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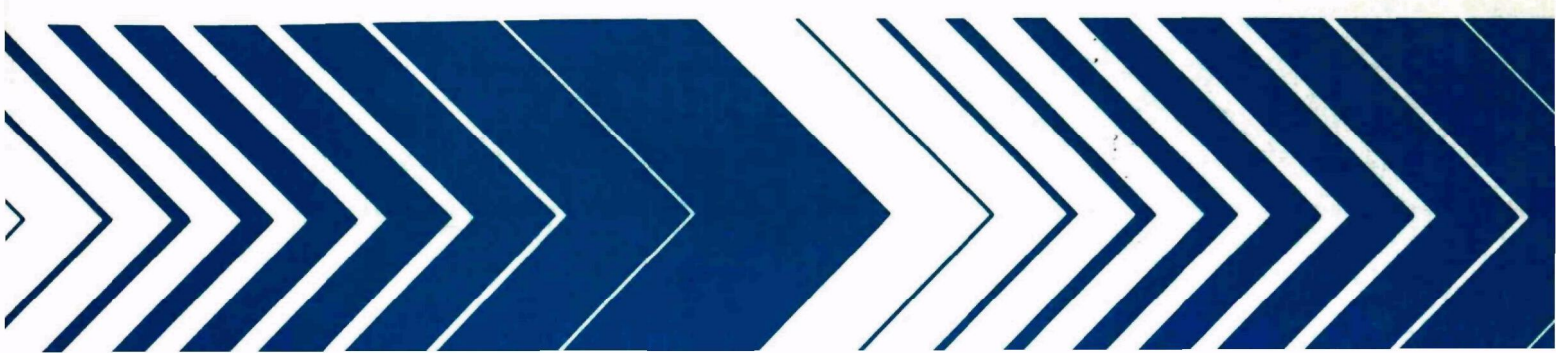

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ANIMAL INVESTIGATION PROGRAM FOR THE NEVADA TEST SITE: 1957-1981

by

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Prepared for the
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ENVIRONMENTAL MONITORING SYSTEMS LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
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INTRODUCTION

In November 1955, the U.S. Atomic Energy Commission (AEC) established a program to investigate claims of injury to domestic animals alleged to be caused by nuclear weapons tests at the Nevada Proving Grounds. The Nevada Proving Grounds was renamed the Nevada Test Site (NTS) and the program that was established developed into the Animal Investigation Program (AIP).

The AIP, as finally conceived, began in 1957 with the purchase of a herd of beef cattle which were allowed to graze on the NTS. This herd was maintained on the NTS until 1981. After roundup and sampling of this herd in the fall of 1981, it was transferred to the University of Nevada at Reno, Nevada. This terminated a 25-year study of a single herd which had lived in an area contaminated by nuclear testing activities. The animal-sampling portion of the AIP is continuing, on a more restricted scale, through periodic sampling from a commercial beef herd and annual collections of samples from bighorn sheep.

This report describes the objectives of the AIP, outlines the history of the Program, and summarizes the results of claims investigations. Also summarized are the results of radionuclide analyses from both the continuing program and associated special studies to measure body burdens of radionuclides in wild and domestic animals.

SUMMARY

During the 25-year existence of the Animal Investigation Program, periodic sampling of various herds of cattle and other indigenous animals was conducted to measure tissue concentrations of radionuclides. The cattle herds sampled included one on the Nevada Test Site (NTS), one at Knoll Creek (KC) in northeastern Nevada and one in the Delamar Valley (DV) in eastern Nevada. Other animals consistently sampled included deer on the NTS and deer and bighorn sheep off the NTS.

The age of sampled animals had no significant effect on tissue cesium-137 concentration. The effective half-life of cesium-137 in beef muscle, following cessation of atmospheric testing, was approximately 1 year. Cesium-137 levels were usually highest in the Knoll Creek herd in northern Nevada, probably the result of higher world-wide fallout associated with the higher precipitation that occurs in that area. These results plus those from Nevada deer herds, both on and off the NTS, indicate that, except for periods immediately following deposition of close-in fallout, tissue concentrations of cesium-137 reflected the deposition of worldwide fallout. The calculated dose commitment from cesium-137 due to the daily ingestion of tissues from the Knoll Creek and/or NTS herd for the 25-year period was 68 mrem [1.6% of the Federal Radiation Council's (FRC) permissible guide for the same period].

Strontium-90 concentration in bone ash from all three Nevada beef herds and from NTS deer generally followed the same pattern. The levels were considered to be a reflection of world-wide fallout as evidenced by higher levels in the Knoll Creek herd. The controlling factor in bone concentration was the exposure which occurred during the period of maximum bone growth, up to 1 year of age. The effective half-life for strontium-90 in adult desert bighorn sheep was calculated to be 4.8 years. The hypothetical dose commitment from strontium-90 produced by activities at the NTS was considered to be negligible for the local offsite population.

Tritium concentrations in the blood and tissues of NTS cattle and wildlife were generally within the ranges present in the general environment. Exceptions were animals which were exposed to specific sources of tritium, e.g., the Sedan Crater and drainage waters from testing areas of Rainier Mesa. The 50-year hypothetical dose commitment from tritium based on the daily consumption of 0.5 kg of meat from the NTS beef herd was only 0.15 mrem.

The skeletal burden of plutonium-239 in NTS beef animals was determined to be more related to the animal's age (length of exposure) than to any changes in the biological availability of the deposited plutonium associated with weathering. It was calculated that an individual living in the same area as the

cattle and ingesting the same diet would increase his skeletal burden by 7 pCi in 10 years. This highly improbable scenario would result in a 2.2 mrem exposure in 10 years which would be equivalent to only 1.3% of the ICRP guideline.

Beef thyroids were found to be a rapid and sensitive indicator of environmental radioiodine. Concentrations reported could usually be related to a specific nuclear explosive test. Little variation in thyroid radioiodine concentration versus age was noted in animals aged between 9 months and maturity. Radioiodine originating from worldwide fallout was higher in areas of greater precipitation.

The cattle thyroid measurements were used to estimate the iodine-131 concentration in human thyroids. Certain factors and assumptions (stated in the dose estimate section) were used to make these estimates. The total hypothetical dose to a two-gram human thyroid for the periods that data were available (approximately 21 years for NTS and 11 for Knoll Creek (KC) and Delamar Valley (DV)) were: NTS, 3160 mrem; Delamar Valley, 2510 mrem; and Knoll Creek, 310 mrem. Based on the guideline, set by the FRC, of 500 mrem/yr to a suitable sample of the general population, none of the hypothetical doses approached the guideline.

Iodine-129 levels in over 100 thyroids collected from animals throughout Nevada, Utah, Wyoming, and Colorado were determined by neutron activation. The iodine-129/iodine-127 atom ratio was several orders of magnitude lower in those thyroids than was reported in thyroids collected near nuclear fuel reprocessing facilities (Magno et al. 1972). Therefore, the NTS was not a significant source of iodine-129 exposure to animal thyroids.

The AIP, in addition to routine surveillance of beef cattle and wildlife, conducted numerous special and ad hoc studies. These included collection of baseline data outside DOE nuclear sites (Central Nevada Test Site, Rulison, Gasbuggy, Rocky Flats, etc.), investigations of suspicious animal deaths and sicknesses, documentation of radionuclide burdens in offsite areas following releases of radioactivity from the NTS, e.g., Baneberry, Cabriolet, Palanquin, etc., and special studies supporting the NTS beef cattle and wildlife investigations, e.g., spring surveys, range surveys, fresh water algae surveys, etc.

The AIP also maintained the NTS beef herd. The calving rate of this herd exceeded 85% each year, and the 180-day weaning weight usually exceeded 400 lbs; both considered above average. No unusual health problems were encountered. Routine necropsy and histopathological examination revealed no consistent pathology that could be attributed to ionizing radiation. Ocular squamous cell carcinomas ("cancer eye") were a consistent finding; however, this condition is prevalent in Hereford cattle exposed to high levels of sunlight.

The studies reported herein suggest that since 1957 no significant amounts of biologically available radionuclides have been contributed to near offsite areas by the nuclear testing activities at the NTS. Further, not only were no harmful health effects detected in cattle maintained for a lifetime within the NTS, but also this herd had above average calving percentages and weaning weights for comparable local herds (Smith 1970).

HISTORY AND OBJECTIVES

Prior to 1955, investigations of animal injuries alleged to be related to the nuclear testing program at the Nevada Test Site (NTS) were handled by various investigators on a fee or consultant basis. The investigators included veterinarians assigned to the U.S. Army (USA), U.S. Public Health Service (USPHS), U.S. and state Departments of Agriculture, and private practitioners. This arrangement was unsatisfactory as there was usually a significant time delay between the alleged incident and the investigation. Furthermore, the investigators were handicapped by a lack of baseline data on the radiation exposure of the species being investigated. The offsite radiological safety report (Sanders et al. 1955) for the Teapot Series recommended that, because of recurring livestock injury reports, it would be desirable to have continuously available the services of a veterinarian with radiological training to supervise a sound investigative program.

The Off-Site Rad-Safe Livestock Studies for the Nevada Operations Office (NVO) of the Atomic Energy Commission (AEC)* began in November of 1955 with the assignment of Ed Johnson, Lt., U.S. Army. The Off-Site Animal Investigation Project was initiated in July of 1957 and continued to be directed by Army veterinary officers until operation was transferred to the USPHS† on June 1, 1964. Other Army officers assigned to this program were Major Garland Farmer, June 1958 to July 1960; Captain Ed Fountain, July 1960 to August 1963; and Captain Scott Reynolds, August 1963 to June 1964.

Raymond Brechbill was the USPHS project officer for the renamed Animal Investigation Program (AIP) until 1969. Veterinary support for the AIP was supplied by Drs. Ronald Engle, Bruce Hull, Stanley Cohen, and Donald Smith. Dr. Smith served as project officer for the AIP from 1969 through 1981 when the program was terminated.

As stated in the first annual report (Johnson 1958), "The primary aims of the Program were: (1) to enhance the Nevada Test Site - Offsite rancher relationships through an active investigative program in their interests, and (2) to provide further information as to the status of the offsite animals in their environment with special emphasis on the radioactivity from

* In January 1975, the NVO was transferred to the U.S. Energy Research and Development Administration (ERDA) which in turn became the Department of Energy (DOE) in October of 1977.

† The Las Vegas USPHS facilities were transferred to the Environmental Protection Agency (EPA) in December of 1970.

fallout. The other objectives of the AIP were: to provide authentic information regarding various claims, complaints, and inquiries arising among livestock raisers, wildlife management personnel, and other groups concerned with animal welfare; and to provide information as to levels of internal radioisotopes that accumulate in grazing animals that ingest fallout under range conditions."

Through the years, these goals were modified to include the following objectives as stated in the 1981 annual report (Smith and Giles, 1983).

"1. To conduct surveillance of domestic and wild animals on and around the NTS in order 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 NVO of the USDOE.
3. To provide public information through education and veterinary advice to the offsite population.
4. To conduct special *ad hoc* investigations."

In order to meet these goals, a program of planned animal collection and sampling became an integral part of the AIP. Animal populations sampled on a recurring basis included cattle from the NTS, Delamar Valley and Knoll Creek beef herds, mule deer from the NTS and adjacent areas, and desert bighorn sheep from southern Nevada (see Figure 1).

The NTS beef herd was established in October 1957, through the purchase of 42 grade Hereford cattle from a local rancher. This herd was maintained on the ranges of the NTS (Smith, 1970) until its disposal in November of 1981. Twice a year, during this entire period, selected animals were removed, sacrificed, and sampled.

Through a cooperative study with the University of Nevada, Reno (UNR), two other herds were sampled semiannually for an extended time. The Delamar Valley (DV) herd (located about 80 km east of the NTS) was sampled from the fall of 1957 through the fall of 1968. The Knoll Creek (KC) herd (located 480 km north of the DV herd) was sampled from the spring of 1958 through the fall of 1968.

NTS mule deer were sampled, generally on a quarterly basis, from 1964 through 1981. Mule deer from counties north and east of the NTS were sampled periodically from 1956 through 1972. Desert bighorn sheep were sampled annually from 1956 through 1981.

Animals which were sampled on a limited schedule or on a one-time basis included other NTS wildlife and feral horses, and cattle from herds located in the Searchlight and Roller Coaster site (Tonopah Test Range) areas of Nevada and the Rocky Flats area of Colorado. Domestic and wild animals were frequently sampled pre- and post-detonation at the sites of special nuclear projects, e.g., Rulison in Colorado, Gnome and Gasbuggy in New Mexico, Dribble in Mississippi, and Faultless in central Nevada. Animals were also sampled in the downwind areas from certain Plowshare cratering events (e.g., Schooner, Palanquin) or in the fallout patterns of underground tests that released radioactivity (e.g., Baneberry and Pin Stripe). Long-term studies were also conducted at sites of known contamination (i.e., Area 13).

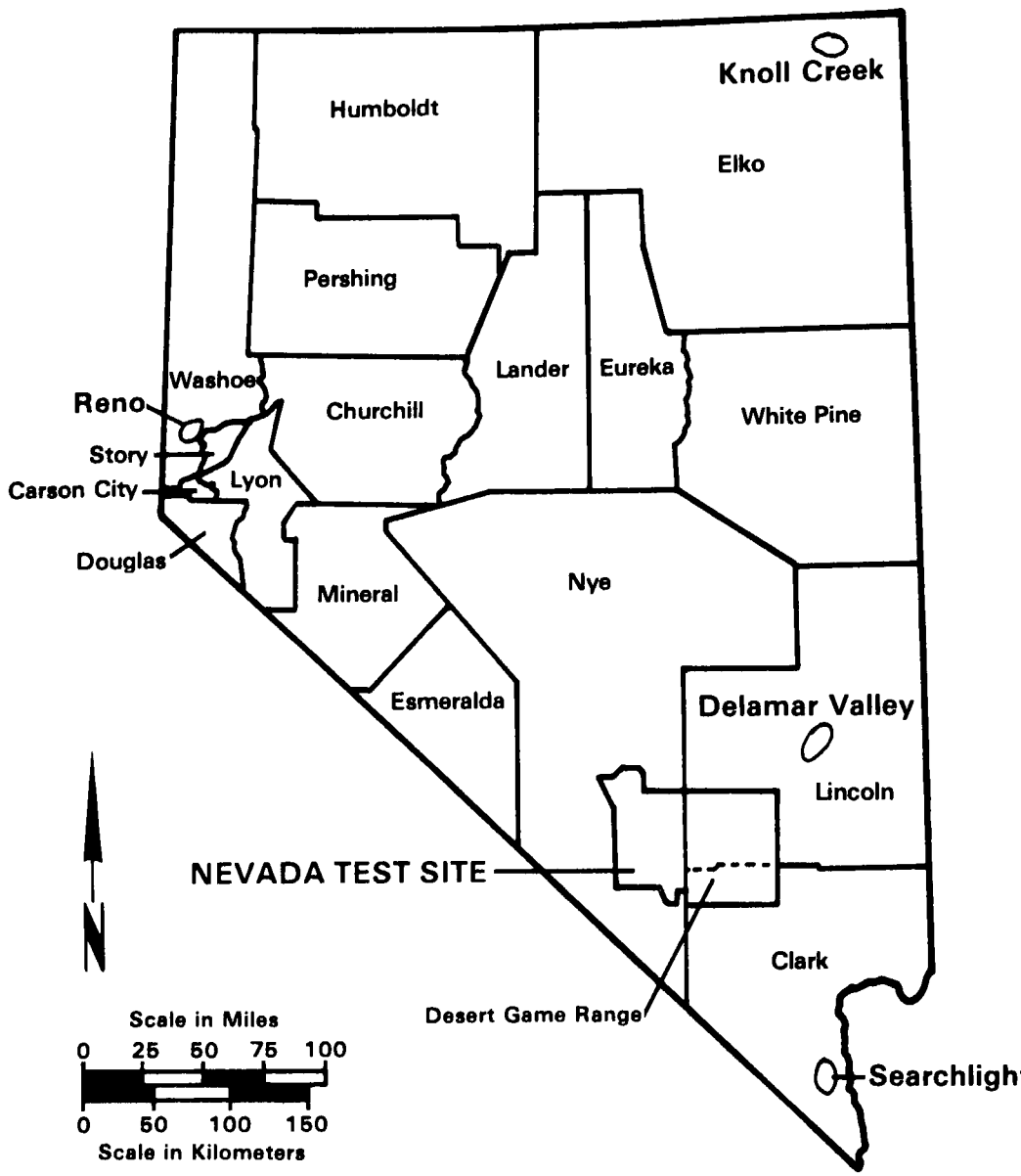

Figure 1. Map of Nevada showing the counties, the Nevada Test Site, the Desert Game Range, and beef cattle sampling areas.

Much of the data on tissue radionuclide burdens and historical happenings have been published in previous AIP annual reports (1958-1961 and 1969-1981), special event reports, or in the open literature as listed in the AIP bibliography and references. Additional data are preserved in the historical files of the AIP. In this report, all investigations of claims alleging radiation damage are summarized and available data are updated and consolidated to provide trend analyses for the longer-lived and/or biologically-active radionuclides such as strontium-90 in bones, cesium-137 and tritium in soft tissues, iodine-129 and -131 in thyroids, and plutonium-238 and -239 in bones and soft tissues.

CLAIMS INVESTIGATIONS

As stated previously, the offsite livestock studies began in November of 1955 with the assignment of Lt. Johnson, USA, to the NVO of the AEC. Records in the AIP files of investigations conducted prior to this time are sparse, but are summarized in excerpts from a project proposal and a memo written by Lt. Johnson (Appendix A). According to these records, the only livestock damage claims that resulted in litigation or compensation occurred in 1953 and 1957.

Fourteen horses, belonging to the Stewart brothers of Alamo, Nevada, suffered beta burns during the Upshot-Knothole Series of 1953. Two of these horses were purchased outright and the Stewarts received monetary compensation for damage to the balance of the animals. Also, during and subsequent to the 1953 series, numerous sheep deaths were reported by southern Utah stockmen. A lawsuit was initiated by several of the ranchers alleging that the sheep losses were due to radiation from the fallout of the series. This litigation, "Bullock vs. U.S. Government", was decided in favor of the government in 1956. However, this case was reopened in 1982 as the judge ruled that the government concealed evidence in the 1956 lawsuit.

During the 1957 test series, a 3-year old stallion owned by Floyd Lamb of Alamo, Nevada, received beta burns while grazing in Kawich Valley. The AEC purchased the animal.

All animal investigations and histories of endemic disease conditions that could be located in the search of AIP historical files are summarized in the lists of Appendix A. Supporting data are available for many of these investigations and are keyed to the necropsy records on file in the AIP office. The records are quite complete for the investigations conducted by Lt. Johnson (November 1955-June 1958) and Maj. Farmer (June 1958-July 1960). Investigations made by Capt. Fountain (July 1960-August 1963) were mentioned in the monthly reports. No records are available for the period when Capt. Reynolds (August 1963-June 1964) was assigned.

The responsibility for the AIP was transferred to the Environmental Monitoring Systems Laboratory-Las Vegas (EMSL-LV) (formerly the Southwestern Radiological Health Laboratory and the Western Environmental Research Laboratory of the U.S. PHS, the National Environmental Research Center, and the Environmental Monitoring and Support Laboratory-Las Vegas of the EPA) on June 1, 1964. Since that time AIP personnel have conducted a number of investigations of illnesses and deaths in domestic and wild animals, which are also summarized in Appendix A.

As a result of these USPHS or EPA investigations, no claims were filed against the AEC, the ERDA, or the DOE. In addition to these case investigations, the AIP conducted studies related to specific nuclear tests both pre- and post-detonation, at the NTS and other nuclear testing sites to document radionuclide levels in the tissue of domestic and wild animals. All of these studies and investigations are documented in formal reports as listed in the bibliography or in the files of the AIP.

During the period 1972 to 1980, the AIP received no requests for investigation of alleged damage to domestic or wild animals in the NTS area. However, there were a number of visits to isolated ranches, which do not have readily available veterinary service, and advice on treatment of sick animals was provided and medicines prescribed.

During 1980, AIP personnel participated in the investigation of alleged plant and animal health effects due to the Three Mile Island accident in Pennsylvania (Gears et al., 1980). In 1981, the sudden deaths of goat kids in Rachel, Nevada, were investigated and a diagnosis of enterotoxemia was made.

STANDARD OPERATING PROCEDURES

The NTS beef herd was generally maintained near Buckboard Mesa in Area 18 of the NTS. Each spring and fall, the herd was rounded up and examined for disease and injury. Each animal was identified, weighed, and sprayed for ectoparasites. All newborn animals were branded and a history of each animal's health and status was kept. At each roundup, six animals were, in general, selected for sacrifice. These consisted of three young (0.5 to 2 years old) and three adult animals. A similar procedure was used by the University of Nevada, Reno, for the other two herds at Delamar Valley and Knoll Creek.

Each of the sacrificed animals was necropsied and any gross pathological conditions noted. Samples of tissues taken for histopathological studies included: adrenal glands, eyes, heart, kidney, liver, lung, spleen, thyroid, gonads, muscle, and any gross lesions that were found. The organ and tissue samples taken for radioanalysis included: thyroid, liver, lung, gonads, tracheobronchial lymph nodes, muscle, blood, femur, rumen contents, and fetus (if present).

Measurements of radionuclides in the bones and soft tissues of animals living on or off the NTS have been made since 1956. The groups of animals in the long-term studies and the periods for which data are available include:

NTS Beef Herd	1957-1981
Delamar Valley Beef Herd	1957-1968
Knoll Creek Beef Herd	1958-1968
NTS Deer Herds	1964-1981
Desert Bighorn Sheep	1956-1981

From December 1964 through 1966, 5 to 12 deer were collected each calendar quarter. After 1966, the schedule was changed to collect one deer per quarter. Whenever possible, deer were used which had been killed by vehicles; otherwise, they were collected by hunting. They were generally collected from the Rainier Mesa-Pahute Mesa area in the northwest portion of the NTS. Deer were occasionally collected from other areas on and off the NTS for special purposes. The same types of samples were collected and the same analyses were performed as for the cattle.

Desert bighorn sheep were not collected by AIP personnel, but rather through cooperation of licensed hunters and the Nevada Department of Wildlife. In general, the hunters collected the hock bone from their kills during the winter hunting season and gave them to the Game Inspectors for transfer to the AIP. The number of samples varied from 7 to 34, depending on hunter success and cooperativeness.

RADIONUCLIDE ANALYSES

The results of radioanalysis of selected tissues from animal herds sampled for many years are summarized in the following sections. Most of these data have been published in the various annual and special reports listed in the references, but only a few reports discussed the trend with time (Smith and Andrews 1981 and Blincoe and Bohman 1970B)--for two important radionuclides, cesium-137 and strontium-90.

The cesium-137 and strontium-90 data are included in the following sections along with iodine-131 and -129, tritium, and plutonium-239. The section on special studies abstracts the results of those studies. The special study results reflect the radionuclide content of the analyzed tissues for only one point in time so the data are not included in sections on trends of individual radionuclides.

CESIUM-137

For a number of years, cesium-137 concentrations were measured in soft tissues (muscle, liver, and lung) and ingesta collected from animals that lived on or near the NTS. Samples were usually collected twice each year, as discussed previously, at each herd's location. Specific sampling details are described in Blincoe et al., 1965, Blincoe and Bohman, 1971, and Smith and Andrews, 1981.

The UNR analyzed samples by single-channel spectrometry (Blincoe et al. 1965) and the EMSL-LV analyzed similar samples by multi-channel spectrometry using NaI(Tl) crystal or Ge(Li) detectors (Smith and Andrews 1981).

As the age of sampled animals had no significant effect on tissue cesium-137 concentrations (Blincoe and Bohman, 1971; Smith and Andrews, 1981), the seasonal sample results were averaged. In order to observe trends, the seasonal averages are plotted in Figure 2. This figure is a compilation of data previously published (Blincoe et al. 1965, Blincoe and Bohman 1971, and Smith and Andrews 1981) and data that have recently become available (Smith et al. 1980, 1981A, 1982, and Smith and Giles 1983).

As shown in Table 1, atmospheric testing was conducted on the NTS prior to October 31, 1958, when a voluntary testing moratorium went into effect that was observed until September 1, 1961. At that time, above-ground testing resumed and continued until August 5, 1963, when a limited test ban

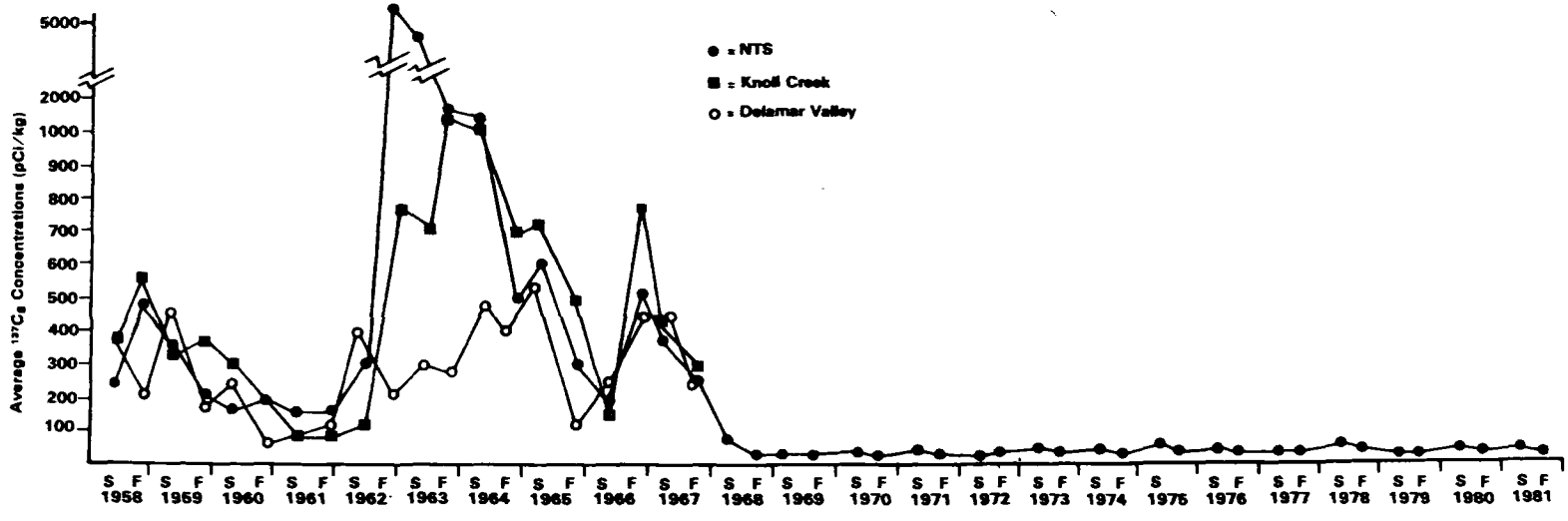

Figure 2. Average ^{137}Cs concentrations in beef cattle muscle.

TABLE 1. NUCLEAR TESTING ACTIVITIES AS RELATED TO HERD SAMPLING DATES

Sampling Period	Radioactivity Releases
Fall 1957	Plumbbob series (5/21 to 10/7/57), NTS. British series (to 12/57), Pacific Ocean. USSR series (to 12/57). Safety tests (12/57), NTS. NTS herd assembled 12/57.
Spring 1958	No local nuclear tests. Hardtack, Phase I (4/58 to 8/58), Pacific Ocean. British series (4/58 to 9/58), Pacific Ocean.
Fall 1958	Hardtack, Phase II (9/12 to 10/30/58), NTS.
Spring 1959	Testing moratorium.
Fall 1959	Testing moratorium.
Spring 1960	Testing moratorium. French tests (2/60 to 4/60), Sahara Desert.
Fall 1960	Testing moratorium. "Kiwi" reactor tests (7/8/60 and 10/19/60), NTS.
Spring 1961	Testing moratorium. French tests (12/60), Sahara Desert.
Fall 1961	USSR tests begin 9/61. U.S. Nougat Series started 9/15/61 - NTS NTS accidental venting - 9/15/61 and 12/22/61.
Spring 1962	US atmospheric detonations (Dominic), Pacific Proving Grounds. NTS cratering detonation (3/5/62). NTS accidental ventings 3/1/62, 4/14/62, 5/19/62, and 6/13/64. USSR atmospheric detonation.
Fall 1962	US atmospheric detonations (Dominic), Pacific Proving Grounds, ended 11/4/62. NTS surface and cratering detonations (7/6 to 7/17/62) and accidental venting (10/19/62). USSR atmospheric detonations ended 12/25/62.
Spring 1963	US safety test (5/15/63, 5/25/63, and 6/9/63), Tonopah Test Range.
Fall 1963	No releases.
Spring 1964	NTS accidental venting (12/12/63 and 3/13/64). Several NTS tests in May and June released minor levels of radioactivity detected on-site only.

(continued)

TABLE 1. (Continued)

Sampling Period	Radioactivity Releases
Fall 1964	NTS accidental venting (8/19/64).
Spring 1965	Chinese atmospheric detonations (10/16/64 and 5/15/65). NTS cratering detonations (12/18/64 and 4/14/65). NTS accidental ventings (12/5/64, 12/16/64, 12/18/64, 2/12/65, and 5/7/65).
Fall 1965	NTS accidental venting (6/16/65).
Spring 1966	NTS accidental ventings (3/5/66 and 4/25/66).
Fall 1966	Chinese atmospheric detonation (5/9/66). NTS accidental ventings (6/15/66 and 9/12/66).
Spring 1967	Chinese atmoshperic detonations (10/27/66 and 12/27/66). NTS accidental venting (1/19/67).
Fall 1967	Chinese atmospheric detonation (6/17/67). NTS accidental ventings (6/26/67, 6/29/67, and 8/31/67).
Spring 1968	Chinese atmospheric detonation (12/24/67). NTS cratering detonations (1/26/68 and 3/12/68). NTS accidental venting (1/18/68).
Fall 1968	No releases.
Spring 1969	NTS cratering detonation (Schooner 12/8/68).
Fall 1969	No releases.
Spring 1970	NTS accidental ventings (10/29/69, 11/13/69, 4/21/70, 5/5/70, and 5/26/70).
Fall 1970	Chinese atmospheric detonation (10/14/70). French atmospheric detonations (7/3/70, 7/27/70, 8/2/70, and 8/6/70), South Pacific Area.
Spring 1971	NTS accidental venting (12/18/70).
Fall 1971	No releases.

(continued)

TABLE 1. (Continued)

Sampling Period	Radioactivity Releases
Spring 1972	Chinese atmospheric detonations (11/18/71, 1/7/72, and 3/18/72).
Fall 1972	No releases.
Spring 1973	No releases.
Fall 1973	Chinese atmospheric detonation (6/26/73).
Spring 1974	No releases.
Fall 1974	Chinese atmospheric detonation (6/17/74).
Spring 1975	No releases.
Fall 1975	No releases.
Spring 1976	No releases.
Fall 1976	Chinese atmospheric detonation (9/25/76).
Spring 1977	No releases.
Fall 1977	Chinese atmospheric detonation (9/27/77).
Spring 1978	Chinese atmospheric detonation (4/14/78).
Fall 1978	No releases.
Spring 1979	No releases.
Fall 1979	No releases.
Spring 1980	No releases.
Fall 1980	Chinese atmospheric detonation (10/15/81).
Spring 1981	No releases.
Fall 1981	No releases.

treaty was signed by the United States and several other nations. Subsequent to that date, all U.S. weapons testing has been conducted underground. Occasionally, these tests have released radioactivity to the atmosphere, as have foreign atmospheric tests and plowshare cratering tests.

Prior to the moratorium, maximum concentrations of Cesium-137 in muscle samples were detected in the 1958 fall samples from the KC (550 pCi/kg) and NTS (480 pCi/kg) herds. These maxima followed 2 consecutive years of nuclear testing on the NTS which ended shortly before sample collection. Muscle tissue concentrations decreased steadily during the moratorium with an average effective half-life of 0.7 year for all three herds (Blincoe and Bohman 1970B).

Tissue levels began to increase following the resumption of testing in the fall of 1961. Peak average levels of cesium-137 (5500 pCi/kg) were found in NTS cattle muscle samples in November of 1962. Those unusually high levels were the result of the NTS cattle being intentionally grazed upon range heavily contaminated by fallout from the accidental venting of the Bandicoot experiment on October 19, 1962, and by fallout from the July 6, 1962, Sedan cratering experiment (Blincoe et al. 1969). Muscle concentrations in all three herds declined from 1962 through the spring of 1966 with an effective half-life of 1.1 years (Blincoe and Bohman 1970B).

Another peak was observed in the fall of 1966 which was probably related to world-wide fallout from foreign atmospheric tests and the accidental venting from Pin Stripe. Again, the muscle concentration declined with an effective half-life of approximately 1 year. By 1968, cesium-137 levels reached a base-line range of approximately 25 pCi/kg which has been maintained for the remaining 13 years of the reporting period.

From 1964-1968, the muscle concentrations of cesium-137 were usually highest in samples from the KC herd. This is probably related to a higher contribution from world-wide fallout because of higher precipitation at the Knoll Creek Range (Bohman et al. 1966).

In general, cesium-137 concentrations in cattle liver followed the same trends as in muscle, but exhibited lower overall concentrations, especially during peak concentration periods. The differences were as much as a factor of two. Results for lung tissue tended to be very similar to those for muscle. Rumen content cesium-137 results followed the same general trend as for muscle tissue, but there was much less correlation between rumen content concentrations and concentrations in the organs than there was among concentrations in the various organs (Smith and Andrews 1981).

Monthly cesium-137 concentrations in air at various continental U.S. locations (U.S. Department of Energy 1980) indicate that peak worldwide fallout occurs during the spring months. This reflects the increased rate of fallout from the stratospheric reservoir during the spring shift in position of the tropopause gap (Glasstone 1962). The increased springtime fallout is especially reflected in the NTS cattle muscle tissue data from 1968 on. This

fast response to recent cesium-137 deposition also indicates a short effective half-life which has been estimated to average 0.9 year by Blincoe and Bohman (1970B). Hood and Comar (1953) reported a 20-day biological half-life for cesium-137 in a cow. Since the Nevada cattle sampled were on range contaminated to an unknown degree, it was not possible to determine ingestion exposure from the data. However, the rapid decrease in tissue concentrations implies both a rapid decrease in vegetation contamination following the peak spring fallout and a short biological half-life.

From December 1964 through 1981, NTS mule deer were periodically (generally on a quarterly basis) collected and tissue samples submitted for analysis by gamma spectrometry. Details of collection, sampling, and analysis were summarized by Smith and Andrews (1981).

The cesium-137 concentrations in muscle samples from the NTS deer are plotted in Figure 3. The concentrations were similar to those observed in NTS cattle for the same time period with the exception of 1968. Close-in fallout from a March 12 cratering experiment (Buggy), which was deposited over the deer collection area, accounted for the elevated cesium-137 concentrations observed in NTS deer muscle samples during the rest of 1968. The high value observed in 1975 probably resulted from the Chinese test of 1974.

It was also noted by Smith and Andrews (1981) that the analytical results from EMSL for tissue samples from NTS cattle and deer collected in the fall of 1965 and spring of 1966 were exceptionally low and should be considered suspect. The cattle muscle data points for these dates that are plotted in Figure 2 were based on data from sample analyses by the UNR (Blincoe and Bohman 1971).

Tissue samples were occasionally collected from deer in other areas of Nevada (Lincoln, White Pine, and northern Nye counties) or in other states (e.g., New Mexico). The concentration of cesium-137 in tissues collected from the deer were comparable to those found in tissues of NTS deer collected during the same time period (Smith and Andrews 1981). The comparability of these results indicate that, except for periods immediately following deposition of local or close-in fallout, tissue concentration of cesium-137 follows the deposition of world-wide fallout.

STRONTIUM-90

Most of the data for this isotope have been summarized and discussed previously either by Kramp (1965), Bohman et al. (1966), or by Smith and Andrews (1981). Details of sampling procedures and analytical methods are discussed in those publications and by Johns et al. (1979). The annual average strontium-90 concentrations in the ash of the bones (femur and/or rib from cattle and hock joints from deer and desert bighorn sheep) of the sampled animals are presented graphically in Figures 4 and 5. As shown in Figure 4, the strontium-90 concentrations in bone ash from cattle from all three Nevada locations and from the NTS deer herd generally follow the same pattern.

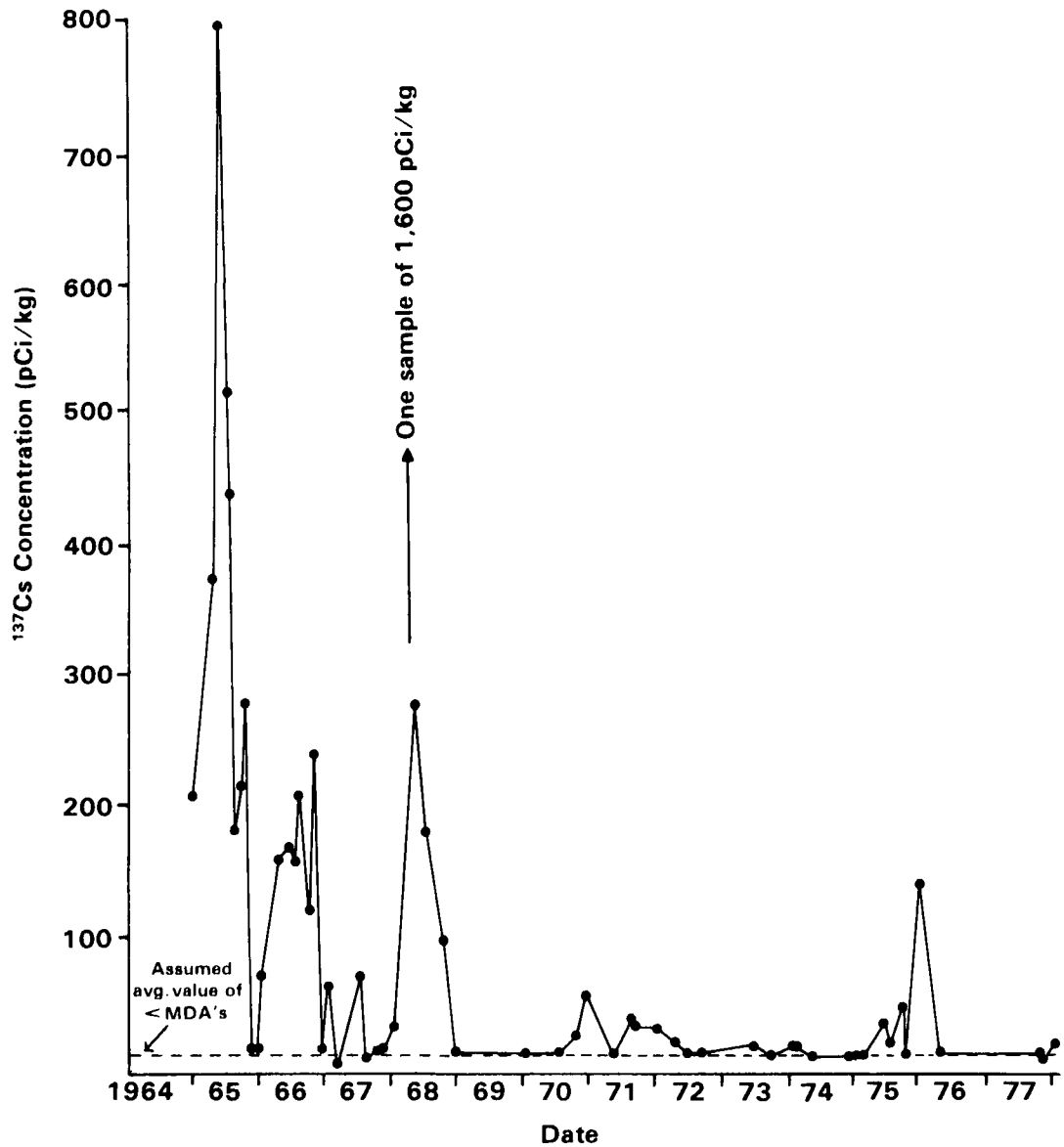

Figure 3. ^{137}Cs concentrations in Nevada Test Site deer muscle.

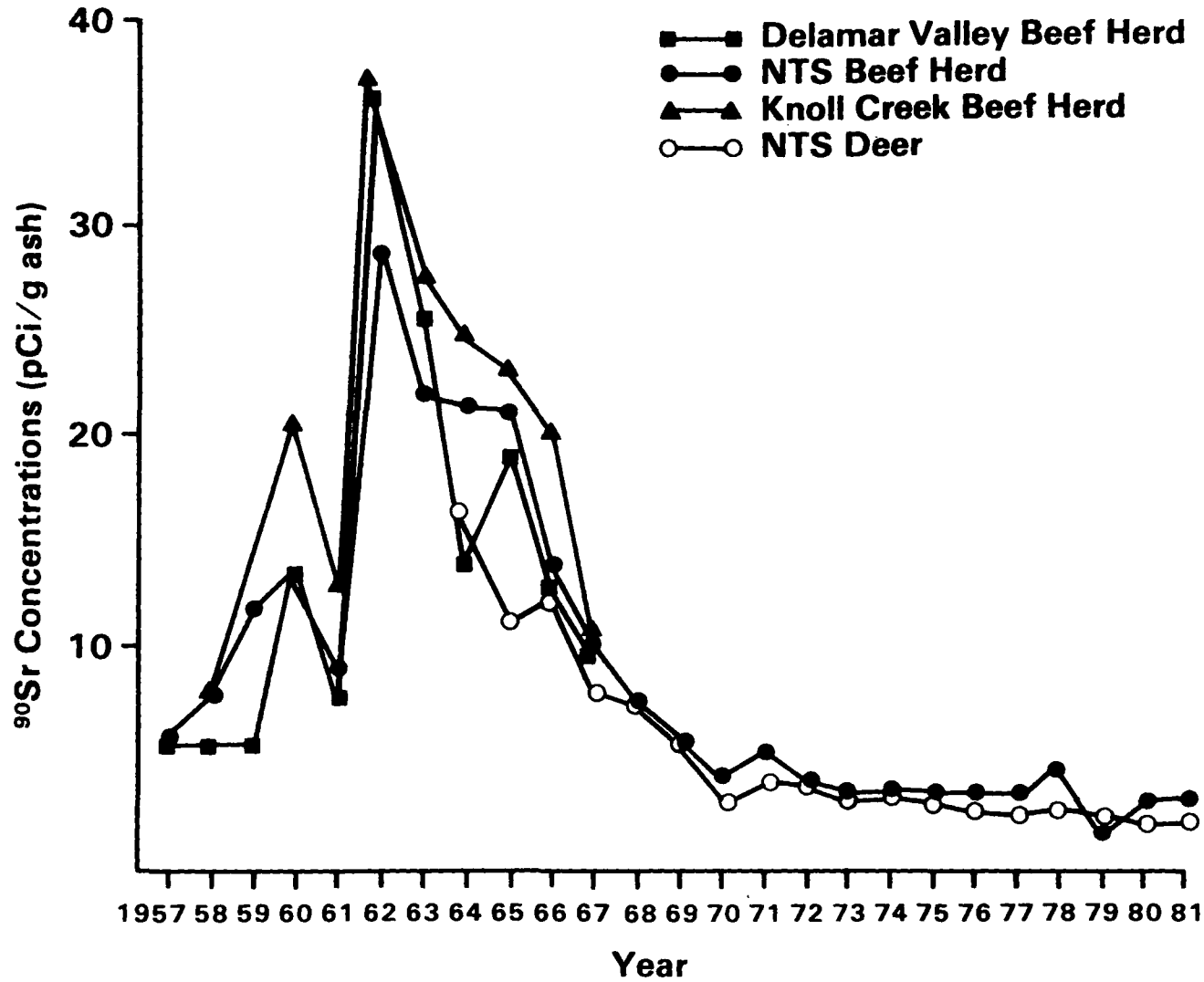

Figure 4. Average ^{90}Sr concentration in bone from Nevada cattle and Nevada Test Site deer.

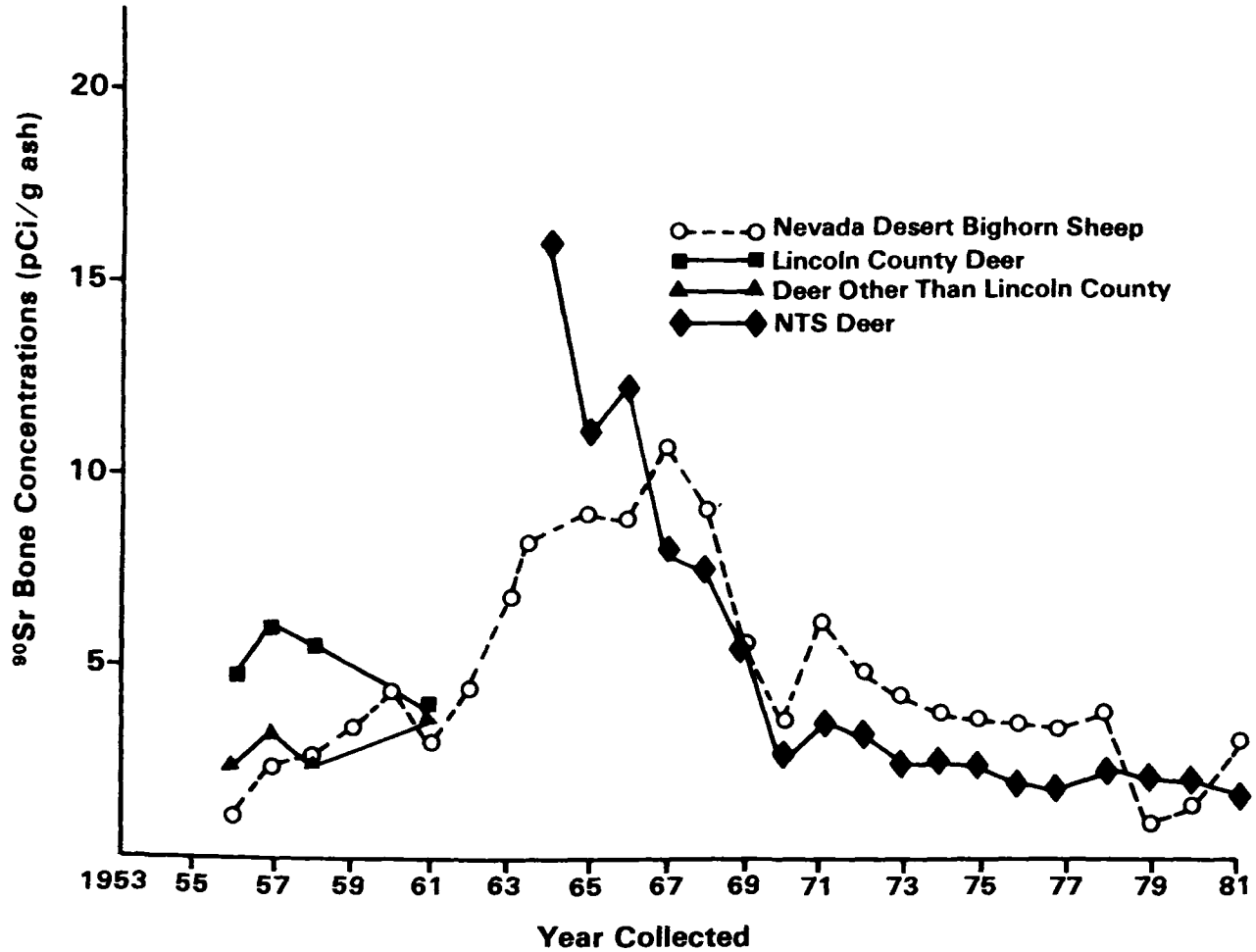

Figure 5. Average ^{90}Sr concentration in bone from deer and desert bighorn sheep.

Peak concentrations occurred in 1960 (1 year after the last test series before the moratorium) and in 1962 (1 year after testing was renewed).

In general, the levels are a reflection of world-wide fallout as evidenced by higher average levels in bones from the KC herd when compared to the DV and NTS herds. As stated previously, the Knoll Creek range is subject to greater annual precipitation with a resultant higher annual deposition of world-wide fallout. Fresh, concentrated, close-in fallout during 1962 did result in significantly higher strontium-90 base levels in the NTS cattle (especially calves) that were deliberately grazed for 30 days on range highly contaminated by fallout from Sedan and Bandicoot (Blincoe et al. 1969).

Approximately one-half of the beef cattle sacrificed each year were under 2 years of age. Therefore, the results for each year tend to reflect recent changes in strontium-90 deposition. Of particular note is the response of younger animals as compared to mature cows. During the period 1958 to 1960, the mature cows had strontium-90 concentrations ranging from half to three-fourths of the averages of the younger animals. In 1961, after a year of low deposition, the mature cows had a concentration 10 percent greater than the average of the young animals (Smith and Andrews 1981).

Through 1966, bones from the NTS beef cattle contained strontium-90 concentrations about twice those reported from the bones of desert bighorn sheep. This probably reflected the fact that half the cattle sampled were less than 2 years of age and, hence, were undergoing rapid bone development during the period of high fallout. After 1966, the strontium-90 concentrations in bones from the two species were approximately equal with slightly higher levels reported in the bighorn sheep. This again can be explained by the higher age at sampling (average of 7+ years) of the bighorn sheep; i.e., the bighorn sheep which were immature during the period of high fallout were being harvested concurrently with younger cattle which were immature during periods of lower fallout.

Analysis of strontium-90 data for desert bighorn sheep as a function of age (Smith and Andrews 1981) showed that the controlling factor in bone concentration was the exposure which occurred during the period of maximum bone growth, up to 1 year of age. Subsequent intake has some effect, but much less. The same analysis showed an effective half-life for strontium-90 in desert bighorn sheep of about 4.8 years. Comparable data for humans yielded effective half-lives of 2.7 and 4.3 years for two population groups (Smith and Andrews 1981).

Strontium-90 concentrations for deer and desert bighorn sheep bone are compared in Figure 5. It is obvious that the results are quite similar. Some small but probably significant differences are: (1) strontium-90 concentrations in deer from Lincoln County during the years 1956 to 1958 are about twice as high as in other deer, and (2) deer samples reached a higher concentration in 1964 than did sheep and dropped off more rapidly thereafter. Deer and bighorn sheep results are very similar for the years 1968 to 1981. This variation may be explained by the more rapid turnover of bone cells and associated increased mineral metbolism which occurs during growth and maturation than that which occurs during adulthood.

The higher concentrations in Lincoln County deer during the late 1950's as compared to those in deer from the rest of the state most likely reflect the immediate effects of close-in fallout from the NTS. The difference in maximum concentrations and the decline in concentrations between deer and sheep is believed to be due primarily to the age of the animals collected. The higher concentrations observed in the sheep bones, during the years from 1967 on, are probably related to the older age at harvest and, hence, exposure to greater fallout levels during the period of rapid growth. The average age of bucks (deer) harvested by hunters is 36 months. Due to the young age of the deer sampled, compared to sheep, the deer tend to reflect conditions during the previous year or two. The reason for the age difference of the animals when killed is that bighorn sheep must either meet a minimum score based on horn size or must be 7 years old to be legal game animals. They are generally 5 to 12 years old. This tends to flatten the response to the effect of exposure during individual years. The decrease in strontium-90 concentrations in bones from all three species that is noted in 1979 is probably not real but related to the fact that a different laboratory did the analysis that year (Smith et al. 1981A).

Strontium-89 (half-life 52 days) was detected only when fresh fission products were present.

TRITIUM

Starting in 1971, samples of blood, urine, or soft tissue collected from NTS cattle, NTS wildlife, and desert bighorn sheep were analyzed for tritium content. These data are depicted graphically in Figures 6 and 7.

As stated previously, the Area 18 beef herd was sampled in the spring and fall of each year. As shown in Figure 6, spring samples usually contained more tritium. These springtime peaks are probably related to the "rainout" from the stratospheric reservoir of tritium by precipitation in the winter and early spring. The native desert vegetation responds to this precipitation with a sudden but transitory green-up of fresh foliage with a high moisture content which is relished by the cattle.

The tritium concentration in the Area 18 beef cattle, the desert bighorn sheep, and NTS wildlife from sites other than Areas 12 and 15 on the NTS were within the ranges present in the general environment as measured by the Noble Gas and Tritium Surveillance Network (Offsite Environmental Monitoring Reports, e.g., Smith et al. 1981B and Black et al. 1982). The Area 15 corralled dairy cattle and Area 15 wildlife (rabbits, coyotes, and quail) frequently contained tritium levels several orders of magnitude higher than those reported for the Area 18 range animals. The source of their exposure is thought to be the Sedan Crater which is approximately 2 miles away. Similar levels of tritium were found in the urine of employees who worked at the Area 15 experimental farm (Douglas et al. 1970).

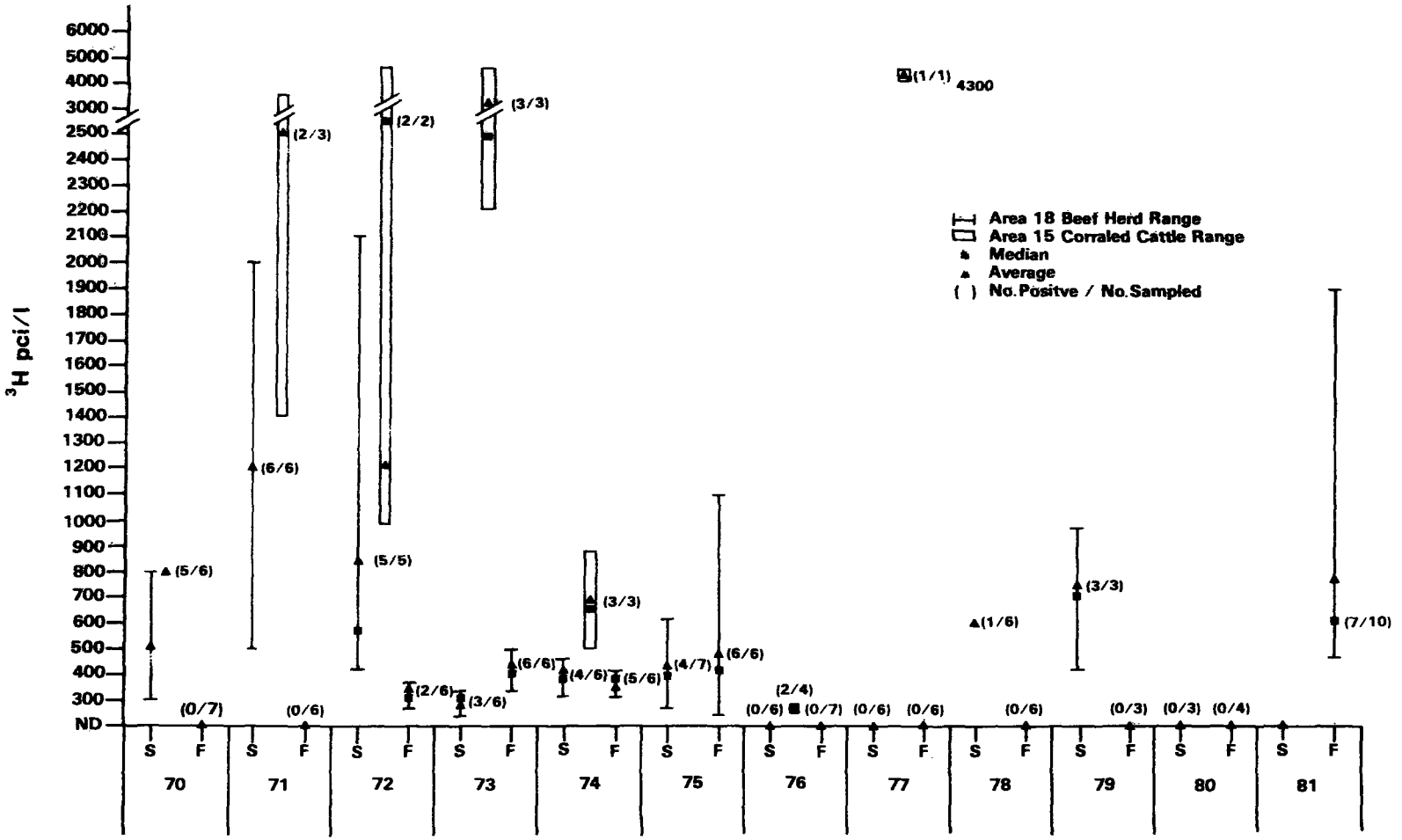

Figure 6. Tritium concentrations in Nevada Test Site cattle, 1970-1981.

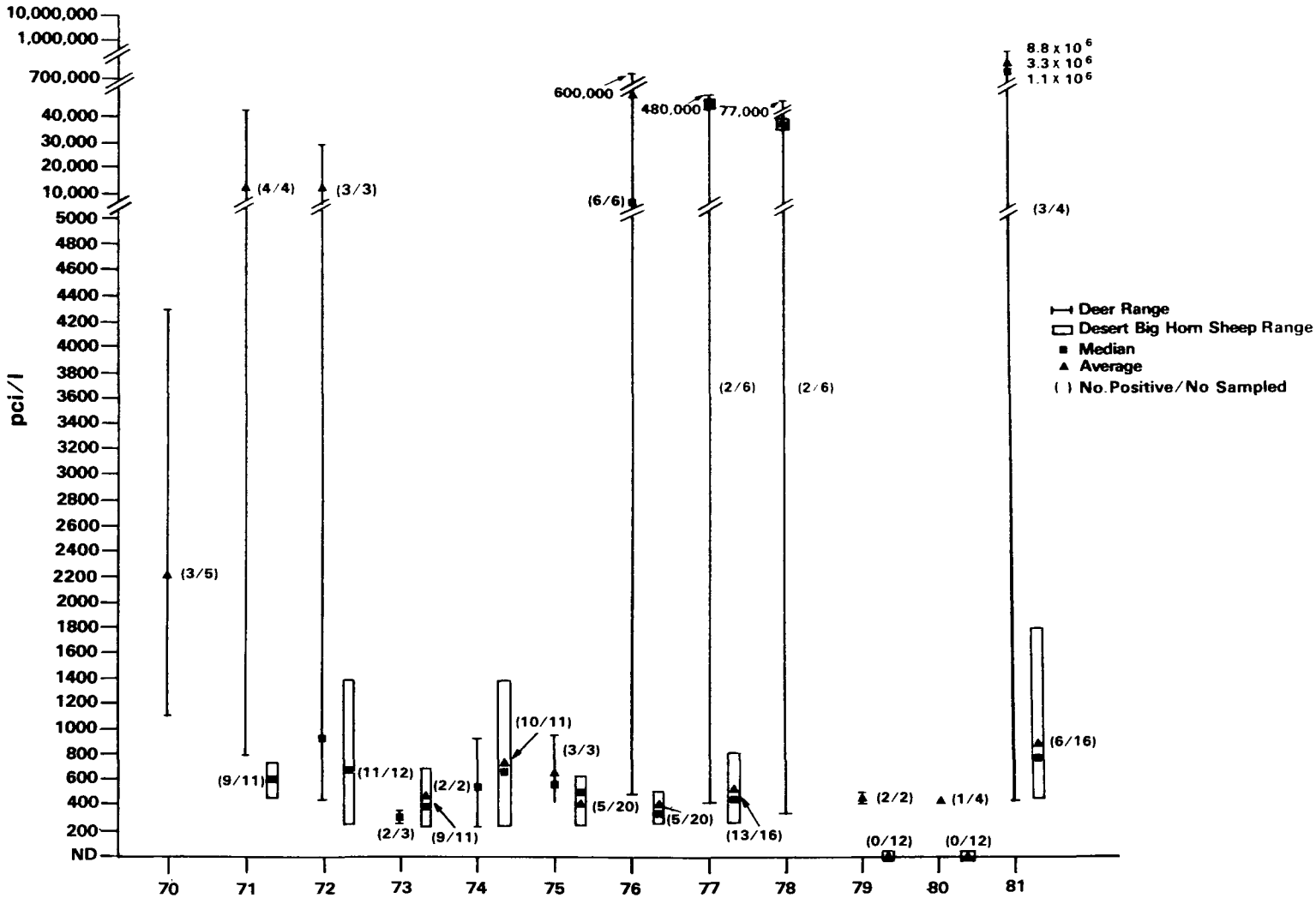

Figure 7. Tritium concentrations in Nevada Test Site deer and desert bighorn sheep, 1970-1981.

Mule deer and other wildlife collected from Area 12 and Rainier Mesa frequently had elevated levels of tritium; e.g., 600 nCi/L in a mule deer in 1976 and 8.8 Ci/L in a deer in 1981 (Figure 7). These animals are thought to have drunk from the contaminated waters which drain from the tunnel test areas of Rainier Mesa (Scoggins, 1982). If these animals became available to the offsite population, a small additional population dose might accrue. The results of a deer migration study (Smith et al. 1982, and Smith and Giles 1983) suggest that NTS deer rarely move to offsite areas and, therefore, do not represent a significant source of exposure for offsite residents.

PLUTONIUM-239

Analysis of femur samples from Area 18, NTS, cattle for plutonium-238 and -239 began in 1972 and continued until the end of the program in 1981. Detectable concentrations of plutonium-238 were rarely found whereas the -239 isotope was frequently detected in measurable concentrations.

Earlier analyses of these data had suggested some changes with time, but the reason for the changes was unclear (Smith et al. 1976A). To clarify this, the analytical results were segregated by the age of the animal as shown in Table 2. Choosing yearling calves as one category should indicate whether or not the plutonium becomes more biologically available with time. Data for the adult animals should clarify the effect of age.

The data from Table 2 are plotted in Figure 8 and the least-squares regression lines indicated. The correlation coefficient for the line fitting the yearling data is only 0.34, indicating little significance for the trend, and most of that apparent trend is due to the higher concentrations reported for 1976 through 1978. Only years for which two or more results were available are plotted in Figure 8. The regression line for the cattle aged 6 to 9 years has a correlation coefficient of 0.55, not markedly more significant than that for the yearlings.

The geometric mean concentration of plutonium-239 in bone, though, tends to be higher for the adult than for the yearling animals. This suggests that age, i.e., length of exposure, is more relevant to the measured concentration in bone than is the concept of change in biological availability. Using this hypothesis and the equation for the least-squares line, adult cattle would have an increase in plutonium concentration in bone of 1 pCi/kg wet weight in the 10-year period from 1972 to 1981.

An individual living in Area 18, NTS, if consuming the same diet as cattle and inhaling/ingesting as much soil, would therefore increase his skeletal burden by about 7 pCi in the 10-year period specified above (assuming a 7-kg skeletal weight).

IODINE-131

Thyroids were collected on a semiannual basis from cattle representing the three Nevada beef herds described earlier in this report. The animal

TABLE 2. PLUTONIUM-239 IN BONE OF NTS CATTLE (pCi/kg wet weight)*

	0.5-1.5 Years Old			6-9 Years Old		
Year	$\bar{x}g$	Sg	No.	$\bar{x}g$	Sg	No.
1972	0.36	1.6	7	1.4	1.5	3
1973	0.56	3.1	4	1.3	1.3	2
1974	0.42	3.6	3	1.4	1.0	2
1975	1.4	5.1	5	0.28	2.2	2
1976	1.3	4.7	4	1.0	1.1	2
1977	1.6	2.0	5	2.8	-	1
1978	1.0	2.2	3	0.6	-	1
1979	1.3	-	1	1.0	2.2	2
1980	3.2	-	1	2.5	2.1	2
1981	0.65	2.6	7	2.4	3.6	5

*Expressed as geometric mean and standard deviation ($\bar{x}g$; Sg).

selection criteria, sampling schedule, and methods were also described or referenced. From 1957 through 1968, a 4-g sample of each thyroid collected was analyzed by UNR on a single-channel gamma-ray spectrometer (Blincoe et al. 1964). From 1969 through 1981, the entire thyroid was analyzed by the EMSL-LV on a 400-channel gamma spectrometer (Smith and Giles 1974).

The average iodine-131 content in the thyroids collected each spring and fall are plotted in Figure 9. The bovine thyroid is a rapid and sensitive indicator of ingestion or inhalation of fresh fission products containing radioiodine. As indicated in Figure 9, the thyroid iodine-131 concentrations could usually be related either to specific nuclear events, local or distant, or to test series that were held on the NTS, in the Pacific, the Sahara Desert, China, or the Soviet Union (Blincoe and Bohman 1962).

The highest average iodine-131 concentrations (125,000 pCi/g) were found in NTS cattle thyroids in November 1958, shortly after the completion of the Hardtack Phase II series of atmospheric tests (September 12 to October 30, 1958) at the NTS. The cattle were intentionally grazed from October 31 to November 21, 1958, on the highly contaminated range of the areas where the tests took place (Blincoe et al. 1969). These peak iodine-131 concentrations fell off rapidly to approximately 10 pCi/g of thyroid in the spring of 1959.

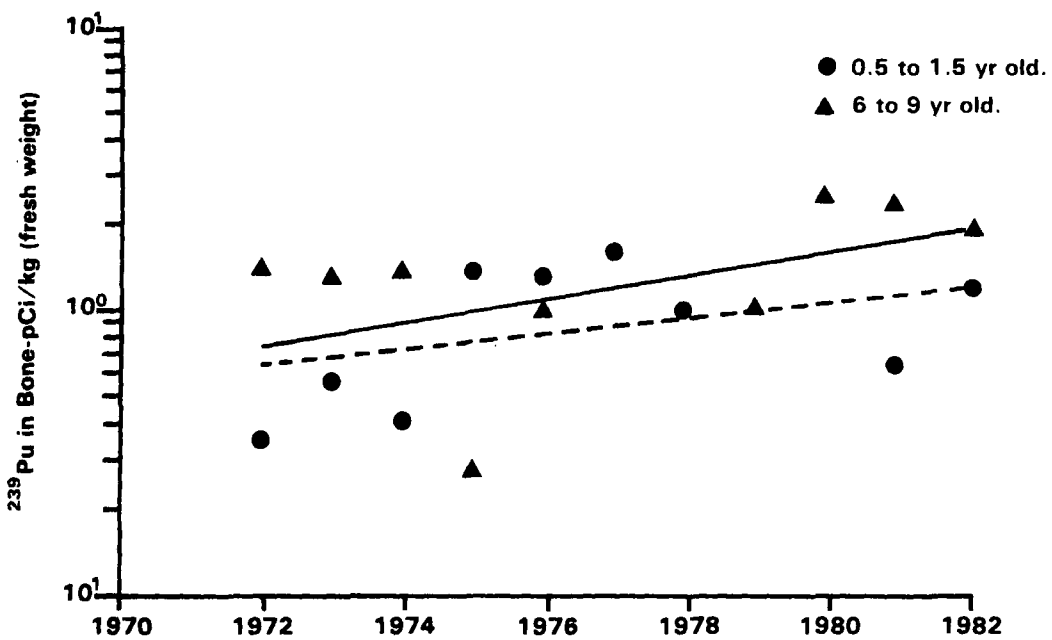

Figure 8. Time trend of plutonium concentration in cattle bone.

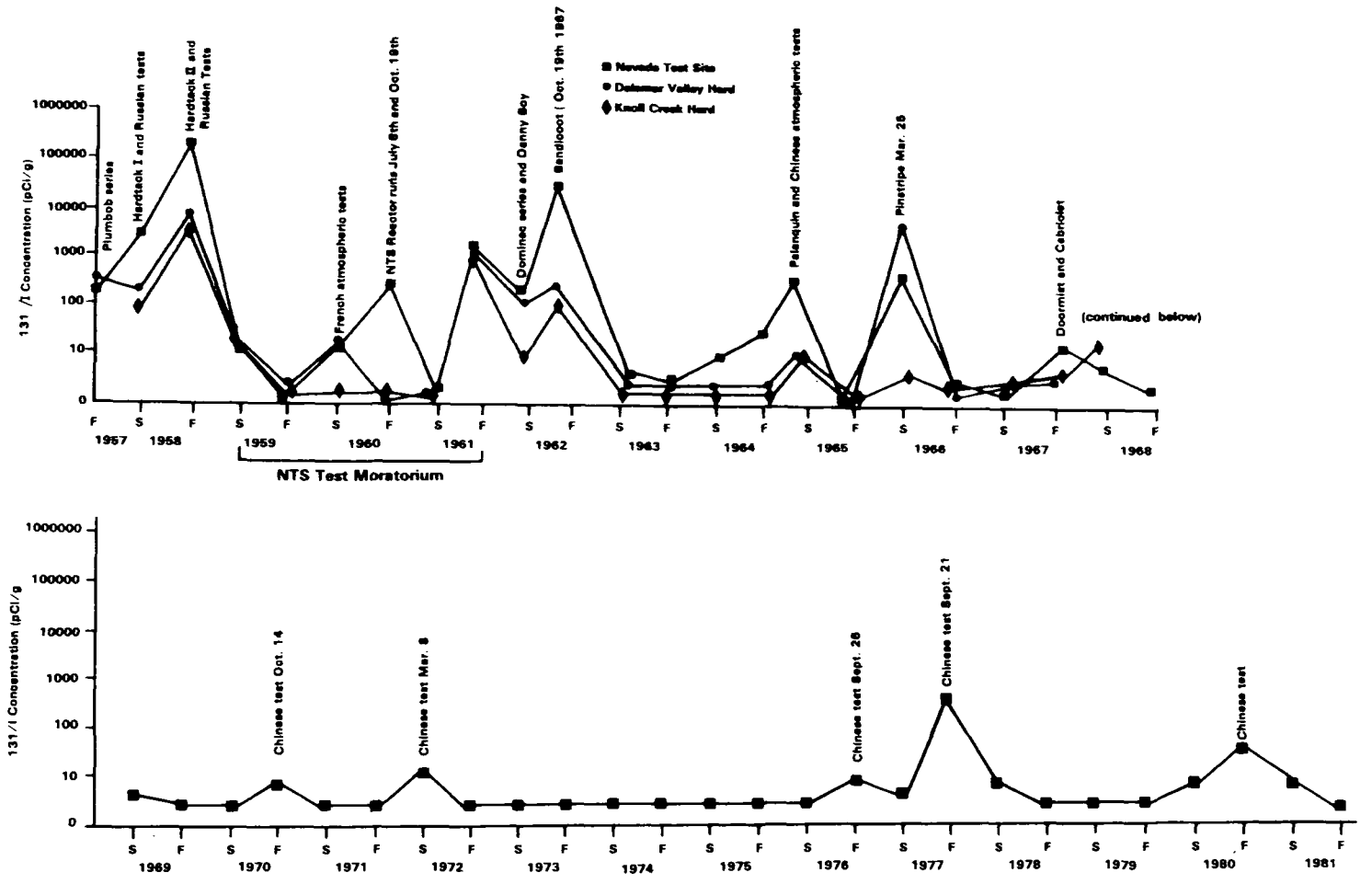

Figure 9. Average ^{131}I concentrations in thyroids from Nevada beef cattle, 1957-1981.

This steep decline resulted from radioactive decay, biological elimination, and the moratorium on testing which began in the fall of 1958. The last U.S. test was on October 30 and final USSR tests occurred in late December. During the remainder of the moratorium, positive iodine-131 thyroid levels were related to foreign weapons tests or U.S. reactor tests.

In comparison, some of the highest iodine-131 concentrations in thyroids from cattle residing off the NTS were reported following a nuclear cratering experiment (Palanquin) which was conducted on April 14, 1965. Thyroids of five cattle from Clark Station (approximately 35 km from Ground Zero) contained an average iodine-131 concentration of 22,600 pCi/g when sampled on May 21, 1965 (Bohman et al. 1968).

Little variation with age was noted in the iodine-131 concentration in thyroids collected from cattle between 9 months of age and maturity (Blincoe et al. 1964).

Thyroids were collected on a quarterly basis from NTS mule deer and on an occasional or periodic basis from other NTS wildlife. Other animals sampled occasionally included domestic and wild animals at nuclear test sites in other states. The levels of iodine-131 found in the thyroids of NTS wildlife were generally similar to those reported for the NTS beef animals sampled at the same time. Exceptions were occasionally noted when animals in a specific area were exposed to a localized source. An example of this occurred in 1970 when thyroids were collected from animals that drank from contaminated waters draining from a test tunnel in Rainier Mesa. These animals had greatly elevated levels of iodine-131 in their thyroids (1.1 μCi/g in a coyote) as reported by Smith and Giles (1974).

It was also noted that thyroid levels of iodine-131 were generally lower in deer and cattle from the Nevada desert ranges than in deer and cattle from eastern states when the source was world-wide fallout (i.e., French, Chinese, Russian, or South Pacific tests). This difference was probably due to higher precipitation rates in the non-arid states (Blincoe and Bohman 1970A).

During the years of 1973, 1974, and 1975, over 100 thyroids were analyzed by neutron activation to determine the iodine-129 content. Thyroids were collected from animals sampled during the routine AIP surveillance activities with NTS wildlife and the beef herd as described by Smith et al. (1976A). In addition, thyroids were collected from animals dying of natural causes at the Area 15 farm, from those sacrificed for other studies (e.g., salt feedlot studies, Shuyler et al. 1975), for the Area 13 grazing studies (Smith et al. 1976C), and special investigations (Smith and Black 1975). During the annual hunting season, thyroids were collected from deer and elk in northern Nevada, Utah, and Wyoming. In addition, thyroids were collected from cattle slaughtered in abattoirs of northern Nevada to provide baseline values.

As stated by Smith, 1977, iodine-129 levels in thyroids from free-grazing NTS and Rocky Flats, Colorado, cattle were statistically higher than levels in thyroids from a northern Nevada background population. However, the concentrations were similar to those considered to be background by other

investigators. The iodine-129/iodine-127 atom ratios reported were several orders of magnitude lower than those reported for animal thyroids collected near nuclear separation facilities. These findings indicated that the NTS was not a significant source for iodine-129.

SPECIAL STUDIES

Baseline Studies

In January of 1968, AIP personnel collected tissue samples from two mule deer and three beef cattle from central Nevada for radioanalysis and histopathologic analysis prior to the Faultless nuclear test. With the exception of iodine-131, radionuclide values were equal to or below those reported in tissues collected during the routine sampling of cattle from KC, DV, and NTS and from deer collected on the NTS. The iodine-131 (150-200 pCi/g) found in the deer thyroids is thought to have come from a Chinese test on December 24, 1967 (Hull and Cohen 1968).

Range Survey, Area 18, NTS

During August 1966, the ocular reconnaissance method (U.S. Department of Interior) of surveying vegetation was used to survey 13,630 acres in Area 18 of the NTS. A total of 233 line transects were established to obtain species distribution, composition, and ground cover for this area since it was the home range for the NTS beef herd.

There were six distinct plant communities identified: two sagebrush (Artemisia arbuscula subsp. nova, A. tridentata), two annual (Salsola Kali var. tenuifolia, Eriogonum), one grass, and one desert shrub. These six communities contained a total of 36 families and 85 species. The A. arbuscula subsp. nova community occupied the largest area, 6,337 acres, and the Eriogonum community the smallest, 17 acres (Brown and Mason 1968).

Composition of Diet of NTS Range Cattle

The radionuclide content and botanical composition of the diet of the beef animals grazing on the Area 18 range of the Nevada Test Site from 1966-1970 was determined by analyzing rumen samples collected from fistulated steers. The radionuclide concentrations were generally low with periodic increases in individual isotope levels which could be traced to a specific contaminating event.

Grass exceded 80% of the diet of 23 out of 43 monthly samples. Squirrel tail grass, Sitanion hystrix, and Indian rice grass, Orhyzopsis hymenoides, were the major components of this portion of the diet. The major browse plants ingested were Gambel's oak, Quercus gambelii, and desert bitter brush, Purshia glandulosa. Russian thistle, Salsola kali, and desert buckwheat, Eriogonum spp. were the main contributors to the forb portion of the diet. At times during the summer months, Russian thistle constituted over 30% of the total diet (Smith et al. 1972).

Preliminary Radiation Surveillance of an Aquatic System

During 1967, a 3-month preliminary radiation surveillance study of an aquatic system was conducted in Upper Pahranagat Lake near the NTS. The objectives of this study were to determine the concentrations of fission products in selected samples and to establish the necessary methodology for radiation surveillance in an aquatic ecosystem (Klien and Brechbill 1972).

Radionuclide concentrations were found to be insignificant in water, aquatic plant, and fish samples. Sediment samples had detectable levels of ^{137}Cs, ^{40}K, ^{90}Sr, and U. Strontium-90 levels in fishbone were low (2.4 pCi/g bone ash) compared to those found in bovine femur samples (6.9 pCi/g bone ash) collected during the same period.

Sheep Death Investigation at Garrison, Utah

The acute death near Garrison, Utah, in January 1971, of some 1,250 sheep from a flock of 2,600 was the object of national attention with its implied cause of either nerve gas from Dugway Proving Grounds or radiation from the NTS. Field and laboratory results confirmed that the cause of death was oxalate poisoning from ingestion of the weed, Halogeton glomerulatus (Western Environmental Research Laboratory 1971).

AIP Activities for the Baneberry Event

On December 18, 1970, an underground nuclear test, conducted at the NTS, released radioactive materials into the atmosphere with resultant onsite and offsite contamination. The AIP developed studies to document the distribution of fission and activation products in the tissue of domestic and wild animals residing within contaminated areas on and surrounding the NTS. These animals were sampled from 12 to 62 days after the detonation. A study of radioiodine secretion in milk from cows at the experimental dairy farm and uptake by calves was started about 24 hours after the venting. A grazing intake study, which utilized fistulated steers, was also carried out from the fifth through the eighth month after detonation (Smith et al. 1975).

NTS Spring Survey

During August 1972, natural springs located on the Nevada Test Site were surveyed to determine their use by wildlife and the effort required for improving water production. Each spring was described and its use by wildlife noted. Methods of improving spring flow were suggested. Minimal effort at most of the springs would result in a significant improvement of waterflow with resulting benefits to wildlife (Giles 1976). These improvements were subsequently made by the employees at the EPA experimental farm.

Bioenvironmental Sampling - Gnome Site

A bioenvironental sampling program of the Gnome Site was conducted during October 1972, to document radionuclide concentrations within plant and animal tissues which may have resulted from the release of radioactivity during the Gnome nuclear explosive test of 1961 and/or from contaminated debris

brought to the surface during reentry of the test cavity. No event-related gamma-emitting radionuclides were detected in the tissues of the birds and animals sampled. Detectable levels of tritium (660-9300 pCi/L) were found in the flesh of all animals sampled. Zirconium-95 and ruthenium-103 were detected in certain grass samples, but were thought to be the result of worldwide fallout. Strontium-90 levels in the bones (1.5 to 7 pCi/g ash) and plant samples were also attributed to worldwide fallout. The data indicated no radiological hazard to man through the ingestion of tissues of wildlife that reside in the area of the Gnome Site (Smith and Giles 1973).

Tissue Burdens of Selected Radionuclides in Beef Cattle around the NTS

During 1972, animals from three beef herds on and around the NTS were extensively sampled to determine tissue burdens of plutonium and uranium. The herds represented animals grazing range contaminated by worldwide fallout (Searchlight herd), animals grazing range contaminated by U.S. atmospheric nuclear detonations (NTS herd), and animals grazing range contaminated by unfissioned nuclear material (TTR herd). Selected animals from the latter herd were also maintained in a feedlot on the NTS for 4 months prior to sampling (Smith et al. 1976A).

Based on geometric mean values, ratios of uranium-234, -235, and -238 levels found in tissues from all groups were consistent with the natural ratios. The plutonium/uranium ratio was generally highest in the liver. The plutonium levels in bone were highest in the femur, with lower levels in the ribs. For the younger animals, the actinide levels were higher in rib than in either femur or vertebrae samples. Both the lung and tracheo-bronchial lymph node data suggest that plutonium inhalation was higher for the NTS herd than for the TTR cattle. The rumen content and reticulum sediment data suggest that the contamination of the range of Area 18 of the NTS and of the Roller Coaster sites on the TTR consisted of larger particles unevenly distributed compared to the relatively uniform deposition from worldwide fallout on the Searchlight Range. The data also suggest that the actinide concentrations in bone increased with age. Fetal tissue concentrations of the actinides indicate that passage through the placental barrier occurs.

The strontium-90 content of bone ash was similar to that measured in other ruminants sampled in past years. The thyroids of cattle sacrificed in May 1972 contained iodine-131 ranging from 2 to 76 pCi/g which was attributed to fallout from a nuclear test conducted on the Chinese mainland on March 8, 1972. Elevated tritium levels were found in the blood of selected cattle from the Roller Coaster herd which were maintained in the feedlot on the Nevada Test Site near the Sedan crater, the site of a nuclear test conducted in 1962.

Actinide Concentrations in Cattle Tissues from Rocky Flats, Colorado

In November 1973, five aged and five young cows that grazed a pasture near the Rocky Flats Plant were sacrificed and various tissues collected for measurement of actinide concentrations.

The strontium-90, uranium-238, and plutonium-239 data were compared to data from cattle herds that graze on and around the Nevada Test Site and from herds located at Searchlight and Reno, Nevada. The data suggest that the Rocky Flats cattle had tissue concentrations of plutonium-239 similar to those collected from the NTS and Roller Coaster herds and that inhalation contributed some fraction of the exposure. The levels of both uranium and plutonium-239 found in the exposed cattle were similar to those found in the general U.S. human population from fallout. Americium concentrations were about 1/4 to 1/2 of the plutonium-239 concentration in the same tissue.

A major difference between the Rocky Flats cattle and the other cattle groups, and one that possibly reduced their exposure to plutonium, was that the exposure of the former group was only 5 to 6 months per year rather than continuous exposure as for the latter groups.

The maximum plutonium concentration in edible tissues from the Rocky Flats cattle, if ingested by humans at the rate of 500 g/day for 50 years, would contribute an estimated bone dose which, at most, is only 0.02 rem from consumption of liver and 0.001 rem from consumption of muscle. This is a small fraction of the background whole-body dose which is 8.5 rem per 50 years in the Denver area (Smith and Black 1975).

The geometric mean values of uranium concentration suggest that the uranium uptake of the Rocky Flats animals was higher than for the other groups, but this is attributed to the higher levels of uranium naturally occurring in soil in the Front Range area.

The strontium-90 concentrations in bone were similar to those found in the other herds. The tritium concentration in blood from the Rocky Flats cattle was consistent with the levels found in their drinking water.

Survey of Fresh Water Algae of the NTS

Fifty-two species of freshwater algae were identified in samples collected from the eight known natural springs of the Nevada Test Site. Although several species were widespread, 29 species were site specific. Diatoms provided the greatest variety of species at each spring. Three-fifths of all algal species encountered were diatoms. Well-developed mats of filamentous green algae (Chlorophyta) were common in many of the water banks associated with the springs and accounted for most of the algal biomass. Major nutrients were adequate, if not abundant, in most spring waters--growth being limited primarily by light and physical habitat. There was some evidence of cesium-137 bioconcentration by algae at several of the springs (Taylor and Giles 1979).

Iodine-129 Study

The data from over 90 thyroids collected during 1973, 1974, and 1975 from animals residing on the Nevada Test Site indicate that iodine-129 to iodine-127 atom ratios in these thyroids are near background levels (8×10^{-9}). However, the median levels in the thyroids of animals living on the

Nevada Test Site are slightly elevated from those found in northern Nevada, but are similar to those found near Denver, Colorado, and Rawlins, Wyoming. Statistical analyses of the iodine-129/iodine-127 ratios in cattle thyroids suggest that three populations were sampled. These populations are: 1) northern Nevada cattle which were considered as a baseline population, 2) corralled Nevada Test Site cattle with intermediate ratios, and 3) free-grazing cattle from the Nevada Test Site and Rocky Flats, Colorado, which had the highest ratios reported. The range and median iodine-129/iodine-127 ratios for the three populations during 1974 and 1975 were as follows: 1) 5.82×10^{-11} to 7.25×10^{-9}, 2.8×10^{-9}; 2) 1.9×10^{-9} to 6.2×10^{-8}, 5.3×10^{-9}; and 3) 2.7×10^{-8} to 3.7×10^{-7}, 1.5×10^{-7} (Smith 1977).

DOSE ESTIMATES

The radionuclide concentrations in the edible tissues sampled during this Program can be used to calculate a maximum hypothetical dose to the offsite human population. When available, the data from animals, collected offsite were used. Otherwise, the data from NTS animals were used. In most cases, the NTS data were not markedly higher than data from offsite animals. The details of the calculation are set forth below for each radionuclide considered.

CESIUM-137

To calculate a 50-year dose commitment for this nuclide, the amount ingested per year is required as is a dose conversion factor. The analytical data indicate that samples from the Knoll Creek herd had the highest concentration. Assuming an offsite resident were to eat 1/2 kg (about 1 lb) per day, the total intake for 6-month periods based on the concentrations measured in the seminannual samples from the Knoll Creek herd can be calculated and then summed for each year as shown in Table 3. The dose conversion factor for an annual intake of Cs-137 is given in Table B-5 in Corley et al. (1981), as 71 merm per μCi/yr ingested, whole-body dose commitment.

If the Knoll Creek data through 1967 and the NTS data from 1968 through 1981 are summed, then the 50-year whole-body dose commitment would total 96 mrem for the 25 years. The maximum hypothetical dose commitment would have been 18 mrem for 1963, and the average would have been about 4 mrem/year, under the assumptions stated above. The dose commitment from worldwide fallout (through 1975) averaged 28 mrad [United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 1977], the NTS contribution could be about 68 of the 96 mrem calculated. The guidelines by the Federal Radiation Council (FRC Report No. 2, September 1961) allow a dose of 170 mrem/yr to the whole body of a suitable sample of the general population. The permissible 25-year dose would then be 4250 mrem. The calculated dose of 68 mrem is only 1.6% of this amount.

STRONTIUM-90

The hypothetical dose commitment from strontium-90 produced by activities at the NTS is probably negligible for the local offsite population. The concentration measured in the various bone samples collected by the AIP, though higher than that expected in human bones, varies in a consistent fashion with

TABLE 3. CESIUM-137 IN CATTLE MUSCLE SAMPLES AND HUMAN DOSE COMMITMENT

Year	NTS Cattle Spring pCi/kg	NTS Cattle Fall pCi/kg	Human Intake μCi	50-year Dose mrem	Knoll Creek Cattle Spring pCi/kg	Knoll Creek Cattle Fall pCi/kg	Human Intake μCi	50-year Dose mrem
1957		390	0.036	2.5				
1958	260	710	0.089	6.3	470	770	0.113	8.1
1959	500	220	0.066	4.7	840	130	0.089	6.3
1960	170	440	0.056	4.0	91	100	0.017	1.2
1961	100	180	0.026	1.8	100	90	0.017	1.2
1962	450	8800	0.85	60	130	900	0.094	6.7
1963	5700	1700	0.68	48	1100	1700	0.256	18
1964	490	300	0.072	5.1	1600	900	0.229	16
1965	750	390	0.10	7.4	870	860	0.158	11
1966	250	140	0.036	2.5	310	660	0.089	6.3
1967	120	70	0.017	1.2	490	350	0.077	5.4
1968	120	43	0.015	1.1				
1969	200	200	0.037	2.6				
1970	60	50	0.010	0.71				
1971	120	60	0.016	1.2				
1972	40	50	0.008	0.58				
1973	50	20	0.006	0.45				
1974	53	10	0.006	0.41				
1975	60	29	0.008	0.56				
1976	39	10	0.004	0.32				
1977	16	10	0.002	0.17				
1978	90	71	0.015	1.0				
1979	38	28	0.006	0.43				
1980	37	24	0.006	0.40				
1981	65	55	0.011	0.78				

the strontium-90 in human bones collected in New York (Smith and Andrews 1981). This suggests that worldwide fallout is the principal source. Furthermore, the concentration in fresh milk is consistently less in semi-arid Nevada than in high rainfall areas of the U.S. Atmospheric tests by the U.S. (both NTS and Pacific) had a kiloton yield equal to about 17% of the total atmospheric testing by all countries. Probably less than half that amount, say 8%, may be due to NTS tests, so the dose commitment of 120 mrad to bone lining cells from all testing (UNSCEAR 1977) would include a maximum of about 10 mrad from NTS activities.

TRITIUM

To calculate a hypothetical dose commitment for this nuclide, the assumption is made that each 1/2 kg of meat consumed daily has the same tritium

concentration as measured in the blood. All the data available are from the NTS beef herd for the period from 1971 to 1981. The 50-year whole-body dose commitment based on a dose conversion factor of 0.1 mrem per μCi/yr ingested (Corley et al. 1981) is only 0.15 mrem.

PLUTONIUM-239

The plutonium-239 concentration in bone collected from NTS beef cattle has not been markedly different from the concentration in bone from cattle that were raised in other areas. This suggests that the "contaminated" range on the NTS provided little plutonium to the body burden of these animals over that contributed by worldwide fallout. The indication in the section on plutonium earlier in this report was that the bone burden of the NTS cattle increased by 1 pCi/kg fresh weight in 10 years.

Using an improbable scenario, i.e., an individual living in Area 18 on the NTS and having the same diet as cattle, one can estimate a body burden. The general population bone concentration is about 0.2 pCi/kg (McInroy et al. 1979) or 1.4 pCi in the skeleton. The 7 pCi increase in 10 years as estimated from cattle data would add to this for an 8.4 pCi total. Assuming the bone burden is half the total, the body burden becomes 17 pCi. Since the ICRP guide for occupational exposure is a body burden of 40,000 pCi or 1,333 pCi for a suitable sample of the population, this calculated 17 pCi is equivalent to only 1.3% of the guideline or 2.2 mrem for this hypothetical 10-year exposure.

RADIOIODINE

For most cases of fallout in earlier years, radioiodines were not measured in environmental samples. On several occasions, though, cattle thyroids were measured for iodine-131. Based on extensive studies of radioiodine transport in the biosphere, it should be possible to make a reasonable estimate of radioiodine concentration in human thyroids given these bovine thyroid measurements. The estimated doses use some known factors and certain assumptions as listed below (Watson and Cline 1967 and Black and Barth 1976).

Published Data

The following factors for radioiodine can be found in the literature:

1) Thyroid weight; bovine = 30 g, 1-year old child = 2 g,
2) Effective half life; bovine = 7.0 days, child = 7.6 days,
3) Content; bovine thyroid has 2-3 times daily intake in spring and summer and 4-5 times the intake in fall and winter,
4) Milk; for a single contaminating event, 10% of intake is secreted in the milk,
5) Bovine milk output; average of 20 liters/day,
6) Uptake; human thyroid uptake is 30% of intake,
7) Peak concentration; in bovine occurs 4 days after start of intake.

Assumptions

These can be conservative so as not to underestimate the problem.

1) Family cow produces 10 liters/day,
2) Bovine thyroid contains twice the daily intake,
3) Child with 2-g thyroid drinks 1 liter/day of milk,
4) Cow thyroid has 1 nCi/g of iodine-131,
5) Family cow has same intake as beef cattle.

Calculation

Cow intake = 1 nCi/g x 30 g/2 = 15 nCi
Cow secretes 10% in milk = 1.5 nCi
Child drinks 1 liter/day of 10 liters/day = 10% = 0.15 nCi
Thyroid uptake = 30% x 0.15 nCi = 0.045 nCi or 0.0225 nCi/g
Ratio of child/bovine thyroid = 0.0225/1.0 or 2.25%

Published reports suggest human thyroids have 0.2 to 0.5% of the amount of radioiodine measured in thyroids from bovine collected in the same area. Since these thyroids were generally from adults, a rounded value of 2% appears reasonable for the ratio of child/bovine thyroid radioiodine content.

Dose Estimation

The iodine-131 conncentration measured in bovine thyroids is shown in Table 4. Where possible, the date of the nearest previous test that released radioactivity offsite is indicated in the table. The estimated peak concentration was then calculated by using 4 days as the time to peak in the bovine thyroid and an effective half-life of 7 days. As an example, use the data in the first row of Table 4, NTS data. From 10/7 to 12/5 is 59 days. Less 4 days to the peak is 55 days or 7.8 effective half-lives. The peak in the bovine thyroid is then estimated as 232 times the measured value or 232 x 375 pCi/g. When this is divided by 50 to get the estimated peak in a child's thyroid, then multiplied by 2, the value indicated in the column headed "Child pCi/2g" is obtained. The dose conversion factor used was 55.2 rad/μCi in the 2 gram thyroid.

The radioiodine dose was calculated only for iodine-131. The dose from shorter half-life iodines could be estimated if deposition time and the delay between that time and milk consumption were known. Iodine-129 was not considered since the amounts found were extremely small.

From Table 4, the total hypothetical dose to a 2-gram human thyroid for all measurements made was: NTS - 3160, Delamar Valley - 2510 mrem, and Knoll Creek - 310 mrem. These represent an average of 144 mrem/yr from NTS, 228 mrem/yr from Delamar Valley, and 26 mrem/yr from Knoll Creek if a child lived in those areas and drank milk from cows in those areas. Of course, this would be impossible for the NTS and the average calculated dose would be even smaller

TABLE 4. IODINE-131 IN CATTLE THYROIDS AND ESTIMATED DOSE TO A 2-g THYROID

Year	Test Date	NTS Data				Delamar Valley Data				Knoll Creek Data			
		Date Sampled	pCi/g	Child pCi/2g	Dose mrem	Date Sampled	pCi/g	Child pCi/2g	Dose mrem	Date Sampled	pCi/g	Child pCi/2g	Dose mrem
1957	10/7	12/5	375	3480	192	12/7	630	7100	393	-			
1958	4/28	6/2	5400	4650	257	5/27	260	124	6.8	5/20	9	2.1	0.1
	10/30	11/23	SS*			11/14	6500	773	42.6	11/6	4500	242	13.4
1959	-	4/23	40	1.6	0.09	4/30	30	1.2	0.07	5/8	25	1.0	0.06
	-	11/12	2	0.08	-	11/3	5	0.2	0.01	11/19	2	-	-
1960	-	4/29	15	0.6	0.03	4/22	16	0.6	0.04	5/7	5	0.2	0.01
	-	11/8	520	21	1.1	10/19	0.5	-	-	11/16	3	-	-
1961	-	5/23	3	0.10	-	5/31	3	0.10	-	5/17	2	-	-
	9/15	11/9	7200	44900	2480	11/16	2700	33700	1860	11/2	1700	5300	293
1962	4/14	5/24	430	608	34	6/11	390	2970	164	5/17	14	10	0.5
	10/19	11/7	SS*			11/14	1300	459	25	10/23	230	9	0.5
1963	5/15	5/23	29	1.7	0.10	5/28	1	-	-	5/16	1	-	-
	-	11/14	2	0.08	-	11/11	5	0.2	-	10/11	4	-	-
1964	4/29	6/11	26	49	2.7	5/27	3	-	-	6/3	2	-	-
	8/19	10/7	61	210	11.6	10/14	3	-	-	10/20	4	-	-
1965	4/14	6/3	730	2800	153	5/20	57	54	3.0	5/5	61	13	0.7
	-	11/3	0	-	-	10/27	0	-	-	10/20	2	-	-
1966	4/25	5/26	640	371	20.5	5/5	3500	254	14	5/8	3	-	-
	-	10/13	0	-	-	10/6	0	-	-	10/20	1	-	-
1967	-	5/31	0	-	-	5/25	1	-	-	5/18	2	-	-
	-	10/14	15	0.6	0.03	10/25	1	-	-	11/23	2	-	-
1968	3/12	6/11	6	0.2	0.01	-				4/24	16	30	1.7
1970	-	10/29	10	0.4	0.02								
1972		5/10	21	0.8	0.05								
1976		10/21	150	6	0.3								
1977	9/21**	10/14	770	123	6.8								
1978		5/17	6	0.2	0.01								

*SS indicates cattle used for special study.
**Foreign weapons test.

in the DV and KC areas because the dose decreases rapidly as the child ages.

The principal contribution to the total dose is due to the result of the fall 1961 sampling. A more logical cause for almost all the radioiodine measured in bovine thyroids at that time would have been the multi-megaton atmospheric tests of the USSR at the end of October. If that is assumed, the calculated NTS-related doses for 1961 decrease to 18, 15, and 6 mrem for the NTS, DV, and KC data, respectively, and the cumulative doses during the time of sampling decreases to 698, 663, and 23 mrem for the three areas respectively.

Based on the guidelines set by the Federal Radiation Council (FRC Report No. 2, September 1961) of 500 mrem/yr to a suitable sample of the general population, none of the hypothetical annual doses exceeded that guideline.

REFERENCES AND BIBLIOGRAPHY

REFERENCES

Black, S. C., and D. S. Barth, Radioiodine Prediction Model for Nuclear Tests, Report EPA-600/4-76-027. U.S. Environmental Protection Agency, Monitoring and Support Laboratory. June 1976.

Black, S. C., R. F. Grossman, A. A. Mullen, G. D. Potter, D. D. Smith, and J. L. Hopper. Offsite Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1981. EPA-600/4-82-061, DOE/DP/00539-046. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 111 pp. 1982.

Blincoe, C., and V. R. Bohman. "Bovine Thyroid Iodine-131 Concentrations Subsequent to Soviet Nuclear Weapons Test." Science. Vol. 131:3531, pp. 690-691. 1962.

Blincoe, C., and V. R. Bohman. "Iodine-131 from Environmental Sources in Nevada Bovine Thyroid Glands from 1961 through 1968." Environmental Science and Technology, Vol. 4:5, pp. 425-429. 1970A.

Blincoe, C., and V. R. Bohman. "Decrease of Bovine Cesium-137 Concentrations Following the Cessations of Atmospheric Nuclear Weapons Testing." Radionuclides in the Environment, Advances in Chemistry Series #93. American Chemical Society, pp. 427-435. 1970B.

Blincoe, C., and V. R. Bohman. "Cesium-137 from Environmental Sources in Desert Range Cattle from 1962 through 1968." Environmental Research 4:3, pp. 193-200. 1971.

Blincoe, C., V. R. Bohman, and E. L. Fountain. "Iodine-131 in Bovine Thyroid Glands from 1957 through 1961." J. Agr. and Food Chem., 12:5, pp. 414-418. 1964.

Blincoe, C., V. R. Bohman, and E. L. Fountain. "Cesium-137 Concentrations in Desert Range Cattle." J. Agr. and Food Chem., 13:2, p. 157. 1965.

Blincoe, C., V. R. Bohman, and E. L. Fountain. "Fallout Concentrations in Cattle Grazing Highly Contaminated Range." Health Physics, Vol. 17, pp. 559-564. 1969.

Bohman, V. R., C. Blincoe, A. L. Lesperance, and C. F. Speth. "Fission Product Uptake by Cattle." Proceedings, Western Section, American Society of Animal Science. Vol. 19, pp. 7-11. 1968.

Bohman, V. R., C. Blincoe, M. A. Wade, A. L. Lesperance, and E. L. Fountain. "Accumulation of Strontium in Bovine Bones." J. Agr. and Food Chem. 14:4, pp. 413-415. 1966.

Brown, K. W., and B. J. Mason. Range Survey, Area 18, Nevada Test Site. SWRHL-52. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 42 pp. 1968.

Corley, J. P., D. H. Denham, R. E. Jaquish, D. E. Michels, H. R. Olson, and D. A. Waite. A Guide for Environmental Radiological Surveillance at U.S. Department of Energy Installations. U.S. Department of Energy Report DOE/EP-0023. July 1981.

Douglas, R. L., B. J. Mason, and A. A. Moghissi. "Variations in Tritium Concentrations in Urine of Employees at the Nevada Test Site Experimental Farm." Presented at the Fifteenth Annual Meeting of the Health Physics Society, Palmer House, Chicago, Illinois. June 28-July 2, 1970.

Farmer, G. R. Off-Site Animal Investigation Project, Second Annual Report. Unnumbered report. Office of Test Operations, United States Atomic Energy Commission, Las Vegas, Nevada. 19 pp. June 30, 1959.

Farmer, G. R. Off-Site Animal Investigation Project. Third Annual Report. Unnumbered report. Office of Test Operations, United States Atomic Energy Commission, Las Vegas, Nevada. 6 pp. June 30, 1960.

Federal Radiation Council. Background Material for the Development of Radiation Protection Standards. Report No. 2. 19 pp. 1961.

Fountain, E. L. Off-Site Animal Investigation Project. Fourth Annual Report. Unnumbered report. Office of Test Operations. United States Atomic Energy Commission, Las Vegas, Nevada. 32 pp. June 30, 1961.

Gears, G. E., G. LaRoche, J. Coble, B. Jaroslow, and D. D. Smith. Investigations of Reported Plant and Animal Health Effects in the Three Mile Island Area. NUREG-0738 and EPA 600/4-80-049. U.S. Nuclear Regulatory Commission, Office of Nuclear Regulation, Washington, D.C., and U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 33 pp. 1980.

Giles, K. R. Springs on the Nevada Test Site and Their Use by Wildlife. NERC-LV-539-26. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 15 pp. 1976.

Glasstone, S. (ed). The Effects of Nuclear Weapons. Revised Edition. U.S. Department of Defense. April 1962.

Hood, S. L., and C. L. Comar. Metabolism of Cesium-137 in Laboratory and Domestic Animals. ORO-91. 31 pp. 1953.

Hull, B. P., and S. L. Cohen. Animal Investigation Program Baseline Studies: Supplemental Test Site "C". SWRHL-54r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 14 pp. 1968.

Johns, F. B., P. B. Hahn, D. J. Thome, and E. W. Bretthauer. Radiochemical Analytical Procedures for Analysis of Environmental Samples. EMSL-LV-0539-17. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 109 pp. March 1979.

Johnson, E. Offsite Animal Investigation Project. First Annual Report. Unnumbered report. Office of Test Operations, United States Atomic Energy Commission, Las Vegas, NV. 9 pp. June 30, 1958.

Klein, W. L., and R. A. Breckbill. Preliminary Radiation Surveillance on an Aquatic System Near the Nevada Test Site June - July 1967. SWRHL-65r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 23 pp. 1972.

Kramp, R. C. "Preliminary Report on ^{90}Sr Levels in Hock Joints of Desert Bighorn Sheep and Mule Deer," pp. 62-67. Desert Bighorn Council 1965 Transaction. 92 pp. 1965.

Magno, P. J. et al. Iodine-129 in the Environment Around a Nuclear Fuel Reprocessing Plant. ORP/FOD 72-5. USEPA. Office of Radiation Programs. 23 pp. 1972.

McInroy, J. F., H. A. Boyd, et al. Deposition and Retention of Plutonium in the United States General Population. LA-UR-81-1175. Los Alamos National Laboratory, New Mexico. 33 pp. 1979.

Sanders, J. B., O. R. Placak, and M. W. Carter. Report of Off-Site Radiological Safety Activities, Operation Teapot, Nevada Test Site. Spring - 1955. Undated and unnumbered report. Santa Fe Operations Office, U.S. Atomic Energy Commission.

Scoggins, W. A. Environmental Surveillance Report for the Nevada Test Site (January 1981 through December 1981). DOE/NV/00410-67. Reynolds Electrical and Engineering Co., Inc. Las Vegas, Nevada. 181 pp. 1982.

Shuyler, L. R., D. D. Smith, D. A. Clark, and J. Barth. "Excretion of Salts by Feedlot Cattle in Response to Variations in Concentrations of Sodium Chloride Added to Their Ration." pp. 336-343. Managing Livestock Wastes. Third International Symposium on Livestock Wastes--1975. PROC-275. 1975.

Smith, D. D. Management History of the AEC Beef Herd: 1 June 1964 - 1 June 1969. SWRHL-80r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 26 pp. 1970.

Smith, D. D. ^{129}I in Animal Thyroids from Nevada and Other Western States. EPA-600/3-77-067. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 22 pp. 1977.

Smith, D. D., and V. E. Andrews. Selected Radioisotopes in Animal Tissues in Nevada: ^{90}Sr and ^{137}Cs Measurements from 1956 to 1977. EPA-600/3-81-027 and DOE/DP/00539-040. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 54 pp. 1981.

Smith, D. D., and S. C. Black. Actinide Concentrations in Tissues from Cattle Grazing Near the Rocky Flats Plant. NERC-LV-539-36. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 47 pp. 1975.

Smith, D. D., and K. R. Giles. Animal Investigation Program 1969 Annual Report. SWRHL-102r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 20 pp. 1970.

Smith, D. D., and K. R. Giles. Report of Bioenvironmental Sampling at the Gnome Site, Carlsbad, New Mexico - October 1972. NERC-LV-539-25. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 35 pp. 1973.

Smith, D. D., and K. R. Giles. Animal Investigation Program 1970 Annual Report. NERC-LV-539-16. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 53 pp. 1974.

Smith, D. D., and K. R. Giles. 1971 Animal Investigation Program Annual Report. NERC-LV-0539-20. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 39 pp. 1975.

Smith, D. D., and K. R. Giles. Animal Investigation Program 1981 Annual Report: Nevada Test Site and Vicinity. EPA 600/3-83-014 and DOE/DP/00539-047. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 64 pp. 1983.

Smith, D. D., K. W. Brown, R. A. Brechbill, K. R. Giles, and A. L. Lesperance. The Radionuclide Concentrations and Botanical Composition of the Diet of Cattle Grazing the Area 18 Range of the Nevada Test Site, 1966-1970. SWRHL-110r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 31 pp. 1972.

Smith, D. D., S. C. Black, K. R Giles, and A. A. Moghissi. Report of Animal Investigation Program Activities for the Baneberry Event. NERC-LV-539-10. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 55 pp. 1975.

Smith, D. D., S. C. Black, K. R. Giles, D. E. Bernhardt, and R. R. Kinnison. Tissue Burdens of Selected Radionuclides in Beef Cattle On and Around the Nevada Test Site. NERC-LV-539-29. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 83 pp. 1976A.

Smith, D. D., K. R. Giles, and D. E. Bernhardt. Animal Investigation Program 1972 Annual Report. NERC-LV-539-35. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 82 pp. 1976B.

Smith, D. D., J. Barth, and R. G. Patzer. "Grazing Studies on a Plutonium-Contaminated Range of the Nevada Test Site," pp. 325-336. Proceedings of the Symposium on Transuranium Nuclides in the Environment. IAEA-SM-199/73. San Francisco, California, November 17-21, 1975. 724 pp. 1976C.

Smith, D. D., K. R. Giles, and D. E. Bernhardt. Animal Investigation Program 1973 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-3. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 89 pp. 1977A.

Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. Animal Investigation Program 1974 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-10. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 95 pp. 1977B.

Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. Animal Investigation Program 1975 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-14. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 88 pp. 1978A.

Smith, D. D., K. R. Giles, D. E. Bernhardt, and K. W. Brown. Animal Investigation Program 1976 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-20. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 111 pp. 1978B.

Smith, D. D., K. R. Giles, D. E. Bernhardt, A. B. Crockett, and R. R. Kinnison. Animal Investigation Program 1977 Annual Report: Nevada Test Site and Vicinity. EMSL-LV-0539-26. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 90 pp. 1979.

Smith, D. D., D. E. Bernhardt, and K. R. Giles. Animal Investigation Program 1978 Annual Report: Nevada Test Site and Vicinity. EPA-600/3-80-096 and DOE/DP/0059-038. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 65 pp. 1980.

Smith, D. D., D. E. Bernhardt, and K. R. Giles. Animal Investigation Program 1979 Annual Report: Nevada Test Site and Vicinity. EPA-600/3-81-035 and DOE/DP/005939-04. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 65 pp. 1981A.

Smith, D. D., R. F. Grossman, W. D. Corkern, D. J. Thome, R. G. Patzer, and J. L. Hopper. Offsite Environmental Monitoring Report: Radiation Monitoring Around United States Nuclear Test Areas, Calendar Year 1980. EPA-600/4-81-047 and DOE/DP/00539-043. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 101 pp. 1981B.

Smith, D. D., D. E. Bernhardt, and K. R. Giles. Animal Investigation Program 1980 Annual Report: Nevada Test Site and Vicinity. EPA-600/3-8-077 and DOE/DP/00539-045. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 55 pp. 1982.

Taylor, W. D., and K. R. Giles. Freshwater Algae of the Nevada Test Site. EMSL-LV-0539-25. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 19 pp. 1979.

United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and Effects of Ionizing Radiation, 1977 Report to the General Assembly, Vienna, Austria. 1977.

U.S. Department of Energy. Environmental Measurements Laboratory Environmental Quarterly, September 1 through December 1, 1979. EML-370. New York, New York. January 1, 1980.

U.S. Department of the Interior, Bureau of Land Management. Ocular Reconnaissance Forage Survey Handbook. BLM Manual 4412. 11A.

Watson, C. R., and J. F. Cline. Radioiodine Environmental Release Studies. Battelle Northwest Laboratories Report BNWL-280, Hanford, WA. 1967.

Western Environmental Research Laboratory. The January 1971 Sheep Death Incident Near Garrison, Utah. SWRHL-114r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 11 pp. 1971.

BIBLIOGRAPHY

Bohman, V. R., M. A. Wade, and C. Blincoe. "Distribution of Strontium in the Bovine Skeleton." Science, Vol. 136:3522, pp. 1120-1121. 1962.

Blincoe, C., V. R. Bohman, and D. D. Smith. "Ingestion of Plutonium and Americium by Range Cattle." Health Physics, Vol. 41, pp. 285-291. 1981.

Bohman, V. R., and A. L. Lesperance. The Accumulation of Fission Product in Bovine Tissues and an Evaluation of Certain Factors Influencing the Uptake of Materials. Annual Report 1967. U.S. Department of Health, Education, and Welfare. Southwestern Radiological Health Laboratory, Las Vegas, Nevada. Contract AT(04-3)-509. 28 pp. 1967.

Bohman, V. R., and C. Blincoe. The Intake and Digestibility of Range Plants Grown on Plutonium-Contaminated Soils as Determined with Grazing Cattle. EMSL-LV-0539-34. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 43 pp. 1980.

Brechbill, R. A. Special Bovine Sampling Study--Project Roller Coaster Sites. SWRHL-53. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 23 pp. June 1969.

Brechbill, R. A., R. E. Engel, and R. C. Kramp. Calcium in Hock Joints of Wildlife Ruminants in Selected Areas of the United States. SWRHL-34r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 8 pp. 1967.

Brown, K. W., and D. D. Smith. The Poisonous Plants of the U.S. Atomic Energy Commission's Nevada Test Site, Nye County, Nevada. SWRHL-33r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 56 pp. 1966.

Brown, K. W., D. D. Smith, D. E. Bernhardt, K. R. Giles, and J. B. Helvie. "Food Habits and Radionuclide Tissue Concentrations of Nevada Desert Bighorn Sheep 1972-1973," pp. 61-68. Desert Bighorn Council 1975 Transactions. 72 pp. 1976. Also, EMSL-LV-539-6. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. Las Vegas, Nevada. 23 pp. 1976.

Brown, K. W., D. D. Smith, and R. P. McQuivey. "Food Habits of Desert Bighorn Sheep in Nevada 1957-1975." Desert Bighorn Council 1976. Transactions. 1978.

Cohen, S. L. "Amputation of the Forelimb of a Desert Bighorn Sheep," pp. 28-37. Desert Bighorn Council 1968 Transactions. 77 pp. 1968.

Daley, E. M. Agronomic Aspects of the Experimental Dairy Farm During 1969. SWRHL-104r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 9 pp. 1971.

Daley, E. M. Agronomic Aspects of the Experimental Dairy Farm - 1970. SWRHL-117r. U.S. Environmental Protection Agency, Western Environmental Research Laboratory, Las Vegas, Nevada. 18 pp. 1972.

Daley, E. M. Agronomic Practices of the Nevada Test Site Experimental Dairy Farm During 1971, 1972, and 1973. EMSL-LV-539-5. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 25 pp. 1976.

Daley, E. M. Five-Year Summary Report of an Experimental Dairy Herd Maintained on the Nevada Test Site 1971 through 1975. EMSL-LV-0539-9. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 45 pp. 1977.

Daley, E. M. Status Report of an Experimental Dairy Herd Maintained on the Nevada Test Site January 1, 1976, through December 31, 1976. EMSL-LV-0539-11. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 27 pp. 1978.

Daley, E. M. Agronomic Practices of the Nevada Test Site Experimental Dairy Farm During 1974 through 1977. EMSL-LV-0539-21. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 34 pp. 1978.

Daley, E. M., and D. D. Smith. Agronomic Aspects of the Experimental Dairy Farm. SWRHL-63r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 41 pp. 1969.

Douglas, R. L. Status of the Nevada Test Site Experimental Farm. SWRHL-36r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 30 pp. 1967.

Engel, R. E., and S. L. Cohen. Principles of Reporting Post-Mortem Findings. SWRHL-35r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 15 pp. 1968.

Engel, R. E. "Methods of Post-Mortem Description of Wildlife Ruminants with Two Commonly Observed Lesions in the Desert Bighorn Sheep," pp. 68-69b. Desert Bighorn Council 1965 Transactions. 92 pp. 1965.

Farmer, G. R. "Effects of Radioactive Fall-Out on Bighorn," pp. 15-19. Desert Bighorn Council 1959 Transactions. 86 pp. 1959.

Farmer, G. R. "Radioactivity in Bighorn Sheep," pp. 23-25. Desert Bighorn Council 1960 Transactions. 107 pp. 1960.

Fountain, E. L. "Fallout, Its Relation to Wildlife," pp. 95-97. Desert Bighorn Council 1961 Transactions. 119 pp. 1961.

Fountain, E. L. "Biological Assays," pp. 53-57. Desert Bighorn Council 1963 Transactions. 202 pp. 1963.

Fountain, E. L., and M. S. Seal. "Strontium-90 in the Bones of Big Game in the Western United States." Health Physics, pp. 1205-1209. 13 pp. November 1967.

Gilbert, R. O., D. D. Smith, and L. L. Eberhardt. "An Initial Synthesis of Area 13 ^{239}Pu Data and Other Statistical Analyses." pp. 237-274. Environmental Plutonium on the Nevada Test Site and Environs. NVO-171. M. G. White, P. B. Dunaway, and W. A. Howard, eds. Nevada Applied Ecology Group, U.S. Energy Research and Development Administration, Las Vegas, Nevada. 322 pp. 1977.

Giles, K. R. A Summer Trapping Method for Mule Deer. EMSL-LV-0539-027. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory,, Las Vegas, Nevada. 5 pp. 1979.

Helvie, J. B., and D. D. Smith. "Summary of Necropsy Findings in Desert Bighorn Sheep," pp.28-42. Desert Bighorn Council 1970 Transactions. 200 pp. 1970.

Leavitt, V. D. Soil Survey of Area 18, Nevada Test Site. SWRHL-74r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 119 pp. 1970.

Smith, D. D. Status of the Bioenvironmental Research Experimental Dairy Herd. July 1, 1966 through December 31, 1968. SWRHL-67r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 90 pp. 1970.

Smith, D. D. "Radiation Surveillance of Ruminants On and About the Nevada Test Site," pp. 101-108. Desert Bighorn Council 1971 Transactions. 110 pp. 1971. Also, NERC-LV-539-18. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 10 pp. 1972.

Smith, D. D. Observations on Wildlife and Domestic Animals Exposed to the Ground Motion Effects of Underground Nuclear Detonations. NERC-LV-539-24. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 11 pp. 1973A.

Smith, D. D. Status of the Environmental Protection Agency's Nevada Test Site Experimental Dairy Herd January 1, 1969 - December 31, 1970. NERC-LV-539-22. U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada. 62 pp. 1973B.

Smith, D. D. "Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada," pp. 151-161. The Dynamics of Plutonium in Desert Environments. Nevada Applied Ecology Group Progress Report, July 1974. NVO-142. P. B. Dunaway and M. G. White, eds. U.S. Atomic Energy Commission, Nevada Operations Office, Las Vegas, Nevada. 369 pp. 1974.

Smith, D. D. "Grazing Studies on Selected Plutonium-Contaminated Areas in Nevada," pp. 125-135. The Radioecology of Plutonium and Other Transuranics in Desert Environments. Nevada Applied Ecology Group Progress Report, June 1975. NVO-153. M. G. White and P. B. Dunaway, eds. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. 503 pp. 1975.

Smith, D. D. "Status Report on Grazing Studies on a Plutonium-Contaminated Range of the Nevada Test Site," pp. 41-45. Studies of Environmental Plutonium and Other Transuranics in Desert Ecosystems. NVO-159. M. G. White and P. B. Dunaway, eds. U.S. Energy Research and Development Administration, Nevada Operations Office, Las Vegas, Nevada. 189 pp. 1976.

Smith, D. D. "Grazing Studies on a Contaminated Range of the Nevada Test Site," pp. 139-149. Environmental Plutonium on the Nevada Test Site and Environs. NVO-171. M. G. White, P. B. Dunaway, and W. A. Howard, eds. Nevada Applied Ecology Group, U.S. Energy Research and Development Administration, Las Vegas, Nevada. 322 pp. 1977A.

Smith, D. D. "Review of Grazing Studies on Plutonium-Contaminated Rangelands," pp. 407-417. Transuranics in Natural Environments. NVO-178. M. G. White and P. B. Dunaway, eds. Nevada Applied Ecology Group, U.S. Energy Research and Development Administration, Las Vegas, Nevada. 710 pp. 1977B.

Smith, D. D. "Area 13 Grazing Studies--Additional Data," pp. 59-93. Selected Environmental Plutonium Research Reports of the NAEG. NVO-192. M. G. White and P. B. Dunaway, eds. Nevada Applied Ecology Group, U.S. Department of Energy, Las Vegas, Nevada. 2 Vol. 759 pp. 1978.

Smith, D. D. Summary Report of the Grazing Studies Conducted on a Plutonium-Contaminated Range in Area 13 of the Nevada Test Site. EMSL-LV-0539-24. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nevada. 104 pp. 1979.

Smith, D. D. Status Report of Area 15 Experimental Dairy Farm: Dairy Husbandry January 1977 - June 1979, Agronomic Practices January 1978 - June 1979. EMSL-LV-0539-32. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 28 pp. 1980.

Smith, D. D., and D. E. Bernhardt. "Actinide Concentrations in Tissues from Cattle Grazing a Contaminated Range," pp. 281-303. Transuranics in Desert Ecosystems. NVO-181. M. G. White, P. B. Dunaway, and D. L. Wireman, eds. Nevada Applied Ecology Group, U.S. Department of Energy, Las Vegas, Nevada. 469pp. 1977.

Smith, D. D., and K. W. Brown, Preliminary Grazing Studies with Rumen-Fistulated Steers at Selected Nuclear Test Sites. EPA-600/3-81-004. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. 32 pp. 1981.

Smith, D. D., and R. E. Engel. Progress Report for the Bioenvironmental Research May 22, 1964 through July 1, 1966. Part I. Experimental Dairy Herd. SWRHL-55r. U.S. Department of Health, Education, and Welfare, Southwestern Radiological Health Laboratory, Las Vegas, Nevada. 106 pp. 1969.

Smith, T. M., A. L. Lesperance, V. R. Bohman, R. A. Brechbill, and K. W. Brown. "Intake and Digestibility of Forages Grazed by Cattle on a Southern Nevada Range." Proceedings, Western Section, American Society of Animal Science: Vol. 19., pp. 277-282. 1968.

APPENDIX A

SUMMARY OF OFFSITE ANIMAL CLAIMS INVESTIGATIONS

1952 to 1981

The OffSite Rad-Safe Livestock Studies for the Nevada Operations Office of the Atomic Energy Commission (AEC) began in November of 1955 with the assignment of Lieutenant Edmund Johnson, Veterinary Corps, U.S. Army. The Animal Investigation Program (AIP) was initiated in July of 1957 and continued to be directed by Army veterinary officers until the operation was transferred to the U.S. Public Health Service (PHS) on June 1, 1964. Other Army officers assigned to this program were Major Garland Farmer, June 1958 to July 1960; Captain Edmund Fountain, July 1960 to August 1963; and Captain Scott Reynolds, August 1963 - June 1964. Animal investigations prior to 1955 were handled by various investigators on a consultant basis and records in the AIP files are sparse. Our knowledge of these investigations is summarized in the following excerpts from a project proposal submitted by Johnson and from a memo written by Johnson.

All animal investigations that could be located in the search of the AIP historical files were summarized in the following lists. Supporting data are available for many of these investigations and are keyed to the necropsy records on file in the AIP office (e.g., OW-15-56).

(Taken from proposal for study submitted by Johnson in November of 1956)

FALLOUT ASSIMILATION IN RANGE CATTLE ON AREAS NEAR THE NEVADA TEST SITE

November 2, 1956

"2. In 1952 during the Snapper Series, cattle grazing in the Kawich Valley, northwest of Nevada Test Site, belonging to Mr. Floyd Lamb of Alamo, Nevada, were exposed to fallout. No studies were undertaken at that time. (Ref: Files at AEC, LVB-Test Division, on Agricultural Research and Development, 7-1 Investigations of Damage to Lamb Cattle.)

3. In 1953 during the Upshot-Knothole Series cattle and horses owned by Mr. Dan Stewart, while grazing in the vicinity of Papoose Lake, east of the northern portion of Nevada Test Site, were exposed to fallout. Several cattle deaths were encountered but no cause of death was established. Beta burns were diagnosed on the horses. These horses were subsequently purchased by the AEC. A sample of the silt and salt deposits from Papoose Lake was shipped to UT-AEC, Oak Ridge, Tennessee, for toxicity feeding trials using sheep. No significant radioactivity above background was found in this soil. (Ref: Files at AEC, LVB-Test Division, on Agricultural Research and Development, 7-1 Investigations of Stewart animals and reports of the UT-AEC Agricultural Research Program, Oak Ridge, Tennessee concerning Stewart horses and cattle.)

4. In 1953 during and subsequent to the Upshot-Knothole Series numerous sheep losses were encountered by southern Utah and Nevada livestock raisers. Investigations by personnel from several organizations were undertaken to explain these losses including UT-AEC, Oak Ridge, Tennessee; LASL, Los Alamos, New Mexico; Hanford Operations, Richland, Washington; University of Nevada, Reno, Nevada; Utah State Agricultural College, Logan, Utah; and others. A claim was submitted by several of the ranchers to the U.S. Government to the effect that radiation from fallout was a contributing factor to the sheep losses. In September 1956 the case came to trial. The case was decided in favor of the U.S. Government. (Ref: Reports from the above-cited organizations concerning sheep losses in southern Utah and Nevada in 1953 and litigation "Bulloch vs. U.S. Government" on file with the U.S. Department of Justice, Salt Lake City, Utah, and with the legal departments of AEC, ALOO.)

5. In 1954 Mr. Floyd Lamb (referred to in Par. A-2 above) stated that steers which he sold during the fall of 1954 averaged 150 lbs. lighter than normal and wondered if the radiation from repeated fallout contamination might not be a factor. No studies were conducted on this matter. (Ref: Files AEC, LVB-Test Division, on Agricultural Research and Development, 7-1 Investigations of damage to Lamb cattle.)

6. In 1955 livestock losses encountered by ranchers in the vicinity of Black Lake, New Mexico, and near Adel, Oregon, were attributed to fall-out. Investigations of these reports were conducted by representatives of AEC and the claims were denied by the AEC. Tissue radioactivity levels were measured by UT-AEC and were considerably below the calculated maximum permissible levels for man as given in Handbook 52, U.S. Department of Commerce, National Bureau of Standards. (Ref: Files AEC, LVB-Test Division, on Agricultural Research

and Development, 7-1 Black Lake Incident and Hart Mountain Antelope Refuge Investigation.)

7. In 1955 one calf was autopsied approximately 24 hours after a test shot and tissue radioanalysis subsequently performed because this animal, one of approximately 100 head, had been exposed to the fallout, following Met shot, 16 miles south of Alamo, Nevada. The level of radiation that these cattle were exposed to was less than 170 mr/hr at H plus 12 hrs. The established radioactivity levels in the tissues analyzed were considerably below the maximum permissible levels for man as given in Handbook 52. (Ref: Files at UT-AEC Agricultural Research Program, Oak Ridge, Tennessee, title of report is unknown.)

8. In 1955 three lambs were purchased from W. E. Thompson at Beryl Junction, Utah, because they were in the Met fallout pattern. The radiation level in this location was less than 27 mr/hr at H plus 12 hrs. One animal was slaughtered and tissue was taken on April 16, 1955, for radioanalysis. On November 17, 1955, the second animal was slaughtered and tissue taken for radioanalysis. June 30, 1956, the third animal was reported to have died from natural causes and was unavailable for radioanalytical work. Tissue radioactivity levels established were below the maximum permissible levels for man per Handbook 52. (Ref: Files at UT-AEC Agricultural Research Program, Oak Ridge, Tennessee, title of report unknown and files at U.S.A.E.C., LVB-Test Division, on Agricultural Research and Development, 6-1 Animal Diseases, case #0-5-55.)

9. In 1955 three deer and one cow from within the Nevada Test Site were autopsied and tissues taken for radioanalysis. The radioactivity levels of all tissues analyzed were considerably below the maximum permissible levels for man per Handbook 52. However, the thyroid gland of one of these deer showed histological damage suggestive of excessive accumulation of radioiodine. (Ref: Files at U.S.A.E.C., LVB-Test Division, on Agricultural Research and Development, 6-1 Animal Diseases, case numbers C-1-55, B-2-55, and C-3-55.)"

The following paragraphs are taken from letter to C. L. Weaver, AEC Rad-Safe Officer, ALOO, from E. L. Johnson, Veterinarian, AEC Las Vegas Branch, Las Vegas, Nevada entitled "Effect of Radiation on Fauna Near Nevada Test Site" June 9, 1958

"Mr. Floyd R. Lamb of Alamo, Nevada, reported "beta burns" on his cattle ranging in Kawich Valley as a result of the 1952 test series. Kawich Valley is from 20-35 miles from the major firing areas at NTS. The exact number so affected is not known, but was probably some 20 head out of a herd of 150. I have seen three of these affected animals. The only grossly observable effects are small patches of whitish hair distributed over the back. One of these three animals has been slaughtered in the course of the Offsite Animal Investigation Project and skin was taken for histopathological study. No report has been received on this tissue. These animals showed no other discernible effects of radiation.

The Stewart Brothers of Alamo, Nevada, had cattle similarly affected as a result of the 1953 test series. These animals ranged in the Papoose Lake, Emigrant Valley, and Penoyer Valley Areas which are from 15 to 55 miles from the major firing areas at NTS. I have seen three of these animals. I believe all of these affected animals have subsequently been sold through the usual commercial channels. The exact number affected is not known.

The same Stewart Brothers referenced above also had 21 head of horses ranging in the Papoose Lake Area which is about 15 miles from the firing areas. From the 1953 test series, 14 of these horses were reported to have contracted serious "beta burns." Two of the horses were purchased outright for scientific studies. The Stewarts were given monetary compensation for the damage to the balance of the "beta burned" animals.

Also during the 1953 test series there were a number of sheep grazing to the north of the test site owned by sheepman in Southwestern Utah. Many sheep died after the bands arrived at their lambing grounds in Utah. A small number of animals died enroute from the grazing areas and numerous lesions and symptoms were reported as "different from anything seen before" by the sheepman and they concluded that the illnesses and deaths were a result of radiation. An intensive investigaiton followed and finally a suit was brought against the U.S. Government which was tried in Salt Lake City, Utah, in September and October of 1956. It was concluded that radiation from fallout was not a contributing factor in the illnesses or deaths of the sheep.

During the 1957 test series Mr. Floyd R. Lamb (referenced above) reported "beta burns" on a 3-year-old stallion which had been grazing in Kawich Valley. I examined the animal and reported that the lesions appeared consistent with beta lesions of the skin from atomic fallout* but the diagnosis was not substantiated histologically. The animal was purchased from Mr. Lamb by the Atomic Energy Commission."

*In a letter to Weaver dated June 23, 1958, Johnson added this sentence: "A biopsy has been requested of these lesions but no report has been received."

DIAGNOSIS FILE

(Taken from AIP history files compiled by
U.S. Army Veterinarian assigned to the AIP)

DIAGNOSIS: Deficiency of Iodine (potential)
LOCATION: Beatty, Nevada
ANIMALS AFFECTED: Any animals of the area
REMARKS: This area is designated as an iodine deficient area in the book "Physiology of Domestic Animals" by Dukes, Figure 163. Dr. John O'Harra has not noted any goiterous calves in this area. Most of the livestock raisers do not feed iodized salt.

DIAGNOSIS: Beta burns
LOCATION: Lamb Range, Kawich Valley, Nevada DATE: August 1952
ANIMALS AFFECTED: 102 beef cattle
INVESTIGATOR: Thompsett, Whipple, & White
ANALYSES: Radiation survey
REMARKS: Not recorded whether any claims were submitted or paid.

DIAGNOSIS: (see remarks)
LOCATION: Southern Utah and Nevada DATE: 1953
ANIMALS AFFECTED: Sheep
INVESTIGATOR: (see remarks)
REMARKS: Investigations by UT-AEC; Oak Ridge, TN; LASL, Los Alamos, NM; Hanford Operations, Richland, WA: University of Nevada, Reno, NV: Utah State Agricultural College, Logan, UT. Claims denied in "Bulloch versus U.S. Government."

DIAGNOSIS: Beta burns
LOCATION: Kawich Valley, Nevada DATE: 1953
ANIMALS AFFECTED: Approximately 100 head bovine
REMARKS: See AEC files at LVB concerning Floyd Lamb's cattle.

DIAGNOSIS: Anaplasmosis
LOCATION: Alamo, Nevada (Penoyer Valley) DATE: 17 Jul 53
ANIMALS AFFECTED: One bovine
REMARKS: Refr. Report, final, Losses of Livestock from Bugher to Pearson, dtd 17 Jul 53 in which one cow that was submitted for post mortem examination was found to be affected with Anaplasma marginale, indicating that it was a carrier. Found in animals belonging to Stewart Brothers, Las Vegas, Nev.

Animals had been grazing in Papoose Lake Area. (See AR&A 7-1, Investigation of Damage to Stewart Livestock)

DIAGNOSIS: Toxicity--perhaps oak poisoning or heavy metal
LOCATION: McKee Ranch, Colistera, NM DATE: Spring 1955
ANIMALS AFFECTED: Beef cattle
INVESTIGATORS: State and Federal Veterinarians.
REMARKS: Hematology & serology

DIAGNOSIS: Pneumoenteritis
LOCATION: Hurricane, Utah DATE: Sept 55
ANIMALS AFFECTED: Bovine, calf
REMARKS: Refr. Case No. D-5-56

DIAGNOSIS: Leptospirosis
LOCATION: Hurricane, Utah DATE: Approx. Dec 55
ANIMALS AFFECTED: Dairy cattle of this vicinity
REMARKS: Disease diagnosis by Dr. Palmer, DVM, USPHS Veterinarian who was doing some public health work in and around St. George, Utah. Out of a group of 80 dairy cows he picked at random 8 blood samples which he submitted to the laboratory at Logan, Utah for testing for Leptosirosis, 7 of which turned out to be positive, some up to a 1:1000 dilution. Local physicians and the State Veterinarian have been notified of these findings.

DIAGNOSIS: Vaginitis, granular
LOCATION: Las Vegas, Nevada LDS Welfare Farm DATE: Jan 56
ANIMALS AFFECTED: numerous animals affected, bovine
REMARKS: From the diagnostic file of the Veterinary Center Las Vegas, Nevada.

DIAGNOSIS: Pneumonia, fibrinous, bilateral
LOCATION: Las Vegas, Nevada DATE: 6 Jan 56
ANIMALS AFFECTED: One Desert Bighorn Sheep
REMARKS: Diagnosis made on basis of necropsy findings. See case No. OW-1-56.

DIAGNOSIS: Myopathy, nutritional
LOCATION: Desert Game Range, Las Vegas, Nevada DATE: 6 Jan 56
ANIMALS AFFECTED: Ovine, Bighorn
REMARKS: See Case OW-1-56

DIAGNOSIS: Karatitis, ocular, ulcerative
LOCATION: Ursine, Nevada DATE: 7 Jan 56
ANIMALS AFFECTED: Cervine
REMARKS: See Cases C-2-56 and C-3-56

DIAGNOSIS: Pneumonia, fibrinous
LOCATION: St. George, Utah DATE: 11 Jan 56
ANIMALS AFFECTED: One Holstein cow
REMARKS: Diagnosis made on basis of clinical symptoms. See Case No. B-4-56.

DIAGNOSIS: Bovine Asthma
LOCATION: Hurricane, Utah DATE: 11 Jan 56
ANIMALS AFFECTED: Beef cattle
REMARKS: Diagnosis made on the basis of history. See Case No. B-5-56.

DIAGNOSIS: Starvation, Exposure
LOCATION: Adel, Oregon (Hart Mtn. Antelop Refuge) DATE: 17 Feb 56
ANIMALS AFFECTED: Bovine, all ages, beef
REMARKS: Diagnosis established upon investigation involved in Case No. B-7-56.

DIAGNOSIS: Carcinoma, epithelial (ocular conjunctiva)
LOCATION: Caliente, Nev (Delamar Valley) DATE: 1 Mar 56
ANIMALS AFFECTED: Bovine, female, Hereford (3)
REMARKS: Diagnosis made on the clincial symptomatology seen in three mature cows of the University of Nevada test herd in the Delamar Valley. The cases were not far advanced. One case may be amenable to surgery. See Case B-4-55.

DIAGNOSIS: Lymphadenitis, caseous
LOCATION: Cedar City, Utah and all of southern Utah and adjacent areas of Nevada. DATE: 28 Mar 56
ANIMALS AFFECTED: Ovine, primarily seen in older ewes.
REMARKS: Dr. Wendell Brooksby of the Utah Extension Service, is of the opinion that this condition is the biggest sheep killer in the area. Organism found to be Corynebacterium pseudotuberculosis. See Case No. O-9-56.

DIAGNOSIS: Hemoglobinuria, Bacillary
LOCATION: Beaver, Utah, area surrounding DATE: 28 Mar 56
ANIMALS AFFECTED: Bovine, dairy and beef animals, number unknown
REMARKS: Condition noted and diagnosed by Dr. Don Thomas, Utah State Extension Veterinarian, he says that there is a lot of this in the Beaver area.

DIAGNOSIS: Leptospirosis
LOCATION: St. George, Utah and vicinity DATE 28 Mar 56
ANIMALS AFFECTED: Bovine, primarily seen in dairy animals.
REMARKS: Condition has been diagnosed by both Dr. Don Thomas, Utah Extension Veterinarian, and Dr. Jack Palmer, U.S. Public Health Service Veterinarian. Mr. Keith Hughes, County Agricultural Agent, is aware of the situation and it is hoped that a testing program will be initiated for the control of the condition.

DIAGNOSIS: Encephalomyelitis
LOCATION: St. George, Utah and "Arizona Strip" DATE: 28 Mar 56
ANIMALS AFFECTED: Ovine
REMARKS: Condition found by Dr. Brooksby. He has determined that the cause is a toxic element or plant. Does not seem to describe it in the literature. See Case No. O-9-56.

DIAGNOSIS: Blind Staggers
LOCATION: St. George, Utah DATE: 28 Mar 56
ANIMALS AFFECTED: Bovine, beef feeders
REMARKS: Case diagnosed by Mr. Hughes, County Agent, animals were on corn silage and perhaps some cane. Seven head were lost about a year ago. Actual cause undetermined.

DIAGNOSIS: Brucellosis Free Area
LOCATION: Cedar City, Utah area also Parowan, Utah and Beryl, Utah DATE: 28 Mar 56
ANIMALS AFFECTED: Bovine, both beef and dairy
REMARKS: These areas are considered by Mr. Wallace Sjoblom, Iron County Agricultural Agent, to be practically Brucellosis Free Areas, not officially so, however.

DIAGNOSIS: Anemia
LOCATION: St. George, Utah DATE: 28 Mar 56
ANIMALS AFFECTED: Bovine, beef primarily
REMARKS: Animals on salt bush and fescue pasture. All ages apparently affected. Case looked into by Utah State Agri. College but no definite diagnosis given. Young animals seem to be counteracting the condition by eating diet recomended by the USAG.

DIAGNOSIS: Selenium Poisoning Chronic
LOCATION: Beatty, Nevada, and surrounding area DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson and ASCS Agent Funk at Tonopah, Nevada. Mostly chronic cases. See several cases every year.

DIAGNOSIS: Poor breeders
LOCATION: Tonopah, Nevada (Nye and Esmeralda Counties) DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson. It is his opinion that the ultimate cause is malnutrition, for the calving percentage will take a definite rise when there is sufficient forage for the animals on the range.

DIAGNOSIS: Selenium Poisoning, chronic
LOCATION: Fish Lake Valley, (Esmeralda County) Nevada DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson and ASCS Agent Funk at Tonopah, Nevada. Mostly chronic cases. See several cases every year.

DIAGNOSIS: Selenium Poisoning, chronic
LOCATION: Ash Meadow, Nevada DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson and ASCS Agent Funk at Tonapah, Nevada. Mostly chronic cases. See several cases every year.

DIAGNOSIS: Big Head Photosensitization
LOCATION: Potts, Nevada area DATE: 5 Apr 56
ANIMALS AFFECTED: Ovine
REMARKS: Diagnosis per ASCS Agent Funk of Tonopah, Nev. Says several cases of this during the past winter.

DIAGNOSIS: Pink eye
LOCATION: Tonopah, Nevada (Nye and Esmeralda Cts) DATA: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson. Says that there is a considerable amount of this infection in the area.

DIAGNOSIS: Peritonitis
LOCATION: Tonopah, Nevada (Nye and Esmeralda Cts) DATE: 5 Apr 56
ANIMALS AFFECTED: Mature Bovine
REMARKS: Diagnosis per ASCS Funk of Tonopah, Nevada. Says he has seen a great many animals that died because of intestinal perforation from coarse spiny brush. A ramification of the malnutrition problem of this area.

DIAGNOSIS: Molybdenum Poisoning
LOCATION: Fish Valley (Esmeralda County Nevada) DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson and ASCS Agent Funk at Tonopah, Nevada. Mostly chronic cases. See several cases every year. Analysis of water from this area revealed from 5-11 ppm of Mo.

DIAGNOSIS: Molybdenum poisoning
LOCATION: Area around Beatty, Nevada DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson and ASCS Agent Funk at Tonopah, Nevada. Mostly chronic cases. See several cases every year.

DIAGNOSIS: Arsenic Poisoning
LOCATION: Tonopah, Nevada area DATE: 5 Apr 56
ANIMALS AFFECTED: Bovine
REMARKS: Diagnosis per County Agent Madson. "Arsenic from mine settling ponds because of 'Arsenic Process' from milling operations used to separate gold and silver."

DIAGNOSIS: Arsenic Poisoning
LOCATION: A potential hazard DATE: 6 Apr 56
ANIMALS AFFECTED: Cattle and sheep
REMARKS: LVB-AEC, Mining Engineer Nelson, "Many gold ores in this area occur with arsenous pyrite and consequently a test for arsenic can be gotten from many mine dumps."

DIAGNOSIS: Hydrocyanic Acid Poisoning
LOCATION: A potential hazard DATE: 6 Apr 56
ANIMALS AFFECTED: Bovine and ovine.
REMARKS: LVB-AEC Mining Engineer Nelson, "One of the milling procedures involves the use of sodium cyanide (water soluble) which during its use in the mill it is kept alkaline in reaction to prevent its escape as HCN gas which happens when the agent is allowed to become acid."

DIAGNOSIS: Starvation--birds were insect eaters and there had been a lengthy period of high winds; therefore, no flying insects.
LOCATION: Corn Creek Field Station, Las Vegas, NV DATE: May 1956
ANIMALS AFFECTED: Migrating birds (Western Tanager) and bat
INVESTIGATOR: Johnson
REMARKS: AW-11-56

DIAGNOSIS: Sterile, equine
LOCATION: Las Vegas, Nevada Ted Frehner DATE: 1 May 56
ANIMALS AFFECTED: One equine, mare
REMARKS: From the diagnostic file of the Veterinary Center, Las Vegs, Nevada

DIAGNOSIS: Molybdenum Poisoning
LOCATION: Hiko, Nevada DATE: 3 May 56
ANIMALS AFFECTED: Bovine
REMARKS: This condition mentioned by Dr. Russ (DVM) of the ARS, USDA at Caliente, Nevada on this date.

DIAGNOSIS: Molybdenum Poisoning
LOCATION: Las Vegas, Nevada (Craig Ranch, just north) DATE: 9 May 56
ANIMALS AFFECTED: Bovine
REMARKS: This condition mentioned by Mr. Hoff, County Agricultural Agent, Clark County. Mr. Hoff says that several cattle were lost by Mr. Craig about 3 years ago but since that time he has been selling his hay for equine consumption.

DIAGNOSIS: Diarrhea, nutritional
LOCATION: Las Vegas, Nevada Leonard Bennett DATE: 9 May 56
ANIMALS AFFECTED: 1 dairy cow
REMARKS: From diagnostic file of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Hemorrhage, gross internal. Fracture of left pubis, right pubis, right acetabulum.
LOCATION: Boulder City, Nevada DATE: 22 May 56
ANIMALS AFFECTED: Ovine, one mature female, bighorn
REMARKS: See Case No. OW-12-56

DIAGNOSIS: Intestinal perforation, bacteremia, toxemia
LOCATION: Caliente, Nevada DATE: 6 Jun 56
ANIMALS AFFECTED: Bovine, one, mature female
REMARKS: See Case No. B-4b-55.

DIAGNOSIS: Metritis, sanguinopurulent
LOCATION: Alamo, Nevada DATE: 6 Jun 56
ANIMALS AFFECTED: Bovine, one, mature female
REMARKS: See Case No. B-4a-55.

DIAGNOSIS: Carcinoma, epithelial, ocular
LOCATION: Fish Lake Valley, Nevada Circle L Ranch DATE: 11 Jun 56
ANIMALS AFFECTED: 2 bovine, herefords
REMARKS: From diagnostic file of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Distemper, equine
LOCATION: Las Vegas, Nevada James Cashman DATE: 13 Jun 56
ANIMALS AFFECTED: 2 equine
REMARKS: From diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Arsenic poisoning, malicious
LOCATION: Las Vegas, Nevada Jack White (NLV) DATE: Jul 56
ANIMALS AFFECTED: Several equine
REMARKS: Hear say that a couple of horse watering tanks on the south end of Mt. Charleston area were poisoned killing several head of horses. Water sample was submited to Mr. Ed Randall, University of Nevada, Reno for analysis.

DIAGNOSIS: Carcinoma, epithelial, ocular
LOCATION: Fish Lake Valley, Nevada Bar Double Nine Ranch DATE: 3 Jul 56
ANIMALS AFFECTED: 2 bovine, Herefords
REMARKS: From diagnostic file of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Myiasis (fly larvae infestation)
LOCATION: Fish Lake Valley, Nevada Circle L Ranch DATE: 3 Jul 56
ANIMALS AFFECTED: One equine
REMARKS: The tail of an Arabian mare was involved; from the diagnostic file of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Pink eye
LOCATION: Caliente, Nevada Emery Conaway DATE: 10 Jul 56
ANIMALS AFFECTED: 30-40% of herd both old and young animals. Variance of the infection in all stages from mild conjunctivitis to complete loss of the eye due to epithelial, bovine.
REMARKS: See Journal No. 2, 10 July 1956.

DIAGNOSIS: Fracture of atlanto-axial articulation
LOCATION: Las Vegas, Nevada DATE: 12 Jul 56
ANIMALS AFFECTED: Ovine, one, mature male, bighorn
REMARKS: See Case No. OW-10b-56.

DIAGNOSIS: Tick infestation, ears
LOCATION: Nipton, California Ted Bernhardt DATE: 13 Jul 56
ANIMALS AFFECTED: One equine
REMARKS: From diagnostic file of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Myiasis (grubs in back)
LOCATION: Searchlight, Nevada Ken Queen DATE: 23 Jul 56
ANIMALS AFFECTED: One equine
REMARKS: The diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Fracture, bilateral of pubii and ischii
LOCATION: St. George, Utah DATE: 23 Jul 56
ANIMALS AFFECTED: Bovine, one, mature female
REMARKS: See Case No. B-14-56.

DIAGNOSIS: Distemper, equine
LOCATION: Las Vegas, Nevada Lew Atkin DATE: 24 Jul 56
ANIMALS AFFECTED: 3 equine
REMARKS: From diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Vaginitis, granular
LOCATION: Clark County, Nevada DATE: Aug 56
ANIMALS AFFECTED: 30% of the dairy herds in Clark County are affected
REMARKS: From the diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Distemper, equine
LOCATION: Las Vegas, Nevada Vegas Stock Farm DATE: 1 Aug 56
ANIMALS AFFECTED: 50 head of equine
REMARKS: From the diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Laminitis, equine
LOCATION: Indian Springs, Nevada Gray DATE: 1 Aug 56
ANIMALS AFFECTED: One equine
REMARKS: Due to overfeeding of "Omaline." From the diagnostic file of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Distemper, equine
LOCATION: Searchlight, Nevada Carl Myers DATE: 6 Aug 56
ANIMALS AFFECTED: 2 equine
REMARKS: From the diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Distemper, equine
LOCATION: Las Vegas, Nevada Tommy Clemmens DATE: 8 Aug 56
ANIMALS AFFECTED: 2 equine
REMARKS: From the diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Distemper, equine
LOCATION: Clark County, Nevada DATE: 31 Aug 56
ANIMALS AFFECTED: equine
REMARKS: See much equine distemper in Clark County, 60% infection, especially in the summer, right after Helldorado Days. From the diagnostic files of the Veterinary Center, Las Vegas, Nevada.

DIAGNOSIS: Asphyxiation
LOCATION: Desert Game Range, Las Vegas, Nevada DATE: 8 Nov 56
ANIMALS AFFECTED: One ovine, wild, female
REMARKS: See Case No. OW-15-56.

DIAGNOSIS: None made--suspected parasitism
LOCATION: Boulder City, Nevada DATE: Nov 56
ANIMALS AFFECTED: Captive prairie falcon
INVESTIGATOR: Johnson
ANALYSES: Necropsy

REMARKS: Investigated at request of U.S. Fish & Wildlife Service.

DIAGNOSIS: Starvation
LOCATION: Caliente, Nevada (Delamar Valley) DATE: 4 Jan 57
ANIMALS AFFECTED: One bovine
REMARKS: Refr: Case No. B-1-57. Three other animals were dead at the nearby watering pond. Starvation was probably the predisposing cause of death, however, these animals were not examined.

DIAGNOSIS: Photosensitization
LOCATION: Hamlin Valley, Utah DATE: 22 Jan 57
ANIMALS AFFECTED: Ovine
REMARKS: A species of Cymopterus found in the vicinity of Hamlin Valley, Utah is described by Dr. Wendell Brooksby as causing a type of photosensitization in sheep. He uses the common name of Wild Carrot in describing the plant. Areas of sheep affected are the unwooled portions of the skin, namely the nose, lips, vulva, and teats. (Cymopterus basaltious (Jones) of western Utah - Clokey; Flora of the Charleston Mtns.)

DIAGNOSIS: Lymphomatosis, visceral
LOCATION: Mrs. Maichle, on Maichle Lane off Mesquite Road, Paradise Valley, Clark County, Las Vegas, Nevada. DATE: 24 Jan 57
ANIMALS AFFECTED: One chicken
REMARKS: Bird was a mature (est. 2 yrs) heavy hen. Not laying, very emaciated suffering from some diarrhea. Comb and wattles were quite cyanotic. Post mortem revealed extensive visceral lymphomatosis involving the reproductive and intestinal tract primarily.

DIAGNOSIS: Starvation
LOCATION: Caliente, Nevada DATE: 30 Mar 57
ANIMALS AFFECTED: Bovine, one
REMARKS: See Case No. B-2-57.

DIAGNOSIS: Tumor, soft tissue exostosis, bilateral
LOCATION: Warm Springs, Nevada (Fallini Ranch) DATE: 13 Jun 57
ANIMALS AFFECTED: One male canine
REMARKS: See Case No. c-4-57.

DIAGNOSIS: Dermatolomycosis (ringworm)
LOCATION: Bradshaw Ranch - Duckwater, Utah DATE: Jun 57
ANIMALS AFFECTED: Horses
INVESTIGATOR: Johnson
REMARKS: Skin scrapings.

DIAGNOSIS: Photosensitization from eating certain plants
LOCATION: Bishop Ranch, Mountain Air, New Mexico DATE: Jun 57
ANIMALS AFFECTED: Horses
INVESTIGATOR: Nordstrom & Sharp
REMARKS: Norstrom was Federal Veterinarian & Sharp State Veterinarian.

DIAGNOSIS: Enteritis, hemorrhagic
LOCATION: Alamo, Nevada DATE: 5 Jul 57
ANIMALS AFFECTED: One male calf, bovine
REMARKS: See Case No. D-6-57.

DIAGNOSIS: Beta burns
LOCATION: Alamo, Nevada DATE: 12 Jul 57
ANIMALS AFFECTED: Three female bovine
REMARKS: See Case No. B-9-57.

DIAGNOSIS: Pneumonia, bilateral
LOCATION: Las Vegas, Nevada (Desert Game Range) DATE: 17 Jul 57
ANIMALS AFFECTED: One female ovine, lamb, wild
REMARKS: See Case No. OW-8-57.

DIAGNOSIS: Pneumonia, bilateral, with hepatization and abscessation
LOCATION: Las Vegas, Nevada (Desert Game Range) DATE: 19 Jul 57
ANIMALS AFFECTED: One female ovine, wild
REMARKS: See Case No. OW-7-57.

DIAGNOSIS: Metritis, sanguino-purulent
LOCATION: Alamo, Nevada DATE: 19 Jul 57
ANIMALS AFFECTED: One female bovine
REMARKS: See Case No. B-10-57.

DIAGNOSIS: Anaplasmosis (suspect)
LOCATION: Hiko, Nevada DATE: 20 Jul 57
ANIMALS AFFECTED: One female bovine
REMARKS: See Case No. B-11-57.

DIAGNOSIS: Dermatomycosis
LOCATION: Duckwater, Nevada DATE: 22 Jul 57
ANIMALS AFFECTED: One male horse (cast) and one female
REMARKS: See Case No. E-5-57.

DIAGNOSIS: Beta burns
LOCATION: Hamich Valley, Nevada DATE: 22 Jul 57
ANIMALS AFFECTED: One male equine
REMARKS: See Case No. E-12-57.

DIAGNOSIS: Blue tongue
LOCATION: Hughes Ranch, Mesquite, Nevada DATE: Aug 57
ANIMALS AFFECTED: Sheep
INVESTIGATOR: Johnson
ANALYSES: Serology, histopathological
REMARKS: O-55.

DIAGNOSIS: Pneumonia--diagnosis made on description of lesions that was provided by owner
LOCATION: Otteson Ranch, Huntington, Utah DATE: Aug 57
ANIMALS AFFECTED: Sheep in spring of 1955
INVESTIGATOR: Johnson & Ingraham

ANALYSES: None
REMARKS: Claim had previously been denied (1955) by the AEC.

DIAGNOSIS: Infectious conjunctivitis
LOCATION: Falleni Ranch, Warm Spring, Nevada DATE: Sep 57
ANIMALS AFFECTED: Cow
INVESTIGATOR: Johnson, Rae, Williams & Brown
ANALYSES: None
REMARKS: Investigation in connection with Operation Plumbbob.

DIAGNOSIS: Beta burns
LOCATION: White Rock Spring, NTS DATE: Sep 57
ANIMALS AFFECTED: Horse
INVESTIGATOR: Johnson
ANALYSES: None
REMARKS: E-18-57. Horse signed over to K. Case by owner for compensation for catching and hauling from area.

DIAGNOSIS: Dermatophytosis (ringworm)
LOCATION: Buke Home, Whitney, Nevada DATE: Nov 57
ANIMALS AFFECTED: Horses
INVESTIGATOR: Johnson
ANALYSES: Skin scrapings
REMARKS: E-21-57.

DIAGNOSIS: Tetanus?
LOCATION: Stewart Ranch, Pioche, Nevada DATE: Aug 58
ANIMALS AFFECTED: Horse
INVESTIGATOR: Farmer & Johnson
ANALYSES: None
REMARKS: Horse died in 1957--diagnosis based on symptoms described by hired man.

DIAGNOSIS: Dogs--mammary tumor, internal parasites, cattle--infections keratitis (pink eye)
LOCATION: Clifford Ranch, Tonopah, Nevada DATA: Sep 58
ANIMALS AFFECTED: Dogs and cattle
INVESTIGATOR: Farmer
ANALYSES: Fecal analysis
REMARKS: Clifford expressed concerned about skin conditions of children during 1951 and 1953 and diabetes in 6-year-old daughter.

DIAGNOSIS: Molybdenum toxicity
LOCATION: Walch Ranch, Adaven, Nevada DATE: Dec 58
ANIMALS AFFECTED: Herford heifers
INVESTIGATOR: Farmer
ANALYSES: Histological.

DIAGNOSIS: Grass tetany
LOCATION: Delmue and Lytle Ranch, Pioche, Nevada DATE: Apr 59
ANIMALS AFFECTED: Cattle
INVESTIGATOR: Farmer

ANALYSES: None
REMARKS: In monthly activities report.

DIAGNOSIS: Grass tetany
LOCATION: Conoway Ranch, Pioche, Nevada DATE: Jun 59
ANIMALS AFFECTED: Cattle
INVESTIGATOR: Farmer
ANALYSES: None
REMARKS: In monthly activities report.

DIAGNOSIS: Vibrionic abortion or enzootic abortion
LOCATION: Bennet Ranch, Watauga, SD DATE: Jun 60
ANIMALS AFFECTED: Sheep
INVESTIGATOR: Farmer & Fountain
ANALYSES: Raidological surveys
REMARKS: Also investigated sheep died in winter and spring of 1959. Investigated by State and Federal Veterinarians.

DIAGNOSIS: Tumorous growth
LOCATION: Stewart Ranch, Alamo, Nevada DATE: Aug 61
ANIMALS AFFECTED: Cow
INVESTIGATOR: Fountain
ANALYSES: None
REMARKS: In monthly activities report.

DIAGNOSIS: Infectious keratitis
LOCATION: Fallini Ranch, Warm Springs, Nevada DATE: Jul 62
ANIMALS AFFECTED: Cattle
INVESTIGATOR: Fountain
ANALYSES: None
REMARKS: In monthly activities report.

DIAGNOSIS: Fungal dermatitis
LOCATION: North Las Vegas, Nevada DATE: Aug 64
ANIMALS AFFECTED: Ground squirrel
INVESTIGATOR: Brechbill and Smith
ANALYSES: Histopathology and clinical laboratory tests
REMARKS: Investigated at request of U.S. Bureau of Sport Fisheries and Wildlife.

DIAGNOSIS: Pneumonia, sinusitis, abscesses, and old age
LOCATION: Corn Creek, Nevada DATE: Sep 64
ANIMALS AFFECTED: Two desert bighorn sheep
INVESTIGATOR: Engel and Smith
ANALYSES: None
REMARKS: Investigated at request of U.S. Fish and Wildlife Service, Desert National Wildlife Ranch.

DIAGNOSIS: Fibrinous pleuritis and septicemia
LOCATION: Joshua Tree National Monument DATE: Oct 64
ANIMALS AFFECTED: Desert bighorn sheep
INVESTIGATOR: Engel

ANALYSES: Histopathologic, radiologic
REMARKS: Investigated at the request of Monument officials.

DIAGNOSIS: No definite--advanced decomposition of carcases precluded adequate necropsy.
LOCATION: Delamar Valley, Nevada DATE: Nov 1964
ANIMALS AFFECTED: Mule deer
INVESTIGATOR: Engel
ANALYSES: Gamma spectroscopy of tissues, botanical analyses of rumen contents and toxin analyses of water samples
REMARKS: Nevada Fish and Game requested assistance in investigating deer dieoff. History suggested "calf diptheria."

DIAGNOSIS: Parasitism and poor nutrition
LOCATION: Baxterville, Mississippi DATE: Nov 64
ANIMALS AFFECTED: Cows
INVESTIGATOR: Smith and Ross
ANALYSES: Hematological
REMARKS: Dr. Ross is a private practioner from Hattiesburg. Investigated at request of USPHS project officer.

DIAGNOSIS: None made as no information on symptoms or necropsy. Owner suspected ingestion of battery fragments.
LOCATION: Dribble Site, Mississippi DATE: Dec 64
ANIMALS AFFECTED: Three cows and one hog
INVESTIGATOR: Harvey and Smith
ANALYSES: Chemical analysis of battery
REMARKS: Only 1 gram of battery missing--insufficient toxins to cause death. Investigated at request of USPHS project officer.

DIAGNOSIS: Widely metastized hemangioendothelioma. Originated from liver.
LOCATION: Corn Creek, Nevada DATE: Jan 65
ANIMALS AFFECTED: Aged, penned bighorn sheep
INVESTIGATOR: Engel
ANALYSES: Histopathological
REMARKS: Investigated at request of Desert National Wildlife Range officials.

DIAGNOSIS: Hardware disease
LOCATION: Paradise Valley, Nevada DATE: May 65
ANIMALS AFFECTED: Bovine
INVESTIGATOR: Cannon and Brechbill
ANALYSES: Radiological
REMARKS: Necropsied by Dr. Cannon, Winnemucca, Nevada.

DIAGNOSIS: Pyometra and peritonitis
LOCATION: McCullough Mountains, Clark County, Nevada DATE: Sep 65
ANIMALS AFFECTED: Desert bighorn sheep
INVESTIGATOR: Engel
ANALYSES: Histopath and radiologic
REMARKS: Investigated at request of Nevada Fish and Game.

DIAGNOSIS: Cornybacterium pyogenes abscesses
LOCATION: Ruby Mountains and Delamar Range, Nevada DATE: Fall 65
ANIMALS AFFECTED: Mule deer
INVESTIGATOR: Smith
ANALYSES: Bacteriological and gamma spectroscopy
REMARKS: Hunter inquiries.

DIAGNOSIS: Bog spavin
LOCATION: Lida, Nevada DATE: 1965
ANIMALS AFFECTED: Horse
INVESTIGATOR: Smith and Fitzsimmons
ANALYSES:
REMARKS: Investigated at request of offsite monitors.

DIAGNOSIS: Trauma from fall
LOCATION: Cabeza Priete Game Range, California DATE: Apr 67
ANIMALS AFFECTED: Desert bighorn sheep
INVESTIGATOR: Hull
ANALYSES: Histopathological and radiological
REMARKS: Requested by refuge manager.

DIAGNOSIS: White spots on back of horse--possible causes pressure necrosis; chemical, beta, or thermal burns.
LOCATION: Hiko, Nevada DATE: Oct 65
ANIMALS AFFECTED: Horses
INVESTIGATOR: Smith and Kimmel
ANALYSES: Hematological, physical examination, skin scrapings
REMARKS: No definite diagnosis--owner more curious than concerned.

DIAGNOSIS: Infectious keratitis (pink eye)
LOCATION: Hiko, Nevada DATE: Oct 66
ANIMALS AFFECTED: Cattle
INVESTIGATOR: Smith and Kimmel
ANALYSES:
REMARKS: Same owner as horses (see above) appropriate treatment.

DIAGNOSIS: Drought--lack of moisture
LOCATION: Lower Virgin River DATE: Oct 66
ANIMALS AFFECTED: Vegetation die-off
INVESTIGATOR: Mason and Brechbill
ANALYSES: Radiological survey, soil profiles, and radiological analysis of soil.
REMARKS: Investigated

DIAGNOSIS: Gunshot
LOCATION: Little Pine Spring, McCullough Mountain, Clark County, Nevada DATE: Jan 66
ANIMALS AFFECTED: Collared peccary
INVESTIGATOR: Brechbill
ANALYSES: Necropsy only
REMARKS: Investigated at request of Nevada Fish and Game.

DIAGNOSIS: Normal
LOCATION: Nevada Test Site DATE: 69
ANIMALS AFFECTED: Two bats, fox, ringtail cats
INVESTIGATOR: Smith
ANALYSES: Laboratory tests
REMARKS: Negative for rabies.

DIAGNOSIS: Pruritis caused by ringworm and lice
LOCATION: Hot Creek Ranch, Nevada DATE: Spring 70
ANIMALS AFFECTED: Beef cattle
INVESTIGATOR: Smith
ANALYSES: Mycology cultures, histopathological and hematological
REMARKS: Potential claims investigation.

DIAGNOSIS: Halogeton poisoning (oxalate toxicity)
LOCATION: Garrison, Utah DATE: Jan 71
ANIMALS AFFECTED: Domestic sheep
INVESTIGATOR: Brown, Stanley, & Smith
ANALYSES: Botanical, histopathological, chemical, radiological
REMARKS: All other investigative agencies agreed on diagnosis.

DIAGNOSIS: Viral enteritis of undetermined origin
LOCATION: Ursine, Nevada DATE: Feb 71
ANIMALS AFFECTED: Rabbits, chickens, dogs, cats, cockatoos, canaries
INVESTIGATOR: Smith and Giles
ANALYSES: Bacterologic culturing of rabbits and chickens; hematological, chemical analyses of water; histopathological and radiological examination of rabbit and chicken tissue.
REMARKS: Diagnosis based on history, and negative analytical results.

DIAGNOSIS: Actinobacilosis
LOCATION: Nyala, Nevada DATE: Feb 71
ANIMALS AFFECTED: Cow
INVESTIGATOR: Smith and James
ANALYSES: None
REMARKS: Diagnosis based on clinical appearance.

DIAGNOSIS: Feline panleukopenia
LOCATION: Duckwater, Nevada DATE: Feb 71
ANIMALS AFFECTED: Cats
INVESTIGATOR: Smith and Giles
ANALYSES: None
REMARKS: Diagnosis based on history.

DIAGNOSIS: Enterotoxomia
LOCATION: Rachel, Nevada DATE: Jun 81
ANIMALS AFFECTED: Goat kid
INVESTIGATOR: Smith and James
ANALYSES: Radiological and histopathological
REMARKS: Diagnosis based on history and necropsy findings.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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16. ABSTRACT
This report summarizes the findings of the Animal Investigation Program from its initiation in 1957 to termination in 1981. The Program investigated the effects of nuclear testing at the Nevada Test Site on domestic and wild animals residing on, and in the vicinity of the Test Site. Claims of injury to animals were investigated and a routine program of collecting tissue samples were the principal activities.

Tissue samples collected were examined histopathologically and were analyzed for specific radionuclides. Analyses of tissue samples from the Nevada Test Site beef herd occurred semiannually over the entire 25-year period and several other beef herds were analyzed for up to 10-year periods. Other animals sampled for extended periods included mule deer and desert bighorn sheep.

The results of the claims investigations are reported as well as analyses for the radionuclides: tritium, strontium-90, iodine-131, cesium-137, and plutonium-239. Also, the results of certain special studies, e.g., in animals around other testing sites such as Mississippi, Colorado, etc., and for special purposes such as at the Rocky Flats Plant in Colorado, and for iodine-129 in thyroids from Nevada cattle are included. Most of the data are presented as trends over time. Calculation of hypothetical doses to man from ingestion of edible tissue are included.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

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