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

Published June 1976

This study performed under a Memorandum
of Understanding No. AT(26-1)-539
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U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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by
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Effective June 29, 1975, the National Environmental Research Center-Las Vegas (NERC-LV) was designated the Environmental Monitoring and Support Laboratory-Las Vegas (EMSL-LV). This Laboratory is one of three Environmental Monitoring and Support Laboratories of the Office on Monitoring and Technical Support in the U.S. Environmental Protection Agency's Office of Research and Development.

FOOD HABITS AND RADIONUCLIDE TISSUE CONCENTRATIONS OF NEVADA DESERT BIGHORN SHEEP 1972-1973*

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Abstract: The botanical composition of the diet and radionuclide content of selected tissues of desert bighron sheep (Ovis canadensis nelsoni) collected during the 1972 and 1973 hunting seasons were determined by analyzing rumen contents, and lung, liver, kidney, and bone tissues.

Botanical examination of the rumen contents showed that grass exceeded 50% of the diet of 10 of 14 animals collected in 1972 and 12 of 18 animals collected in 1973. Desert needlegrass (Stipa speciosa), Indian rice grass (Oryzopsis hymenoides), and squirrel tail (Sitanion hystrix) were the major grasses utilized. The dominant shrub species consumed included the joint firs (Ephedra viridis) and (Ephedra nevadensis), Mohave yucca (Yucca schidigera), and cliff rose (Cowania mexicana).

*Presented at the 19th Annual Meeting of the Desert Bighorn Council, April 9-11, 1975, Indio, California.

With the exception of potassium-40, gamma-emitting radionuclides were not detected in desert bighorn sheep tissue. The tritium levels reported were within environmental levels. Strontium-90 levels averaged 4.9 and 4.1 pCi/gram of bone ash for 1972 and 1973, respectively, continuing the downward trend observed in recent years. Uranium levels were similar to those reported from cattle grazing the same general geographic areas. The daily consumption for one year of 500 grams of liver containing the highest levels of plutonium and uranium would result in a dose to the human bone, the tissue expected to receive the highest dose, of approximately 1 mrem/year. This is less than 1% of the radiation protection guides for the general population.

INTRODUCTION

The U.S. Fish and Wildlife Service of the U.S. Department of Interior and the Environmental Monitoring and Support Laboratory-Las Vegas (EMSL-LV) of the U.S. Environmental Protection Agency have in past years initiated and cooperated in many investigations concerning the desert bighorn sheep (Ovis canadensis nelsoni). The information and data obtained from these cooperative studies such as reported by Helvie and Smith (1970), Kramp (1965), and Cohen (1968), have contributed not only to a greater understanding of this animal's behavior, but also to better management practices.

Investigations to determine radionuclide concentrations in various tissues of wildlife species have been conducted for many years by the Animal Investigation Program (AIP) of EMSL-LV. This program was established in 1957 by the U.S. Atomic Energy Commission (AEC). (Recently renamed the Energy Research and Development Administration, ERDA). The program assesses fission and activation products in biological samples, maintains veterinary relations with off-site populations, and investigates alleged damage to domestic animals from the ERDA testing activities.

During the past few years, a number of studies have been conducted in Nevada in areas inhabited by desert bighorn sheep. These investigations have been conducted in both southern Nevada and central Nevada. The emphasis has been either on habitat analysis or vegetative surveys and, in some cases, food habit analyses. A few reports have been published concerning radionuclide concentration in selected tissues of big game animals in the southern Nevada area.

The data from most of these reports have been incorporated into a soon to be published book entitled, The Desert Bighorn, Its Life, History, Ecology, and Management, edited by Lowell Sumner and Gale Monson (1971). Other data, which will be extremely useful to investigators, include bighorn habitat evaluations by Ferrier and Bradley (1971) and Breyen (1971), and the floras of the Virgin and the McCullough Mountains by Armstrong (1969) and Bostick (1973).

Most of the data dealing with radionuclide concentrations in desert bighorn sheep have been reported in AIP annual progress reports. Some additional data have been published in Desert Bighorn Council Transactions. These papers were authored by Smith (1971), Kramp (1965), and Fountain (1962).

In 1972, a cooperative study between the two Federal agencies mentioned and the Nevada Fish and Game Commission was initiated to identify species composition of vegetation in the rumen ingesta of desert bighorn sheep and to determine the radioactive concentration in selected tissues. The data presented in this report are from animals collected during the 1972 hunt from November 16 to December 17, and from the 1973 hunt from November 17 to December 16.

The authors are indebted to personnel of the Region III Headquarters of the Nevada Department of Fish and Game for disseminating sample collection kits and receiving samples from participating hunters. The cooperation of these sportsmen in collecting samples from their kills made this study possible.

METHODS

Prior to the 1972 and 1973 hunting seasons, hunters were given an indoctrination course which emphasized the identification of legally harvestable rams. During this course, each hunter was requested, on a voluntary basis, to collect the following tissues,

lung, liver, kidney, and bone, and to collect a sample of rumen ingesta.

The samples were delivered to EMSL-LV for radionuclide and food habit analyses. All samples except the bone were analyzed for gamma-emitting radionuclides on a 4- by 4-inch NaI(Tl) crystal attached to a 400-channel pulse height analyzer. Kidney samples were analyzed for tritium using the method described previously by Moghissi et al. (1973).

The samples for strontium, plutonium, and uranium analyses were prepared by dry ashing. Plutonium and uranium were analyzed by alpha spectroscopy (Talvitie, 1971 and 1972). Other radionuclide analytical procedures used at the NERC-LV are described by Johns (1970).

The botanical analysis of the rumen ingesta was accomplished by examining a random aliquot of the ingesta with a binocular microscope. The sample was washed on a fine mesh screen preparatory to examination. After the species in the sample were identified, a visual estimate of the percentage of each species was made and recorded (Leach, 1956). No effort was made to determine the radionuclide content of individual species found in the rumen ingesta.

The browse and forb species were identified according to Munz (1965) and grasses according to Hitchcock (1950).

In 1972, the tissues and rumen ingesta from 14 animals were analyzed. All were harvested in southern Nevada with eight collected on the Desert National Wildlife Range, two from the Meadow Valley Range, two from the Muddy Mountain area, and one each from the McCullough Mountains and the Eldorado Mountains. These rams ranged from 4 to 11 years of age.

In 1973, 18 animals were sampled. Similar to the 1972 hunt, most of these animals were collected in southern Nevada with 10 coming from the Desert National Wildlife Range. Of the remaining eight animals, three were collected in the Muddy Mountains-Boulder Wash area, two from the Eldorado Mountains, one from the Meadow Valley Range area, one from the Highland Range, and one from central Nevada near the Lone Mountain in Esmeralda County. These rams ranged from 4 to 10 years of age.

RESULTS AND DISCUSSION

Food Habits Analysis

The animals collected on the Desert National Wildlife Range will be discussed and presented as a single grouping, because of their geographical relationship. The data from the remaining animals, except the ram harvested in Esmeralda County during the 1973 hunt, will be composited and presented as another separate group. The

compositing of data from the latter group was done because of the small sample size collected from any specific geographical area.

Tables 1 and 2 show the botanical composition of forage utilized by desert bighorn sheep collected on the Desert National Wildlife Range in 1972 and 1973, respectively. The data show that in 1972 grasses exceeded 70% of the diet of five of the eight animals collected, with two having less than 15% and 40%. Browse species contributed an average of 40% composition, with animals No. 1 and No. 4 having in excess of 85%. The forbs in the rumen contents of these eight animals averaged less than 1.0%. However, wild buckwheat (Eriogonum spp.) was present in 75% of the desert bighorn sheep collected. Identified grasses included blue grass (Poa spp.) and desert needlegrass (Stipa speciosa) which contributed an average of 2.4% and 1.0%, respectively, to the diet of these animals while unidentified grasses constituted 53.2% of the diet. Cliff rose (Cowania mexicana), the joint firs (Ephedra viridis) and (Ephedra nevadensis), and big sagebush (Artemisia tridentata) were the major browse species consumed, contributing 12.8%, 10.6%, 9.8%, and 5.9% of the diet, respectively.

In 1973, the type of vegetation consumed by the ten animals collected on the Desert National Wildlife Range was comparable to that utilized by the eight animals collected in 1972. Grasses

made up slightly more than 50% of the diet with browse species contributing 45%. Forb species consumption increased over 1972 with the spurge (Euphorbia spp.) and other unidentified species contributing over half of the forbs utilized. A total of seven grasses were identified in the ingesta with four of these contributing an average of 39.4% of the diet. The frequency of occurrence of these four species in the rumen was 80% for Stipa speciosa, 70% for Indian rice grass (Oryzopsis hymenoides), 50% for squirrel tail (Sitanion hystrix), and 60% for Hilaria jamesii. The major difference in browse species utilized between the two years was the presence of the Mohave yucca (Yucca schidigera). This species, which was absent in 1972, contributed over 17.0% of the diet and occurred in 70% of the animals in 1973. Other important browse species included Ephedra viridis, Cowania mexicana, four-winged saltbush (Atriplex canescens), and Artemisia tridentata.

Tables 3 and 4 show the average botanical composition and frequency of occurrence of plant species eaten by the second group of animals harvested in southern Nevada from areas other than the Desert National Wildlife Range during the 1972 and 1973 hunting seasons. Grasses were the dominant type of vegetation by composition found in these animals with 73% in 1972 and 72% in 1973. Forbs exceeded 13% of the diet in the 1973 animals with Euphorbia spp. accounting for 7.8% of this total. The amount of forbs in the ingesta of the 1972 animals, 1.2% (Table 3), and that consumed by the 1973 animals,

harvested on the Desert National Wildlife Range, 0.7% (Table 1), are comparable. The occurrence of browse species for both groups was approximately the same with Ephedra viridis heading the list followed by Cowania mexicana, Ephedra nevadensis, and Artemisia tridentata. Yucca schidigera was present in both groups of 1973 animals (Tables 2 and 4); however, the difference is quite significant. An explanation for this difference is difficult as Yucca schidigera is commonly found in all the bighorn habitats. The preferred grasses were approximately the same as those found in the animals collected on the Desert National Wildlife Range, with Oryzopsis hymenoides, Stipa speciosa, Sitanion hystrix, and Hilaria jamesii being dominant.

The single ram harvested on the Lone Mountain in Esmeralda County had nearly 100% grass in its rumen. There was only a trace amount of Eriogonium spp. in the ingesta and no browse species. The preferred grasses included Stipa speciosa followed by Sitanion hystrix, and giant wild rye (Elymus cinereus). The data obtained from this animal substantiated the work done by Yoakum (1964). He concluded that grasses were the preferred food during the fall and winter months in this area.

The results of the food habit analysis from all these animals which were collected in a variety of geographical areas in southern Nevada, support previous investigations by Barrett (1964),

Yoakum (1966), and Browning (1971). They reported that grasses made up more than 50% of the diet of animals collected on the Desert National Wildlife Range, the Meadow Valley Range, and near the Potosi Mountain.

Radionuclide Content of Selected Tissues

The radionuclide data for each tissue from each animal sampled during 1972 and 1973 are presented in the AIP annual reports authored by Smith et al. (1975 a, b). These data are summarized in Tables 5 and 6 and in the following discussion. The data are expressed as pCi or fCi. A pCi is 10^{-12} Curies and a fCi is 10^{-15} Curies. The Curie is a group of units indicating 3.7×10^{10} disintegrations per second or the disintegration rate of one gram of radium.

Other than the naturally occurring potassium-40, gamma-emitting radionuclides did not exceed minimum detectable activities (MDA) in any of the tissues sampled during 1972 or 1973. The rumen contents occasionally contained detectable levels of zirconium-95, ruthenium-103, cesium-137, and cerium-141.

Tritium levels in the aqueous portion of the kidneys during 1972 ranged from 260 to 1,800 pCi/liter (median value 355 pCi/liter) while the 1973 levels ranged from 240 to 730 pCi/liter (median value of 390 pCi/liter). These values are considered to be within

environmental limits as the water from Lake Mead in 1973 averaged 890 pCi/liter (range of 640 to 1,300 pCi/liter) as reported by the Monitoring Operations Division of EMSL-LV (1974).

The average strontium-90 content in the 1972 bones was 4.9 pCi/gram of ash and 4.1 pCi/gram of ash in the 1973 samples. This continues the downward trend observed in recent years; e.g., the average for 1971 was 5.8 pCi/gram of ash.

As reflected in Tables 5 and 6, bone (hock) was the only tissue sampled during both years in sufficient numbers to allow meaningful comparison of actinide values. The actinide levels in desert bighorn sheep are generally of the same magnitude as reported in cattle from similar areas. Uranium values were higher in animals collected in southern Nevada than in animals from the Desert National Wildlife Range. This was also found in a 1972 study with cattle from an area near Searchlight, Nevada, and from the Nevada Test Site (Smith et al. 1976). This probably reflects the levels of naturally occurring uranium present in the soils of the two areas (Garside 1973).

Human dose estimates, for assumed ingestion of the liver from bighorn sheep, are given in Table 7. The estimates are for human bone, based on postulated consumption of 500 grams of liver per day from the animal containing the highest measured concentrations of

plutonium and uranium. The concentrations of radionuclides, in pCi per kilogram of wet tissue versus gram of ash, are taken from the tabulation by Smith et al. (1975 a, b).

The dose calculation parameters are based on the data and assumptions of the International Commission on Radiological Protection (1959, 1968). Details concerning the calculations of the dose conversion parameters are given by Smith et al. (1976).

The total dose committment to the bone, accrued over a 50-year period after ingestion for one year, is 7 mrem.* The total dose rate at the end of one year's ingestion (not given in Table 7) is about 1 mrem/year. This is less than 1% of the radiation protection guides of the National Council on Radiation Protection and Measurements (1971) for a sample of the general population.

It is obvious from these calculations that the consumption of the flesh of these animals would pose little hazard to the public. Insufficient data are available to draw any conclusions on possible radiation effects on the desert bighorn sheep. However, detrimental or deleterious effects have not been observed in domestic animals whose tissues contained similar levels of radionuclides. Moreover, pathological lesions have not been found at necropsy that could be attributed to ionizing radiation.

*The mrem is 0.001 rem, a radiation dosimetry quantity that considers energy absorption and biological effectiveness.

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Table 1

Botanical Composition by Percent of Forage Eaten by Bighorn Sheep Collected on the Desert National Wildlife Range, Nevada-1972

Species	Animal 1	2	3	4	5	6	7	8	Av. Composition (%)	Frequency (%)
Other (unidentified)	6.0	67.0	74.0	10.0	33.0	89.0	76.0	71.0	53.2	100
Poa spp.	0.0	0.0	0.0	0.0	7.0	0.0	2.0	10.0	2.4	37
Stipa speciosa	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	12
Hilaria jamesii	1.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	25
Festuca spp.	0.0	0.0	0.0	2.0	0.0	0.0	0.0	3.0	0.6	25
Stipa spp.	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.5	12
Oryzopsis hymenoides	0.0	0.0	1.0	0.0	0.0	2.0	0.0	0.0	0.3	25
Bromus tectorium	0.0	0.0	T	0.0	0.0	0.0	0.0	0.0	T	12
Total grass	7.0	79.0	75.0	12.0	40.0	95.0	78.0	84.0	58.7	
Other (unidentified)	T	0.0	0.0	1.0	2.0	1.0	0.0	0.0	0.5	50
Eriogonum spp.	0.0	1.0	T	0.0	1.0	T	T	T	0.2	75
Chaenactis spp.	0.0	T	0.0	0.0	0.0	T	0.0	0.0	T	25
Phacelia spp.	0.0	0.0	0.0	0.0	0.0	0.0	T	0.0	T	12
Total forbs	T	1.0	T	1.0	3.0	1.0	T	T	0.7	
Cowania mexicana	89.0	1.0	1.0	0.0	0.0	1.0	9.0	1.0	12.8	75
Ephedra viridis	0.0	0.0	0.0	84.0	0.0	0.0	0.0	0.0	10.6	12
Ephedra nevadensis	0.0	2.0	20.0	0.0	54.0	1.0	0.0	1.0	9.8	62
Artemisia tridentata	4.0	15.0	2.0	0.0	0.0	T	12.0	14.0	5.9	75
Other (unidentified)	0.0	2.0	2.0	0.0	3.0	1.0	1.0	0.0	1.1	62
Cercocarpus intricatus	0.0	0.0	0.0	2.0	0.0	1.0	0.0	0.0	0.3	25
Ceanothus greggii	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.1	12
Pinus monophylla	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	T	12
Total shrubs	93.0	20.0	25.0	87.0	57.0	4.0	22.0	16.0	40.6	

T = trace

Table 2

Botanical Composition by Percent of Forage Eaten by Bighorn Sheep Collected on the Desert National Wildlife Range, Nevada-1973

Species	Animal 1	2	3	4	5	6	7	8	9	10	Av. Composition (%)	Frequency (%)
Stipa speciosa	6.0	6.0	19.0	10.0	34.0	0.0	0.0	24.0	21.0	19.0	13.9	80
Oryzopsis hymenoides	9.0	20.0	0.0	0.0	13.0	13.0	36.0	0.0	6.0	6.0	10.3	70
Sitanion hystrix	17.0	0.0	0.0	0.0	0.0	0.0	26.0	16.0	15.0	21.0	9.5	50
Other (unidentified)	0.0	18.0	9.0	26.0	0.0	15.0	0.0	0.0	3.0	14.0	8.5	60
Hilaria jamesii	0.0	0.0	6.0	4.0	0.0	0.0	19.0	17.0	6.0	4.0	5.7	60
Stipa spp.	0.0	0.0	0.0	14.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	10
Elymus cinereus	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.6	10
Bromus tectorium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.2	10
Total grass	32.0	44.0	34.0	54.0	47.0	34.0	81.0	59.0	51.0	64.0	50.1	
Other (unidentified)	2.0	2.0	4.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	1.6	40
Euphorbia spp.	0.0	0.0	0.0	0.0	3.0	0.0	3.0	0.0	4.0	0.0	1.0	30
Sphaeralcea spp.	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	4.0	0.0	0.6	20
Eriogonum spp.	0.0	T	1.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.4	30
Erodium cicutarium	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.3	10
Linum lewisii	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.3	10
Astragalus spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T	T	10
Total forbs	2.0	2.0	5.0	0.0	8.0	8.0	6.0	0.0	11.0	T	4.2	

Table 2 (contd)

Botanical Composition by Percent of Forage Eaten by Bighorn Sheep Collected on the Desert National Wildlife Range, Nevada-1973

Species	Animal 1	2	3	4	5	6	7	8	9	10	Av. Composition (%)	Frequency (%)
Yucca schidigera	36.0	32.0	38.0	0.0	4.0	28.0	4.0	0.0	0.0	32.0	17.4	70
Ephedra viridis	0.0	0.0	11.0	17.0	12.0	14.0	2.0	2.0	0.0	0.0	5.8	60
Cowania mexicana	7.0	16.0	6.0	6.0	19.0	0.0	1.0	1.0	0.0	0.0	5.6	70
Atriplex canescens	0.0	0.0	0.0	0.0	6.0	0.0	0.0	28.0	0.0	0.0	3.4	20
Artemisia tridentata	20.0	0.0	0.0	2.0	4.0	0.0	0.0	2.0	0.0	2.0	3.0	50
Juniperus monosperma	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	26.0	0.0	2.8	20
Cercocarpus intricatus	0.0	4.0	4.0	9.0	0.0	9.0	0.0	0.0	0.0	0.0	2.6	40
Other (unidentified)	3.0	0.0	2.0	0.0	0.0	4.0	0.0	8.0	0.0	0.0	1.7	40
Yucca brevifolia	0.0	0.0	0.0	8.0	0.0	0.0	6.0	0.0	0.0	0.0	1.4	20
Encelia spp.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	1.2	10
Colegyme ramosissima	0.0	0.0	0.0	3.0	0.0	3.0	0.0	0.0	0.0	0.0	0.6	20
Atriplex spp.	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	10
Total shrubs	66.0	54.0	61.0	46.0	45.0	58.0	13.0	41.0	38.0	34.0	45.7	

T = trace

Table 3

Botanical Composition and Frequency of Occurrence of Plant Species Eaten by Six Bighorn Sheep Collected in Southern Nevada-1972*

Species	Common Name	Average Composition (%)	Frequency (%)
Other (unidentified)		69.0	100
Hilaria jamesii	Galleta grass	1.3	83
Festuca spp.	Fescue	1.0	16
Stipa speciosa	Desert needlegrass	0.5	16
Oryzopsis hymenoides	Indian rice grass	0.3	16
Poa spp.	Blue grass	0.2	16
Hordeum spp.	Wild barley	0.2	16
	Total grass	73.0	
Eriogonum spp.	Wild buckwheat	0.5	100
Other (unidentified)		0.3	16
Helianthus spp.	Sunflower	0.2	33
Sphaeralcea spp.	Mallow	0.2	16
	Total forbs	1.2	
Ephedra viridis	Joint fir	12.0	33
Other (unidentified)		7.3	66
Ephedra nevadensis	Nevada joint fir	2.7	66
Ceanothus greggii	Desert ceanothus	1.3	33
Ceanothus spp.	Ceanothus	0.8	50
Yucca spp.	Yucca	0.6	16
Artemisia tridentata	Big sagebrush	0.5	50
Cowania mexicana	Cliff rose	0.2	33
Cercocarpus intricutus	Little-leaved mahogany	0.2	33
Coleogyne ramosissima	Blackbrush	0.2	33
Encelia spp.	Encelia	T	16
Atriplex canescens	Four-winged saltbush	T	33
	Total browse	25.8	

T = trace

*Excluding the Desert National Wildlife Range

Table 4

Botanical Composition and Frequency of Occurrence of Plant Species Eaten by Seven Bighorn Sheep Collected in Southern Nevada-1973*

Species	Common Name	Average Composition (%)	Frequency (%)
Oryzopsis hymenoides	Indian rice grass	23.4	100
Stipa speciosa	Desert needlegrass	22.8	100
Sitanion hystrix	Squirrel tail	13.9	57
Other (unidentified)		8.1	57
Elymus cinereus	Giant wild rye	1.4	29
Hilaria jamesii	Galleta grass	1.4	29
Sporobolus spp.	Dropseed	0.9	14
	Total grass	71.9	
Euphorbia spp.	Spurge	7.8	71
Other (unidentified)		2.6	57
Argemone spp.	Poppy	0.8	29
Eriogonum spp.	Wild buckwheat	0.7	43
Erodium cicutarium	Heron's bill	0.6	29
Chaenactis spp.	Pincushion	0.6	29
Linum lewisii	Blue flax	0.1	14
	Total forbs	13.2	
Cowania mexicana	Cliff rose	5.1	29
Other (unidentified)		3.8	71
Artemisia tridentata	Big sagebrush	2.0	14
Ephedra viridis	Joint fir	1.4	43
Yucca schidigera	Mohave yucca	0.9	29
Ephedra nevadensis	Nevada joint fir	0.9	14
Quercus gambelii	Gambel's oak	0.4	14
Coleogyne ramosissima	Black brush	0.3	29
Arctostaphylos spp.	Manzanita	0.1	14
	Total browse	14.9	

*Excluding the Desert National Wildlife Range

Table 5

Summary of Actinide and Strontium Levels in the Ash from Selected Tissues from Desert Bighorn Sheep Collected on the Desert National Wildlife Range, Nevada, 1972-1973

Tissue	Year	^{238}Pu fCi/g	^{239}Pu fCi/g	^{234}U fCi/g	^{235}U fCi/g	^{238}U fCi/g	^{89}Sr pCi/kg	^{90}Sr pCi/kg
		# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median
Bone	1972	6 0 <0.87-<2.2 <2	6 4 <1.3-5.2 3.1	6 6 1.2-7.7 6.4	6 1 <0.31-<0.88 <0.43	6 6 1.1-7.3 6	6 0 <3.4-<4.7 <3.5	6 6 3.4-9.4 4.8
	1973	8 7 0.77-45 2.4	8 4 <0.41-2.6 1.6	8 8 1.8-6.4 2.85	8 0 <0.28-<1.2 <0.43	8 8 1-3.9 1.8	8 2 <1-<28 1.75	8 8 2.4-7.7 4.3
Liver	1972	NO SAMPLES COLLECTED						
	1973	7 5 <1.6-790 11	7 7 5.4-210 83	2 2 4.5-49 26.7	2 0 <2.4-<12 7.2	2 2 5.5-25 15.3	NA	NA
Lung	1972	1 0 <5.4	1 1 18	NA	NA	NA	NA	NA
	1973	10 7 3.3-130 11	10 6 <7.1-190 19	6 6 5.8-140 14	6 1 <4.6-6.4 <1.75	6 6 1.7-150 10.5	NA	NA

NA = Not analyzed.

Table 6

Summary of Actinide and Strontium Levels in the Ash from Selected Tissues from Desert Bighorn Sheep Collected in Southern Nevada, 1972-1973*

Tissue	Year	^{238}Pu fCi/g	^{239}Pu fCi/g	^{234}U fCi/g	^{235}U fCi/g	^{238}U fCi/g	^{89}Sr pCi/kg	^{90}Sr pCi/kg
Bone	1972	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median	# Samples # >MDA Range Median
		5 0 <0.76-<2.9 <2.2	5 4 <1.3-17 2.9	5 5 4.7-16 10	5 2 <0.4-2 <0.63	5 5 4.4-15 9.2	5 0 <3.4-<5.2 <4	5 5 2.6-7.9 2.6
	1973	7 6 <1.7-77 17	7 2 <0.62-15 <1.5	7 7 1.5-16 3.8	7 1 <0.41-1.5 <0.49	7 6 <0.91-13 2.5	7 0 <0.83-<22 <2	7 7 1.2-11 2.6
Liver	1972	NO SAMPLES COLLECTED						
	1973	1 1 1,800 ± 310	1 1 670 ± 140	1 1 710 ± 78	1 1 35 ± 14	1 1 610 ± 72	NA	NA
Lungs	1972	NO SAMPLES COLLECTED						
	1973	8 7 <6.9-1,000 33	8 4 <5.2-29 <14	7 6 <12-170 46	7 2 <2.5-10 <5	7 7 8.9-170 34	NA	NA

NA = Not analyzed.

*Excluding the Desert National Wildlife Range

Table 7

Estimated Human Bone Doses from Ingestion of Liver
Dose Accrued Over 50-Year Period After
Ingestion of 500 Grams per Day for 1 Year

Nuclide	Maximum Observed Concentration pCi/kg of Wet Tissue	Dose Factor mrem:pCi/day	50-Year Dose mrem
^{238}Pu	33	0.27	4.5
^{239}Pu	12	0.31	1.9
^{234}U	13	0.036	0.2
		TOTAL	7

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