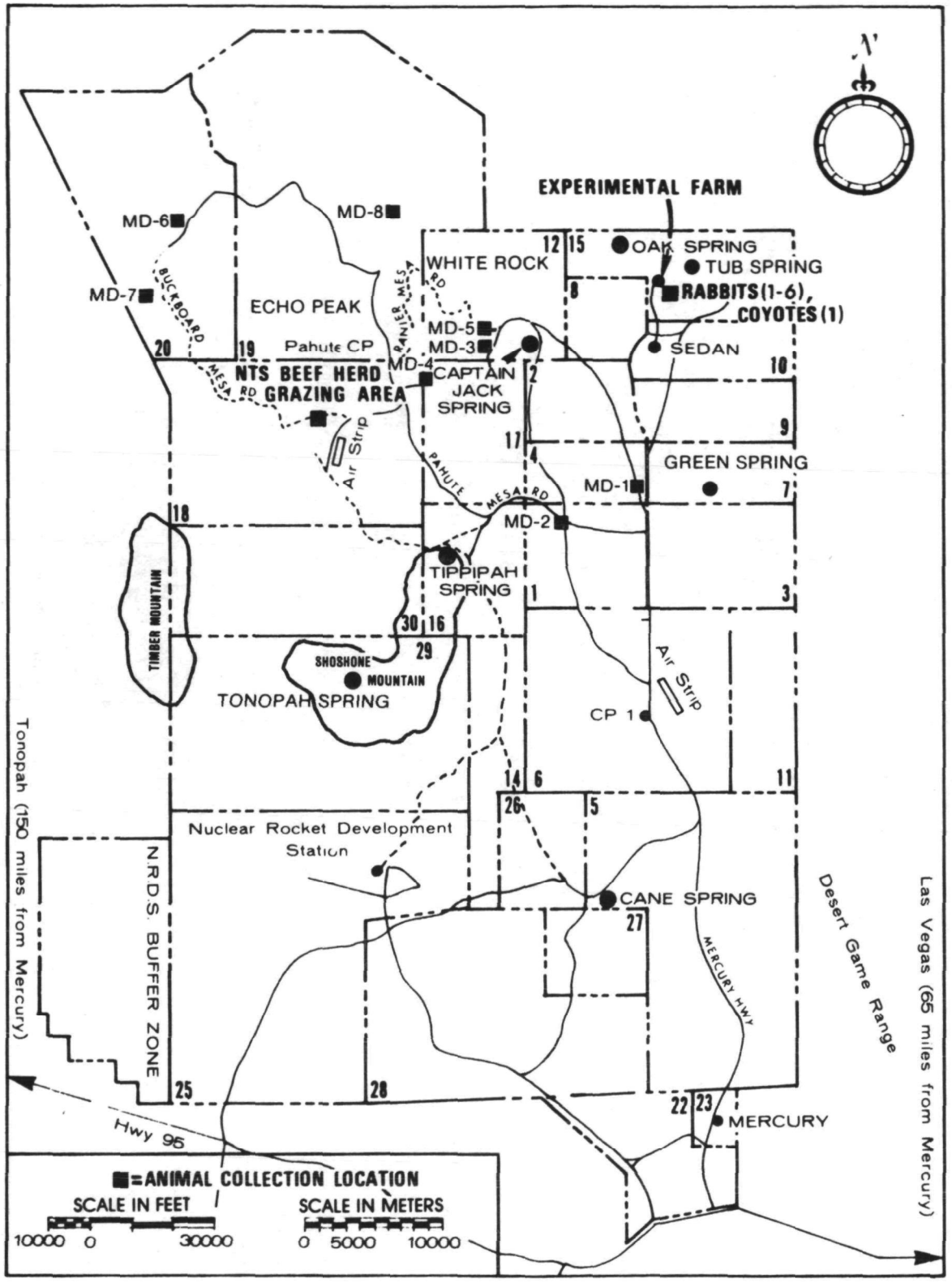

Figure 1. Location of sampling sites and facilities on the Nevada Test Site

TABLE 2. VITAL STATISTICS OF NEVADA TEST SITE WILDLIFE SAMPLED DURING 1975

Animal No.	Sex	Estimated Age (yrs)	Weight (kg)	Date Collected	Remarks
Coyote-1	F	0.25	4	07/23/75	Collected at NTS farm, partly digested rabbit tissue in stomach.
Mule Deer-1	F	3-3.5	34	01/21/75	Road kill, Tippipah Highway between Areas 12 and 4 fair to good condition.
Mule Deer-2	M	2-4	50-55	05/22/75	Road kill, Area 17, Pahute Mesa Road, 3 miles west of sand and gravel plant.
Mule Deer-3	M	5.5	70-73	06/16/75	Road kill, Area 17, Stockade Wash Road, 1 mile past Holmes Road turnoff.
Mule Deer-4	M	5.5-6	75-80	08/03/75	Road kill, Stockade Wash Road by substation.
Mule Deer-5	M	Unk	Unk	08/21/75	Road kill, Stockade Wash and Holmes Roads, Area 12, eaten by predators.
Mule Deer-6	F	3	59	09/10/75	Road kill, Area 20, 20 miles west of first aid station.
Mule Deer-7	F	4	64	09/11/75	Capture attempt kill, syringe penetrated lung, Area 20, 3 miles from first aid station.
Mule Deer-8	M	2-2.5	80-85	11/11/75	Road kill, Dead Horse Flat Road and Pahute Junction by reservoir.
Rabbits 1-6	Unk	Unk	Unk	04/06/75	These cottontail rabbits were collected by shotgun fire at the Area 15 farm. Unfortunately, necropsy records were lost so vital statistics are unknown.

Unk = Unknown

TABLE 3. VITAL STATISTICS OF DESERT BIGHORN SHEEP SAMPLED DURING 1975

Animal No.	Age and Sex (yrs)	Date Collected	Samples Collected	Remarks
1	8-M	11/20/75	Bone, kidney, lung	Hunter kill, Tri Canyon Area, Meadow Valley Range.
2	3-M	11/17/75	Kidney, lung	Hunter kill, Fossil Ridge, Las Vegas Range.
3	10-M	12/05/75	Bone, kidney, lung	Hunter kill, Elbow Canyon Area, Las Vegas Range.
4	8-M	11/24/75	Bone, kidney, lung	Hunter kill, South end of Arrow Canyon Range.
5	9-M	12/06/75	Bone, kidney, lung	Hunter kill, Gas Peak Area, Las Vegas Range.
6	5-M	11/15/75	Bone, kidney, lung	Hunter kill, Central Highland Range.
7	9-M	12/11/75	Bone, kidney, lung	Hunter kill, Grapevine Canyon, Sheep Range.
8	5-M	11/15/75	Bone, kidney, lung	Hunter kill, Cathedral Cove, Black Mountains.
9	5-M	11/16/75	Bone, kidney, lung	Hunter kill, Cathedral Cove, Black Mountains.
10	7-M	11/15/75	Bone, kidney, lung	Hunter kill, Lonesome Wash, Eldorado Range.
11	7-M	12/08/75	Bone, kidney, lung	Hunter kill, Central Eldorado, near powerline.
12	5-M	11/15/75	Bone, kidney, lung	Hunter kill, Pyramid Peak, Black Mountains.
13	6-M	11/25/75	Bone, kidney, lung	Hunter kill, Cabin Spring, Sheep Range
14	6-M	11/17/75	Kidney, lung	Hunter kill, Pyramid Peak, Black Mountains.
15	5-M	12/10/75	Bone, kidney, lung	Hunter kill, Monkey Hole, Eldorado Range.
16	5-M	11/20/75	Bone, lung	Hunter kill, Mormon Peak, Mormon Mountains.
17	8-M	12/14/75	Bone, kidney, lung	Hunter kill, Quartz Peak, Pintwater Range.
18	10-M	11/15/75	Bone	Hunter kill, Disappointment Canyon, Sheep Range.
19	8-M	12/11/75	Kidney, lung	Hunter kill, Shalecut Spring, Sheep Range.
20	7-M	12/19/75	Bone, lung	Hunter kill, Tim Spring, Pintwater Range.
21	11-M	12/22/75	Bone	Hunter kill, Quartz Spring, Pintwater Range.

TABLE 3. VITAL STATISTICS OF DESERT BIGHORN SHEEP SAMPLED DURING 1975 (continued)

Animal No.	Age and Sex (yrs)	Date Collected	Samples Collected	Remarks
22	5-M	12/20/75	Kidney, lung	Hunter kill, Sand Spring, Pintwater Range.
23	7-M	11/17/75	Kidney, lung	Hunter kill, Twin Buttes, Sheep Range.
24	8-M	12/08/75	Lung	Hunter kill, Sheep Canyon, Lone Mountain.
25	5-M	12/20/75	Lung	Hunter kill, Sand Spring, Pintwater Range.

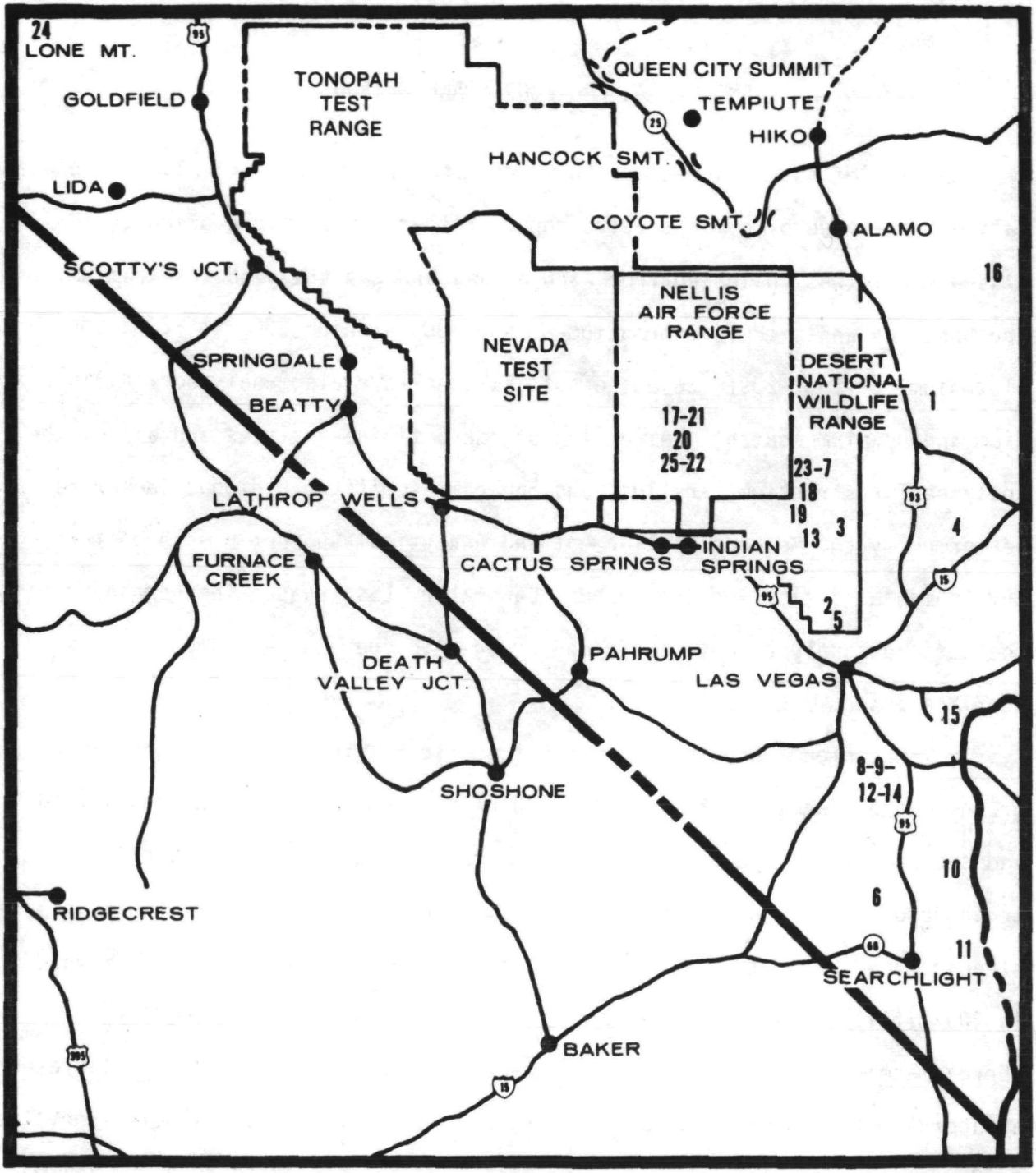

Figure 2. Approximate collection sites of 1975 desert bighorn sheep.

ANALYTICAL PROCEDURES AND METHODS

Samples of soft tissues and rumen contents were qualitatively and quantitatively analyzed by gamma spectroscopy. Either a blood or a urine or a tissue sample was collected from each animal and was analyzed for tritium. The bone was analyzed for strontium-89 and -90, uranium-234 and -238, and plutonium-238 and -239. Selected soft tissues were also analyzed for plutonium and uranium content. A portion of the actinide analyses and all of the analyses for strontium, tritium, and the gamma-emitting radionuclides were performed by the Methods Development and Analytical Support Branch of the Environmental Monitoring and Support Laboratory-Las Vegas. The remainder of the actinide analyses were performed by the Albuquerque Laboratory of the Eberline Instrument Corporation.

Rumen contents and soft tissues of sufficient volume (the latter were ground) were placed in 200-milliliter aluminum containers which were sealed and stored for gamma analysis. Those of smaller volume, i.e., thyroid, tracheobronchial lymph nodes, kidneys, etc., were first macerated in a blender, then brought to volume by suspending in agar, and placed and sealed in 200-milliliter aluminum containers. All samples were analyzed for approximately 1,200 minutes on lithium-drifted germanium detectors calibrated at approximately 0.5 kiloelectronvolts per channel in the 60-kiloelectronvolts to 2-megaelectronvolts range. These detectors are connected to a PDP 11/20 computer for gamma spectral data accumulation and analysis.

Tissues for strontium, plutonium, and uranium analyses were prepared by dry ashing. Plutonium and uranium were analyzed by alpha spectroscopy using plutonium-236 and uranium-232 as internal tracers (Talvitie 1971, 1972). Other radionuclide analytical procedures used at the Environmental Monitoring and Support Laboratory-Las Vegas were described previously (Johns 1975).

The activity values for plutonium-239 listed in this report are actually the sum of the individual isotopic activities of plutonium-239 and -240. The alpha emissions of these two isotopes cannot be separately identified (resolved) by alpha spectrometric analysis.

All data are reported with the 95 percent confidence level counting error and are corrected to time of sample collection. Results which show a net sample activity less than the two-sigma counting error are reported as less than the minimum detectable activity. The approximate minimum detectable activities and analytical procedures are summarized in appendix A.

Tissue and lesion samples collected for histopathological examination were first fixed in a 10-percent Formalin® solution. They were then dehydrated with alcohol and embedded in paraffin prior to sectioning with a microtome. A 5-micrometer section was placed on a glass slide, stained with hematoxylin and eosin, and delivered to a pathologist for interpretation.

When fresh blood was available, 2 milliliters was withdrawn from the jugular vein and placed in a heparinized tube, and two blood-smear slides were made. These were airmailed to the United Medical Laboratories, Inc., of Portland, Oregon, where a complete blood-cell count and a differential count were made. Other analyses performed included hemoglobin, hematocrit, and packed cell volume.

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Botanical analyses of the rumen-content samples were accomplished by washing random aliquots of the ingesta with water. After washing, the samples were each placed in a shallow pan and suspended in approximately 200 milliliters of water. Identification of the vegetation was completed by examining each fragment with the aid of a binocular microscope. Following the identification, a visual estimate of the percentage composition for each species was made and recorded. The shrubs and forbs were identified according to Munz and Keck (1965) and McMinn (1964) and the grasses according to Hitchcock (1950).

RESULTS AND DISCUSSION

NEVADA TEST SITE CATTLE

The analytical results from tissues collected from the Nevada Test Site grazing beef cattle during May and October of 1975 are presented in the tables of appendix B and C, respectively. No corralled cattle from the Area 15 farm were sampled during 1975.

The only gamma-emitting radionuclide that was consistently detected was naturally occurring potassium-40. Occasionally, detectable levels of cesium-137 were found in the rumen contents and soft tissues of the Area 18 range cattle. The highest level of cesium-137 reported was 60 ± 14 picocuries/kilogram of muscle from a 4-year-old Hereford cow sampled in May of 1975.

Tritium levels in the blood collected from the Area 18 cattle sampled in May ranged from less than 210 picocuries/liter to 620 picocuries/liter with a median value of 280 picocuries/liter. Tritium levels were slightly higher for the cattle sampled in the fall with a range of 220 picocuries/liter to 1,100 picocuries/liter and a median value of 440 picocuries/liter. However, tritium values from both groups of cattle were well below values of up to 2,200 picocuries/liter of atmospheric moisture which were detected in Beatty, Nevada, during 1975 (Monitoring Operations Division 1976).

As shown in figure 3, strontium-90 values in femur samples from grazing cattle averaged 3.8 picocuries/gram of ash which does not vary significantly from levels reported in 1972, 1973, and 1974 (Smith et al., 1976, 1977a, and 1977b). As in previous years, the peak strontium-90 value (15 picocuries/gram

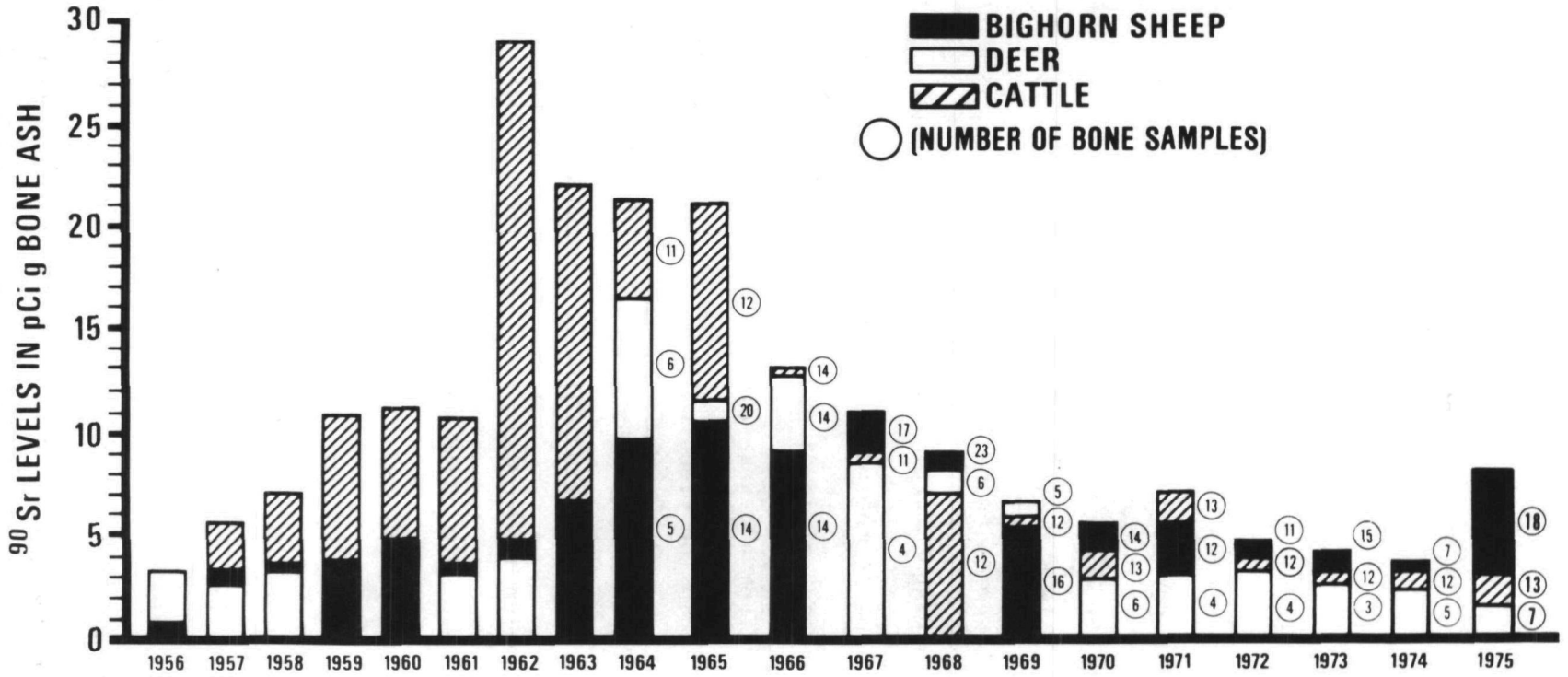

Figure 3. Annual averages of ^{90}Sr in bones of cattle, deer, and desert bighorn sheep 1956-1975.

of ash) was found in the femur of an aged cow (13+ years). Strontium-89 was not detectable in any femurs.

Plutonium-238 is present in the environment primarily as a result of the burnup of the SNAP-9A power source (Krey and Krajewski 1972; Hardy et al., 1972). The expected ratio of plutonium-239 to plutonium-238 is roughly 25. Although plutonium-238 was not frequently detected in the tissues sampled, the expected plutonium-239/plutonium-238 ratio of approximately 25 was seldom reached. Usually the ratios were in the 5 to 10 range. It has been postulated (Patterson et al., 1974; and Matlack et al., 1976) that plutonium-238 may be more rapidly solubilized and thus potentially more mobile under environmental conditions than is plutonium-239. Thus, it is possible that the plutonium 239:238 ratios for animal tissue (plutonium tissue concentrations are in part a result of uptake by plants) may be lower than the ratios for fallout and soil. There were several instances (see appendices B-3, B-7, and D-1) in which plutonium-238 values exceeded plutonium-239 values. Although these values were verified, they are suspect and may have resulted from sample contamination either during processing at the Area 15 farm where plutonium-238 studies have been conducted or during the analytical processes.

During this report period, alpha spectrometry analyses were made on several counting systems in different laboratories. Differences in sample size and chemical yield may account for the wide variations in the "less than" values.

The uranium isotopic ratios for some of the samples in the appendices are different from the expected natural ratios (uranium-234, -235, and -238, approximately 1:0.05:1). These differences may relate to varying enrichment of the contaminating nuclear material, analytical or sampling error, and/or solubility differences. Several investigators (Osmund 1974, Thurber 1962) have

found that the 1:1 ratio of uranium-234 to uranium-238 found in natural uranium does not hold true for samples that have undergone leaching or partial dissolution. It is thought that uranium-234 becomes more soluble than uranium-238 because of recoil fractionation of the isotopic matrix during the decay process. Results of the long-term hydrological monitoring program at the Nevada Test Site reported in the annual Environmental Monitoring reports (Monitoring Applications Laboratory 1975, and Monitoring Operations Division 1976) show relative activity ratios for uranium isotopes on the order of 4:0.05:1.

The median values of actinide data from the tables in appendices B and C are summarized in table 4. The increased actinide levels during October that were observed in rumen contents were also noted in 1973 and 1974. This may be related to the range conditions at that time of the year, i.e., forage is scant and dry, and more soil is probably ingested during the grazing process.

Figures 4, 5, and 6 show comparisons of plutonium-239 levels in lungs, livers, and femurs from the Area 18 beef herd from the years 1971 through 1975. As there is considerable overlapping of the ranges reported, no clear trends are readily apparent and levels reported appear to remain relatively constant. Femur and lung data are nearly identical for each year with liver being a factor of 2 or 3 lower.

NEVADA TEST SITE MULE DEER

The analytical results from tissues of the Nevada Test Site mule deer are presented in the tables of appendix D. As was the case for the Nevada Test Site beef cattle, the only gamma-emitting radionuclide detected, other than naturally occurring potassium-40, was cesium-137 which was occasionally found in tissue and rumen-content samples. The highest level of cesium-137 reported

TABLE 4. MEDIAN VALUES OF ACTINIDE CONCENTRATIONS IN TISSUES FROM NEVADA TEST SITE CATTLE (pCi/kg wet wt.)

Tissue	ACTINIDE AND HERD SAMPLED									
	^{238}Pu		^{239}Pu		^{234}U		^{235}U		^{238}U	
	May*	Oct†	May*	Oct†	May*	Oct†	May*	Oct†	May*	Oct†
Lungs	0.44	0.1	2.6	0.95	0.33	1	<0.02	<0.02	0.39	0.45
Tracheobronchial Lymph Nodes	<2.9	6	26.5	16.5	25.5	NA	<9.2	NA	36.5	NA
Muscles	0.26	<0.02	0.55	0.1	0.29	0.52	0.05	<0.02	<0.15	0.37
Livers	0.19	<0.03	0.71	<0.69	0.19	<0.83	<0.05	<0.03	<0.07	<0.79
Rumen Contents	0.53	2.2	4.9	10.4	2	NA	<0.09	NA	1.2	NA
Reticulum Sediments	9	38	40.5	180	390	NA	17	NA	285	NA
Femurs	<0.9	0.33	<1.8	<0.9	1	2.6	<0.23	<0.12	0.56	1.8

*May = Beef cattle sampled in May
†Oct = Beef cattle sampled in October
NA = Not analyzed

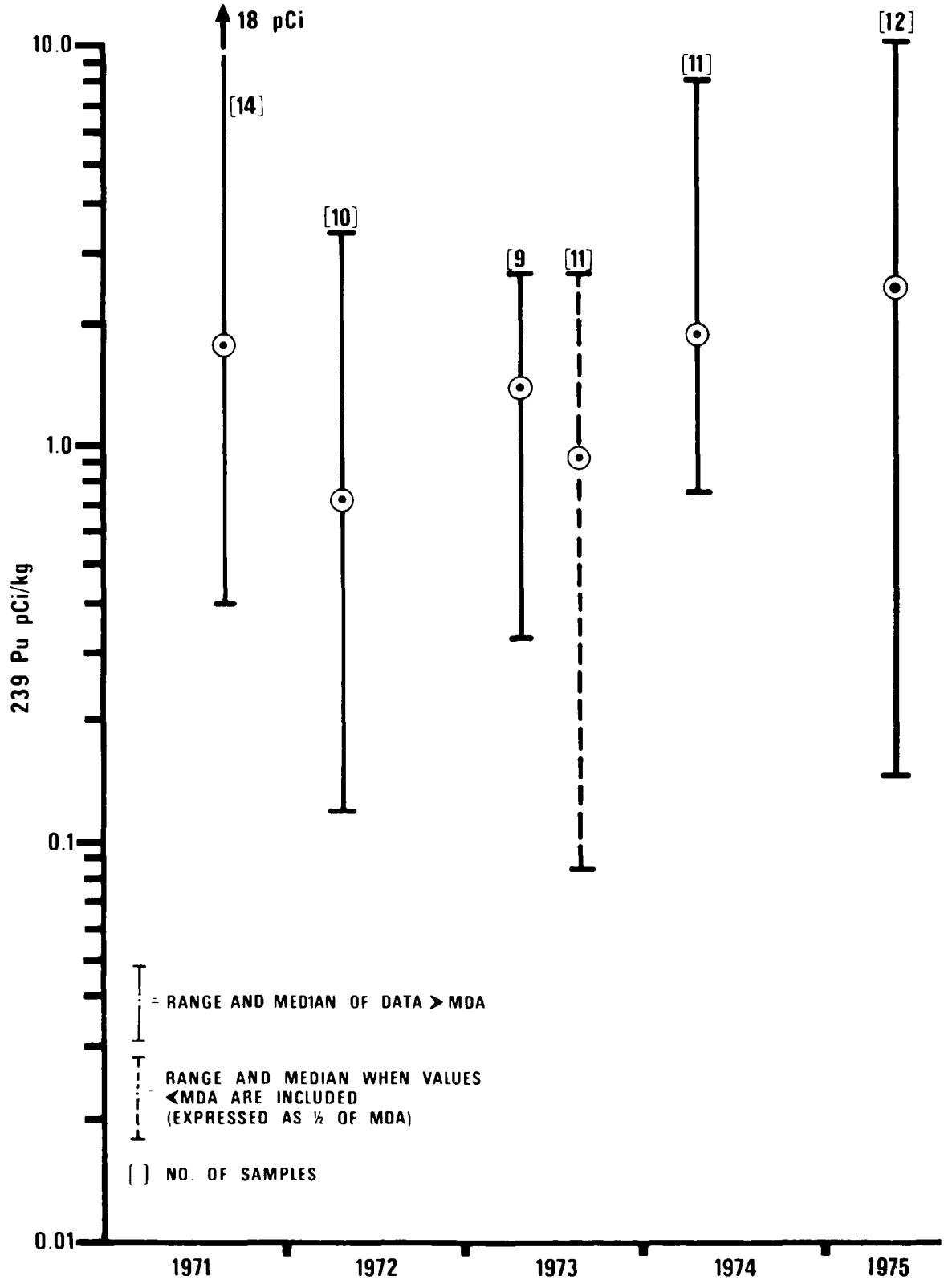

Figure 4. Ranges and median values of ^{239}Pu in fresh lung tissues from Nevada Test Site beef cattle 1971-1975.

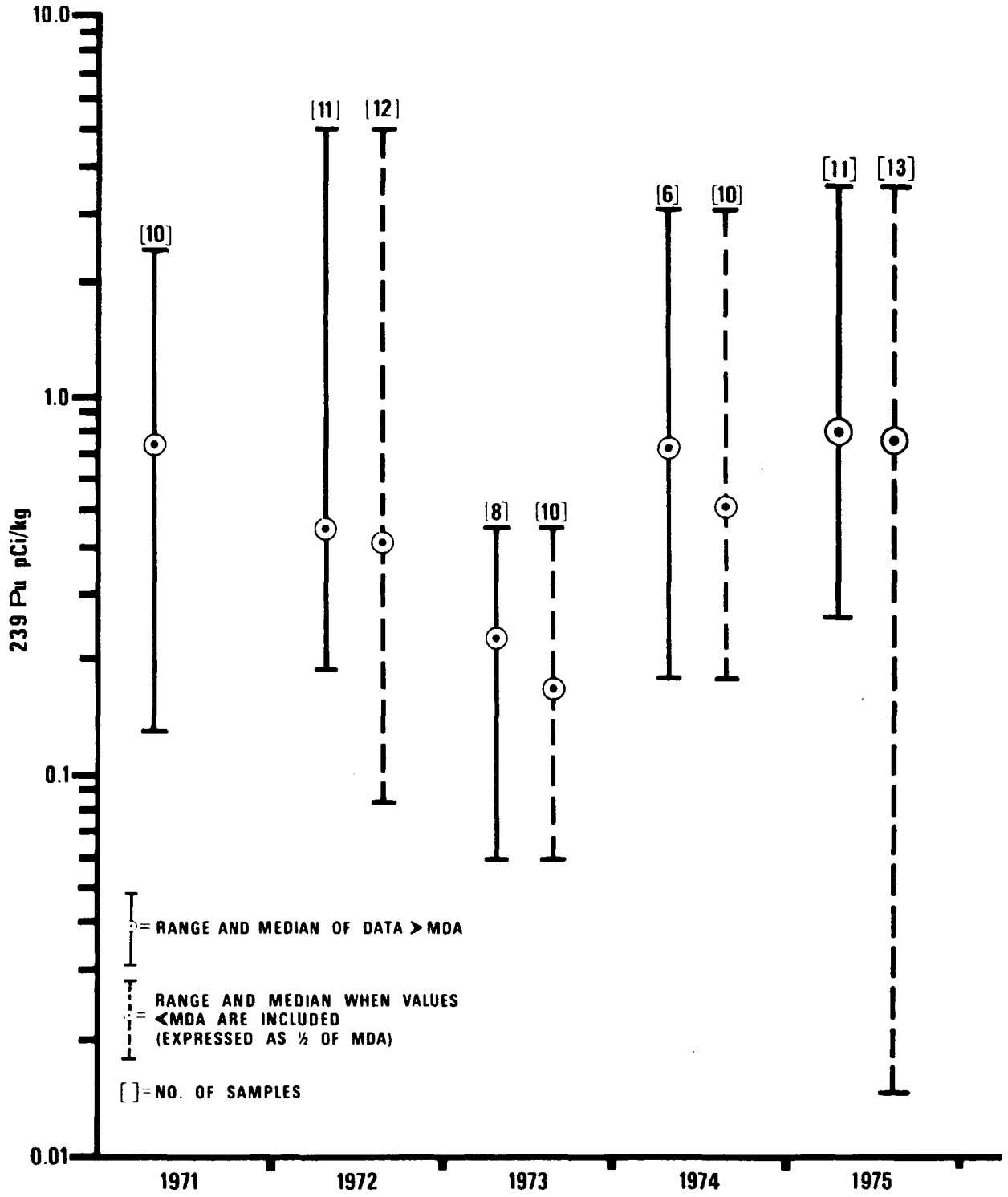

Figure 5. Ranges and median values of ^{239}Pu in fresh liver tissues from Nevada Test Site beef cattle 1971-1975.

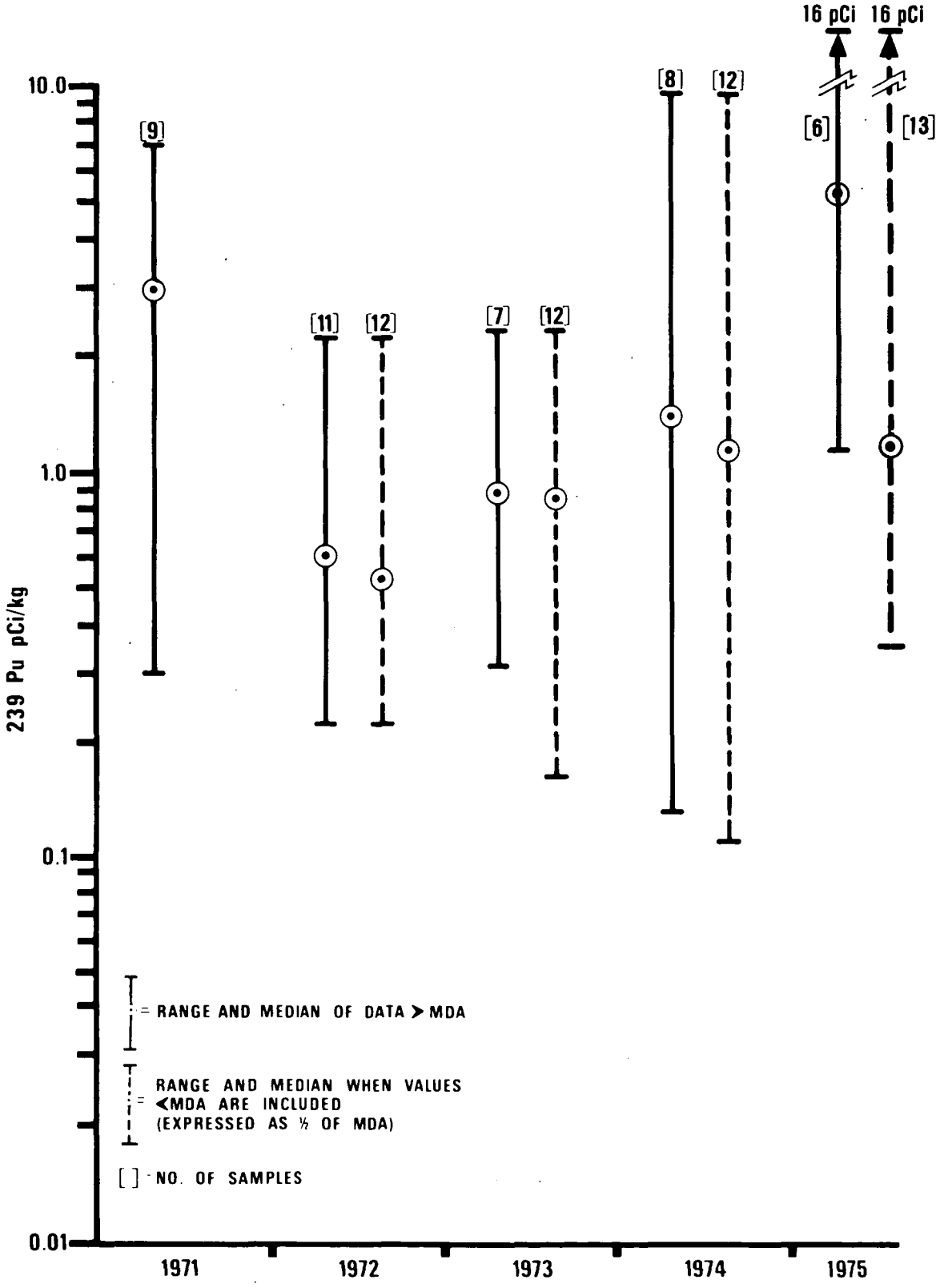

Figure 6. Ranges and median values of ^{239}Pu in fresh femur tissues from Nevada Test Site beef Cattle 1971-1975.

was 140 picocuries/kilogram in a muscle sampled from deer number 8.

The average strontium-90 level in bones from these deer was 2.3 picocuries/gram of ash which is not significantly different from the levels of 2.6 and 2.7 picocuries/gram of ash reported in 1973 and 1974 (see figure 3).

The median values of actinide levels in Nevada Test Site deer are shown in table 5. These levels are of the same magnitude as those reported in 1973 and 1974 with one exception; for some unknown reason the plutonium-239 concentrations in the lung, liver, and bone samples from animal 8 were significantly elevated. In order to verify the results, the analytical laboratory recalculated and/or reanalyzed the samples and reported similar levels. Actinide levels in the rumen contents of the mule deer were lower than those reported for the Nevada Test Site cattle. This is probably a reflection of their eating habits, as deer are browsers rather than grazers. Also, their habitat, in general, is less contaminated than the Area 18 range.

TABLE 5. MEDIAN VALUES OF ACTINIDE LEVELS IN 1975 NEVADA TEST SITE DEER TISSUES (pCi/kg wet wt.)

Tissue	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
Lungs	<0.13	0.47	0.45	<0.03	0.45
Muscle	<0.07	0.15	0.45	<0.03	0.36
Liver	<0.16	0.48	0.53	<0.04	0.35
Rumen Contents	0.43	2.2	2.4	0.2	2
Bone	<1.4	<3	3.3	<0.25	3

DESERT BIGHORN SHEEP

Analytical data from selected tissues of desert bighorn sheep are listed in the tables of appendix E. The only gamma-emitting radionuclide detected, other than naturally occurring potassium-40, was cesium-137 which was found occasionally in lung and kidney tissues. Muscle and liver tissues were not collected as they were retained by the hunters who furnished the samples.

Tritium levels in the aqueous portion of kidney tissues ranged from <240 to 620 picocuries/liter with a median value of <310 picocuries/liter.

While the median strontium-90 concentration in 18 bone samples was 3.5 picocuries/gram of ash, the average concentration was 8.6 picocuries/gram of ash as shown in figure 3. Although this average is nearly twice that observed in recent years, if the data from four animals (numbers 8, 16, 20, and 21) were not included, the average would 3.4 picocuries/gram of ash which would be similar to that reported each of the last 4 years. Strontium-90 surveillance in milk (ICR Report No. 19) and air (HASL-321) gave no indication of significantly increased worldwide or localized fallout during 1974 or 1975 so the elevated levels in these four animals are thought to be anomalies. As in most of the previous years, strontium levels were higher in the desert bighorn sheep than the other two ruminant species sampled. This result is probably due to their habitat being at higher elevations (more precipitation) and to the older age of sampled animals due to hunting regulations.

The median values of plutonium levels in lung and bone tissues from desert bighorn sheep are shown in table 6. Although both plutonium-238 and plutonium-239 were frequently found in the lungs, detectable levels of plutonium-238 were found in only 2 of 18 bone samples and plutonium-239 was found in 7 of the 18.

TABLE 6. MEDIAN VALUES OF PLUTONIUM LEVELS IN 1975 DESERT BIGHORN SHEEP TISSUES (pCi/kg wet wt.)

Tissue	^{238}Pu	^{239}Pu
Lungs	0.22	0.65
Bone	<0.53	<0.76

NEVADA TEST SITE RABBITS

Selected tissues from six Area 15 cottontail rabbits were collected and analyzed. The soft tissues were analyzed for gamma-emitting radionuclides and the bones for strontium and plutonium. These data are tabulated in the tables of appendix F.

Plutonium-238 and -239, and cesium-137 levels detected in these tissues were of the same magnitude as those found in Nevada Test Site cattle and deer. However, the strontium-90 levels in the bones averaged 19.7 picocuries/gram of ash, which is a factor of 6 to 10 higher than that observed in the Nevada Test Site ruminants. These values are also a factor of three greater than those reported for Area 15 rabbits in 1974 (Smith et al., 1977b). The highest values found in two of the rabbits (37 picocuries/gram of ash) were verified by the analytical laboratory.

NEVADA TEST SITE COYOTE

An immature female coyote was collected at the Area 15 farm and selected tissue samples submitted for analysis. The analyzed data are presented in table 7. Gamma-emitting radionuclides detected in the tissues of this animal include naturally occurring potassium-40, cesium-137, and metastable rhodium-102. The cesium-137 levels were about 10 times the magnitude of the

TABLE 7. RADIONUCLIDE CONCENTRATIONS IN TISSUES COLLECTED FROM AREA 15, NEVADA TEST SITE, COYOTE

Tissue Type	^{3}H (pCi/l)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)	K (g/kg)	^{137}Cs (pCi/kg)	^{102m}Rh (pCi/kg)
Bone†	NA	0.006 ± 0.003 1.3 ± 0.6	0.009 ± 0.003 2.1 ± 0.77	<74 <17000	9.6 ± 1.3 2,200 ± 310	23	NA	NA	ND
Muscle†	NA	0.085 ± 0.04 0.85 ± 0.36	0.05 ± 0.03 0.48 ± 0.3	NA	NA	1	3.8 ± 0.6	350 ± 8	ND
Lungs†	NA	<0.03‡ <0.25	1.6 ± 0.19‡ 16 ± 1.9	NA	NA	1	ND	150 ± 20	ND
Kidney	8,400 ± 350‡	NA	NA	NA	NA	NA	3.4 ± 0.7	340 ± 50	ND
Liver	NA	<0.01 <0.38	0.09 ± 0.02 3.4 ± 0.8	NA	NA	3.8	2.4 ± 0.3	250 ± 15	ND
Stomach Contents	NA	NA	NA	NA	NA	NA	4.7 ± 0.5	110 ± 17	52 ± 25
Skin	NA	NA	NA	NA	NA	NA	ND	520 ± 34	ND

*Wet weight
†Actinide analysis by Eberline Instrument Corporation.
NA = Not analyzed
ND = Not detected
‡Recounts verified original results.

levels seen in the herbivore animals sampled (ruminants and rabbits). The source of the metastable rhodium-102 is unknown; however, this radionuclide was also found in the stomach contents of two coyotes collected from the Area 15 farm during 1974 (Smith et al., 1977b). Also detected was an unexpectedly elevated tritium level of 8,400 picocuries/liter in the aqueous portion of the kidneys. The counting calculation for this value was verified by the analytical laboratory. This level might be related to a series of studies in which fish were exposed to tritium which were conducted in fish tanks located in a greenhouse at the Area 15 farm (Patzer et al., 1973). The level found in the coyote's kidney was about 1 percent of the exposure level maintained in the fish tanks which in turn was about 1 percent of the Maximum Permissible Concentration of tritium for occupational exposure as stated in the U.S. Atomic Energy Commission's regulation 10-CFR-20. The plutonium-239 lung burden of 16 picocuries/kilogram is nearly identical to data reported for coyote lungs in 1974 (Smith et al., 1977b).

NEVADA TEST SITE WATERS

Several natural springs that serve as a source of water for wildlife were sampled during 1975. These waters were analyzed for gamma-emitting radionuclides and for tritium. The analytical results are presented in table 8. Detectable levels were only found in two samples; Captain Jack Spring contained 7.1 ± 2 picocuries/liter of cesium-137 and a sample from the Tub Spring contained 250 ± 230 picocuries/liter of tritium.

TABLE 8. RADIONUCLIDE CONCENTRATIONS IN NEVADA TEST SITE SPRING WATERS

Spring Name	Date Sampled	^{137}Cs (pCi/l)	^{3}H (pCi/l)
Captain Jack	05/03/75	7.1 ± 2	<230
Tub Spring	03/20/75	GSN	250 ± 230
Tippipah	04/09/75	GSN	<230
Green	04/08/75	GSN	<230
White Rock	03/20/75	GSN	<230
Topopah	05/07/75	GSN	<230

GSN = Gamma spectrum negligible

NECROPSY AND HISTOPATHOLOGICAL EXAMINATIONS

All sacrificed animals were necropsied and selected tissue and lesion samples were collected for histopathological evaluation. Animals that died from natural causes were also necropsied if a prosector was available and histopathological specimens were collected if unaffected by postmortem changes. The gross and microscopic pathologies observed are summarized in appendix G. Also included are the results of hematology examinations when performed. The total white blood cell count levels may be depressed as most of the blood samples were collected after death.

As in previous years, sarcocysts were detected in muscle tissues (cow number 1). This ubiquitous parasite is commonly found in cattle from other areas and has little clinical significance. Other histopathological findings were usually consistent with the general condition of the individual animal or were the result of agonal struggling. Ocular squamous cell carcinoma (cow number 12) is frequently observed in aged Hereford cattle exposed to the sun (Moulton 1961). No pathology, gross or microscopic, was observed that could be directly attributed to ionizing radiation.

HYPOTHETICAL DOSE ESTIMATES

Although meat from animals living on the Nevada Test Site is not available for consumption by the general public, the dose to a standard man based on postulated consumption of the meat can be calculated. The dose estimates are not presented as an implication of potential doses, but rather to place the reported radionuclide concentrations in perspective. The dose estimates are based on the techniques and parameters of the International Commission for Radiation Protection (1959, 1968) and Dillman (1969). The estimates were from the maximum observed concentrations of the radionuclides in edible tissues of the cattle and deer sampled (summarized in table 9), and the postulated consumption of 500 grams (about 1 pound) of the meat each day for a year.

The International Commission for Radiation Protection (1959) and the U.S. Energy Research and Development Administration (1975) present different dose criteria for various parts of the body, based on estimates of relative radiosensitivity. The National Council on Radiation Protection and Measurements (1971) recognizes this philosophy, but recommends simplifying the guides for the general population, and uses the minimum guide (0.5 rem per year for the whole body) for all body organs. The National Council on Radiation Protection and Measurements emphasizes that this is a simplifying administrative decision, rather than a reduction of the guides based on new technical information.

Table 9 presents a summary of the maximum observed concentrations in edible tissues of the animals. The indicated error terms are the two-sigma counting error. The total analytical errors or uncertainties (two-sigma) for the plutonium and uranium results are estimated to be about

TABLE 9. SUMMARY OF PEAK RADIONUCLIDE CONCENTRATIONS IN EDIBLE TISSUE FROM NEVADA TEST SITE CATTLE AND DEER (pCi/kg fresh wt.)

Nuclide	AREA 18 CATTLE May 75			AREA 18 CATTLE Oct 75			NTS MULE DEER		
	Muscle	Liver	Blood (pCi/l)	Muscle	Liver	Blood (pCi/l)	Muscle	Liver	Blood (pCi/l)
^{234}U	0.5	0.36	NA	5.6	0.68 (<1.1)	NA	0.93	0.62	NA
^{235}U	0.05 (<0.065)*	0.012 (<0.07)	NA	<0.9	<0.4	NA	0.07	<0.07	NA
^{238}U	0.33	0.31	NA	1.73	0.6 (<1.3)	NA	0.64	0.65	NA
^{238}Pu	0.85	0.32	NA	<0.04	0.016 (<0.3)	NA	0.09 (<0.28)	1.1	NA
^{239}Pu	1.3	1.6	NA	0.38	3.1	NA	2.3	14	NA
^{137}Cs	71	ND	NA	29	ND	NA	140	29	NA
^{3}H	NA	NA	620	NA	NA	1,100	NA	NA	990

*Both values are listed when a less than minimum detectable activity value is reported as being higher than a detectable value from a similar tissue.
NA = Not analyzed
ND = Not detected

200 femtocuries/kilogram for results of several hundred femtocuries/kilogram, or several times the indicated counting errors. Thus, values under several hundred femtocuries/kilogram have limited statistical significance.

Table 10 indicates postulated doses on the maximum concentrations for the various nuclides taken from the data summarized in table 9. The column on the right indicates the respective fraction of the guide of 500 millirems/year for the various postulated doses. The doses from plutonium, uranium, and to a lesser extent, cesium-137, are not delivered in 1 year. For practical purposes, however, the integrated doses for a 1-year ingestion period are related to the yearly guide.

The highest postulated dose, 2.2 millirems, is for plutonium-239 and for ingestion of liver from a mule deer. All of the other postulated doses are less than 1.5 millirem. Due to the low level of the uranium results, some of the "less than" results were greater than actual values. Thus, postulated doses were calculated for the actually detected values and for the listed "less than" values. Values were also calculated for both bovines and mule deer.

The postulated dose to man from any single radionuclide is less than 1 percent of the guide of 500 millirems/year. The maximum values are 0.3 and 0.4 percent for cesium-137 in mule deer muscle and plutonium-239 in mule deer liver, respectively. The maximum values for bovines are about 0.1 percent, which are about the same values as for 1974 (Smith et al., 1977b). Hence, one would assume that an insignificant potential health hazard would exist for humans consuming the postulated doses.

TABLE 10. POSTULATED DOSE TO MAN FOLLOWING INGESTION OF SELECTED TISSUES FOR 1 YEAR

Nuclide	Human Organ for Which Dose was Calculated	Animal Tissue Containing Maximum Concentration	pCi/kg of Tissue	Dose Factor mrem:pCi/day (1-y ingestion)	Dose (mrem)	Percent of 0.5 rem*
^{3}H†	Body water	Area 18 cattle, Oct 75, blood	1,100	3.6×10^{-5}	0.02	<0.01
^{137}Cs	Whole body tissue	NTS mule deer, muscle	140	0.022	1.5	0.3
^{137}Cs	Whole body tissue	Area 18 cattle, May 75, muscle	71	0.022	0.8	0.16
^{234}U	Bone	Area 18 cattle, Oct 75, liver	5.6	0.019	0.05	0.01
^{235}U	Bone	Area 18 cattle, May 75, muscle	<0.9	0.018	<0.008	<0.01
^{235}U	Bone	NTS mule deer, muscle	0.07	0.018	<0.001	<0.01
^{238}U	Bone	Area 18 cattle, Oct 75, muscle	1.7	0.017	0.01	<0.01
^{238}Pu	Bone	NTS mule deer, liver	1.1	0.27	0.1	0.03
^{238}Pu	Bone	Area 18 cattle, May 75, muscle	0.85	0.27	0.1	0.02
^{239}Pu	Bone	Area 18 cattle, Oct 75, liver	3.1	0.32	0.5	0.1
^{239}Pu	Bone	NTS mule deer, liver	14	0.32	2.2	0.4

*The doses from uranium and plutonium-238 and -239, and to a lesser extent cesium-137, are not delivered within the 1-year ingestion period, but, for simplification, the doses have been related to the guide for 1 year. The doses for uranium and plutonium are actually for a 50-year period, but it should be recognized that the doses are resulting from ingestion over a 1-year period.

†The tritium concentration was for blood. It is assumed the muscle concentration(water plus organic)per kilogram was equal to the blood concentration per liter.

FOOD HABIT ANALYSIS

In addition to the tissue samples obtained from the desert bighorn sheep for radionuclide analysis, ingesta from 20 of the 24 animals were collected for food habit determination (see appendix H). All of the ingesta examined were from rams which were estimated to be from 3 to 11 years of age and had been harvested during the yearly fall hunting season.

The geographical regions represented by the harvested sheep, as described by Brown et al. (1977), include the U.S. Desert National Wildlife Range and the extreme southern Nevada region. Ten of the animals were collected from the Las Vegas, Pintwater, and Sheep Ranges located within the boundaries of the U.S. Desert National Wildlife Range. The remaining animals were harvested from the Meadow Valley, Highland, and Eldorado Ranges, and from the Black Mountains.

The vegetation of these two regions is similar in that they both have a well-developed, lower sonoran flora represented by desert riparian, creosote bush, blackbrush, and saltbush communities. Even though many areas within the extreme southern Nevada region have well-developed and extensive areas of woodland or forested plant communities, the four mentioned extreme southern mountain ranges do not. The woodland vegetative type is, however, quite extensive in all three of the mountain ranges located on the U.S. Desert National Wildlife Range. The woodland types are generally found at the mid-elevations, 1,700 to 2,100 meters, and include the juniper-pinyon, riparian, and cliff communities. Above 2,100 meters elevation, a coniferous forest consisting of fir-pine communities is common in addition to small pseudo-alpine communities found at the summits of the higher peaks.

The botanical composition of the forage utilized by the desert bighorn sheep collected on the Desert National Wildlife Range is shown in table 11. Grasses were the preferred forage type contributing 54 percent of the diet, with shrubs contributing 40 percent, and forbs the remaining 6 percent. Preferred species included the grasses, Indian rice (*Oryzopsis hymenoides*), squirrel tail (*Sitanion hystrix*), cheat (*Bromus tectorum*), and desert needle (*Stipa speciosa*), accounting for approximately 25, 11, 6, and 5 percent of the total diet, respectively. Fifteen different shrub species were identified with little-leaved mountain mahogany (*Cercocarpus intricatus*) contributing nearly 9 percent of the diet and brittle-bush (*Encelia farinosa*), big sagebrush (*Artemisia tridentata*), and Nevada joint-fir (*Ephedra nevadensis*) accounting for approximately 6, 5, and 3 percent of the total diet, respectively. Forb species were the least utilized by the sheep with the desert buckwheat (*Eriogonum* sp.) contributing 1 percent.

Table 12 shows the food habit results of the 10 animals harvested from the four mountain ranges located in the extreme southern Nevada region. The forage preference of these sheep, similar to those collected from the Desert National Wildlife Range, was grasses which accounted for 43 percent of their total diet. Six identified grass genera comprised 33 percent of the diet, with Indian rice and squirrel tail dominant, contributing in excess of 16 and 8 percent, respectively. The slightly higher utilization of the grasses by the sheep harvested on the Desert National Wildlife Range is perhaps due to the greater abundance of grasses at the higher elevations.

Shrubs were well represented in the diet, with 10 species identified. Preferred shrubs included barrel cactus (*Echinocatus acanthodes*), silk tassel (*Garrya flavescens*), and Nevada joint-fir (*Ephedra nevadensis*) contributing

TABLE 11. THE PLANT SPECIES AND THE PERCENT COMPOSITION OF FORAGE EATEN BY THE DESERT BIGHORN SHEEP RAMS HARVESTED FROM THE U.S. DESERT NATIONAL WILDLIFE RANGE DURING NOVEMBER AND DECEMBER 1975

Species	Average Composition Percent	Frequency of Occurrence Percent
Oryzopsis hymenoides	25.2	90.0
Sitanion hystrix	10.7	90.0
Bromus tectorum	5.6	60.0
Stipa speciosa	4.7	50.0
Hilaria jamesii	0.9	10.0
Hilaria rigida	0.5	10.0
Unidentified Grasses	6.4	50.0
Total Percent Grasses	54.0	100.0
Cercocarpus intricatus	8.7	60.0
Encelia farinosa	6.2	10.0
Artemisia tridentata	4.7	50.0
Ephedra nevadensis	3.1	50.0
Purshia glandulosa	2.6	10.0
Atriplex confertifolia	2.5	40.0
Coleogyne ramosissima	2.5	40.0
Thamnosma montana	2.8	10.0
Garrya flavescens	0.8	10.0
Rosa sp.	0.3	10.0
Cowania mexicana	0.3	10.0
Eriogonum microthecum	0.2	10.0
Eurotia lanata	0.2	20.0
Encelia frutescens	0.1	10.0
Atriplex canescens	0.1	10.0
Unidentified Shrubs	4.9	80.0
Total Percent Shrubs	40.0	100.0
Eriogonum sp.	1.0	70.0
Cirsium mohavense	0.6	10.0
Chaenactis sp.	0.4	20.0
Euphorbia sp.	0.1	10.0
Sphaeralcea ambigua	0.1	10.0
Unidentified Forbs	3.8	10.0
Total Percent Forbs	6.0	100.0

TABLE 12. THE PLANT SPECIES AND THE PERCENT COMPOSITION OF FORAGE EATEN BY TEN DESERT BIGHORN SHEEP RAMS HARVESTED IN SOUTHERN NEVADA DURING NOVEMBER AND DECEMBER 1975

Species	Average Composition Percent	Frequency of Occurrence Percent
Oryzopsis hymenoides	15.0	100.0
Sitanion hystrix	8.3	90.0
Stipa speciosa	4.0	30.0
Bromus tectorum	2.5	30.0
Hilaria rigida	2.5	30.0
Stipa sp.	0.9	20.0
Unidentified Grasses	9.8	90.0
Total Percent Grasses	43.0	100.0
Echinocactus acanthodes	10.0	20.0
Garrya flavescens	9.0	20.0
Ephedra nevadensis	8.6	70.0
Cercocarpus intricatus	2.0	30.0
Artemisia arbuscula	1.0	10.0
Eriogonum fasciculatum	1.0	10.0
Atriplex sp.	1.0	10.0
Quercus turbinella	1.0	10.0
Eriogonum microtheum	0.3	10.0
Atriplex confertifolia	0.1	10.0
Unidentified Shrubs	11.0	80.0
Total Percent Shrubs	45.0	100.0
Euphorbia setiloba	3.4	30.0
Eurphorbia sp.	1.6	20.0
Eriogonum sp.	1.2	60.0
Sphaeralcea ambigua	T*	10.0
Unidentified Forbs	5.8	100.0
Total Percent Forbs	12.0	100.0

*T = Trace, less than 0.1%

approximately 10, 9, and 9 percent, respectively. The overwhelming shrub species preference per number of animals, however, was Nevada joint-fir which was identified in the ingesta of 7 of the 10 animals examined.

Forb species which contributed 12 percent of the total diet of these animals were made up primarily of two identified genera, the spurges (*Euphorbia*) and the desert buckwheats which contributed about 5 and 1 percent, respectively.

As previously reported by Brown et al. (1976 and 1977) and Smith et al. (1977b) and further illustrated by the data in tables 11 and 12, bighorn sheep inhabiting the mountain ranges of Nevada prefer grasses. The utilization of shrubs by sheep during 1975 was 16 percent greater than that observed during the 1974 hunting season (1975 average was 42.5 percent and 1974 average was 26.5 percent).

OTHER ACTIVITIES

BEEF HERD

During 1975, the Animal Investigation Program's beef herd continued to subsist on the natural vegetation of Area 18. Semiannual roundups of the herd were conducted in May and October. At each roundup, all captured animals were examined, weighed, and sprayed for ectoparasites. The 1975 calves were branded, vaccinated, identified with tattoos and ear tags, and when indicated were castrated and dehorned. Sixteen calves were weaned. Ninety-one animals were accounted for during the October roundup.

DEER MIGRATION STUDY

During the summer months, a sizable mule deer herd resides in a mountainous, lightly forested section in the northern one-third of the Nevada Test Site. As winter approaches, this herd leaves the higher elevations of its summer range (normally above 1,500 meters elevation) in the pinion-juniper vegetation range and migrates to an unknown destination. During the summer of 1975, a study was begun to determine the migration patterns of this deer herd by tracking individual deer which were captured and outfitted with collars containing miniature radiotransmitters. The deer were released and their movements were followed on a weekly basis.

Initially, capture efforts involved the use of immobilizing drugs (Sernylan® and Acepromazine®) injected by a syringe projectile fired from a

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powder driven Cap-Chur® gun (Palmer Chemical and Equipment Company, Inc., Douglasville, Georgia). The target deer were momentarily transfixed by hand-held spotlights at night. Although several deer were successfully captured in this manner, many man-hours were required to locate, approach, and immobilize these deer. Late in the season, an attempt was made to increase the efficiency of capture through the use of traps (Clover 1954 and 1956). Traditional baits such as alfalfa, apples, grain, etc., failed; therefore, a technique using water as a bait was developed (Giles 1977).

An initial problem of high mortality (probably from respiratory distress) in captured deer during the first few days following release was overcome through the prophylactic administration of atropine, corticosteroids, and antibiotics at time of capture. Eight mule deer were successfully captured and outfitted with identification tags and radiotransmitting collars. Their movements were monitored on a weekly basis via either ground or aerial vehicles.

During the fall and winter months, deer tagged in the Echo Peak area (see figure 7) moved in a southwesterly direction toward Timber Mountain while those tagged on Rainier Mesa moved south to Shoshone Mountain. Unfortunately, a defect in the transmitting collars (breakage of leads between battery and transmitter) led to early failure of all but two of the transmitters. This problem was corrected in the improved version of the collars used during 1976. Several of the tagged deer were observed during the summer of 1976 in the same areas where they were originally captured.

Despite the difficulties encountered, much was achieved during the summer. This included the development of a new trapping technique, increased proficiency in the use of drugs and capture equipment, the increased

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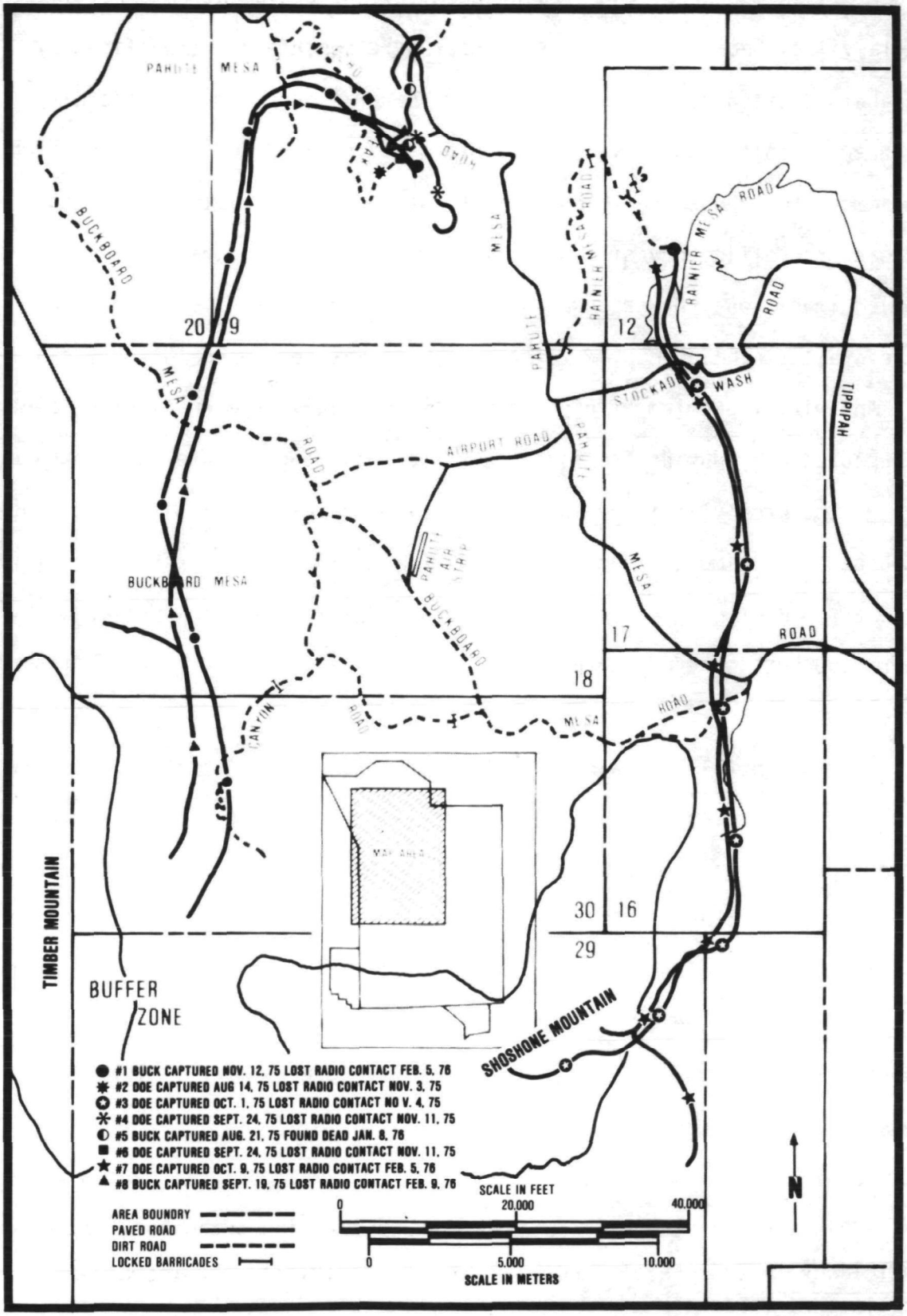

Figure 7. NTS Mule Deer Migration Patterns - Fall and Winter 1975

awareness of the capabilities and limitations of the telemetry equipment, and the development of a regimen of postcapture treatment to assure survival of the animal. These accomplishments were used in good stead during the studies conducted during 1976.

NEVADA TEST SITE SPRING RENOVATION

During 1975, the Animal Investigation Program was charged by the U.S. Energy Research and Development Administration's Nevada Operations Office to improve the natural springs of the Nevada Test Site for the benefit of the wildlife to the extent that manpower and resources were available. Renovation efforts were based on the findings of a survey by Giles (1976). Geographic location, waterflow, spring condition, and usage were also noted in this report. Springs deemed appropriate for renovation efforts included White Rock, Tub, Oak, and Cane.

Debris were removed from the source tunnels at White Rock Spring (Area 12). A new pipeline was installed from the water sources to the existing water tank.

Oak Spring (Area 15) required extensive excavation. The entrance was overgrown with Gambel's Oak and filled in with dirt. Dirt and brush were removed by hand down to the level of the existing pipeline. The old pipeline was removed and replaced with plastic pipe with a dirt screen placed inside the spring to prevent debris from plugging the pipeline. The existing water tanks were replaced with a galvanized water tank. This system provides a maintenance-free year-round water supply.

Tub Spring (Area 15) was renovated by excavating a rock slide which had plugged the pipeline. A wire screen was placed over the pipe entrance to prevent recurrence of the blockage. The original pipeline and reservoir tanks were reused.

Cane Spring (Area 27) was renovated by laying a 16-meter plastic pipeline to a plastic reservoir. This spring now provides a year-round water source.

Captain Jack Spring (Area 12) was in good condition and was checked periodically to ensure that it remained so.

Renovation of Topopah (Area 29), Green (Area 7), and Tippipah (Area 16) Springs was determined to be either too expensive or not feasible due to inadequate waterflow.

INVESTIGATIONS, SURVEYS, AND OTHER STUDIES

During 1975, there were no livestock damage claims that required investigation.

The Animal Investigation Program's rumen-fistulated steers were used in a study to determine plutonium uptake by animals grazing a contaminated range. Details and data from this study, conducted under the auspices of the Nevada Applied Ecology Group, are presented elsewhere (Smith 1974, and Smith et al., 1976).

Portions of thyroids collected as part of the Animal Investigation Program routine surveillance activities were analyzed for iodine-129 by neutron activation. Details and data from this study were published elsewhere (Smith 1977).

PUBLIC INFORMATION

The off-site public information program continued by direct contact with ranchers, by lectures to civic organizations, by public displays featuring a fistulated steer, and by presentations to groups touring the Environmental Monitoring and Support Laboratory-Las Vegas or the Nevada Test Site facilities. During 1975, the objectives and findings of the Animal Investigation

Program were described to over 700 Nevada Test Site visitors in 21 different tour groups. A rumen-fistulated steer served as a feature attraction at an educational exhibit displayed at the annual Earth Day open house at the Environmental Monitoring and Research Laboratory-Las Vegas in April and at the Southern Nevada Youth Fair held in March at the Las Vegas Convention Center. An estimated 20,000 people visited the exhibit at these locations and received information on the Animal Investigation Program's objectives and findings.

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A. SUMMARY OF ANALYTICAL PROCEDURES AND MINIMUM DETECTABLE ACTIVITIES

Type of Analysis	Analytical Equipment	Counting Period (Min)	Analytical Procedures	Sample Size	Minimum Detectable Activities (pCi/total sample)*
Gamma spectroscopy	Lithium-drifted germanium detectors calibrated at approximately 0.5 keV per channel input to 4096 channels resident in the core of the PDP 11/20 computer.	∿ 1,200	Radionuclide concentrations quantitated from gamma spectrum by PDP 11/20 computer using a least squares technique.	200-ml aluminum cans	For: ^{54}Mn, ^{60}Co, ^{95}Zr, ^{103}Ru, ^{124}Sb, ^{132}Te, ^{131}I, ^{134}I, ^{137}Cs, ^{140}Ba - 7 pCi For: ^{125}Sb, ^{141}Ce - 30 pCi For: ^{65}Zn, ^{106}Ru, ^{144}Ce - 20 pCi For: ^{181}W - 85 pCi For: ^{241}Am - 35 pCi For: ^{22}Na - 4 pCi
$^{89-90}$Sr	Low-background thin-window, gas-flow proportional counter with a 5.7-cm diameter window (80 µg/cm^2).	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous equations.	2 g of ash	For: ^{89}Sr - 5 pCi ^{90}Sr - 2 pCi
^{3}H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	5 ml	∿ 1 pCi
$^{238-239}$Pu ^{234,235,} ^{238}U	Alpha spectrometer with silicon surface barrier detectors operated in vacuum chambers.	400-1,400	Ash sample is digested with acid, purified by solvent extraction and/or ion exchange, electroplated on stainless steel planchet, and counted by alpha spectrometer.	100 g - 1 kg wet weight 1 - 10 g ash	For all alpha-emitting radionuclides - ∿ 0.02 pCi

*The minimum detectable activities in terms of total activity per sample for standard geometries and counting times are based on a combination of a number of technical experiments and operational experience. By means of experimentation, the minimum detectable activities have been defined as that activity which produced a ± 100 percent deviation at the 95 percent confidence level. These values are approximations and are applicable to ideal conditions and simple complexes of nuclides. Complex spectra or spectra showing naturally occurring radionuclides can raise the minimum detectable activities considerably. The detection limit for each sample is defined as that radioactivity which equals the two-sigma counting error.

B-1. ACTINIDE CONCENTRATIONS IN LUNGS, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
1	47 ± 13 710 ± 190	200 ± 31 3,000 ± 460	37 ± 8.7 550 ± 130	<1.5 <23	26 ± 7.3 390 ± 110	1.5
2	19 ± 11 350 ± 200	480 ± 56 8,600 ± 1,000	16 ± 6.7 290 ± 120	4.3 ± 3.4 77 ± 62	29 ± 7.8 520 ± 140	1.8
3	SAMPLE LOST					
4	34 ± 14 710 ± 290	350 ± 43 7,400 ± 910	NA	NA	NA	2.1
5	<6 <120	85 ± 19 1,700 ± 390	9.5 ± 1.8 190 ± 37	<0.75 <15	7 ± 1.4 140 ± 29	2
6 †	25 ± 10 540 ± 220	100 ± 23 2,200 ± 500	23 ± 6.8 510 ± 150	<1.4 <30	18 ± 5.9 400 ± 130	2.2
7 †	<1.8‡ <20	13 ± 8.2‡ 140 ± 90	30 ± 12 330 ± 130	<1.8 <20	13 ± 7.3 140 ± 80	1.1
Median	22 445	150 2,600	23 330	<1.8 <23	18 390	1.9
Range	<1.8-47 <20-710	13-480 140-8,600	9.5-37 190-550	<0.75-4.3 <15-77	7-29 140-520	1.1-2.2

*Wet weight
NA = Not analyzed
‡Analysis by Eberline Instrument Corporation
†Recount verified original result.

B-2. ACTINIDE CONCENTRATIONS IN TRACHEOBRONCHIAL LYMPH NODES, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.14 <1.5	3.2 ± 0.47 35 ± 5.2	3.5 ± 2.2 39 ± 24	<0.91 <10	4.5 ± 2.2 49 ± 24	1.1
2	0.27 ± 0.11† 5.7 ± 2.3	11 ± 1.1† 230 ± 23	2 ± 0.86 42 ± 18	<0.26 <5.4	1.8 ± 0.76 37 ± 16	2.1
3	<0.09 <2.2	0.81 ± 0.16 21 ± 4.2	0.96 ± 0.58 25 ± 15	<0.35 <9	1.4 ± 0.69 36 ± 18	2.6
4	1.1 ± 0.46 14 ± 6	1.8 ± 0.54 24 ± 7	<2 <26	<0.92 <12	3 ± 2.2 39 ± 28	1.3
5	<0.41 <3.7	<0.29 <2.6	<1.8 <16	<1 <9.4	<1.9 <17	0.91
6	<0.3 <2.1	4.1 ± 0.97 29 ± 6.9	2.5 ± 1.7 18 ± 12	<0.66 <4.7	2.1 ± 1.4 15 ± 10	0.71
7			SAMPLE NOT COLLECTED			
Median	<0.29 <2.95	2 26.5	2.3 25.5	<0.79 <9.2	2 36.5	1.2
Range	<0.09-1.1 <1.5-14	<0.29-11 <2.6-230	0.96-3.5 <16-42	<0.26-<1 <4.7-<12	1.4-4.5 15-49	0.71-2.6

*Wet weight
†Recount verified original result.

B-3. ACTINIDE CONCENTRATIONS IN MUSCLES, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
1	7.8 ± 5.1 140 ± 92	33 ± 9.4 590 ± 170	16 ± 8.9 280 ± 160	<2.9 <53	11 ± 7.2 190 ± 130	1.8
2	13 ± 3.7 300 ± 90	23 ± 5.4 550 ± 130	21 ± 5.8 500 ± 140	2.1 ± 1.7 50 ± 40	14 ± 4.6 330 ± 110	2.4
3	<3.1 <40	<4.8 <62	20 ± 4.9 260 ± 64	3.3 ± 2.2 43 ± 28	4.8 ± 2.5 63 ± 32	1.3
4	17 ± 8.3 400 ± 200	54 ± 16 1,300 ± 390	NA	NA	NA	2.4
5	30 ± 10 850 ± 290	<5.7 <160	5.7 ± 5 160 ± 140	<2.3 <65	<3.9 <110	2.8
6†	17 ± 8.7 260 ± 130	50 ± 15 750 ± 230	20 ± 6.7 300 ± 100	<2 <30	18 ± 6 270 ± 90	1.5
7†	<1.8 <20	15 ± 7.3 170 ± 80	35 ± 18 380 ± 200	<1.8 <20	<9.1 <100	1.1
Median	13 260	23 550	20 290	<2.2 48	<10 <150	1.8
Range	<1.8-30 <20-850	<4.8-54 <62-1,300	5.7-35 160-500	<1.8-3.3 <20-<65	<3.9-18 63-330	1.1-2.8

*Wet weight
NA = Not analyzed
†Analysis by Eberline Instrument Corporation

B-4. ACTINIDE CONCENTRATIONS IN LIVERS, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
1	<6.5 <200	52 ± 17 1,600 ± 530	10 ± 4.5 320 ± 140	<1.7 <53	3.9 ± 2.8 120 ± 88	3.1
2	<7.5 <210	25 ± 8.2 700 ± 230	5 ± 3.9 140 ± 110	<1.7 <47	<2.6 <74	2.8
3	<5.9 <160	41 ± 10 1,100 ± 280	7 ± 4.4 190 ± 120	<2 <53	<2.6 <69	2.7
4	17 ± 8.3 190 ± 91	68 ± 15 750 ± 170	16 ± 6.5 180 ± 72	<3.6 <40	5.8 ± 5.2 64 ± 57	1.1
5	<5.9 <89	47 ± 15 710 ± 230	4.2 ± 1.1 63 ± 16	0.8 ± 0.51 12 ± 7.6	2.9 ± 0.93 44 ± 14	1.5
6†	8.9 ± 3.1 320 ± 110	17 ± 6.9 620 ± 250	10 ± 5.6 360 ± 200	<1.9 <70	6.1 ± 4.2 220 ± 150	3.6
7†	<1.7 <20	37 ± 20 450 ± 290	30 ± 8.3 360 ± 100	<1.7 <20	26 ± 6.7 310 ± 80	1.2
Median	<6.5 190	41 710	10 190	<1.7 <47	3.9 <74	2.7
Range	<1.7-17 <20-320	17-68 450-1,600	4.2-30 63-360	0.8-<3.6 12-<70	<2.6-6.1 44-310	1.1-3.6

*Wet Weight
†Analysis by Eberline Instrument Corporation

B-5. ACTINIDE CONCENTRATIONS IN RUMEN CONTENTS, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.04 <0.66	0.51 ± 0.11 8.7 ± 1.9	0.5 ± 0.05 8.5 ± 0.79	0.05 ± 0.01 0.82 ± 0.17	0.18 ± 0.02 3.1 ± 3.8	1.7
2	0.34 ± 0.05 5.4 ± 0.75	6.2 ± 0.69 100 ± 11	0.11 ± 0.02 1.8 ± 0.25	<0.003 <0.05	0.08 ± 0.01 1.2 ± 0.2	1.6
3	0.01 ± 0.01 0.17 ± 0.17	0.17 ± 0.03 2.8 ± 0.42	0.21 ± 0.02 3.3 ± 0.39	0.04 ± 0.01 0.63 ± 0.15	0.04 ± 0.01 0.64 ± 0.15	1.6
4	<0.03 <0.34	0.1 ± 0.04 1.3 ± 0.56	0.15 ± 0.03 2 ± 0.39	<0.01 <0.09	0.15 ± 0.03 1.9 ± 0.38	1.3
5	<0.01 <0.15	0.41 ± 0.06 4.9 ± 0.69	NA	NA	NA	1.2
6	0.04 ± 0.01 0.53 ± 0.12	0.15 ± 0.02 1.8 ± 0.24	0.08 ± 0.02 0.98 ± 0.28	<0.01 <0.07	0.03 ± 0.01 0.35 ± 0.16	1.2
7†	0.11 ± 0.02 3.9 ± 0.61	0.35 ± 0.04 12 ± 1.3	NA	NA	NA	3.4
Median	<0.04 0.53	0.35 4.9	0.15 2	<0.01 <0.09	0.08 1.2	1.6
Range	<0.01-0.34 <0.15-5.4	0.1-6.2 1.3-100	0.08-0.5 0.98-8.5	<0.003-0.05 <0.05-0.82	0.03-0.18 0.35-3.1	1.2-3.4

*Wet weight
NA = Not analyzed
†Analysis by Eberline Instrument Corporation

B-6. ACTINIDE CONCENTRATIONS IN RETICULUM SEDIMENTS, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.01 <6.4	0.04 ± 0.01 37 ± 11	0.47 ± 0.04 410 ± 39	0.02 ± 0.01 15 ± 5.3	0.3 ± 0.03 260 ± 28	88
2	<0.01 <7.9	0.04 ± 0.02 31 ± 13	0.88 ± 0.07 720 ± 60	0.02 ± 0.01 19 ± 5.9	0.91 ± 0.07 750 ± 61	82
3	0.01 ± 0.01 10 ± 9.2	0.11 ± 0.03 110 ± 28	0.25 ± 0.03 250 ± 32	0.007 ± 0.006 7.4 ± 5.6	0.25 ± 0.03 250 ± 320	100
4	<0.01 <6.8	0.03 ± 0.02 23 ± 15	0.34 ± 0.01 290 ± 85	<0.02 <15	0.2 ± 0.07 170 ± 58	85
5	<0.08 <67	0.8 ± 0.45 700 ± 400	0.42 ± 0.14 370 ± 120	<0.02 <14	0.35 ± 0.13 310 ± 110	88
6	<0.01 <10	0.05 ± 0.03 44 ± 24	0.56 ± 0.09 450 ± 75	0.02 ± 0.01 14 ± 9.6	0.51 ± 0.09 410 ± 69	81
7	SAMPLE NOT COLLECTED					
Median	<0.01 9	0.05 40.5	0.45 390	0.02 17	32.5 285	86.5
Range	<0.01-<0.08 <6.4-<67	0.03-0.11 23-700	0.25-0.88 250-720	0.007-0.02 7.4-<14	0.2-0.91 170-750	81-100

*Wet weight

B-7. ACTINIDE AND STRONTIUM CONCENTRATIONS IN FEMURS, AREA 18 CATTLE, MAY 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	9 ± 6.7 1,900 ± 1,400	<4.4 <930	4.8 ± 2.3 1,000 ± 490	<0.7 <140	3 ± 1.8 630 ± 380	<3.9 <820	3.4 ± 1 710 ± 210	21
2	<3.9 <1,200	15 ± 4.5 4,800 ± 1,400	1.9 ± 1.9 600 ± 590	<0.7 <230	2.6 ± 1.8 800 ± 570	<6.1 <1,900	15 ± 1.7 4,500 ± 520	31
3	<3.9 <820	5.2 ± 3.5 1,100 ± 740	7.6 ± 3.2 1,600 ± 680	<2.1 <440	2.7 ± 2.4 560 ± 500	<3 <630	1.8 ± 0.76 380 ± 160	21
4	<3.6 <890	10 ± 4.4 2,500 ± 1,100	2 ± 1.9 510 ± 480	<0.88 <220	<1.8 <440	<1.1 <280	3.2 ± 0.88 800 ± 220	25
5	<3.6 <930	<2.7 <700	6.2 ± 3.2 1,600 ± 820	<0.85 <220	<1.7 <450	<3.7 <950	4.2 ± 1 1,100 ± 260	26
6	<2.6 <770	<6 <1,800	2.2 ± 1.1 660 ± 660	<1.2 <350	<1.8 <530	<3.7 <1,100	2.6 ± 0.93 780 ± 280	30
7	<8.6 <1,900	36 ± 17 7,900 ± 3,800	15 ± 4.2 3,400 ± 930	<1 <230	15 ± 4.1 3,300 ± 910	<43 <9,400	3.3 ± 0.86 730 ± 190	22
Median	<3.9 <930	<6 <1,800	4.8 1,000	<0.88 <230	2.6 560	<3.7 <950	3.3 780	25
Range	<2.6-9 <770-1,900	<2.7-36 <700-7,900	1.9-15 510-3,400	<0.7-<2.1 <140-<440	<1.7-15 <440-3,300	<1.1-<43 <280-<9,400	1.8-15 380-4,500	21-31

*Wet weight

B-8. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,* AREA 18 CATTLE, MAY 1975

Animal No.	Rumen Contents K (g/kg) ^{137}Cs (pCi/kg)	Liver K (g/kg)	Lungs K (g/kg)	Muscle K (g/kg) ^{137}Cs (pCi/kg)	Kidneys K (g/kg) ^{137}Cs (pCi/kg)	Blood ^{3}H (pCi/l)
1	No analysis	4.6 ± 3.9	2.8 ± 0.6	3.6 ± 0.5 60 ± 14	2.1 ± 0.2 <MDA	<240
2	GSN	3.5 ± 2.8	Sample lost	GSN	2.6 ± 0.1 <MDA	<240
3	0.88 ± 0.3 19 ± 8.3	GSN	2.7 ± 0.3	3.8 ± 2.6 44 ± 4	GSN	280 ± 240
4	0.55 ± 0.2 <MDA	3.8 ± 3.5	2.8 ± 0.4	3.9 ± 0.3 41 ± 6.4	GSN	620 ± 250
5	GSN	2.6 ± 0.3	3.5 ± 0.9	4.1 ± 4 <MDA	GSN	410 ± 250
6	GSN	2.8 ± 0.3	GSN	3 ± 0.3 71 ± 18	2.6 ± 1.8 36 ± 9.3	340 ± 240
7	4.5 ± 0.2 58 ± 4.9	2.2 ± 0.6	2.2 ± 0.3	3.9 ± 0.5 44 ± 6.7	1.9 ± 0.3 30 ± 3.8	<210
Median	0.88 35.7	3.2	2.8	3.85 44	2.35 33	280
Range	0.55-4.5 19-58	2.2-4.6	2.2-3.5	3-4.1 41-71	1.9-2.6 30-36	<210-620

* Wet weight
<MDA = Less than minimum detectable activity
GSN = Gamma spectrum negligible

C-1. ACTINIDE CONCENTRATIONS IN LUNGS, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
8†	<4.5 <50	44 ± 16 480 ± 180	117.3 ± 74.5 1,290 ± 820‡	<1.8 <20‡	117.3 ± 74.5 1,290 ± 820‡	1.1
9†	<5 <60	38 ± 17 460 ± 200	32 ± 13 380 ± 150	<1.7 <20	25 ± 11 300 ± 130	1.2
10†	<3.6 <40	13 ± 7.3 140 ± 80	91 ± 47 1,000 ± 520	<3.6 <40	41 ± 26 450 ± 290	1.1
11†	25 ± 13 270 ± 140	380 ± 62 4,200 ± 680	45 ± 12 500 ± 130	<1.8 <20	36 ± 10.9 400 ± 120	1.1
12†	9.1 ± 4.5 100 ± 50	86 ± 13 950 ± 140	31 ± 8.2 340 ± 90	<1.8 <20	36 ± 7.3 400 ± 80	1.1
13†§	22.7 ± 9.1 340 ± 100	220 ± 20 3,300 ± 300	570 ± 80 8,500 ± 1,200	<7.3 <110	187 ± 41.3 2,800 ± 620	1.5
Dupl. 13†	34 ± 23.3 510 ± 350	449 ± 109 6,730 ± 1,640	638 ± 79 9,570 ± 1,180	<12 <180	223 ± 43 3,390 ± 640	1.5
Median	9.1 100	86 950	91 1,000	<1.8 <20	41 450	1.1
Range	<3.6-34 <40-510	13-449 140-6,730	31-638 340-9,570	<1.7-<12 <20-<180	25-223 300-3,340	1.1-1.5

*Wet weight
†Analysis by Eberline Instrument Corporation
‡Low tracer yield
§Sample split at collection and submitted for analysis as blind duplicate

C-2. ACTINIDE CONCENTRATIONS IN TRACHEOBRONCHIAL LYMPH NODES, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
8	<0.12 <2.1	<0.16 <2.8	NA	NA	NA	1.8
9	<0.05 <1.8	0.1 ± 0.08 4.1 ± 3	NA	NA	NA	4
10	0.33 ± 0.22 8.3 ± 5.4	<0.10 <2.4	NA	NA	NA	2.5
11	0.7 ± 0.3 3.7 ± 1.8	5.4 ± 0.9 29 ± 5.3	NA	NA	NA	0.54
12	5.4 ± 3.3 54 ± 33	31 ± 6 310 ± 60	NA	NA	NA	1
13	8.3 ± 3.8 240 ± 110	19 ± 4.5 550 ± 130	NA	NA	NA	2.9
Median	0.52 6	2.8 16.5	--	--	--	2.15
Range	<0.05-8.3 <1.8-240	<0.1-31 <2.4-550	--	--	--	0.54-4

*Wet weight
NA = Not analyzed

C-3. ACTINIDE CONCENTRATIONS IN MUSCLES, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
8†	<3.6 <40	24 ± 13 260 ± 140	12 ± 8.2 130 ± 90	<1.8 <20	14 ± 10 150 ± 110	1.1
9†	<1.8 <20	9.1 ± 5.5 100 ± 60	26 ± 14 290 ± 150	<1.8 <20	21 ± 12 230 ± 130	1.1
10†	<2.2 <20	7.9 ± 5.6 70 ± 50	42 ± 19 370 ± 170	<2.2 <20	29 ± 16 260 ± 140	0.89
11†	<1.8 <20	<1.8 <20	78 ± 21 860 ± 230	<8.2 <90	48 ± 18 530 ± 200	1.1
12†	<2.1 <20	5.3 ± 4.2 50 ± 40	55 ± 15 520 ± 140	<2.1 <20	39 ± 13 370 ± 120	0.95
13† §	<2.1 <30	27 ± 7 380 ± 100	400 ± 51.4‡† 5,600 ± 720	<5.7‡† <80	106 ± 23†† 1,490 ± 320	1.4
Dupl. 13‡	<2.1 <30	10.7 ± 5 150 ± 70	386 ± 84.3‡† 5,400 ± 1,180	<2.1‡† <30	123.6 ± 43‡† 1,730 ± 600	1.4
Median	<2.1 <20	9.1 100	55 520	<2.1 <20	39 370	1.1
Range	<1.8-<3.6 <20-<40	<1.8-27 <20-380	12-400 130-5,600	<1.8-<8.2 <20-<90	14-123.6 150-1,730	0.89-1.4

*Wet Weight
‡Analysis by Eberline Instrument Coporation
†Recount verified original result.
§Sample split at collection and submitted for analysis as blind duplicate

C-4. ACTINIDE CONCENTRATIONS IN LIVERS, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
8	2.2 ± 1.9 16 ± 14	32 ± 5.3 240 ± 39	NA	NA	NA	0.74
9†	<2 <30	<2 <30	<65 <980	<2 <30	<65 <980	1.5
10†	<19 <300	190 ± 94 3,100 ± 1,500	32 ± 21 520 ± 330	<2.5 <40	31 ± 19 490 ± 310	1.6
11†	<5.3 <80	100 ± 25 1,500 ± 370	<73 <1,100	<2 <30	<87 <1,300	1.5
12†	<2.1 <30	<49 <690	<79 <1,100	<2.1 <30	<79 <1,100	1.4
13† §	<2.3 <30 ‡	47 ± 34 610 ± 440‡	52 ± 25.4 680 ± 330	<2.3 <30	46 ± 23 600 ± 300	1.3
Dupl. 13†	<2.3 <30	84 ± 41 1,090 ± 530	31.5 ± 16 410 ± 210	<2.3 <30	31.5 ± 16 410 ± 210	1.3
Median	<2.3 <30	<49 <690	<58.5 <830	<2.2 <30	<55.5 <790	1.4
Range	<2-<19 16-<300	<2-190 <30-3,100	31.5-<79 410-<1,100	<2-<2.8 <30-<40	31-<87 410-<1,300	0.74-1.6

*Wet weight
NA = Not analyzed
†Analysis by Eberline Instrument Corporation
‡Low tracer yield
§Sample split at collection and submitted for analysis as blind duplicate

C-5. ACTINIDE CONCENTRATIONS IN RUMEN CONTENTS, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
8	0.042 ± 0.0096 2 ± 0.460	0.150 ± 0.020 7.1 ± 0.960	NA	NA	NA	4.8
9	0.003 ± 0.009 0.490 ± 0.190	0.1 ± 0.023 2.2 ± 0.480	NA	NA	NA	2.1
10	0.032 ± 0.008 1 ± 0.250	0.420 ± 0.039 13 ± 1.2	NA	NA	NA	3.1
11	11 ± 0.09 40 ± 33	0.56 ± 0.24 200 ± 85	NA	NA	NA	36
12	0.080 ± 0.014 2.4 ± 0.430	1.7 ± 0.13 51 ± 4	NA	NA	NA	3
13	0.035 ± 0.010 0.780 ± 0.220	0.350 ± 0.042 7.7 ± 0.920	NA	NA	NA	2.2
Median	0.039 2.2	0.39 10.4	--	--	--	3.05
Range	0.003-0.11 0.49-40	0.1-1.7 2.2-200	--	--	--	2.1-36

*Wet weight
NA = Not analyzed

C-6. ACTINIDE CONCENTRATIONS IN RETICULUM SEDIMENTS, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
8	0.07 ± 0.02 66 ± 22	0.1 ± 0.03 100 ± 27	NA	NA	NA	100
9	0.02 ± 0.01 14 ± 6.4	0.22 ± 0.03 150 ± 220	NA	NA	NA	68
10	NA	NA	NA	NA	NA	NA
11	0.150 ± 0.024 150 ± 29	0.520 ± 0.059 520 ± 59	NA	NA	NA	100
12	<0.009 <4.9	0.032 ± 0.012 18 ± 6.7	NA	NA	NA	56
13	0.25 ± 0.047 38 ± 7.1	3.2 ± 0.35 480 ± 52	NA	NA	NA	15
Median	0.07 38	0.22 150	--	--	--	68
Range	<0.009-0.25 <4.9-150	0.032-3.2 100-520	--	--	--	15-100

*Wet weight
NA = Not analyzed

C-7. ACTINIDE AND STRONTIUM CONCENTRATIONS IN FEMURS, AREA 18 CATTLE, OCTOBER 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
8	<3.8 <880	31 ± 14 7,200 ± 3,200	9.1 ± 3.7 2,100 ± 840	<0.35 <80	7 ± 3.2 1,600 ± 740	<16 <3,700	2.9 ± 1.3 660 ± 300	23
9	<1.4 <300	76 ± 29 16,000 ± 6,100	16 ± 6.2 3,400 ± 1,300	<1.6 <340	13 ± 5.7 2,800 ± 1,200	<14 <3,000	1.9 ± 1.2 400 ± 250	21
10	<1.7 <300	<2.6 <470	13 ± 4.7 2,400 ± 840	<0.72 <130	7.2 ± 3.4 1,300 ± 620	<27 <4,800	2.6 ± 1.2 460 ± 220	18
11	<3.6 <900	<4 <1,000	9.6 ± 3.6 2,400 ± 910	<0.7 <170	6.4 ± 3 1,600 ± 750	<14 <3,600	2.2 ± 1.2 550 ± 300	25
12	<1.3 <360	3.4 ± 3.1 930 ± 840	16 ± 5.6 4,200 ± 1,500	<0.37 <100	7.8 ± 3.7 2,100 ± 1,000	<13 <3,600	2.4 ± 1.1 640 ± 290	27
13	<0.18 <50	<1.1 <320	10 ± 3.9 2,900 ± 1,100	<0.32 <90	9.6 ± 3.6 2,700 ± 1,000	<14 <3,800	3 ± 0.8 850 ± 220	28
Median	<1.55 <330	<3.7 <965	11.5 2,650	<0.535 <115	7.5 1,850	<14 <3,650	2.5 595	24
Range	<0.18-<3.8 <50-<900	<1.1-76 <320-16,000	9.1-16 2,100-4,200	<0.32-<1.6 <80-<340	6.4-13 1,300-2,800	<13-<27 <3,000-<4,800	1.9-3 400-850	18-28

*Wet weight

C-8. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,* AREA 18 CATTLE, OCTOBER 1975

Animal No.	Rumen Contents K (g/kg) ^{137}Cs (pCi/kg)	Liver K (g/kg)	Lungs K (g/kg)	Muscle K (g/kg) ^{137}Cs (pCi/kg)	Kidneys K (g/kg) ^{137}Cs (pCi/kg)	Blood ^{3}H (pCi/l)
8	1.8 ± 0.2 27 ± 1.8	3.1 ± 0.2	2.2 ± 0.3	3 ± 0.6 29 ± 7.5	No analysis	510 ± 210
9	2.3 ± 0.3 <MDA	3.1 ± 0.4	2.9 ± 0.3	4.6 ± 0.3 <MDA	2.8 ± 0.3 26 ± 3.4	360 ± 210
10	1.7 ± 0.4 <MDA	4.3 ± 0.2	2.7 ± 0.7	4.3 ± 0.3 <MDA	2.7 ± 0.4 39 ± 9.7	1,100 ± 220
11	2.5 ± 0.3	3.1 ± 0.2	2.7 ± 0.8	4.1 ± 0.4 <MDA	2.1 ± 0.3 <MDA	220 ± 200
12	1.7 ± 0.3 20 ± 5.6	1.9 ± 0.2	3 ± 0.9	3.5 ± 0.2 <MDA	No analysis	440 ± 210
13	1.5 ± 0.3 15 ± 30	No analysis	No analysis	No analysis	2 ± 0.2 19 ± 3.1	330 ± 210
Median	1.75 20	3.1	2.7	4.1 <MDA	2.4 26	400
Range	1.5-2.5 15-27	1.9-4.3	2.2-3	3-4.6 <MDA-29	2-2.8 19-39	220-1,100

* Wet weight
< MDA = Less than minimum detectable activity

D-1. ACTINIDE CONCENTRATIONS IN LUNGS, NTS, MULE DEER, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
1	<6.5 <130	23 ± 7.5 470 ± 150	NA	NA	NA	2
2	26 ± 9.3 360 ± 130	10 ± 8.6 140 ± 120	NA	NA	NA	1.4
3†	27 ± 20 570 ± 420	41 ± 25 870 ± 520	19 ± 5.2 400 ± 110	<1.4 <30	16 ± 4.8 330 ± 100	2.1
4†	<5.5 <60	22 ± 9.1 240 ± 100	40 ± 15 440 ± 160	<2.7 <30	21 ± 10 230 ± 110	1.1
5	SAMPLE NOT COLLECTED					
6†	<3.6 <40	11 ± 6.4 120 ± 70	41 ± 25 450 ± 270	<3.6 <40	41 ± 25 450 ± 270	1.1
7†	<10 <120	62 ± 20 740 ± 240	41 ± 27 490 ± 320	<2.5 <30	47 ± 28 560 ± 340	1.2
8†	67 ± 15‡ 740 ± 160	590 ± 55‡ 6,500 ± 610	89 ± 31 980 ± 340	<2.7 <30	82 ± 29 900 ± 320	1.1
Median	<10 <130	23 470	41 450	<2.7 <30	41 450	1.2
Range	<3.6-67 <40-740	10-590 120-6,500	19-89 400-980	<1.4-<3.6 <30-<40	16-82 230-900	1.1-2.1

*Wet weight
NA = Not analyzed
†Analysis by Eberline Instrument Corporation
‡Recount verified original result.

D-2. ACTINIDE CONCENTRATIONS IN MUSCLES, NTS, MULE DEER, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	Ash (%)
1	<3.1 <44	<1.8 <25	NA	NA	NA	1.4
2†	4.7 ± 3.7 90 ± 70	7.4 ± 4.7 140 ± 90	NA	NA	NA	1.9
3†	<7.2 <130	48 ± 17 860 ± 310	52 ± 13 930 ± 240	3.9 ± 3.3 70 ± 60	23 ± 8.3 410 ± 150	1.8
4†	<25‡† <280	210 ± 67‡† 2,300 ± 740	35 ± 17 390 ± 190	<1.8 <20	28 ± 15 310 ± 170	1.1
5†	<2.7 <30	11 ± 5.5 120 ± 60	19 ± 11 210 ± 120	<1.8 <20	24 ± 14 260 ± 150	1.1
6†	<2.5 <30	<4.2 <50	42 ± 17 510 ± 210	<2.5 <30	37 ± 16 440 ± 190	1.2
7†	<2.5 <30	13 ± 7.5 160 ± 90	14 ± 9.2 170 ± 110	<2.5 <30	16 ± 10 190 ± 120	1.2
8†	<14 <150	56 ± 21 620 ± 230	74 ± 32 810 ± 350	<2.7 <30	58 ± 32 640 ± 350	1.1
Median	<3.9 <67	12 150	38.5 450	<2.5 <30	26 360	1.2
Range	<2.5-<25 <30-<280	<1.8-210 <25-2,300	14-74 170-930	<1.8-3.9 <20-70	16-58 190-640	1.1-1.9

*Wet weight
NA = Not analyzed
‡Analysis by Eberline Instrument Corporation
†Recount verified original result.

D-3. ACTINIDE CONCENTRATIONS IN LIVERS, NTS, MULE DEER, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/g*)	Ash (%)
1	<4.6 <130	<6.4 <180	NA	NA	NA	2.8
2†	<9.1 <410	7.6 ± 7.6 340 ± 340	14 ± 8.4 620 ± 380	<1.1 <50	7.6 ± 6.2 340 ± 280	4.5
3†	<8.2 <180	55 ± 23 1,200 ± 510	24 ± 19 530 ± 410	<3.2 <70	24 ± 19 530 ± 410	2.2
4†	<4.6 <60	42 ± 28 540 ± 370	39 ± 21 510 ± 270	<4.6 <60	27 ± 15 350 ± 200	1.3
5	SAMPLE NOT COLLECTED					
6†	<4.3 <60	30 ± 21 420 ± 300	37 ± 18 520 ± 250	<2.1 <30	46 ± 21 650 ± 300	1.4
7†	NA	NA	24 ± 12 360 ± 180	<2 <30	21 ± 11 320 ± 170	1.5
8†	79 ± 19‡ 1,100 ± 270	1,000 ± 110‡ 14,000 ± 1,500	38 ± 17 530 ± 240	<1.4 <20	24 ± 14 340 ± 190	1.4
Median	<6.4 <155	36 480	30 525	<2.1 <40	24 345	1.5
Range	<4.3-79 <60-1,100	<6.4-1,000 180-14,000	14-39 360-620	<1.1-<4.6 <20-<70	7.6-46 320-650	1.3-4.5

*Wet weight
NA = Not analyzed
†Analysis by Eberline Instrument Corporation
‡Recount verified original result.

D-4. ACTINIDE CONCENTRATIONS IN RUMEN CONTENTS, NTS, MULE DEER, 1975

Animal No.	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{234}U (pCi/g Ash) (pCi/kg*)	^{235}U (pCi/g Ash) (pCi/kg*)	^{238}U (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.05 ± 0.01 0.43 ± 0.1	0.12 ± 0.02 1.1 ± 0.15	1.2 ± 0.37 11 ± 3.3	0.06 ± 0.06 0.56 ± 0.52	1.1 ± 0.34 10 ± 3	0.89
2	0.01 ± 0.01 0.23 ± 0.16	0.06 ± 0.01 1.8 ± 0.4	0.08 ± 0.03 2.4 ± 0.86	<0.01 <0.22	0.07 ± 0.03 2 ± 0.78	3.1
3	0.16 ± 0.0073 0.35 ± 0.16	0.073 ± 0.015 1.6 ± 0.32	0.059 ± 0.011 1.3 ± 0.24	0.003 ± 0.0026 0.07 ± 0.06	0.05 ± 0.0095 1.1 ± 0.21	2.2
4	0.02 ± 0.01 0.19 ± 0.12	0.17 ± 0.03 2.2 ± 0.35	NA	NA	NA	1.3
5	SAMPLE NOT COLLECTED					
6	0.038 ± 0.013 0.99 ± 0.33	0.16 ± 0.026 4.2 ± 0.67	NA	NA	NA	2.6
7	0.027 ± 0.014 0.93 ± 0.48	0.094 ± 0.025 3.3 ± 0.89	NA	NA	NA	3.5
8	0.21 ± 0.5 4.7 ± 1.1	0.77 ± 0.12 17 ± 2.7	NA	NA	NA	2.2
Median	0.038 0.43	0.12 2.2	0.08 2.4	<0.01 <0.22	0.07 2	2.2
Range	0.01-0.21 0.19-4.7	0.06-0.77 0.094-17	0.059-1.2 1.3-11	0.003-0.06 0.07-0.56	0.05-1.1 1.1-10	0.89-3.5

*Wet weight
NA = Not analyzed

D-5. ACTINIDE AND STRONTIUM CONCENTRATIONS IN HOCK BONES, NTS, MULE DEER, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{234}U (fCi/g Ash) (fCi/kg*)	^{235}U (fCi/g Ash) (fCi/kg*)	^{238}U (fCi/g Ash) (fCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<3.2 <680	<2.9 <600	2.9 ± 2.3 600 ± 490	<1.2 <260	2.6 ± 2 540 ± 430	<1.1 <230	0.57 ± 0.43 120 ± 90	21
2	<7.1 <1,700	<13 <3,000	<5 <1,200	<2.2 <540	<4.2 <1,000	<2.2 <520	2.6 ± 0.88 620 ± 210	24
3	SAMPLE LOST							
4†	<3.2 <910	8.6 ± 7.9 2,400 ± 2,200	16 ± 4.6 4,400 ± 1,300	<1.2 <340	11 ± 3.6 3,000 ± 1,000	<1.3 <360	2.1 ± 0.75 580 ± 210	28
5†	<4.8 <1,400	<10 <3,000	11 ± 3.1 3,300 ± 910	<0.86 <250	10 ± 2.9 3,000 ± 830	<1.8 <530	3 ± 0.93 880 ± 270	29
6†	<14 <3,000	<17 <3,600	21 ± 5.2 4,400 ± 1,100	<0.86 <180	22 ± 5.2 4,700 ± 1,100	<1.5 <320	2.8 ± 0.90 590 ± 190	21
7†	<5.3 <1,000	11 ± 6.3 2,000 ± 1,200	17 ± 6.3 3,200 ± 1,200	<0.58 <110	19 ± 6.8 3,600 ± 1,300	<1.4 <270	2 ± 0.84 380 ± 160	19
8†	130 ± 46 35,000 ± 13,000	2,700 ± 570 750,000 ± 160,000	27 ± 5.7 7,600 ± 1,600	<0.36 <100	20 ± 4.6 5,500 ± 1,300	<1.4 <400	3 ± 0.86 830 ± 240	28
Median	<5.3 <1,400	11 <3,000	16 3,300	<0.86 <250	11 3,000	<1.4 <360	2.6 590	24
Range	<3.2-130 <680-35,000	<2.9-2,700 <600-750,000	2.9-27 600-7,600	<0.36-<2.2 <100-<540	2.6-22 540-5,500	<1.1-<2.2 <230-<530	0.57-3 120-880	19-29

*Wet weight

†Actinide analysis by Eberline Instrument Corporation (Reanalysis of sample #8, and recounts of samples #4, 5, 6, and 7, verified original results reported, both for plutonium and uranium.)

D-6. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, NTS, MULE DEER, 1975

Animal No.	Rumen Contents K (g/kg)* ^{137}Cs (pCi/kg)	Liver K (g/kg)	Lungs K (g/kg) ^{137}Cs (pCi/kg)	Muscle K (g/kg) ^{137}Cs (pCi/kg)	Kidney K (g/kg) ^{137}Cs (pCi/kg)	Blood ^{3}H (pCi/l)
1	No analysis	2.3 ± 0.4 <MDA	GSN	3.4 ± 0.2 <MDA	3.4 ± 0.7 <MDA	990 ± 230
2	Sample lost	3 ± 0.2 29 ± 6.2	2.9 ± 0.9 43 ± 4.1	3.3 ± 0.3 38 ± 11	2.3 ± 0.2 49 ± 8.7	590 ± 250
3	2.1 ± 0.3 15 ± 9.5	3.5 ± 0.5 <MDA	2.1 ± 0.5 MDA	2.9 ± 0.3 27 ± 10	2.8 ± 0.3 <MDA	In analysis
4	1.8 ± 0.4 <MDA	2.8 ± 0.3 <MDA	1.9 ± 0.6 <MDA	3 ± 0.2 27 ± 2.7	4 ± 0.7 <MDA	430 ± 300
5	Sample not collected	Sample not collected	Sample not collected	4 ± 0.3 72 ± 11	Sample not collected	Sample not collected
6	3.4 ± 0.5 29 ± 6.6	1.7 ± 0.5 <MDA	2.4 ± 0.3 <MDA	3 ± 0.5 <MDA	2.9 ± 0.3 25 ± 3.6	In analysis
7	4.1 ± 0.5 <MDA	3.3 ± 0.3 <MDA	2.7 ± 0.1 <MDA	3.4 ± 0.5 <MDA	1.8 ± 0.4 22 ± 3.1	In analysis
8	1.9 ± 0.3 53 ± 3.2	2.5 ± 0.1 14 ± 2.1	2 ± 0.4 24 ± 7	2.8 ± 0.5 140 ± 14	2.2 ± 0.4 <MDA	In analysis
Median	2.1 29	2.8 <MDA	2.3 <MDA	3.2 38	2.8 25	
Range	1.8-4.1 15-53	1.7-3.5 <MDA-29	1.9-2.9 <MDA-43	2.8-4 27-140	1.8-4 22-49	

* Wet weight
<MDA = Less than minimum detectable activity
GSN = Gamma spectrum negligible

E-1. ACTINIDE CONCENTRATIONS* IN LUNGS, DESERT BIGHORN SHEEP, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg†)	^{239}Pu (fCi/g Ash) (fCi/kg†)	Ash (%)	Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg†)	^{239}Pu (fCi/g Ash) (fCi/kg†)	Ash (%)
1	6.25 ± 2.08 110 ± 40	34.4 ± 5.2 610 ± 90	1.8	15	64 ± 20 1,190 ± 370	100 ± 28 1,860 ± 520	1.9
2	<8.33 <260	20.8 ± 8.3 660 ± 260	3.2	16	9.73 ± 4.32 220 ± 100	29.2 ± 7.6 650 ± 170	2.2
3	17.6 ± 4 300 ± 70	24.3 ± 5.4 410 ± 90	1.7	17	6.32 ± 4.21 130 ± 90	56.8 ± 12.6 1,160 ± 260	2
4	21 ± 7.6 540 ± 200	17.1 ± 7.6 440 ± 200	2.6	19	27.7 ± 12.6 580 ± 320	88.2 ± 25.2 2,240 ± 640	2.6
5	18.7 ± 4.7 300 ± 80	32.7 ± 6.2 530 ± 100	1.6	20	16.8 ± 7 220 ± 90	107 ± 20 1,400 ± 260	1.3
6	<2.56 <40	6.7 ± 3.8 290 ± 70	1.7	22	10 ± 4 210 ± 90	89 ± 12 1,900 ± 260	2.1
7	5.56 ± 2.78 140 ± 70	55.6 ± 11.1 1,390 ± 280	2.5	23	<6.9 <200	<6.9 <200	2.9
8	22.2 ± 8.9 470 ± 190	40 ± 13.3 840 ± 280	2.1	24	12.4 ± 6.9 260 ± 140	26.2 ± 9.7 540 ± 200	2.1
9	12.5 ± 3.6 210 ± 60	24 ± 5.4 420 ± 90	1.7	25	51.4 ± 28.6‡ 970 ± 540	297 ± 74‡ 5,629 ± 1,410	1.9
10	<18.8 <320	<31.2 <530	1.7	Median	12.4 220	34.4 650	2.1
11	3.09 ± 2.06 90 ± 60	47.3 ± 7.2 1,410 ± 210	2.97	Range	<2.56-64 <40-1,190	<6.9-297 130-5,620	1.3-3.2
12	6.56 ± 4.92 140 ± 100	11.5 ± 6.6 240 ± 140	2.1				
13	15.7 ± 4.5 480 ± 140	42.7 ± 9 1,300 ± 270	3.1				
14	8.33 ± 3.57 150 ± 60	79.8 ± 10.7 1,430 ± 190	1.8				

*All analyzed by Eberline Instrument Company
†Wet weight
‡Recount verified original result.

E-2. ACTINIDE AND STRONTIUM CONCENTRATIONS IN BONE, DESERT BIGHORN SHEEP, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<1 <340	<1.1 <390	<9.1 <3,100	2.4 ± 0.85 820 ± 290	34
2		SAMPLE NOT COLLECTED			
3	<1.3 <390	1.7 ± 1.3 500 ± 370	<7.6 <2,200	3.8 ± 0.9 1,100 ± 260	29
4	<1.4 <510	<0.7 <260	<8.6 <3,200	3.2 ± 0.86 1,200 ± 320	37
5	<0.9 <310	<0.7 <240	<6.8 <2,300	2.7 ± 0.82 920 ± 280	34
6	<2 <550	<1.7 <450	<7.4 <2,000	1.9 ± 0.67 520 ± 180	27
7	<1.6 <530	<2.2 <740	<11 <3,500	4.8 ± 0.94 1,600 ± 310	33
8	<2.3 <890	<2.5 <960	<4.5 <1,700	24 ± 4.2 9,100 ± 1,600	38
9	<1.7 <440	5.8 ± 2.9 1,500 ± 750	<6.5 <1,700	3.2 ± 0.58 840 ± 150	26
10	<2 <530	<1.8 <480	<7.4 <2,000	2.4 ± 0.56 660 ± 150	27
11	<1.6 <430	3 ± 1.7 800 ± 460	<4.8 <1,300	2 ± 0.56 540 ± 150	27
12	<2.6 <690	<2.8 <760	<8.1 <2,200	2.2 ± 0.7 590 ± 190	27
13	<2 <430	8.6 ± 3.9 1,800 ± 810	<8.6 <1,800	5.2 ± 0.81 1,100 ± 170	21
14		SAMPLE NOT COLLECTED			
15	<3.2 <1,100	<2.2 <750	<4.7 <1,600	3.2 ± 0.56 1,100 ± 190	34
16	<2.7 <570	<3.7 <780	<34 <7,200	23 ± 3.4 4,800 ± 720	21
17	1.7 ± 1.3 590 ± 440	7.9 ± 2.6 2,700 ± 890	<7.6 <2,600	6.5 ± 0.94 2,200 ± 320	34
18	<1.6 <530	<1.8 <610	<14 <4,600	4.5 ± 1 1,500 ± 340	33
19		SAMPLE NOT COLLECTED			
20	<0.96 <230	17 ± 3.8 4,000 ± 920	<5 <1,200	40 ± 6.7 9,600 ± 1,600	24
21	<2.1 <650	3.2 ± 2.3 990 ± 700	<7.6 <1,500	19 ± 6.1 6,000 ± 1,900	31
Median	<1.7 <530	<2.4 <755	<7.6 <2,200	3.5 1,100	30
Range	<0.9-<3.2 <230-<1,100	<0.7-17 <240-4,000	<4.5-110 <1,200-<3,500	1.9-40 520-9,600	21-38

*Wet weight
Note: Uranium-234, -235, and -238 were not analyzed.

E-3. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,* DESERT BIGHORN SHEEP, 1975

Animal No.	Lungs K (g/kg) ^{137}Cs (pCi/kg)	Kidneys K (g/kg) ^{137}Cs (pCi/kg)	Kidneys ^{3}H (pCi/l)
1	0.8 ± 0.5 <MDA	2.7 ± 0.6 53 ± 24	620 ± 250
2	GSN	3.5 ± 0.6 <MDA	<240
3	0.6 ± 0.4 <MDA	4.1 ± 0.6 110 ± 20	280 ± 240
4	1.7 ± 0.3 <MDA	2.3 ± 0.3 26 ± 9.9	<240
5	7.8 ± 0.7 <MDA	2.5 ± 3.3 38 ± 7.8	<240
6	1.7 ± 0.4 <MDA	4.2 ± 0.6 <MDA	340 ± 307
7	2 ± 1 <MDA	3.7 ± 0.5 61 ± 25	500 ± 240
8	0.8 ± 0.7 <MDA	4.4 ± 0.9 <MDA	<307
9	1.9 ± 0.6 <MDA	4.5 ± 1 590 ± 12	470 ± 309
10	GSN	7.3 ± 0.8 52 ± 12	<310
11	5.6 ± 0.7 <MDA	3.9 ± 1.1 <MDA	<310
12	3.1 ± 1.2 <MDA	5.5 ± 0.8 40 ± 8.6	<310
13	2.4 ± 0.3 36 ± 6.3	3.5 ± 2.8 <MDA	<280
14	1.8 ± 0.02 <MDA	4.5 ± 0.7 43 ± 10	<300

E-3. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES,* DESERT BIGHORN SHEEP, 1975 (continued)

Animal No.	Lungs K (g/kg) ^{137}Cs (pCi/kg)	Kidneys K (g/kg ^{137}Cs (pCi/kg)	Kidneys ^{3}H (pCi/l)
15	0.9 ± 0.2 <MDA	2.9 ± 1.2 <MDA	<310
16	0.8 ± 0.7 <MDA	Sample not collected	Sample not collected
17	1.8 ± 0.2 30 ± 40	2.5 ± 0.4 71 ± 4.8	<310
18	Sample not collected	Sample not collected	Sample not collected
19	1.7 ± 0.6 <MDA	2.7 ± 0.5 <MDA	<310
20	Analysis incomplete	Sample not collected	Sample not collected
21	Sample not collected	2.3 ± 0.6 83 ± 15	<310
22	1 ± 0.6 <MDA	3.3 ± 1.4 110 ± 55	<310
23	1 ± 0.9	1.4 ± 0.9 <MDA	<280
24	GSN	Sample not collected	Sample not collected
25	GSN	Sample not collected	Sample not collected
Median	1.7 <MDA	3.5 57	<310
Range	0.6-7.8 <MDA-36	1.4-7.3 <MDA-590	<240-620

* Wet weight
<MDA = Less than minimum detectable activity
GSN = Gamma spectrum negligible

F-1. ACTINIDE AND STRONTIUM CONCENTRATIONS IN BONE, NTS, AREA 15, RABBITS, 1975

Animal No.	^{238}Pu (fCi/g Ash) (fCi/kg*)	^{239}Pu (fCi/g Ash) (fCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<9 <990	14 ± 11 1,500 ± 1,200	<10 <1,100	8.3 ± 1.6 910 ± 180	11
2	<2.3 <230	24 ± 6.8 2,400 ± 680	<12 <1,200	11 ± 2 1,100 ± 200	10
3	<6.2 <580	<9.1 <860	<11 <1,000	10 ± 1.8 980 ± 170	9.4
4	<3.5 <320	15 ± 5.2 1,400 ± 480	<20 <1,800	37 ± 3.2 3,400 ± 290	9.2
5	<10 <1,000	55 ± 16 5400 ± 1,600	<21 <2,100	37 ± 3.5 3,600 ± 340	9.8
6	<9.9 <930	41 ± 13 3,900 ± 1,200	<10 <950	15 ± 2.1 1,400 ± 2,100	9.4
Median	<7.6 <750	19.5 1,950	<11.5 <1,150	13 1,250	9.6
Range	<2.3-<10 <230-<1,000	<9.1-55 <860-5,400	<10-<21 <950-<2,100	8.3-37 910-3,600	9.2-11

*Wet weight

F-2. GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES,* NTS, AREA 15, RABBITS, 1975

Animal No.	Muscle K (g/kg) ^{137}Cs (pCi/kg)	Pelt K (g/kg) ^{137}Cs (pCi/kg)	G. I. Tract K (g/kg) ^{137}Cs (pCi/kg)
1	3.5 ± 0.5 58 ± 12	4.7 ± 0.5 40 ± 11	3.5 ± 0.8 <MDA
2	4.7 ± 0.9 71 ± 8.1	GSN	5.9 ± 0.4 140 ± 6.5
3	In analysis	2.6 ± 0.7 <MDA	4.4 ± 0.5 110 ± 8.4
4	3.7 ± 0.6 90 ± 7.8	1.7 ± 1.6 <MDA	3.7 ± 0.4 230 ± 18
5	3.3 ± 0.2 72 ± 5.1	1.7 ± 1.3 170 ± 20	2.9 ± 0.2 69 ± 0.3
6	4.2 ± 0.4 97 ± 12	<MDA 100 ± 18	3.5 ± 0.6 130 ± 11
Median	3.7 72	2.2 <MDA	3.6 130
Range	3.3-4.7 58-97	<MDA-4.7 <MDA-170	2.9-5.9 <MDA-230

* Wet weight
<MDA = Less than minimum detectable activity
GSN = Gamma spectrum negligible

APPENDIX G. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN NECROPSIED ANIMALS

AREA 18 CATTLE, MAY

1 Necropsy findings: Fibrinous adhesions between liver and diaphragm.

Histopathological findings: Sarocysts and mild lymphocytic infiltration of cardiac muscle.

Hematological findings: RBC/cmm 7.6 x 10^6, WBC/cmm 6 x 10^3, MCV/cu.μ 57, Hb g% 15, Hematocrit % 43.

Clinical diagnosis: Normal mature cow.

2 Necropsy findings: No gross lesions noted. Animal was in excellent condition and barren.

Histopathological findings: Slight emphysema of lungs probably from agonal struggling.

Hematological findings: RBC/cmm 7.8 x 10^6, WBC/cmm 6.2 x 10^3, MCV/cu.μ 59, Hb g% 16.4, Hematocrit % 46.

Clinical diagnosis: Normal aged cow.

3 Necropsy findings: No gross lesions noted. Rumen contents contained rubber and twine foreign objects.

Histopathological findings: No lesions noted.

Hematological findings: RCB/cmm 7.3 x 10^6, WBC/cmm 7.8 x 10^3, MCV/cu.μ 48, Hb g% 13, Hematocrit % 35.

Clinical diagnosis: Normal yearling steer.

4 Necropsy findings: Emphysematous areas in lungs as result of agonal struggling.

Histopathological findings: No lesions noted.

Hematological findings: RBC/cmm 7.2 x 10^6, WBC/cmm 5.9 x 10^3, MCV/cu.μ 55, Hb g% 13.1, Hematocrit % 40.

Clinical diagnosis: Normal mature steer.

5 Necropsy findings: No gross lesions noted.

Histopathological findings: No lesions noted.

APPENDIX G. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN NECROPSIED ANIMALS (continued)

AREA 18 CATTLE, MAY (continued)

5 Hematological findings: RBC/cmm 8.04 x 10^6, WBC/cmm 4.5 x 10^3, MCV/cu.μ 47, Hbg% 12.9, Hematocrit % 38.

Clinical diagnosis: Normal yearling steer.

6 Necropsy findings: Emphysematous areas in lungs as result of agonal struggling.

Histopathological findings: Hemosiderosis of spleen, mineralized foci in medulla of kidney.

Hematological findings: RBC/cmm 8.4 x 10^6, WBC/cmm 6.6 x 10^3, MCV/cu.μ 59, Hbg% 17.8, Hematocrit % 50.

Clinical diagnosis: Normal mature steer.

7 Necropsy findings: Not necropsied because of extensive trauma.

Histopathological findings: No samples collected.

Hematological findings: No samples collected.

Clinical diagnosis: Normal yearling heifer. Death as a result of collision with a motor vehicle.

AREA 18 CATTLE, OCTOBER

8 Necropsy findings: No gross lesions noted.

Histopathological findings: Mild lipidosis of liver. Spermatogonia present in testes, no spermatids.

Hematological findings: RCB/cmm 10.8 x 10^6, WBC/cmm 6 x 10^3, MCV/cu.μ 41, Hbg% 12.1, Hematocrit % 44.

Clinical diagnosis: Normal male calf.

9 Necropsy findings: No gross lesions noted.

Histopathological findings: Well developed follicles in the spleen. No spermatogenesis in testes.

Hematological findings: RBC/cmm 6.9 x 10^6, WBC/cmm 11 x 10^3, MCV/cu.μ 63, Hbg% 12.6, Hematocrit % 44.

Clinical diagnosis: Normal male calf.

APPENDIX G. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN NECROPSIED ANIMALS (continued)

AREA 18 CATTLE, OCTOBER (continued)

10 Necropsy findings: No gross lesions noted.

Histopathological findings: Well developed follicles in spleen. No spermatogenesis in testes.

Hematological findings: RBC/cmm 7.8 x 10^6, WBC/cmm 5.5 x 10^3, MCV/cu.μ 49, Hb g% 10.5, Hematocrit % 38.

Clinical diagnosis: Normal male calf.

11 Necropsy findings: Pregnant with 60-day fetus, slight adhesions between rumen and diaphragm.

Histopathological findings: Hemorrhage in lung, probably terminal congestion. Cortical congestion of adrenal. Several developing follicles in ovary. Hemosiderosis of spleen.

Hematological findings: RBC/cmm 7 x 10^6, WBC/cmm 5.5 x 10^3, MCV/cu.μ 61, Hb g% 12.6, Hematocrit % 43.

Clinical diagnosis: Normal mature cow.

12 Necropsy findings: Extensive squamous cell carcinoma of left eye and orbit. No other gross lesions noted.

Histopathological findings: Squamous cell carcinoma of eye. Lipidosis of liver, focal pleural fibrosis of lung, mineralization of pelvis of kidney, focal ulceration and inflamation of eyelid.

Hematological findings: RBC/cmm 6.5 x 10^6, WBC/cmm 5.6 x 10^3, MCV/cu.μ 63, Hb g% 12.3, Hematocrit % 41.

Clinical diagnosis: Aged cow with squamous cell carcinoma.

13 Necropsy findings: No gross lesions noted. Pregnant with 45-day fetus.

Histopathological findings: No lesions noted.

Hematological findings: RBC/cmm 6.6 x 10^6, WBC/cmm 6.3 x 10^3, MCV/cu.μ 65, Hb g% 13.1, Hematocrit % 43.

Clinical diagnosis: Normal mature cow.

MULE DEER

1-6 All these deer were victims of collision with motor vehicles. Necropsies revealed extensive trauma in all cases. Histopathology and hematology samples were not collected as advanced postmortem changes had occurred

APPENDIX G. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN NECROPSIED ANIMALS (continued)

MULE DEER (continued)

prior to necropsy. No disease conditions had occurred prior to necropsy. All apparently normal at time of death.

7 Necropsy findings: Animal was euthanized following an unsuccessful attempt to capture with immobilizing drugs administered by a syringe projectile fired from a powder-powered capture gun. The syringe penetrated the thoracic cavity and did extensive trauma to the lungs. No other gross lesions noted.

Histopathological findings: No lesions noted.

Hematological findings: Blood sample not collected.

Clinical diagnosis: Normal mature female deer.

8 Necropsy findings: Extensive trauma as a result of collision with a motor vehicle. No disease conditions noted. Histopathology and hematology samples not collected as advanced postmortem changes had occurred by time of necropsy. Animal was apparently normal at time of death.

DESERT BIGHORN SHEEP

All sheep sampled were collected by participants in annual hunt. No necropsies performed, but all animals appeared to be healthy. All were mature males.

COYOTE

Necropsy findings: No gross lesions noted. Stomach contents consisted largely of rabbit tissue.

Histopathological findings: No lesions noted.

Hematological findings: Blood samples not collected.

Clinical diagnosis: Normal immature female.

*As reported by senior author.
†As reported by Dr. Billy C. Ward, College of Veterinary Medicine, Drawer V, Mississippi State University, Starkville, Mississippi.

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
1	*Ephedra nevadensis*	Nevada joint-fir	stems	10
	Unknown shrub		stem-leaf fragments	16
	Oryzopsis hymenoides	Indian ricegrass	seeds-stems-leaves	18
	Sitanion hystrix	Squirrel tail grass	stems-leaves	14
	Bromus tectorum	Cheat grass	stems-seeds	2
	Unknown grass		stems-leaves	17
	Euphorbia sp.	Spurge	leaves	12
	Eriogonum sp.	Buckwheat	stems	2
	Unknown forb		herbaceous fragments	9
2	*Encelia farinosa*	Brittle bush	stems-leaves-seeds	62
	Ephedra nevadensis	Nevada joint-fir	stems	10
	Unknown shrub		woody fragments	4
	Sitanion hystrix	Squirrel tail grass	stems-leaves	13
	Stipa speciosa	Desert needlegrass	stems-leaves	6
	Unknown grass		stems-leaves	2
	Unknown forb		herbaceous fragments	3
	Eriogonum sp.	Buckwheat	stems	T*
5	*Atriplex confertifolia*	Shadscale	leaves	1
	Eriogonum microthecum	Great Basin buckwheat brush	stems-leaves	2
	Ephedra nevadensis	Nevada joint-fir	stems	7
	Coleogyne ramosissima	Blackbrush	stems-leaves	19
	Artemisia tridentata	Big sagebrush	leaves	5
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	41
	Bromus tectorum	Cheat grass	seeds-stems-leaves	7
	Sitanion hystrix	Squirrel tail grass	stems-leaves	6
	Unknown grass		stems-leaves	9
	Unknown forb		stems-leaves	3

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975 (continued)

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
6	*Echinocatus acanthodes*	Barrel catus	spines-tissue	31
	Cercocarpus intricatus	Little-leaved mahogany	stems-leaves	7
	Quercus turbinella	Scrub oak	leaves	6
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	22
	Hilaria rigida	Big galleta	stems-leaves	6
	Stipa speciosa	Desert needlegrass	stems-leaves	11
	Unknown grass		stems-leaves	8
	Eriogonum sp.	Buckwheat	stems	
	Unknown forbs		leaf fragments	9
7	*Artemisia tridentata*	Big sage	stems-leaves	22
	Cercocarpus intricatus	Little-leaved mahogany	stems-leaves	11
	Ephedra nevadensis	Nevada joint-fir	stems	4
	Shrub sp.		woody fragments	3
	Hilaria rigida	Big galleta	stems-leaves	5
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	35
	Sitanion hystrix	Squirrel tail grass	stems-leaves	12
	Unknown grass		stems-leaves	4
	Unknown forb		herbaceous fragments	3
	Eriogonum sp.	Buckwheat	stems	1
8	*Garrya flavescens*	Silk tassel	stems-leaves	63
	Bromus tectorum	Cheat grass	stems-leaves-seeds	9
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	7
	Sitanion hystrix	Squirrel tail grass	stems-leaves	2
	Stipa speciosa	Desert needlegrass	stems-leaves	9
	Unknown grass		stems-leaves	4
	Unknown forb		herbaceous fragments	6
9	*Ephedra nevadensis*	Nevada joint-fir	stems	6
	Cercocarpus intricatus	Little-leaved mahogany	stems-leaves	11
	Atriplex sp.	Saltbush	stem-leaf fragments	10

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975 (continued)

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
9	Unknown shrubs		stem-leaf fragments	5
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	23
	Stipa sp.	Desert needlegrass	stems-leaves	2
	Sitanion hystrix	Squirrel tail grass	stems-leaves	12
	Unknown grass		stem fragments	11
	Euphorbia setiloba	Euphorbia	stems-leaves	8
	Eriogonum sp.	Buckwheat	stems	4
	Unknown forbs		stem-leaf fragments	8
10	*Ephedra nevadensis*	Nevada joint-fir	stems	19
	Eriogonum microthecum	Great Basin buckwheat brush	leaves-stems	3
	Unknown shrub		woody fragments	6
	Bromus tectorum	Cheat grass	stems-leaves-seeds	14
	Hilaria rigida	Big galleta	stems-leaves-seeds	12
	Oryzopsis hymenoides	Indian ricegrass	stem-leaves	9
	Sitanion hystrix	Squirrel tail grass	stems-leaves	19
	Unknown grass		stems-leaves	9
	Euphorbia sp.	Spurge	leaves	4
	Unknown forb		stems-leaves	5
11	*Ephedra nevadensis*	Nevada joint-fir	stems	23
	Unknown shrub		woody fragment	34
	Hilaria rigida	Big galleta	stems-leaves	7
	Unknown grass		stems-leaves	24
	Sitanion hystrix	Squirrel tail grass	stems-leaves	3
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	4
	Eriogonum sp.	Buckwheat	stems	2
	Sphaeralcea ambigua	Desert mallow	leaf tissue	T*
	Unknown forb		leaf fragments	3

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975 (continued)

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
12	*Ephedra nevadensis*	Nevada joint-fir	stems	14
	Atriplex confertifolia	Shadscale	stems-leaves	1
	Unknown shrub		stem fragments	2
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	37
	Sitanion hystrix	Squirrel tail grass	stems-leaves	11
	Unknown grass		stems-leaves	5
	Euphorbia setiloba	Euphorbia	leaves	26
	Unknown forb		stem fragments	4
13	*Ephedra nevadensis*	Nevada joint-fir	stems	6
	Thamnosma montana	Rue	stems	28
	Encelia frutescens	Encelia	seeds	1
	Cercocarpus intricatus	Little-leaved mahogany	stems-leaves	6
	Coleogyne ramosissima	Blackbrush	leaves	2
	Unknown shrub		woody fragments	3
	Oryzopsis hymenoides	Indian ricegrass	seeds-stems-leaves	39
	Unknown grass		stems-leaves	7
	Sitanion hystrix	Squirrel tail grass	stems-leaves	6
	Chaenactis sp.	Pincushion	seeds	1
	Eriogonum sp.	Buckwheat	stems	T*
	Unknown forb		herbaceous fragments	1
14	Unknown shrub #1		fragments	20
	Unknown shrub #2		fragments	19
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	21
	Stipa sp.	Desert needlegrass	stems-leaves	7
	Unknown grass		stems-leaves	15
	Sitanion hystrix	Squirrel tail grass	stems-leaves	6
	Eriogonum sp.	Buckwheat	stems	3
	Unknown forb		stem-leaf fragments	9

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975 (continued)

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
15	*Echinocactus acanthodes*	Barrel catus	spines-tissue	74
	Ephedra nevadensis	Nevada joint-fir	stems	12
	Unknown browse (shrubs)		woody fragments	1
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	6
	Sitanion hystrix	Squirrel tail grass	stems-leaves	4
	Eriogonum sp.	Buckwheat	stems-leaves	1
	Unknown forb		stems	2
16	*Garrya flavescens*	Silk tassel	stems leaves	29
	Eriogonum fasciculatum	Woody buckwheat	leaves	7
	Artemisia arbuscula	Sagebrush	stems-leaves	8
	Ephedra nevadensis	Nevada joint-fir	stems	2
	Unknown Shrub #1		leaves	7
	Cercocarpus intricatus	Little-leaved mahogany	leaf fragments	4
	Unknown shrub #2		woody fragments	3
	Stipa speciosa	Desert needlegrass	stems-leaves	20
	Sitanion hystrix	Squirrel tail grass	stems-leaves	10
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	3
	Unknown grass		stems-leaves	4
	Unknown forb		herbaceous fragments	3
17	*Purshia glandulosa*	Antelope brush	stems-leaves	26
	Eurotia lanata	Winterfat	stems-leaves	1
	Unknown shrub		woody fragments	7
	Bromus tectorum	Cheat grass	stems-leaves-seeds	19
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	21
	Unknown grass		stems-leaves	9
	Sitanion hystrix	Squirrel tail grass	stems-leaves	8
	Unknown forb		herbaceous fragments	5
	Eriogonum sp.	Buckwheat	stems	3
	Euphorbia sp.	Spurge	leaves	1

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975 (continued)

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
19	*Artemisia tridentata*	Big sagebrush	stems-leaves	9
	Cercocarpus intricatus	Little-leaved mahogany	stems-leaves	19
	Unknown shrub		woody fragments	8
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	15
	Sitanion hystrix	Squirrel tail grass	stems-leaves	22
	Stipa speciosa	Desert needlegrass	stems-leaves	15
	Unknown grass		stems-leaves	2
	Eriogonum sp.	Buckwheat	stems	2
	Unknown forb		herbaceous fragments	8
20	*Artemisia tridentata*	Big sagebrush	leaves	3
	Atriplex confertifolia	Shadscale	leaves	3
	Atriplex canescens	Four-winged saltbrush	leaves	1
	Unknown shrub #1		woody fragments	5
	Unknown shrub #2		woody fragments	8
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	29
	Bromus tectorum	Cheat grass	leaves-seeds	14
	Hilaria jamesii	Galleta grass	stems-leaves	9
	Sitanion hystrix	Squirrel tail grass	stems-leaves	4
	Unknown grass		stems-leaves	6
	Cirsium mohavense	Thistle	stems-leaves	6
	Sphaeralcea ambigua	Desert mallow	stems-leaves-seeds	1
	Unknown forbs		herbaceous fragments	11
21	*Atriplex confertifolia*	Shadscale	stems-leaves	16
	Cercocarpus intricatus	Little-leaved mahogany	stems-leaves	4
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	28
	Bromus tectorum	Cheat grass	stems-leaves	8
	Sitanion hystrix	Squirrel tail grass	stems-leaves	21
	Stipa speciosa	Desert needlegrass	stems-leaves	2

APPENDIX H. BOTANICAL ANALYSES OF DESERT BIGHORN SHEEP RUMEN CONTENTS, 1975 (continued)

Animal No.	Scientific Name	Common Name	Plant Part	Composition Percent
21	Unknown grass		stems-leaves	14
	Unknown forb		herbaceous fragments	4
	Eriogonum sp.	Buckwheat	stems-leaves	3
22	*Cercocarpus intricatus*	Little-leaved mahogany	stems-leaves	31
	Cowania mexicana	Cliff rose	leaves	3
	Atriplex confertifolia	Shadscale	stems-leaves	5
	Coleogyne ramosissima	Blackbush	stems-leaves	3
	Ephedra nevadensis	Nevada joint-fir	stems	4
	Unknown shrub		woody fragments	3
	Bromus tectorum	Cheat grass	stems-leaves	1
	Stipa speciosa	Desert needlegrass	stems-leaves	9
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves	21
	Sitanion hystrix	Squirrel tail grass	stems-leaves	14
	Unknown grass		stems-leaves	4
	Unknown forbs		herbaceous fragments	2
23	*Cercocarpus intricatus*	Little-leaved mahogany	stems-leaves	16
	Garrya flavescens	Silk tassel	leaves	8
	Artemisia tridentata	Big sagebrush	stems-leaves	8
	Coleogyne ramosissima	Blackbrush	leaves	2
	Eurotia lanata	Winterfat	stems-leaves	1
	Unknown shrub		woody fragments	8
	Rosa sp.	Wild rose	leaf fragments	3
	Bromus tectorum	Cheat grass	stems-leaves-seeds	6
	Stipa speciosa	Desert needlegrass	stems-leaves	14
	Oryzopsis hymenoides	Indian ricegrass	stems-leaves-seeds	22
	Unknown grass		stems-leaves	6
	Chaenoctis sp.	Pincushion	seeds	3
	Eriogonum sp.	Buckwheat	stems	1
	Unknown forb		herbaceous fragments	2

*T = Trace, less than 0.1%.

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