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Nevada Test Site and vicinity

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ANIMAL INVESTIGATION PROGRAM 1979 ANNUAL REPORT: Nevada Test Site and Vicinity

by

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ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
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ABSTRACT

Data are presented from the radioanalyses of tissues collected from cattle, mule deer, desert bighorn sheep, rabbits, chukar, golden eagles, and other wildlife that resided on or near the Nevada Test Site during 1979. Routine and special activities of the Animal Investigation Program are also discussed.

Other than the naturally occurring potassium-40, gamma-emitting radionuclides were detected infrequently.

Strontium-90 concentrations in bones from deer, cattle, and desert bighorn sheep were lower than those of recent years. Tritium concentrations were generally within expected environmental limits with the exception of animals exposed to known sources of contamination; e.g., drainage ponds from Area 12 tunnels or the Sedan Crater. Plutonium levels in all tissues from all species showed little variation to those levels in samples collected in recent years. Radionuclide tissue concentrations were generally higher in the tissues of animals residing in Area 15 than in similar animals collected from other Nevada Test Site areas.

Hypothetical annual dose estimates to man were calculated on the basis of the daily consumption of 0.5 kilogram of liver or muscle from animals that contained peak radionuclide levels. The highest postulated dose was 2.6 millirems to bone for plutonium-238 in liver obtained from a mule deer. This dose is about 0.5 percent of the 500 millirems per year radiation protection guide for individuals in the general population. All other postulated doses for consumption of the tissue containing other radionuclides are about 0.3 percent or less of the standard.

The movements of 25 mule deer outfitted with collars containing a radio transmitter unit were monitored on a weekly basis. During the winter months, all deer left their summer range on the mesas of the Nevada Test Site. However during 1979, the deer were dispersed over the widest area observed since 1975. Several deer wintered on the Nellis Bombing and Gunnery Range to the north and one wintered near Black Mountain. A deer captured in December 1979 was observed 7 months later in the Barley Creek area of Nye County which is appromately 160 kilometers from its capture point.

No gross or microscopic lesions were found in necropsied animals that could be directly attributed to the effects of ionizing radiation.

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INTRODUCTION

Since 1964, U.S. Environmental Protection Agency's (USEPA) Environmental Monitoring Systems Laboratory* at Las Vegas (EMSL-LV) has conducted the Animal Investigation Program (AIP) for the Nevada Operations Office of the U.S. Department of Energy. During 1979, the major objectives of the AIP were:

1. To conduct surveillance of domestic and wild animals on and around the Nevada Test Site (NTS) to assess the radionuclide burden present in their tissues and to detect pathological effects from the burdens.

2. To investigate alleged damage to domestic animals and wildlife resulting from the activities of the Nevada Operations Office of the U.S. Department of Energy.

3. To provide public information through education and veterinary advice to the offsite population.

4. To conduct special ad hoc investigations.

Progress during 1979 in achieving these objectives and summaries of the data collected are presented in this report. Previous reports (Fountain 1961; Smith and Giles 1970, 1974, and 1975; and Smith et al., 1976, 1977a, 1977b, 1978a, 1978b, 1979 and 1980) have detailed the history, evolution, and accomplishments of the AIP since its beginning in 1957.

*Effective June 3, 1979, the Environmental Monitoring and Support Laboratory, Las Vegas, Nevada was designated the Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

SAMPLE COLLECTION

Nevada Test Site animals sampled during 1979 included cattle, mule deer, rabbits, chukars, eagles, a coyote, a bobcat and a feral horse. Desert bighorn sheep that range the mountainous areas to the south and east of the NTS were also sampled. Animals sampled included those that died from natural causes or through accidents, those collected through the cooperation of licensed hunters, and those that were sacrificed as part of the routine sampling activities of the program.

Animals collected (killed), either by rifle or shotgun fire, were necropsied immediately after death and any gross pathological conditions 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 gross lesions (if any) were sampled and prepared for histopathlogical evaluation. If fresh blood was available, heparinized samples were collected for hematological examination. Tissues collected from large animals for radioanalyses included rumen or stomach contents, liver, lungs, tracheobronchial lymph nodes, muscle, thyroids, blood, kidneys, fetus (if present), and bone (femurs or hock). Tissues collected from small animals (rabbit, chukar, and eagle) for radioanalyses included bone from the entire skeleton, muscle, skin, entire gastrointestinal tract, and composited internal organs (liver, lungs, kidneys, and spleen).

Six beef cattle from the NTS herd were sampled during 1979. Sampling information is presented in Table 1. Except for a brief weaning period, when the calves were maintained at the Area 15 farm, each animal sampled spent its entire life grazing on the Area 18 range of the NTS (Figure 1). 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).

AIP investigators collected tissue samples from four NTS adult mule deer (*Odocoileus hemionus*). Two of the deer were sampled after being struck by motor vehicles. Five jackrabbits (*Lepus californicus*) and one desert cottontail (*Sylvilagus audubonii*) were collected. These animals were collected at the Area 15 experimental farm or on the Area 18 beef cattle range. Other NTS animals sampled included one feral horse (*Equus caballus*), one coyote (*Canis latrans*), one bobcat (*Lynx rufus*), two golden eagles (*Aquila chrysaetos*), and three chukar (*Alectoris chukar*). Collection locations are noted on Figure 1 and sampling information is listed in Table 2.

Through the cooperation of State and Federal wildlife officials and participating hunters, bone and kidney samples were collected from 12 mature desert bighorn sheep (*Ovis canadensis nelsoni*) rams during the annual hunt.

TABLE 1. SAMPLING INFORMATION FOR NEVADA TEST SITE CATTLE, 1979

Animal Number	Sex	Age (years)	Weight (kg)	Date Sampled	Remarks
1	F	2	250	05/15	Animal paralyzed from dystocia, necropsied and sampled in field.
2	M	6	610	05/17	Aged steer, excellent condition
3	M	5	650	05/17	Aged steer, excellent condition
4	F	11	391	10/18	Pre-cancerous plaques at medial canthus of both eyes
5	M	0.5	170	10/18	Bull calf
6	M	4	580	10/18	Steer

Sampling information for these animals is presented in Table 3 and the collection sites are shown in Figure 2. The majority of the sheep were collected from Clark County in southern Nevada, with three coming from the Desert National Wildlife Range or the Nellis Air Force Range which are contiguous to the NTS. Two animals were collected from the Silver Peak and Lone Mountain areas which are north and west of the NTS.

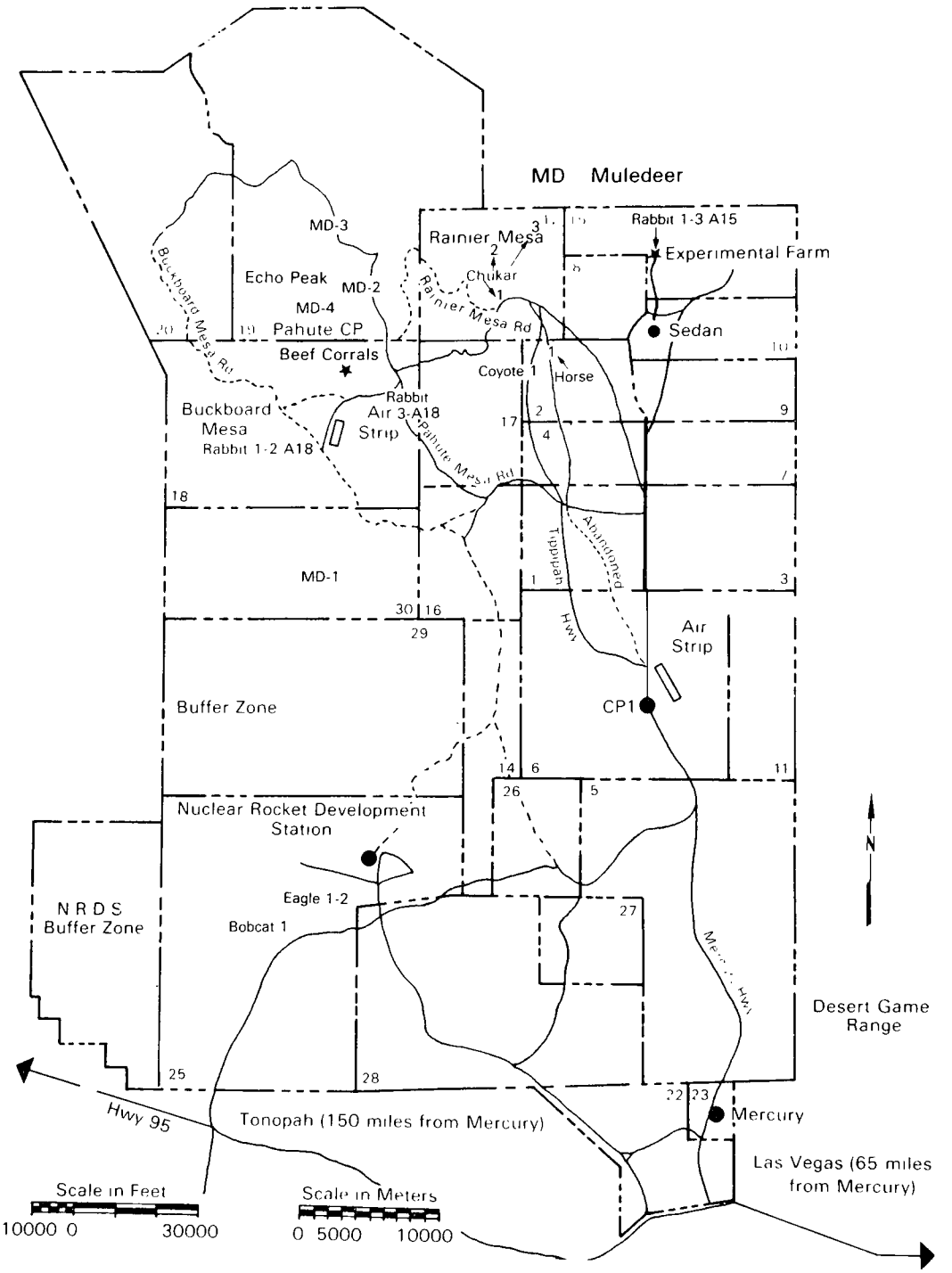

Figure 1. Sampling locations on the Nevada Test Site, 1979.

TABLE 2. SAMPLING INFORMATION FOR NEVADA TEST SITE WILDLIFE, 1979

Animal Number	Sex	Estimated Age (years)	Weight (kg)	Date Collected	Remarks
Mule Deer-1	M	4-5	55-60	01/04	Collected on road to Motorola Site, Shoshone Mt., Area 29.
Mule Deer-2	M	2-3	60	07/11	Accident victim on Pahute Mesa Road, Area 19.
Mule Deer-3	F	1-2	45	08/29	Accident victim on Pahute Mesa Road, Area 19. Liver not sampled as consumed by predators.
Mule Deer-4	F	0.5	30	12/18	Collected 1/2 mile N.E. of Echo Peak repeater site, Area 19.
Horse-1	M	0.5-0.75	120	11/19	Hit by car on Tippipah Highway in Area 12 on November 12. Treated at Area 15 until death on November 17.
Rabbit-1-A18	F	<1	2.2	06/01	Jackrabbit collected on Buckboard Mesa Road, Area 18.
Rabbit-2-A18	M	>1	2.3	06/01	Jackrabbit collected on Buckboard Mesa Road, Area 18.
Rabbit-3-A18	M	<1	2.1	06/01	Jackrabbit collected along Airport Road, Area 18.
Rabbit-1-A15	F	1	2.3	07/24	Jackrabbit collected at Area 15 farm.
Rabbit-2-A15	M	>1	1.0	07/24	Cottontail collected at Area 15 farm.

(continued)

TABLE 2. (Continued)

Animal Number	Sex	Estimated Age (years)	Weight (kg)	Date Collected	Remarks
Rabbit-3-A15	M	>1	2.0	07/24	Jackrabbit collected at Area 15 Farm.
Coyote-1	F	0.5	10	01/06	Hit by motor vehicle on Tippipah Highway 1/2 mile from Area 12 Camp.
Bobcat-1	M	Adult	10	12/01	Electrocuted in pumphouse at Area 400.
Eagle-1	M	Adult	3.2	01/24	Electrocuted at substation, Area 400.
Eagle-2	F	Adult	4.2	01/27	Electrocuted at substation, Area 400.
Chukar-1	?	Adult	0.6	12/04	Collected above E Tunnel, Rainier Mesa, Area 12.
Chukar-2	?	Adult	0.7	12/04	Collected at Trailer Park above G Tunnel, Rainier Mesa, Area 12.
Chukar-3	?	Adult	0.9	12/04	Collected above T Tunnel, Rainier Mesa, Area 12. Two chukars composited for samples.

TABLE 3. SAMPLING INFORMATION FOR DESERT BIGHORN SHEEP, 1979

Animal Number	Sex	Estimated Age (years)	Date Collected	Remarks
1	M	4	12/10	Killed at Wamp Spring, Las Vegas Range, DNWR, Area 78*.
2	M	5	12/11	Killed in Deadman's Canyon, DNWR, Area 77*.
3	M	7	11/18	Killed in Boscoe Canyon, Area 71*.
4	M	7	11/25	Killed near Carter Mines, Morman Mountains, Area 80*.
5	M	5	11/24	Killed in Newberry Range, Area 86*.
6	M	9	11/24	Killed in Morman Mountains, Area 80*.
7	M	10	11/27	Killed in McCullough Range, Area 84*.
8	M	6	11/22	Killed at Cane Spring, Area 70*.
9	M	6	11/17	Killed on Black Mountain, Area 81*.
10	M	4	11/20	Killed on North Eldorado Mountain, Area 85*.
11	M	7	11/18	Killed in Newberry Range, Area 86*.
12	M	4	12/29	Killed north of Quartz, Area 74*.

*Nevada Wildlife Department Bighorn Sheep Management Area
DNWR = Desert National Wildlife Range

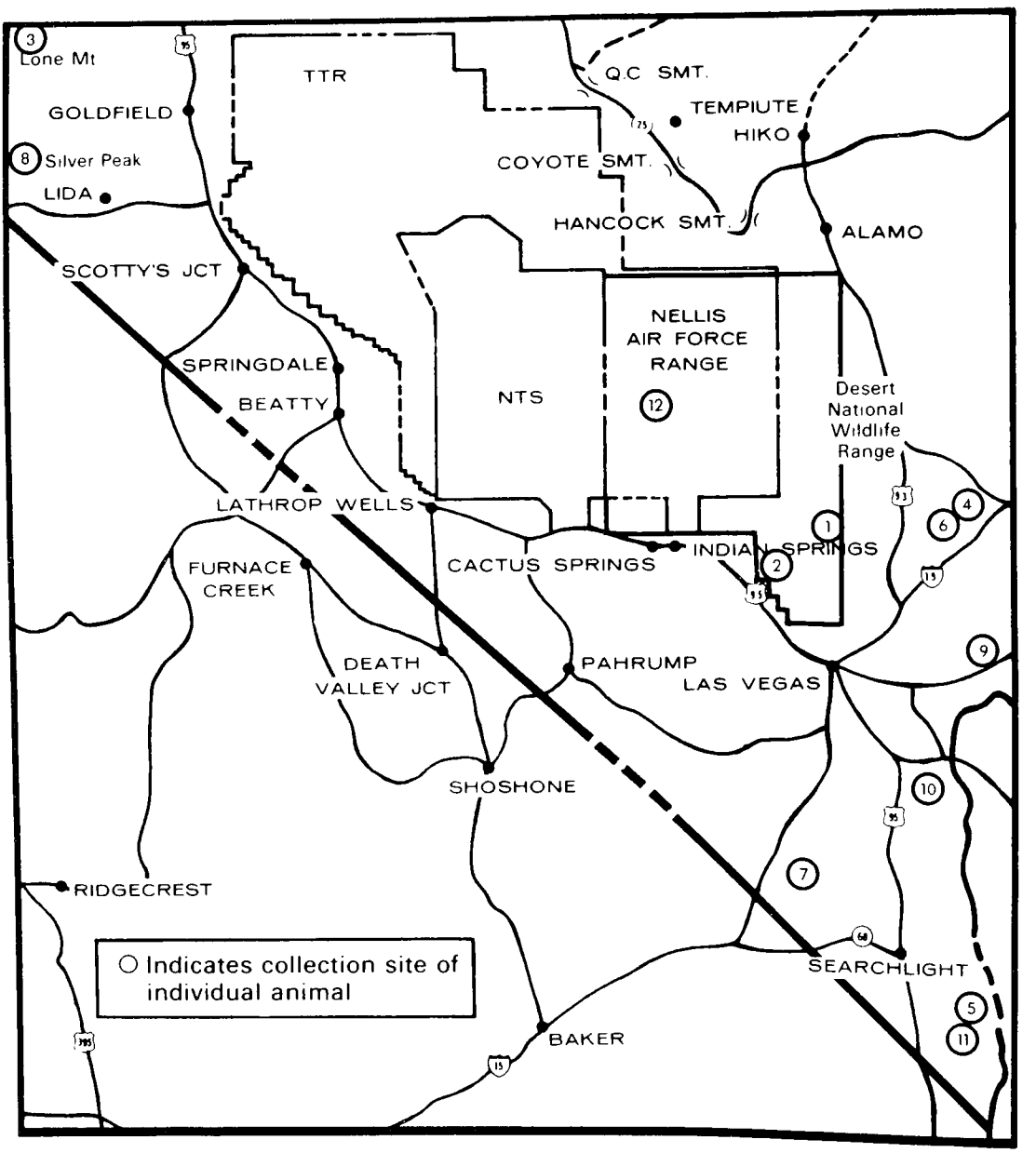

Figure 2. Approximate collection sites of 1979 desert bighorn sheep.

ANALYTICAL PROCEDURES AND METHODS

Gamma-emitting radionuclides in samples of soft tissues and rumen contents were analyzed by gamma spectrometry. A sample of blood or of tissue was collected from each animal and analyzed for tritium. Bone samples were analyzed for strontium-89 and -90 and plutonium-238 and -239. Selected soft tissues were also analyzed for plutonium content. The EMSL-LV performed all of the analyses for tritium and the gamma-emitting radionuclides. Eberline Instrument Corporation (EIC) Albuquerque, N. Mex., performed the plutonium and the strontium analyses.

Rumen contents and soft tissues of sufficient volume were placed in 300-milliliter aluminum containers with a 10-percent Formalin® solution as a preservative. The containers were then sealed and stored for gamma analysis. Those tissues of smaller volume, i.e., thyroid gland, tracheobronchial lymph nodes, etc., were first macerated in a blender and then brought to a standard volume by suspending in agar. These samples were also sealed in 300-milliliter aluminum containers. Muscle, liver, lungs, kidneys, and fetal samples were counted for approximately 1,200 minutes on lithium-drifted germanium detectors calibrated at approximately 0.5 kiloelectronvolts (keV) per channel in the 60-KeV to 2-megaelectronvolts (MeV) range. These detectors are connected to a Nuclear Data 6620 computerized gamma spectral accumulation and analysis system. Other tissue samples such as thyroids, tracheobronchial lymph nodes, skin, and gonads, as well as rumen or stomach and gastrointestinal contents, were counted for 1,000 minutes using a 4- by 4-inch NaI (Tl) crystal also connected to the Nuclear Data 6620 for spectral accumulation. This spectrometer is calibrated at 10 KeV per channel in the 60-KeV to 2-MeV range. The data reduction of the spectra was performed using a least squares program resident on a CDC-6400 computer.

Tissues for strontium and plutonium analyses were prepared by ashing and radiochemical separation. Plutonium was analyzed by alpha spectrometry using plutonium-236 as an internal tracer. Details of the analytical procedures used by EIC are proprietary information but are similar to those described by Talvitie 1971, 1972; Wish and Rowell 1956; Mitchell 1960; Hagan and Arrhenius 1963; and Major et al. 1975. The EMSL-LV radionuclide analytical procedures were those described by Johns (1979).

All data are reported with the 95 percent confidence interval based on counting statistics and are corrected to time of sample collection. The minimum detectable activity is defined as 3.29 times the standard deviation based on counting. Results which show a net sample activity less than the MDA are reported as such. The approximate minimum detectable activities and analytical procedures are summarized in Appendix A.

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.

Quality assurance samples were included in each group of samples submitted for plutonium analyses. These were liver and muscle samples purchased at a local meat market and to which a known amount of plutonium was added. The data from the quality assurance samples are presented in Appendix B.

Tissue and lesion samples collected for histopathological examination were fixed with a 10-percent Formalin solution and delivered to a pathologist for interpretation.

RESULTS AND DISCUSSION

QUALITY ASSURANCE SAMPLES

The analytical data for samples spiked with plutonium-238 and -239 are listed in Appendix B. The bias (defined as the percent difference between activity detected and activity added) for plutonium-239 ranged from +3 to -73 and averaged -38 percent. The bias for plutonium-238 analyses ranged from -19 to -80 with an average bias of -44 percent. The quality of all plutonium analyses was assumed to be similar when conclusions were drawn from the data.

NEVADA TEST SITE CATTLE

The analytical results from tissues collected from the Area 18 beef cattle are presented in the tables of Appendix C.

Naturally occurring potassium-40 was the only gamma-emitting radionuclide consistently detected in both the May and October samples. Cesium-137 was occasionally detected in the ingesta or soft tissue samples. If detected, the cesium-137 levels were within a narrow range of activity; for example, four of six muscle samples contained detectable levels ranging from 23 to 38 picocuries per kilogram (pCi/kg). Beryllium-7 (a naturally occurring radionuclide) was the only other gamma-emitter detected and it was found in only one rumen content sample collected in October.

Tritium was not detected in any of the animals sampled in October but was found in all three of the cattle sampled in May. The tritium levels in the blood from these cattle ranged from 510 to 970 picocuries per liter (pCi/l). These levels fall within the range of <400 to 980 pCi/l of atmospheric moisture (average of <400 pCi/l) found in air samples collected at Beatty, Nevada for the Noble Gas and Tritium Surveillance Network (Nuclear Radiation Assessment Division, 1980).

Strontium-90 concentrations in the femur samples from the Area 18 cattle ranged from 0.4 to 3.1 picocuries per gram (pCi/g) of ash with an average of 1.3. As shown in Figure 3, this value is nearly an order of magnitude lower than those of recent years. This apparent marked decrease in the strontium concentration in femur of the Area 18 cattle is probably not real but related to the fact that 1979 was the first year that EIC performed all the strontium analyses for the AIP samples. The bias determined from strontium-90 quality assurance samples submitted to EIC for another study (Smith and Brown, 1980) averaged -38 percent (range of 6.6 to 171 percent) and the reported activities

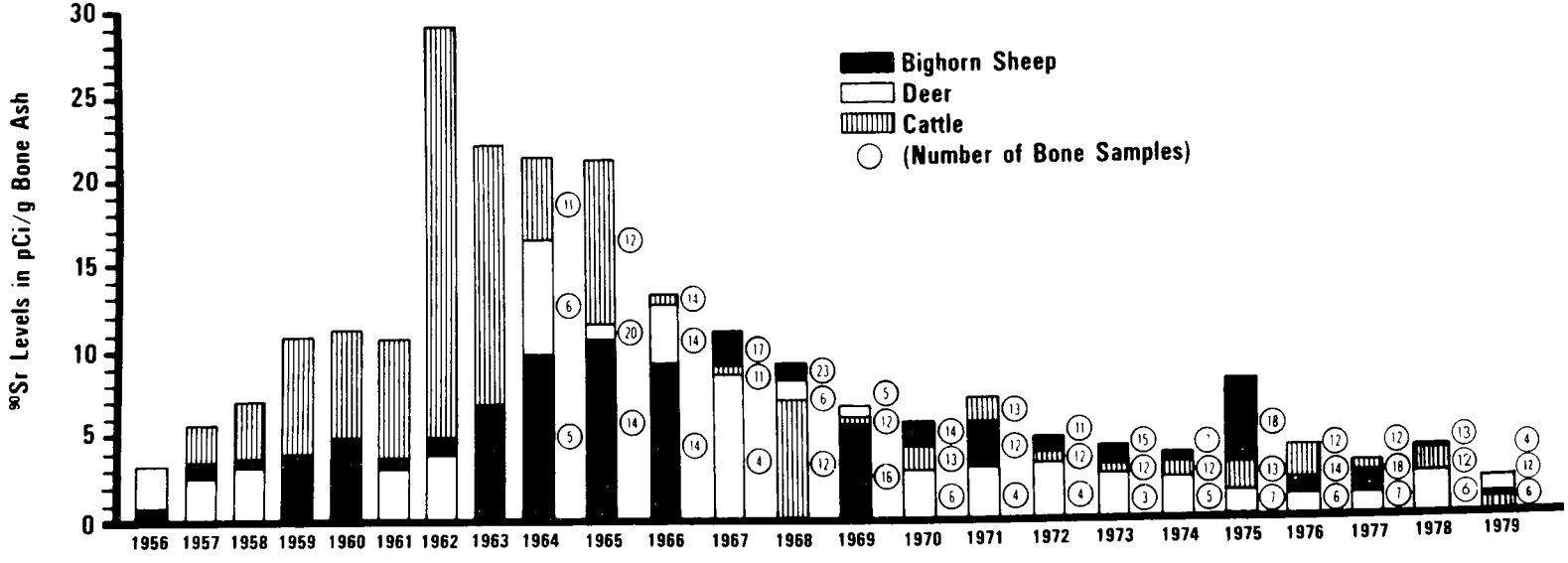

Figure 3. Annual averages of ^{90}Sr in bones of cattle, deer and desert bighorn sheep 1956-1979.

were generally lower than the amount of activity added to the sample. Strontium-89 was not detected in any of the animals' femurs.

Plutonium-238 is present in the environment primarily as a result of the burnup of a SNAP-9A power source (Krey and Krajewski 1972; Hardy et al. 1972). The expected ratio of plutonium-239 to plutonium-238 is roughly 25. However, this expected ratio is seldom reached in the animal tissues listed in the appendices of this report. The ratios present are quite variable, but generally range between 1 and 10. It has been postulated (Patterson et al. 1974; and Matlock et al. 1976) that plutonium-238 may be more rapidly solubilized and thus potentially more mobile under environmental conditions than is plutonium-239. This may explain why the plutonium 239:238 ratios for animal tissue are usually lower than the ratios for fallout and soil.

Because of budgetary restraints and the consistent findings of prior years, (Smith et al. 1979) the plutonium analyses of the soft tissues were limited to the May sampling except for gonads and a fetus. As shown in Table 4, the concentrations detected in the 1979 tissues were generally of the same magnitude as those sampled in 1978.

Plutonium-238 and -239 were detected in gonads from a cow and a bull sampled in October. The values for plutonium-239 (0.74 and 1.4 pCi/kg respectively) exceeded those reported for muscle tissue and were similar to concentrations in the femurs, lungs, and livers of animals sampled in May.

TABLE 4. RANGES OF PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES FROM NEVADA TEST SITE CATTLE, MAY 1978 AND MAY 1979

	Concentrations (pCi/kg Wet Weight)			
	Plutonium-238		Plutonium-239	
Tissue	May 1978	May 1979	May 1978	May 1979
Lungs	<0.76 - <1.1	0.14 - <0.22	<0.76 - 2.2	1.6 - 3.1
Muscles	0.94 - <1.3	0.04 - <0.1	<0.94 - <1.3	0.09 - <0.13
Livers	<0.63 - 1.6	<0.22 - <0.43	<0.63 - 2.4	0.6 - 0.7
Rumen Contents	0.54 - 8.5	0.2 - 0.63	1.1 - 400	1.1 - 3
Femurs	<2.3 - <5.8	<1.1 - <2.8	<2.3 - <5.8	<1.2 - 1.5

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 cattle, naturally occurring potassium-40 was the only gamma-emitting radionuclide that was consistently detected. Cesium-137 was occasionally detected in the rumen contents and soft tissue samples. The highest level reported in the tissues was 52 pCi/kg in kidney tissue collected from deer number 1. Beryllium-7 was reported in the rumen contents of animal numbers 1 and 2. Beryllium-7 is a naturally occurring radionuclide that is produced by cosmic radiation.

Tritium concentrations in the blood or kidneys of the deer ranged from <350 to 480 pCi/l. These levels are well within the range found in atmospheric moisture at Beatty, Nevada (Nuclear Radiation Assessment Division, 1980).

Strontium-90 concentrations in hock bones ranged from 1.7 to 3.8 pCi/g of ash with an average of 2.6 pCi/g ash (Figure 3). The 1978 average was also 2.6 pCi/g of ash. Strontium-89 was not detected.

As in 1978, (Smith et al. 1980) plutonium-239 was frequently detected in all the soft tissue with the most consistent finding in the lungs and rumen content samples. Plutonium-239 (2 ± 0.7 pCi/kg) was reported in the gonads collected from a male deer (#1). Again, as in 1978, plutonium was not detected in any of the hock bones sampled.

DESERT BIGHORN SHEEP

Analytical data from bone and kidney samples are listed in Appendix E. The average strontium-90 concentration in the hock bones was 1.7 pCi/g of ash (Figure 3). Strontium-89, plutonium-238 and -239 were not detected in any of the animals sampled. Detectable levels of plutonium-239 have generally been reported in 10 to 25 percent of the bone samples analyzed during the last few years.

Cesium-137 concentrations ranging from 13 to 35 pCi/kg wet weight were detected in the kidneys of only five of the sheep. Tritium was not found in any of the kidney samples.

NEVADA TEST SITE RABBITS

Area 18 Rabbits

In June, three Area 18 jackrabbits were collected and selected tissues sampled. The analytical data are presented in the tables of Appendix G.

Concentrations of potassium-40 and cesium-137 detected were of similar magnitude to those found in corresponding tissues collected from the beef

cattle which also graze this area. Beryllium-7 was not detected in the ingesta of any of the rabbits.

Tritium levels in the aqueous portion of the muscle tissues from all three rabbits were reported as <350 pCi/l. This is not greatly different from that found in the Area 18 cattle and was considered to be within normal environmental limits. Strontium-90 values ranged from 0.55 to 2.4 pCi/g of bone ash with a median value of 0.88 pCi/g. Strontium-89 was not detected in the bones of any of the rabbits.

Plutonium levels in the internal organs and bones were similar to those reported from the Area 18 beef cattle. Plutonium concentrations in those samples subject to external contamination, i.e. the gastrointestinal tract and the skin, were markedly higher than the internal tissues. Plutonium concentrations detected in the rabbit muscle tissue were usually higher than those reported for the cattle. This may be due to external contamination introduced by trauma from the passage of 20-gauge shotgun pellets.

Area 15 Rabbits

Rabbits from the Area 15 experimental farm were collected and sampled in July. Analytical data from analyses of their tissues are summarized in the tables of Appendix H.

Similar spectra and concentrations of gamma-emitting radionuclides were observed in the Area 15 rabbit tissues as were found in the Area 18 jackrabbits. Tritium concentrations in the aqueous portion of the Area 15 rabbit tissues were all above the lower limit of detection with a median value of 1,300 pCi/l and a range of 700 to 3,900 pCi/l.

Strontium-90 values in bone ranged from 0.32 to 3.0 pCi/g of ash with a median value of 2.2 pCi/g. Strontium-89 was not detected in any bone samples.

Plutonium concentrations in the muscles and internal organs of the Area 15 rabbits were similar to those from the Area 18 rabbits. This was also true of the bone concentrations except that reported for rabbit #2. This value of 17 ± 3.6 pCi/kg is the highest value detected in a bone sample from an Area 15 rabbit since the first samples were collected in 1974 and must be viewed as suspect.

The plutonium levels in tissues subject to environmental contamination (skin and gastrointestinal tract) were generally higher in the rabbits from Area 15. These findings and those noted for other Area 15 animals in previous reports (Smith et al. 1977b, 1978a, 1978b, 1979 and 1980) indicate that the environs of Area 15 contain elevated levels of tritium and plutonium when compared to other NTS areas that are frequently sampled by the AIP.

NEVADA TEST SITE HORSE

A feral colt that died at the Area 15 farm soon after being struck by a motor vehicle, was necropsied and sampled. The analytical data from these samples are listed in Appendix H.

Cesium-137 levels in the soft tissues ranged from 33 to 58 pCi/kg. The bone ash contained 3.6 ± 0.24 pCi/g of strontium-90. Strontium-89, plutonium-238 and -239 were not detected in any of the samples. There is nothing remarkable about any of these findings which probably reflects the juvenile status of the animal at its death.

NEVADA TEST SITE CARNIVORES

A juvenile coyote and a mature bobcat were sampled following their accidental deaths. Analytical data for these samples are presented in Appendices I and J.

Cesium-137 was detected in the soft tissues of both animals with slightly higher levels present in the bobcat. The value of 200 pCi/kg in the bobcat's muscle was the highest cesium-137 concentration reported from any NTS animal during 1979.

The tritium concentration in the aqueous portion of the coyote's kidney was reported as 1,900 ± 310 pCi/l. As the coyote was killed near the Area 12 camp, the source of this tritium was thought to be the waters that drain the tunnel test areas of Rainier Mesa.

Both the coyote and bobcat contained similar levels of strontium-90 in the bones (4.9 versus 2.3 pCi/g ash) and plutonium-239 in the lungs (0.85 versus 0.81 pCi/kg). These concentrations are comparable to those found in coyotes sampled in previous years.

NEVADA TEST SITE CHUKARS

The AIP collected chukars in December from camps at each of three tunnel areas (E, G, and T tunnels) in Area 12. The data from their tissues are reported in Appendix K.

The strontium-90, cesium-137, plutonium-238 and -239 concentrations reported were not significantly different from those of 1978. However, the tritium levels in the aqueous portion of the muscle tissue ranged from 1.4×10^4 to 2.3×10^6 pCi/l. These elevated levels undoubtedly resulted from the use of the tunnel drainage waters by the chukars as their sole water supply.

NEVADA TEST SITE EAGLES

Golden eagles migrate through the NTS every winter. They frequently perch on the transformers at various substations where their great wing span often results in fatal shorting across two electrical circuits. During 1979 two eagles were sampled following such accidents. The data from their tissues are listed in Appendix L.

No unexpected radionuclides were detected and the concentrations were similar to those of previous years. The strontium-90 concentrations in bone ash were 3.1 and 2.6 pCi/g. Tritium concentrations in the aqueous portion of muscle tissue were 1,200 and 840 pCi/l which was considered within normal environmental limits. Plutonium-239 was detected only in internal organ samples.

NEVADA TEST SITE SPRING WATERS AND ALGAE

Several natural springs that serve as a source of water for wildlife were sampled during 1979. The spring locations are shown in Figure 1. The waters were analyzed for gamma-emitting radionuclides and tritium. The results are shown in Table 5.

Detectable levels of gamma-emitting radionuclides were not found in any of the waters and the tritium levels were either within environmental limits or below detectable concentrations.

Algae samples were also collected from Cane, Captain Jack, and Topopah Springs. All of these samples contained detectable levels of naturally occurring potassium-40. In addition, algae from Topopah Spring contained 29 ± 16 pCi of cesium-137 per kilogram wet weight and the algae from Cane Spring contained 190 ± 41 pCi of cesium-137 and 60 ± 28 pCi of cobalt-60 per kilogram wet weight.

TABLE 5. TRITIUM AND GAMMA ANALYSIS OF NEVADA TEST SITE SPRING WATERS, 1979

		Water Analysis	
Spring Name	Date	Gamma Analysis	^{3}H pCi/l
Cane	5/4	GSN	<320
Captain Jack	5/4	GSN	1,000 ± 210
Tippipah	5/4	GSN	560 ± 210
Topopah	5/4	GSN	<320
Green	5/4	GSN	420 ± 200
Tub	5/4	GSN	<320
White Rock	5/4	GSN	<320
Oak	5/4	GSN	730 ± 190

GSN = Gamma Spectrum Negligible

NECROPSY AND HISTOPATHOLOGICAL EXAMINATIONS

Sacrificed animals were necropsied and selected tissue and lesion samples were collected for histopathological evaluation. The gross and microscopic pathology observed are summarized in Appendix M.

As in previous years, sarcocysts were detected in deer skeletal muscle tissues. This is a ubiquitous parasite found in both warm- and cold-blooded vertebrates and is considered to have little clinical significance (Merck and Company 1973).

The incidence of other clinical conditions encountered in beef animals, such as the ocular squamous cell carcinoma (number 4), was felt to be within normal limits for the populations examined. Occasionally observed histologic findings; e.g., hemosiderosis of the spleen, mild liver and kidney changes, and myositis, were felt to be within normal levels by the examining pathologist. 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 various doses to a standard man based on postulated consumption of the edible tissues has been 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 Radiological Protection (1959, 1968, 1977) and Dillman (1969). The estimates were calculated using the maximum observed concentrations of the radionuclides in edible tissues of the cattle, deer, rabbits and chukar sampled (summarized in Table 6), and the postulated consumption of 500 grams (about 1 pound) of the meat each day for a year. The minimum detectable values of Table 6 were used in the dose calculations when they were the maximum value for a given tissue.

Although doses are calculated for ingestion of tissues from a chukar and rabbit, these doses are not compared to the dose guide. Furthermore, these doses are not used in discussing the maximum hypothetical doses because it is doubtful that enough similar tissue could be obtained to provide the 1-year intake quantities.

The International Commission for Radiological Protection (1959) and the U.S. Department of Energy (1977) 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 to the whole body for an individual in an uncontrolled area) 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 6 presents a summary of the maximum observed concentrations in selected tissues of the animals. The indicated confidence intervals are twice the standard deviation (2S) based on counting statistics. The total analytical uncertainties at two standard deviations for the plutonium results are estimated to be about 0.2 pCi/kg for results of several tenths of a pCi/kg, or several times the indicated counting uncertainties. Thus, differences between values, when the values are under several tenths of a pCi/kg, have limited statistical significance given the total analytical uncertainties of the results.

Table 7 lists postulated doses based on the data for maximum concentrations for the various nuclides summarized in Table 6. The column on the right shows the respective fraction of the radiation protection guide of 500 millirems per year for the various postulated doses. The doses from plutonium 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, 2.6 millirems (mrem), would result from ingesting deer meat (liver). This dose estimate is based on a quality factor (ICRF, 1975) of 20, rather than the value of 10 used in former reports. This dose is 0.5 percent of the guide of 500 mrem per year. All of the other postulated doses are about 1 mrem or less and are similar to those estimated for 1977 and 1978 (Smith et al. 1978b, 1979 and 1980).

TABLE 6. SUMMARY OF PEAK RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES FROM NEVADA TEST SITE ANIMALS, 1979

	Radionuclide Concentrations (pCi/kg wet weight)								
	Area 18 Cattle			NTS Mule Deer			Area 18 Rabbits	Area 5 Rabbits	NTS Chukar
Nuclide	Muscle	Liver	Kidney (pCi/l)	Muscle	Liver	Kidney (pCi/l)	Muscle	Muscle	Muscle
^{238}Pu	<0.099	0.25 ± 0.14	NA	<1.3	9.5 ± 1.7	NA	<1.4	<1.1	<1.3
^{239}Pu	<0.099	0.69 ± 0.25	NA	4.6 ± 2.3	4.6 ± 1.0	NA	3.9 ± 1.8	3.2 ± 1.0	0.35 ± 0.16
^{137}Cs	38 ± 13	25 ± 16	NA	22 ± 11	<7.0	NA	34 ± 14	59 ± 21	37 ± 16
^{3}H	NA	NA	970 ± 290*	NA	NA	480 ± 120*	<350*	3900 ± 260*	2.3×10^{6}* ± 4×10

NA = Not analyzed
* = pCi/l - aqueous portion of kidney or muscle

TABLE 7. POSTULATED DOSE TO MAN FOLLOWING INGESTION OF SELECTED TISSUES FOR ONE YEAR

Nuclide	Human Organ for Which Dose was Calculated	Animal Tissue Containing Maximum Concentration	pCi/kg of Tissue	Dose Factor mrem:pCi/da (1-year ingestion)*	Dose (mrem)	Percent 0.5 rem
^{3}H†	Body water	NTS chukar, muscle	2.3×10^{6}†	3.6×10^{-5}	41.	‡
^{3}H†	Body water	Area 18 cattle, kidney	970 ± 290†	3.6×10^{-5}	0.02	<0.1
^{137}Cs	Whole body tissue	Area 15 rabbit, muscle	59 ± 21	0.022	0.65	‡
^{137}Cs	Whole body tissue	Area 18 cattle, muscle	38 ± 13	0.022	0.42	0.1
^{238}Pu	Bone	NTS mule deer, liver	9.5 ± 1.7	0.54	2.6	0.5
^{239}Pu	Bone	NTS mule deer, liver	4.6 ± 1.0	0.32	1.5	0.3

* The doses from 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 one year. The doses for 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 dose factors are based on a quality factor (QF) of 1 for tritium and cesium-137 and 20 for plutonium-238-239 (ICRP, 1977. The QF of 20 used for plutonium is twice the value used in previous reports (Smith et al. 1978b, 1979, 1980). Therefore the doses reported here are twice the values that would have been obtained using the dose factor from former reports.

†The reported tritium concentrations are for muscle and kidney tissue. It is assumed that the concentration in edible tissues (water plus organic) is equal to that of the reported results.

‡The percent of the 0.5 rem dose guide is not calculated for these tissues because it is not reasonable to assume that someone could consume 500 g of meat per day from these small animals. Specifically, it is doubtful whether there are that many chukars on the Nevada Test Site.

OTHER ACTIVITIES

DEER MIGRATION STUDY

A sizeable mule deer herd resides in the mountainous regions of the NTS during the summer. If they move to unrestricted lands, these deer may be hunted by members of the public. A study to determine migration patterns of the herd through tracking of individual deer outfitted with collars containing miniature radio transmitters was begun in 1975 and continued through 1979.

From August through December 1979, 26 NTS mule deer (Table 8) were captured, either by chemical restraint of free-ranging animals (Smith et al. 1978a) or by trapping (Giles 1979). Ten deer were outfitted with collars containing new radio transmitters, ear tags, and reflective numbers. One deer was outfitted with a re-conditioned radio transmitter collar that had been recovered from a deer captured prior to 1979. One deer died from unknown causes within 10 days of capture. Another deer was killed when it was hit by a motor vehicle. Both radios were recovered and placed on other deer during 1979. These 11 newly installed transmitters brought to 25 the total number of working transmitters in the field (14 from previous years). Laboratory personnel monitored the movements of the deer weekly with hand-held receivers and directional antenna. Thirteen other deer were captured but were unsuitable for collaring and were released after visible markers (ear tags and reflective collars) had been attached.

Eighteen of the deer were captured at the Area 19 trapsite and immobilized with M-99™ (etorphine). The other eight deer were captured with the Cap Chur™ gun (Palmer Chemical Company) and immobilized with Sernylan™ (phencyclidine hydrochloride), and acepromazine maleate (Ayerest Laboratories, Inc.).

The deer did not follow the migration pattern of the last few winters. The deer tagged in Areas 19 and 20 were dispersed over a wider area of the NTS and Nellis Bombing and Gunnery Range (NBGR) and several migrated to the north. As shown in Figure 4 one male deer traveled west off NTS onto the NBGR in the vicinity of Black Mountain, which is approximately 40 km north-northeast of Beatty, Nevada. Two does wintered in the NBGR just west of the Area 20 boundary. One doe and one buck wintered north of Area 19 on the NBGR in the southern portion of the Belted Range. A doe captured on December 4, 1979 at the Echo Peak trap site was observed in June and August 1980 by survey crews working on the MX site selection in the Barley Creek Area of Nye County. This sighting, reported by the Nevada Department of Wildlife, took place over 160

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TABLE 8. DEER CAPTURE INFORMATION, 1979

I.D.	Age Estimated	Sex	Weight Estimated (kg)	Date Captured	Capture Location	Comments
1 Red	3-4	F	43	07/05	2 miles east of First Aid Station along Pahute Mesa Road, Area 20	Found dead 07/17/79 1/2 mile east of capture site. Cause of death unknown, seen day after capture - appeared to be okay. Radio recovered.
1 Red	1	M	40	08/16	Echo Peak trap site, Area 19	Road kill 07/18/80. Echo Peak turnoff on Pahute Mesa Road, radio recovered.
2 Red	3-4	F	41	07/17	Mud pond along Pahute Mesa Road at junction of Areas 19 and 20	Road kill 10/08/79 1 mile west of Pahute C.P. on Pahute Mesa Road. Radio recovered.
2 Red	2-3	F	62	10/10	Turnoff to U-19-F along Pahute Mesa Road, Area 19	Doe in good flesh. Wintered Timber Mountain, 40 Mile Canyon.
3 Red	3-4	F	42	07/10	Pahute Mesa Road at junction of Areas 19 and 20	Lactating doe in good condition spent portion of summer and all winter on Timber Mountain and Beatty Wash areas.
4 Red	6-7	M	90	07/18	Echo Peak trap site, Area 19	Previously captured 09/22/76 as old tag #A. Buck in excellent condition. Spent winter on Timber Mountain, 40 Mile Canyon area.
5 Red	4-5	F	45	08/17	Echo Peak trap site, Area 19	Lactating doe in good flesh. Spent winter on south Timber Mountain.
6 Red	2-3	F	46	07/26	1 mile east of First Aid Station, Area 20	Dry doe in good flesh, no tracking data, unable to locate animal after second day. No visual sighting or radio signal.
7 Red	3-4	F	45	08/21	2.5 miles N.W. of Echo Peak trap site, Area 19	Lactating doe in fair flesh. Winter Timber Mountain, 40 Mile Canyon area.
8 Red	2-3	M	55	09/19	U-19-E and Dead Horse Flat Road, Area 19	Buck in good flesh. Wintered on bombing and gunnery range west of Area 20 in the Black Mountain area.
9 Red	5-6	F	62	10/09	East of the mud plant at section of Areas 19 20	Lactating doe in excellent condition. Wintered Area 30 and Timber Mountain area.
10 Red	1-2	F	47	10/16	Echo Peak trap site, Area 19	Wintered north end of Area 19 in the Belted Range.
4 Blue	2-3	F	45	06/25	Echo Peak trap site, Area 19	Lactating doe in good condition, given reconditioned radio. Seen 09/13/79 with two fawns. Wintered in Yucca Mountain and Buggy area.
K	1	M	34	07/06	Echo Peak trap site, Area 19	Buck too small for radio - given visual tag.
L	1	M	40	07/17	Echo Peak trap site, Area 19	Buck too small for radio - given visual tag.

(continued)

TABLE 8. (Continued)

I.D.	Age Estimated	Sex	Weight Estimated (kg)	Date Captured	Capture Location	Comments
M	3-4	M	85	09/14	Echo Peak trap site, Area 19	Buck too large for radio given visual tag.
N	5-6	M	85	09/20	Echo Peak trap site, Area 19	On 08/10/77 was outfitted with Blue 7 radio which was lost at a later date. Now too large for radios, given visual tag only.
P	5-6	M	95	09/14	Echo Peak trap site, Area 19	Buck too large for radio given visual tag.
S	1	M	45	09/79	Echo Peak trap site, Area 19	Small buck given ear tag and red tags. Seen U-19-E Res. 07/28/80.
F-2	fawn	F	13	09/20	Echo Peak trap site, Area 19	Female fawn. Given ear tags.
F-3	fawn	M	17	10/10	Echo Peak trap site, Area 19	Male fawn in good flesh. Given ear tags only.
F-4	fawn	F	18	10/10	Echo Peak trap site, Area 19	Female fawn in good flesh. Given ear tags only. Seen in Echo Peak area 12/17-18/79, seen 1/2 mile North of traps 07/28/80.
F-5	fawn	F	17	10/11	Echo Peak trap site, Area 19	Female fawn in good flesh. Given ear tags only.
A-1	5-6	M	114	10/11	Echo Peak trap site, Area 19	Large buck in excellent flesh. Given ear tags and visual tag.
B-1	3-4	F	68	12/04	Echo Peak trap site, Area 19	Doe in good flesh. Given ear tags and reference number. Seen Echo Peak 12/17/79, seen Bailey Creek, over 100 miles from capture site 06/20/80. 08/13/80 reported by MX missle survey crew to Nevada Department of Wildlife.
C-1	1	F	42	12/05	Echo Peak trap site, Area 19	Female fawn given ear tags only. Retrapped following night.

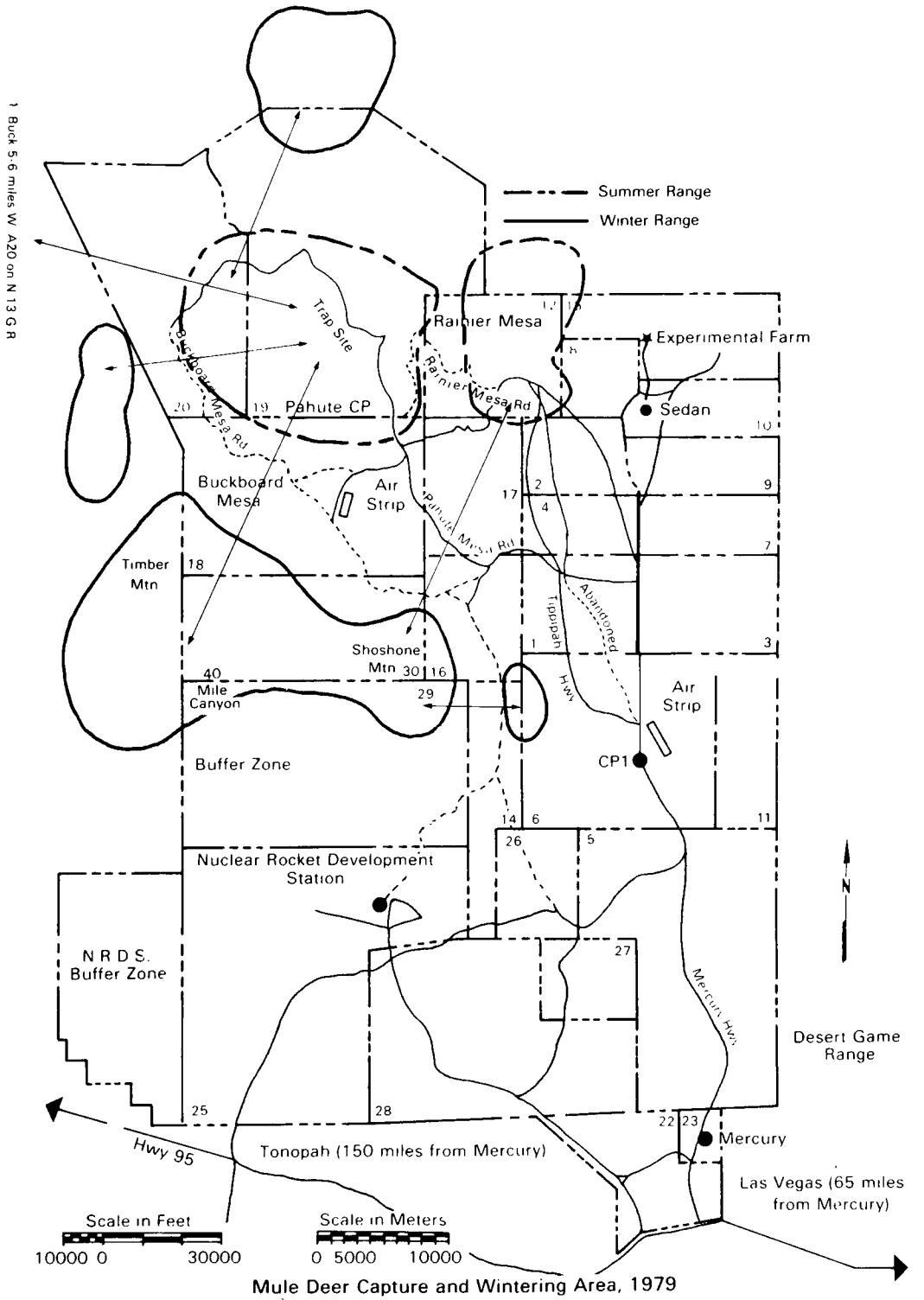

Figure 4. Mule deer capture and wintering areas, 1979.

km from the capture point. The remainder of the deer tagged in Area 19 went south to Timber Mountain, 40 Mile Canyon areas and Beatty Wash.

INVESTIGATIONS AND OTHER PROJECTS

There were no livestock damage claims that required investigation during 1979.

AIP personnel monitored the natural springs of the NTS on a periodic basis and repaired or rehabilitated as indicated.

The beef herd was maintained on the natural vegetation of Area 18. Grazing areas were controlled by moving the water supply to various locations during the year. Cottonseed oil meal supplement was fed during the winter months.

PUBLIC INFORMATION AND AREA 15 FARM

The offsite public information program continued by direct contact with ranchers, by lectures to civic organizations, and by briefings of groups touring the EMSL-LV or the NTS Experimental Farm. During 1978, the objectives and findings of the AIP were presented to 275 NTS visitors in 20 different tour groups. Approximately 200 additional drop-in visitors to the farm received informal briefings.

The Area 15 farm, in addition to its major function as an experimental dairy farm, also served as the field station for the NTS operation of the AIP. As such it provided the facilities for the maintenance of the horses, rumen-fistulated steers, and beef bulls; weaning of calves; and production of alfalfa hay. A reorganization and reduction in force at EMSL-LV in 1979 resulted in changes in the farm operation. In June the dairy herd was dispersed and in September maintenance of the farm was placed under a contractor (Lloyd Enterprises).

The Area 15 farm served as a training site for participants in the Radiological Emergency Response Course sponsored by the Nuclear Regulatory Commission, Office of State Programs. This course, taught by the Reynolds Electrical and Engineering Company for DOE, NVO, was presented 16 times during 1979.

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TABLE A-1. 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 Spectrometry	Lithium-drifted germanium detectors calibrated at approximately 0.5 KeV per channel input to 4096 channels resident in the core of the Nuclear Data 6620 computer-based gamma spectrometry system.	1,200	Radionuclide concentrations quantitated from gamma spectrum by Nuclear Data 6620 computer-based gamma spectrometry system using vendor supplied software.	300-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}Cs, - 30 pCi For: ^{65}Zn, ^{106}Ru, ^{144}Ce - 20 pCi For: ^{181}W - 85 pCi For: ^{7}Be - 45 pCi
	or by				
	10-cm-thick by 10 cm-diameter NaI (Tl-activated) crystal with input to Nuclear Data 6620 calibrated at 10 keV per channel in the 60 keV to 2 MeV range.	1,000	Radionuclide concentration quantitated by CDC-6400 computer using Least Squares Technique.	300-ml aluminum cans	For: ^{241}Am - 35 pCi For: ^{22}Na - 4 pCi For: K - 0.08 g
$^{89-90}Sr$	Low-background thin-window, gas-flow proportional counter with a 5.7-cm diameter window (80 $\mu g/cm^2$).	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 - 3 pCi
^{3}H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	5 ml	0.4 pCi/ml H_2O
$^{238-239}Pu$	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.	0.1-1 kg wet weight 1 - 10 g of ash	For all isotopes - 0.04 pCi

* The minimum detectable activities in terms of total activity per sample for standard geometries and counting times are defined as those activities which equal 3.29 times the standard deviation based on counting only [Environmental Measurements Laboratory (EML-formerly HASL) Procedures Manual, HASL-300, pages D-08-02 through D-08-06, August 1974]. 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.

TABLE B-1. PLUTONIUM QUALITY ASSURANCE RESULTS

Tissue Type	Wet Weight (g)	Nuclide	Activity Added (pCi/kg)	Activity Reported (pCi/kg)	Percent* Deviation
Liver	672	^{239}Pu	7.4	2.0 ± 0.76	-73
		^{238}Pu	1.6	1.3 ± 0.57	-19
Liver	617	^{239}Pu	13	8.3 ± 1.5	-36
		^{238}Pu	3.5	2.1 ± 053	-40
Liver	682	^{239}Pu	5.6	3.4 ± 0.91	-39
		^{238}Pu	0.48	<0.33	-31
Liver	839	^{239}Pu	0	1.04 ± 0.72	
		^{238}Pu	0	0.72 ± 0.58	
Muscle	764	^{239}Pu	0	<0.14	
		^{238}Pu	0	<0.16	
Muscle	788	^{239}Pu	1.4	0.66 ± 0.22	-53
		^{238}Pu	3.5	1.5 ± 0.35	-57
Muscle	645	^{239}Pu	6.0	7.5 ± 1.3	+25
		^{238}Pu	1.7	1.04 ± 0.38	-38
Muscle	756	^{239}Pu	3.0	3.1 ± 0.54	+ 3
		^{238}Pu	3.6	0.69 ± 0.21	-80

*Percent deviation $= \frac{(x-u)}{u} \times 100$

where x = activity reported
u = activity added

TABLE C-1. PLUTONIUM CONCENTRATIONS IN LUNGS AND TRACHEOBRONCHIAL LYMPH NODES, BEEF CATTLE, AREA 18, NTS, MAY 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu pCi/g Ash) (pCi/kg*)	Ash (%)
	Lungs		
1	0.011 ± 0.007 0.14 ± 0.091	0.17 ± 0.035 2.2 ± 0.45	1.3
2	0.013 ± 0.009 0.14 ± 0.1	0.14 ± 0.032 1.6 ± 0.36	1.1
3	<0.031 <0.22	0.45 ± 0.11 3.1 ± 0.75	0.7
Median	0.013 0.14	0.14 2.2	1.1
Range	0.011-<0.031 0.14-<0.22	0.14-0.45 1.6-3.1	0.7-1.3
	Tracheobronchial Lymph Nodes		
1	Sample not collected		
2	0.076 ± 0.068 0.46 ± 0.41	0.77 ± 0.23 4.6 ± 1.4	0.6
3**	<0.06 <1.4	<0.1 <2.3	2.3
Median			
Range	<0.06-0.076 0.46-<1.4	0.77-<0.1 <2.3-4.6	0.6-2.3

*Wet weight
**Recounted data

TABLE C-2. PLUTONIUM CONCENTRATIONS IN MUSCLES AND LIVERS, BEEF CATTLE, AREA 18, NTS, MAY 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu pCi/g Ash) (pCi/kg*)	Ash (%)
	Muscles		
1	0.008 ± 0.007 0.04 ± 0.035	<0.027 <0.13	0.5
2	<0.004 <0.092	0.004 ± 0.003 0.092 ± 0.069	2.3
3	<0.004 <0.099	0.004 ± 0.003 0.099 ± 0.072	2.8
Median	<0.004 <0.092	0.004 0.099	2.3
Range	<0.004-0.008 0.04-<0.099	0.004-<0.027 0.092-<0.13	0.5-2.8
	Livers		
1	0.007 ± 0.004 0.25 ± 0.14	0.019 ± 0.007 0.69 ± 0.25	3.6
2	<0.005 <0.22	0.014 ± 0.005 0.6 ± 0.26	4.4
3	<0.014 <0.43	0.019 ± 0.010 0.6 ± 0.31	3.1
Median	0.007 0.25	0.014 0.6	3.6
Range	<0.005-<0.014 <0.22 -<0.43	0.014-0.019 0.6 -0.69	3.1-4.4

*Wet weight

TABLE C-3. PLUTONIUM CONCENTRATIONS IN RUMEN CONTENTS AND RETICULUM SEDIMENTS, BEEF CATTLE, AREA 18, NTS, MAY 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu pCi/g Ash) (pCi/kg*)	Ash (%)
	Rumen Contents		
1	0.022 ± 0.008 0.63 ± 0.23	0.077 ± 0.018 2.2 ± 0.52	2.9
2	0.02 ± 0.007 0.2 ± 0.075	0.1 ± 0.02 1.1 ± 0.2	1.0
3	0.043 ± 0.014 0.6 ± 0.19	0.21 ± 0.043 3.0 ± 0.6	1.4
Median	0.022 0.6	0.1 2.2	1.4
Range	0.02-0.043 0.2-0.63	0.077-0.21 1.1-3	1-2.9
	Reticulum Sediments		
1	Sample not collected		
2**	4.9 ± 0.58 3,800 ± 450	230 ± 27 180,000 ± 21,000	78
3	0.013 ± 0.007 11 ± 6.1	0.086 ± 0.022 75 ± 19	87
Median			
Range	0.013-4.9 11-3,800	0.086-230 75-180,000	78-87

*Wet weight
**Verified by Eberline-duplicate analyses done.

TABLE C-4. PLUTONIUM CONCENTRATIONS IN GONADS AND FETUS, BEEF CATTLE, AREA 18, NTS, OCTOBER 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu pCi/g Ash) (pCi/kg*)	Ash (%)
	Gonads		
4	0.098 ± 0.066 1.1 ± 0.78	0.12 ± 0.073 1.4 ± 0.86	1.2
5	0.082 ± 0.050 1.4 ± 0.84	0.045 ± 0.037 0.74 ± 0.61	1.7
6	Sample not collected		
Median			
Range	0.082-0.098 1.1-1.4	0.045-0.12 0.74-1.4	1.2-1.7
	Fetus		
4	0.003 ± 0.002 0.22 ± 0.17	0.014 ± 0.005 0.94 ± 0.37	7

* Wet weight

TABLE C-5. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN FEMURS, BEEF CATTLE, AREA 18, NTS, 1979

Animal Number	^{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 (%)
		May			
1	<0.006 <1.1	0.007 ± 0.004 1.2 ± 0.71	<0.19 <34	3.1 ± 0.4 550 ± 70	18
2	<0.007 <2.1	<0.004 <1.2	<0.22 <67	0.4 ± 0.16 120 ± 50	31
3	<0.009 <2.8	0.006 ± 0.005 1.5 ± 1.2	<0.14 <34	0.6 ± 0.17 150 ± 40	24
Median	<0.007 <2.1	<0.006 1.2	<0.19 <34	0.6 150	24
Range	<0.006-<0.009 <1.1-<2.8	<0.004-<0.007 <1.2-1.5	<0.14-<0.22 <34-<67	0.4-3.1 120-550	18-31
		October			
4	<0.011 <3.2	0.006 ± 0.004 1.8 ± 1.2	<0.1 <29	0.71 ± 0.19 210 ± 60	29
5	<0.006 <1.5	<0.009 <2.3	<0.13 <33	2.4 ± 0.1 610 ± 30	25
6	<0.009 <2.5	<0.009 <2.5	<0.1 <27	0.73 ± 0.14 200 ± 40	28
Median	<0.009 <2.5	<0.009 <2.3	<0.1 <29	0.73 210	28
Range	<0.006-<0.011 <1.5-<3.2	0.006-<0.009 1.8-<2.5	<0.1-<0.13 <27-<33	0.71-2.4 200-610	25-29

* Wet weight

TABLE C-6. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, BEEF CATTLE, AREA 18, NTS, MAY 1979

Animal Number	Muscles K (g/kg*) ^{137}Cs(pCi/kg*)	Lungs K (g/kg*)	Livers K (g/kg*)	Kidneys K (g/kg*) ^{137}Cs(pCi/kg*)	Rumen Contents K (g/kg*) ^{137}Cs(pCi/kg*)	Blood ^{3}H (pCi/l)
1	4.1 ± 0.34 23 ± 16	5.0 ± 0.38	3.6 ± 0.24	8.9 ± 0.74 <7**	7.3 ± 0.64 <7**	970 ± 290
2	4.8 ± 0.32 30 ± 14	3.9 ± 0.43	8.3 ± 0.7	3.1 ± 0.28 21 ± 10	2.1 ± 0.22 <7**	510 ± 280
3	4.4 ± 0.34 38 ± 13	14 ± 1.5	3.3 ± 0.33	3.9 ± 0.3 <7**	16 ± 2 24 ± 10	680 ± 280
Median	4.4 30	5.0	3.6	3.9 <7**	7.3 <7**	680
Range	4.1 - 4.8 23 - 38	3.9 - 14	3.3 - 8.3	3.1 - 8.9 <7** - 21	2.1 - 16 <7** - 24	510 - 970

*Wet weight
**In total sample

TABLE C-7. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, BEEF CATTLE, AREA 18, NTS, OCTOBER 1979

Number	Muscles (g/kg*) ^{137}Cs(pCi/kg*)	Lungs K (g/kg*) ^{137}Cs(pCi/kg*)	Livers K (g/kg*) ^{137}Cs(pCi/kg*)	Kidneys K (g/kg*) ^{137}Cs(pCi/kg*)	Rumen Contents K (g/kg*) ^{137}Cs(pCi/kg*) ^{7}Be(pCi/kg*)	Blood ^{3}H(pCi/l)
4	2.3 ± 0.17 <7**	11 ± 1.0 <7**	3.7 ± 0.41 16 ± 15	3.3 ± 0.27 <7**	2.5 ± 0.23 32 ± 15 770 ± 210	<350
5	4.8 ± 0.17 28 ± 12	4.7 ± 0.23 65 ± 12	3.5 ± 0.29 25 ± 16	3.8 ± 3.0 26 ± 12	3.1 ± 0.31 <7** <45**	<350
6	1.5 ± 0.21 <7**	12 ± 0.52 24 ± 22	4.1 ± 0.27 <7**	3.9 ± 0.85 <7**	3.5 ± 0.23 <7** <45**	<350
Median	2.3 7**	11 24	3.7 16	3.8 <7**	3.1 <7** <45**	<350
Range	1.5 - 4.8 <7** - 28	4.7 - 12 <7** - 65	3.5 - 4.1 <7** - 25	3.3 - 39 <7** - 26	2.5 - 3.5 <7** - 32 <45** - 770	<350 - <350

*Wet weight
**In total sample

TABLE D-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, MULE DEER, NTS, 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
		Muscles	
1	<0.004 <0.24	0.018 ± 0.007 1.1 ± 0.4	5.9
2	<0.003 <0.078	0.016 ± 0.007 0.42 ± 0.18	2.6
3	<0.02 <0.21	<0.049 <0.51	1.0
4	<0.023 <1.3	0.082 ± 0.04 4.6 ± 2.3	5.6
Median	<0.012 <0.23	<0.34 <0.81	4.1
Range	<0.003-<0.023 <0.078-<1.3	0.016-0.082 0.42-4.6	1-5.9
		Gonads	
1	<0.007 <0.26	0.053 ± 0.019 2 ± 0.7	3.7
		Lungs	
1	<0.008 <0.24	0.03 ± 0.013 0.92 ± 0.4	3.1
2	<0.039 <0.41	0.028 ± 0.02 0.29 ± 0.21	1
3	<0.005 <0.075	0.006 ± 0.004 0.09 ± 0.06	1.5
4	<0.035 <1.3	0.089 ± 0.028 3.4 ± 1.1	3.8
Median	<0.022 <0.33	0.029 0.62	2.3
Range	<0.005 - <0.039 <0.075 - <1.3	0.006 - 0.089 0.09 - 3.4	1-3.8

(continued)

TABLE D-1. (Continued)

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
		Livers	
1	0.16 ± 0.028 9.5 ± 1.7	0.076 ± 0.017 4.6 ± 1.0	6.1
2	<0.004 <0.23	<0.005 <0.28	5.3
3	Sample not collected		
4	<0.012 <0.69	0.021 ± 0.014 1.2 ± 0.82	5.9
Median	<0.012 <0.69	0.021 1.2	5.9
Range	<0.004 - 0.16 <0.23 - 9.5	<0.005 - 0.076 <0.28 - 4.6	5.3-6.1
		Rumen Contents	
1	<0.013 <0.62	0.074 ± 0.028 3.6 ± 1.3	4.8
2	<0.007 <0.085	0.038 ± 0.014 0.46 ± 0.17	1.2
3	0.014 ± 0.006 0.19 ± 0.081	0.049 ± 0.013 0.66 ± 0.18	1.4
4	<0.042 <2.0	0.08 ± 0.037 3.8 ± 1.7	4.8
Median	<0.01 <0.41	0.062 2.1	3.1
Range	<0.007-<0.042 <0.085-<2.0	0.038-0.08 0.46-3.8	1.2-4.8

* Wet weight

TABLE D-2. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN HOCK BONES, MULE DEER, NTS, 1979

Animal Number	^{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 (%)
1	<0.015 <5.4	<0.005 <1.8	<8.4 <3,000	3.8 ± 0.12 1,300 ± 40	36
2	<0.012 <4.2	<0.009 <3.1	<0.26 <91	1.8 ± 0.2 630 ± 70	35
3	<0.009 <3.3	<0.005 <1.9	<0.17 <63	2.9 ± 0.2 1,100 ± 70	37
4	<0.008 <2.0	<0.005 <1.2	<2.1 <520	1.7 ± 0.18 430 ± 45	25
Median	<0.011 <3.8	<0.007 <1.9	<1.2 <300	2.4 870	36
Range	<0.008-<0.015 <2.0 -<5.4	<0.005-<0.009 <1.2 -<3.1	<0.17-<8.4 <63 -<3,000	1.7 -3.8 430 -1,300	25-37

* Wet weight

TABLE D-3. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, MULE DEER, NTS, 1979

Number	Muscles K(g/kg*) ^{137}Cs(pCi/kg*)	Lungs K(g/kg*)	Livers K(g/kg*)	Kidneys K(g/kg*) ^{137}Cs(pCi/kg*) ^{3}H(pCi/l†)	Rumen Contents Kg(g/kg*) ^{137}Cs(Pci/kg*) ^{7}Be(pCi/kg*)	Thyroids K(g/kg*)	Blood ^{3}H(pCi/l)
1	5.0 ± 0.29 22 ± 11	4.0 ± 0.39	4.8 ± 0.5	3.3 ± 0.27 52 ± 13 NA	3.2 ± 0.48 62 ± 30 820 ± 410	<0.08‡	460 ± 250
2	8.5 ± 0.62 <7.0‡	5.8 ± 0.49	4.7 ± 0.32	4.4 ± 0.44 <7.0‡ NA	2.4 ± 0.26 <7.0‡ 210 ± 130	1.7 ± 0.25	480 ± 280
3	7.6 ± 0.58 <7.0‡	1.7 ± 0.22	S.N.C.	3.5 ± 0.76 <7.0‡ <350	5.4 ± 0.32 <7.0‡ <45‡	1.0 ± 0.25	NA
4	7.4 ± 0.56 <7.0‡	3.7 ± 0.51	3.1 ± 0.29	7.3 ± 0.59 <7.0‡ <380	6.1 ± 0.3 <7.0‡ <45‡	S.N.C.	S.N.C.
Median	7.5 <7.0‡	3.85	4.7	3.95 <7.0‡ <370	4.3 <7.0‡ <45‡	1.7	470
Range	5 - 8.5 <7.0‡ - 22	1.7 - 5.8	3.1 - 4.8	3.3 - 7.3 <45‡ - 52 <350 - <380	2.4 - 6.1 <7.0‡ - 62 <45‡ - 820	<0.08‡ - 1.9	460-480

*Wet weight
†Aqueous portion of kidney
‡In total sample
NA = Not analyzed
S.N.C. = Sample not collected

TABLE E-1. PLUTONIUM AND STRONTIUM CONCENTRATION IN BONES, DESERT BIGHORN SHEEP, 1979

Animal Number	^{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 (%)
1	<0.013 <3.3	<0.019 <4.9	<1.9 <480	1.2 ± 0.15 300 ± 39	26
2	<0.023 <10	<0.023 <10	<2.2 <960	1.7 ± 0.17 750 ± 74	44
3	<0.005 <1.6	<0.012 <3.9	<4.7 <1,500	4.1 ± 0.28 1,300 ± 90	33
4	<0.006 <1.5	<0.004 <0.99	<3.3 <820	2.5 ± 0.22 600 ± 54	25
5	<0.002 <0.68	<0.004 <1.4	<2.4 <800	1.04 ± 0.14 350 ± 48	34
6	<0.014 <5.6	<0.009 <3.6	<4.2 <1,700	2.4 ± 0.2 940 ± 80	40
7	<0.004 <1.5	<0.006 <2.2	<2.6 <940	1.5 ± 0.17 550 ± 62	37
8	<0.004 <2.0	<0.007 <3.5	<2.7 <1,300	1.3 ± 0.16 640 ± 80	50
9	<0.002 <0.54	<0.003 <0.82	<2.7 <730	1.2 ± 0.15 310 ± 41	27
10	<0.003 <1.1	<0.006 <2.1	<2.0 <690	0.72 ± 0.12 250 ± 42	35
11	<0.005 <1.6	<0.006 <1.9	<2.3 <750	1.02 ± 0.14 330 ± 45	32
12	<0.008 <2.7	<0.011 <3.7	<2.1 <720	2.2 ± 0.21 740 ± 71	34
Median	<0.005 <1.6	<0.007 <2.9	<2.5 <810	1.4 580	34
Range	<0.002-<0.023 <0.54-<10	<0.003-<0.23 <0.82-<10	<1.9-<4.7 <480-<1,700	0.72-4.1 250-1,300	25-50

*Wet weight

TABLE E-2. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN KIDNEYS, DESERT BIGHORN SHEEP, 1979

Animal Number	K (g/kg*)	^{137}Cs (pCi/kg*)	^{3}H (pCi/l†)
1	4.6 ± 0.28	13 ± 11	<300
2	12 ± 0.76	<7.0‡	<300
3	5.0 ± 0.42	<7.0‡	<300
4	4.0 ± 0.44	25 ± 17	<300
5	4.3 ± 0.47	34 ± 17	<300
6	8.6 ± 0.56	<7.0‡	<300
7	9.6 ± 0.6	<7.0‡	<300
8	5.6 ± 0.44	36 ± 24	<300
9	7.1 ± 0.66	<7.0‡	<300
10	9.8 ± 0.92	<7.0‡	<300
11	3.2 ± 0.32	35 ± 15	<240
12	4.7 ± 0.65	<7.0‡	<300
Median	5.3	<7.0‡	<300
Range	3.2-12	<7.0‡ - 36	<240 - <300

*Wet weight
†Aqueous portion of kidney tissue
‡In total sample

TABLE F-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 18, NTS, 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
	Muscles		
1	<0.031 <0.99	<0.031 <0.99	3.2
2	<0.025 <1.4	0.07 ± 0.033 3.9 ± 1.8	5.6
3	<0.015 <0.39	0.033 ± 0.013 0.88 ± 0.36	2.7
Median	<0.025 <0.99	0.033 <0.99	3.2
Range	<0.015-<0.031 <0.39-<1.4	<0.031-0.07 0.88-3.9	2.7-5.6
	Internal Organs		
1	0.02 ± 0.011 1.1 ± 0.59	0.13 ± 0.031 7.5 ± 1.7	5.6
2	<0.092 <0.88	0.15 ± 0.054 1.4 ± 0.52	1.0
3	<0.034 <0.72	0.075 ± 0.03 1.6 ± 0.64	2.1
Median	<0.72 <0.88	0.13 1.6	2.1
Range	0.02-<0.88 <0.72-1.1	0.075-0.15 1.4-7.5	1-5.6

*Wet weight

(continued)

TABLE F-1. (Continued)

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
	G. I. Tract		
1	0.055 ± 0.042 3.5 ± 2.7	0.2 ± 0.089 13 ± 5.7	6.4
2	0.36 ± 0.14 8.3 ± 3.1	11 ± 2.0 250 ± 47	2.3
3	0.13 ± 0.039 3.3 ± 0.95	0.83 ± 0.14 20 ± 3.4	2.5
Median	0.13 3.5	0.83 20	2.5
Range	0.055-0.36 3.3-8.3	0.2-11 13.250	2.3-6.4
	Skin		
1	<0.079 <2.2	0.77 ± 0.18 22 ± 5.0	2.8
2	0.072 ± 0.026 5.9 ± 2.1	0.43 ± 0.082 35 ± 6.6	8.1
3	0.11 ± 0.062 3.1 ± 1.7	0.7 ± 0.18 20 ± 5	2.8
Median	<0.079 3.1	0.7 22	2.8
Range	0.072-0.11 <2.2-5.9	0.43-0.77 20-35	2.8-8.1

*Wet weight

TABLE F-2. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES, RABBITS, AREA 18, NTS, 1979

Animal Number	^{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 (%)
1	<0.012 <2.8	<0.01 <2.3	<0.16 <37	0.55 ± 0.21 130 ± 50	23
2	<0.008 <1.9	<0.008 <1.9	<0.14 <33	0.88 ± 0.26 210 ± 60	24
3	<0.007 <1.2	<0.015 <2.5	<0.12 <20	2.4 ± 0.3 390 ± 50	16
Median	<0.008 <1.9	<0.015 <2.3	<0.14 <33	0.88 210	23
Range	<0.007-<0.012 <1.2-<2.8	<0.008-<0.015 <1.9-<2.5	<0.12-<0.16 <20-<37	0.55-2.4 130-390	16-24

TABLE F-3. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 18, NTS, 1979

	Muscles	Internal Organs	G.I. Tract	Skin
Animal Number	K(g/kg*) ^{137}Cs(pCi/kg*) ^{3}H(pCi/l†)	K(g/kg*)	K(g/kg*) ^{137}Cs(pCi/kg*)	K(g/kg*) ^{137}Cs(pCi/kg)
1	9.0 ± 0.73 <7‡ <350	6.6 ± 0.42	5.2 ± 0.39 59 ± 14	15 ± 1.4 <7.0‡
2	6.6 ± 0.32 25 ± 12 <350	6.5 ± 0.51	8.1 ± 0.81 190 ± 43	9.9 ± 0.92 110 ± 49
3	4.5 ± 0.36 34 ± 14 <350	19 ± 16	4.5 ± 0.35 46 ± 19	6.1 ± 1.1 <7.0‡
Median	6.6 25 <350	6.6	5.2 59	9.9 <7.0‡
Range	4.5 - 9 <7‡ - 34 <350 -<350	6.5 - 19	4.5 - 8.1 46 -190	6.1 - 15 <7.0‡-110

* Wet weight † Aqueous portion of muscle ‡ In total sample

TABLE G-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 15, NTS, 1979

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
		Muscles	
1	<0.031 <0.84	0.096 ± 0.042 2.6 ± 1.1	2.7
2	<0.074 <1.1	0.087 ± 0.05 1.3 ± 0.81	1.5
3	<0.018 <0.57	0.10 ± 0.03 3.2 ± 1.0	3.2
Median	<0.031 <0.84	0.096 2.6	2.7
Range	<0.018-<0.074 <0.57-<1.1	0.087-0.1 1.3-3.2	1.5-3.2
		G. I. Tract	
1	0.17 ± 0.034 5.2 ± 1.1	6.9 ± 0.85 220 ± 27	3.2
2	0.066 ± 0.025 3.6 ± 1.4	1.04 ± 0.19 57 ± 10	5.5
3	0.11 ± 0.03 5.6 ± 1.4	4.8 ± 0.64 230 ± 31	4.8
Median	0.11 5.2	6.9 220	4.8
Range	0.066-0.17 3.6-5.6	4.8-1.04 57-230	3.2-5.5

(continued)

TABLE G-1. (Continued)

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
		Internal Organs	
1	<0.018 <0.8	0.13 ± 0.036 5.9 ± 1.6	4.5
2	<0.18 <2.5	0.48 ± 0.2 6.9 ± 2.9	1.4
3	<0.14 <1.5	0.35 ± 0.15 3.6 ± 1.5	1.0
Median	<0.14 <1.5	0.35 5.9	1.4
Range	<0.018-<0.18 <0.8-<2.5	0.13-0.48 3.6-6.9	1.0-4.5
		Skin	
1	0.27 ± 0.093 22 ± 7.7	9.1 ± 2.0 750 ± 170	8.2
2	0.57 ± 0.34 8.7 ± 5.3	6.0 ± 1.5 92 ± 23	1.5
3	0.18 ± 0.05 14 ± 3.6	8.4 ± 1.3 660 ± 98	7.8
Median	0.27 14	8.4 660	7.8
Range	0.18-0.57 8.7-22	6-9.1 92-750	1.5-8.2

* Wet weight

TABLE G-2. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES, RABBITS, AREA 15, NTS, 1979

Animal Number	^{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 (%)
1	<0.016 <2.9	<0.011 <2.0	<0.07 <13	0.32 ± 0.1 58 ± 18	18
2	<0.01 <1.6	0.11 ± 0.023 17 ± 3.6	<0.31 <49	2.2 ± 0.4 350 ± 60	16
3	0.006 ± 0.005 0.97 ± 0.81	0.011 ± 0.006 1.8 ± 0.97	<0.12 <19	3.0 ± 0.3 490 ± 50	16
Median	<0.01 <1.6	0.011 <2.0	<0.12 <19	2.2 350	16
Range	0.006-<0.016 0.97-<2.9	<0.011-0.11 1.8-17	<0.07-<0.31 <13-<49	0.32-3.0 58-490	16-18

* Wet weight

TABLE G-3. GAMMA-EMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 15, NTS, 1979

Animal Number	Muscles K(g/kg*) ^{137}Cs(pCi/kg*) ^{3}H(pCi/l**)	Internal Organs K(g/kg*)	G.I. Tract K(g/kg*) ^{137}Cs(pCi/kg*)	Skin K(g/kg*) ^{137}Cs(pCi/kg*)
1	6.5 ± 0.32 46 ± 14 3,900 ± 260	4.6 ± 0.44	4.5 ± 0.21 150 ± 13	8.4 ± 0.86 260 ± 58
2	8.3 ± 0.43 59 ± 21 1,300 ± 230	6.9 ± 1.3	5.9 ± 0.28 60 ± 12	31 ± 3.8 290 ± 23
3	2.8 ± 0.18 16 ± 8.3 770 ± 240	4.0 ± 0.54	4.7 ± 0.23 65 ± 12	10 ± 0.68 320 ± 37
Median	6.5 46 1,300	4.6	4.7 65	10 290
Range	2.8 - 8.3 16 - 59 770 - 3,900	4.0 - 6.9	4.5 - 5.9 60 - 150	8.4 - 31 260 - 320

*Wet weight
**Aqueous portion of muscle

TABLE H-1. PLUTONIUM, STRONTIUM, AND GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES, NTS HORSE, 1979

Tissue Type	^{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*)
Bone	<0.009 <2.1	<0.006 <1.4	<4.2 <970	3.6 ± 0.24 820 ± 56	23	NA
Muscle	<0.11 <0.75	<0.13 <0.92	NA	NA	0.7	6.3 ± 0.29 58 ± 13
Liver	<0.18 <0.38	<0.25 <0.53	NA	NA	0.2	4.8 ± 0.78 33 ± 11
Lung	<0.061 <0.63	<0.05 <0.51	NA	NA	1.0	4.9 ± 0.5 40 ± 21
Kidney	NA	NA	NA	NA	NA	2.9 ± 0.27 40 ± 12

* = Wet weight
NA = Not Analyzed

TABLE I-1. PLUTONIUM, STRONTIUM, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES, NTS COYOTE, 1979

Tissue Type	^{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*)	^{3}H(pCi/l†)
Bone	<0.5 <1.1	<0.3 <0.65	<11 <2,400	4.9 ± 0.33 1,100 ± 70	22	NA	NA
Muscle	<0.01 <0.41	<0.005 <0.2	NA	NA	4.1	5.8 ± 0.45 6.9 ± 10	NA
Liver	<0.011 <0.69	0.008 ± 0.006 0.5 ± 0.38	NA	NA	6.3	4.1 ± 0.45 41 ± 24	NA NA
Lung	0.009 ± 0.006 0.24 ± 0.16	0.032 ± 0.013 0.85 ± 0.34	NA	NA	2.6 2.6	9 ± 0.92 <7.0‡	NA
Stomach Contents	<0.004 <0.3	<0.009 <0.67	NA	NA	7.5	3.9 ± 2.0 120 ± 110	NA NA
Kidney	NA	NA	NA	NA	NA	5.2 ± 1.2 <7.0‡	1,900 ± 310

* = Wet weight
† = From aqueous portion of kidney
‡ = In total sample
NA = Not Analyzed

TABLE J-1. PLUTONIUM, STRONTIUM, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES, NTS BOBCAT, 1979

Tissue Type	^{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*)	^{3}H(pCi/l**)
Bone	<0.009 <2.6	<0.011 <3.1	<5.1 <1,500	2.3 ± 0.27 650 ± 77	28	NA	NA
Muscle	<0.039 <1.4	<0.035 <1.3	NA	NA	3.6	11 ± 0.64 200 ± 34	NA
Liver	<0.015 <0.63	<0.014 <0.56	NA	NA	4.1	4.1 ± 0.33 67 ± 18	NA
Lung	<0.13 <0.54	0.19 ± 0.087 0.81 ± 0.37	NA	NA	0.4	3.3 ± 0.58 170 ± 46	NA
Kidney	NA	NA	NA	NA	NA	5.2 ± 1.4 130 ± 59	<350

* = Wet weight
** = From aqueous portion of kidney
NA = Not Analyzed

TABLE K-1. PLUTONIUM, STRONTIUM, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES, NTS CHUKARS, 1979

Animal No. and Tissue Type	^{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*)	^{3}H(pCi/l†)
1 Bone	<0.01 <0.96	<0.019 <1.8	<5.2 <500	1.7 ± 0.29 160 ± 28	9.6	NA	NA
2 Bone	<0.011 <1.1	<0.021 <2.2	<7.8 <800	3.4 ± 0.41 350 ± 42	10	NA	NA
3 Bone	0.008 ± 0.006 0.78 ± 0.59	0.007 ± 0.005 0.68 ± 0.49	<14.1 <1,400	1.3 ± 0.28 130 ± 27	9.8	NA	NA
1 Muscle	<0.023 <1.3	<0.032 ± 0.01 <1.8 ± 0.95	NA	NA	5.7	10 ± 0.52 <7.0‡	$2.3x10^6 \pm 3.8x10^3$
2 Muscle	<0.23 <0.61	<0.2 <0.53	NA	NA	0.3	8 ± 0.39 37 ± 16	$1.4x10^4 \pm 3.8x10^2$
3 Muscle	<0.022 <0.27	0.029 ± 0.013 0.35 ± 0.16	NA	NA	1.2	4.7 ± 0.34 <7.0‡	$2.1x10^5 \pm 1.2x10^3$
1 Internal Organs	<0.065 <3.0	0.1 ± 0.071 4.7 ± 3.3	NA	NA	4.6	46 ± 3.4 <7.0‡	NA
2 Internal Organs	<0.033 <1.8	0.099 ± 0.056 5.4 ± 3.0	NA	NA	5.5	20 ± 1.9 <7.0‡	NA
3 Internal Organs	<0.009 <0.84	<0.009 <0.84	NA	NA	9.3	13 ± 1 <7.0‡	NA

(continued)

TABLE K-1. (Continued)

Animal No. and Tissue Type	^{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*)	^{3}H(pCi/l†)
1	0.34 ± 0.16	0.96 ± 0.3	NA	NA	2.6	15 ± 1.1	NA
G.I. Tract	9.0 ± 4.1	25 ± 7.8				<7.0‡	
2	<0.46	<0.69	NA	NA	0.8	21 ± 1.3	NA
G.I. Tract	<3.4	<5.6				190 ± 36	
3	0.016 ± 0.008	0.018 ± 0.008	NA	NA	5.7	8.9 ± 0.62	NA
G.I. Tract	0.91 ± 0.45	1.0 ± 0.48				<7.0‡	

* = Wet weight
† = From aqueous portion of muscle
‡ = In total sample
NA = Not analyzed

TABLE L-1. PLUTONIUM, STRONTIUM, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES, NTS, EAGLES, 1979

Animal No. and Tissue Type	^{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*)	^{3}H(pCi/l†)
1 Bone	<0.003 <0.65	<0.003 <0.65	<4.0 <875	3.1 ± 0.19 670 ± 41	22	NA	NA
2 Bone	<0.003 <0.69	<0.003 <0.69	<6 <1,400	2.6 ± 0.11 590 ± 25	23	NA	NA
1 Muscle	<0.005 <0.35	<0.01 <0.71	NA	NA	7	3.8 ± 0.14 <7.0‡	1,200 ± 290
2 Muscle	<0.002 <0.11	<0.002 <0.11	NA	NA	5.3	4.2 ± 0.33 53 ± 16	840 ± 120
1 Internal Organs	<0.007 <0.47	0.031 ± 0.012 21 ± 0.8	NA	NA	6.7	6.9 ± 0.53 <7.0‡	NA
2 Internal Organs	<0.041 <1.0	0.17 ± 0.072 4.2 ± 1.8	NA	NA	2.5	7 ± 0.29 <7.0‡	NA
1 Stomach Contents	<0.026 <0.74	<0.026 <0.74	NA	NA	2.8	5.9 ± 0.76 110 ± 55	NA
2 Stomach Contents	<0.009 <0.35	<0.009 <0.35	NA	NA	3.9	5.3 ± 0.77 62 ± 32	NA

* = Wet weight
† = Aqueous portion of muscle
NA = Not analyzed
‡ = In total sample

APPENDIX M. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN NECROPSIED ANIMALS, 1979

AREA 18 CATTLE, MAY

1

Necropsy findings: Animal showed posterior paralysis and had recently given birth. No gross lesions noted.

Histopathological findings: The liver shows diffuse but mild fatty change in the hepatocytes. The spleen shows no significant lesions. The kidney exhibits mild chronic inflammatory changes in the pelvis characterized by infiltration of a few mononuclear cells and mild fibrosis. No significant lesions are seen in the lung. The adrenal shows no significant lesions. The muscle, heart, and eye show no significant lesions. No important pathologic findings were noticed in any of these tissues.

Clinical diagnosis: Normal heifer with obturator paralysis from dystocia.

2

Necropsy findings: The lungs were emphysematous from agonal struggling. Abdominal cavity contained several hundred milliliters of serum.

Histopathological findings: Moderate hemosiderosis of the spleen. A small number of mineralized tubules are found in the kidney. These are incidental findings.

Clinical diagnosis: Normal, aged Hereford steer in excellent condition.

3

Necropsy findings: Lungs are emphysematous with atelectic areas in the apical lobes. These lesions are most probably the result of agonal struggling. The

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

rumen contained a mass 16 centimeters in diameter that is made up of entangled 1/2" nylon rope.

Histopathological findings: Moderate hemosiderosis of the spleen. Skeletal muscle shows minimal focal subacute nonsuppurative myositis. This probably represents an incidental finding resulting from mild inflammatory lesion of a muscle fiber.

Clinical diagnosis: Normal aged Hereford steer in excellent condition.

4

Necropsy findings: Precancerous plaques at corneal-sclera junction of medial canthus of both eyes.

Histopathological findings: The lungs show some thickening of alveoli with hyperplasia of the smooth muscle and peribronchial lymphoid infiltration is observed. The kidneys exhibit mild interstitial fibrosis occurring in a focal pattern primarily in medulla and pelvis. A few desclimated epithelial cells are seen in the collecting ducts. Liver shows mild fatty changes primarily located in the central lobular area. There is hyperplasia and excessive keratinization forming an epithelial plaque at the corneal-scleral junction of the eye. This lesion is undermined by lymphocytic cells. This lesion possibly represents a precursor to squamous cell carcinoma. The epithelial plaque noted in the cornea is a lesion worthy of note in this study.

Clinical diagnosis: Normal aged Hereford cow.

5

Necropsy findings: No gross lesions noted.

Histopathological findings: No significant lesions noted. The testicle has numerous interstitial cells. The seminiferous tubules are adequate but not yet producing mature sperm.

Clinical diagnosis: Normal bull calf.

6

Necropsy findings: No gross lesions noted.

Histopathological findings: There is lymphoid infiltrate beneath the cornea near corneal conjunctival junction of the eye. Mild to moderate hemosiderin pigment is located in the red pulp of the spleen. The liver shows diffuse, mild fatty changes involving primarily, but not exclusively, the central lobular areas.

Clinical diagnosis: Normal mature steer in excellent condition

NEVADA TEST SITE MULE DEER

1

Necropsy findings: Trauma associated with bullet passage through the lungs. No other gross lesions noted. Ticks were found in the axillary region.

Histopathological findings: The testicle shows no evidence of spermatogenesis. Interstitial cells are sparse and the few that are present contain some vecuolar degenerative changes. Comments: This probably represents a normal deer testicle, in the inactive state. Several large sarocysts are observed in the skeletal muscle.

Clinical diagnosis: Normal mature male deer.

2

Necropsy findings: Extensive trauma associated with contact with rapidly moving vehicle. These include fractures of the left rib cage and of the right humerus. The liver was fragmented and the rumen had ruptured releasing its contents throughout the abdominal cavity. The lungs showed evidence of agonal struggling. Advanced postmorten changes precluded sampling for histopathological examination.

Clinical diagnosis: Normal mature male deer that died in collision with motor vehicle.

3

Necropsy findings: Not necropsied as hind quarters and most internal organs consumed by predators. Samples not collected for histopathological or hematological examinations.

Clinical diagnosis: Mature doe that was killed in collision with motor vehicle.

4

Necropsy findings: No gross lesions noted except those associated with trauma of bullet passage.

Histopathological findings: The eye exhibits lymphocytic infiltration, forming a small nodular pattern at the corneal-conjunctival junction. The lungs show moderate focal hyperinflation. There is mild colloid depletion of the thyroid.

Clinical diagnosis: Normal immature doe.

5

NEVADA TEST SITE HORSE

Animal died five days after being struck by motor vehicle. Was not necropsied but lesions of pneumonia were noted by dissector along with signs of pleuritis. Samples not collected for histopathological or hematological examination.

Clinical diagnosis: Pneumonia brought on by stress associated with trauma and captivity.

NEVADA TEST SITE BOBCAT

Necropsy findings: No gross lesions noted. Advanced postmortem changes present.

Histopathological findings: Lungs congested and edematous, other tissues exhibit postmortem autolysis.

Clinical diagnosis: Normal adult bobcat that was apparently electrocuted.

NEVADA TEST SITE COYOTE

Necropsy findings: Included those associated with the trauma of being struck by a motor vehicle and being shot. The spine was fractured in the lumbar region and the skull and brain was extensively traumatized from bullet passage. Shallow, partially healed dermal ulcers were noted along the rear toes and medial surface of the thigh.

Histopathological findings: No significant lesions observed.

Clinical diagnosis: Immature female coyote whose death was caused by trauma.

NEVADA TEST SITE EAGLES 1 & 2

Both birds were electrocuted by shortcircuiting a substation at the NRDS. They were not necropsied and no lesions were noted during sample collection. Samples were not collected for histopathological or hematological examination. Both were apparently normal at time of death.

NEVADA TEST SITE RABBITS AND CHUKAR

All of these animals were collected by shotgun fire. All were placed in a freezer until necropsied. No gross lesions were noted. All were apparently

normal at time of death. Samples for histopathological or hematological examinations were not collected.

DESERT BIGHORN SHEEP

All of these animals were mature males that were killed by licensed hunters. No necropsies were performed but all were apparently normal at time of death. No samples were collected for histopathological or hematological examinations.

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT

Data are presented from the radioanalyses of tissues collected from animals that resided on or near the Nevada Test Site (NTS). Gamma-emitting radionuclides were detected infrequently. Strontium-90 concentrations in bones were lower than those of recent years. Tritium and plutonium levels varied little from previous years. Radionuclide tissue concentrations were generally higher in animals from Area 15 than in similar animals from other NTS areas.

The highest postulated annual dose estimate to man was 2.6 millirems to bone based on the daily consumption of 0.5 kg of deer liver containing peak levels of plutonium-238. This dose is about 0.5 percent of the 500 millirems per year radiation protection guide for individuals in the general population. Postulated doses for other radionuclides are about 0.3 percent or less of the standard.

The movements of 25 mule deer outfitted with collars containing a radio transmitter unit were monitored weekly. During the winter all deer left their summer range on the NTS. The deer dispersed over the widest areas observed since 1975. A deer captured in December 1979 was observed 7 months later in the Barley Creek area of Nye County which is approximately 160 kilometers from its capture point.

No gross or microscopic lesions were found in necropsied animals that could be directly attributed to the effects of ionizing radiation.

17. KEY WORDS AND DOCUMENT ANALYSIS

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