ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

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DISEASE AND PARASITE STUDIES

by

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Volume X
Annual Project Segment Report
Federal Aid in Wildlife Restoration
Project W-15-R-3 and W-17-1, Work Plan P

STUDY PLAN SEGMENT REPORT

FEDERAL AID IN WILDLIFE RESTORATION

STATE:	Alaska		
PROJECT NO.:	W-15-R-3 and W-17-1	TITLE:	Big Game Investigations
STUDY PLAN:	P	TITLE:	Disease and Parasite Investigations
JOB NOS.:	1	TITLE:	Caribou and Reindeer
	2	TITLE:	Sheep
	3	TITLE:	Alternate Host Species
	4	TITLE:	Radiological Survey
	5	TITLE:	Nutritional Physiology of Caribou and Moose

PERIOD COVERED: January 1, 1968 to December 31, 1968

OBJECTIVES

To determine the incidence and distribution of potential pathogens in Alaskan wildlife species and alternate or reservoir hosts.

To determine whenever possible or practical the extent that such organisms may contribute to mortality or lowered productivity or economic value of affected wildlife species.

To determine the extent that wildlife pathogens depreciate the value of game animals for use as food by humans or may be a threat to domestic animal industry.

To assist other agencies in determining the levels of Strontium-90, Cesium-137 and other radioactive fallout contaminants in Alaskan wildlife species and vegetation.

To develop useful techniques for biochemically evaluating the nutritional state of wild ungulates and the nutritional quality of their forage.

Job No. 1: Caribou and Reindeer

PROCEDURES

At the present time the primary effort in rangiferine disease studies is focused on the long term study of brucellosis in caribou. In this respect we are continuing our close cooperation with the Animal Disease Eradication Division, U.S. Department of Agriculture who are monitoring the disease in reindeer. In these studies the following specific procedures are emphasized.

1. Serological surveilance of brucellosis prevalence in major caribou herds particularly those in the Nelchina and Arctic areas.

2. Confirmation by isolation of suspected brucellar infections.

3. Serological studies on potential reservoir host species.

4. Aerial surveillance of the occurrence of animals displaying gross symptoms (i.e. limping, retention of afterbirth) of brucellosis during calving.

5. Surveillance from the ground of concentrations of animals during the spring and fall migrations through Anaktuvuk Pass in the Arctic to detect and collect specific animals for bacteriological and/or other studies.

6. Routine autopsies of animals taken for subsistence purposes by native or sport hunters or specifically for the purposes of various scientific studies (e.g. radiation studies, disease and parasite studies, etc.).

7. Examination of specimens submitted to our laboratory by the public.

8. Preparation of a definitive bibliography on the "Diseases, Parasites, and Disorders of Caribou and Reindeer."

9. Publication of data at suitable intervals.

FINDINGS

A. Serological Studies:

The data derived from our serological studies on several herds are summarized in Table 1. Again, brucellosis reactors were encountered only in the Arctic herd. This year 5.3 percent of 171 animals tested positive, while in 1967, 9.5 percent of 162 were positive. Whether the data reflect a true decline in reactors or sampling error is not known. I am inclined to believe that the latter may be the case.

Table 1. Prevalence of brucellosis serological reactors in several caribou herds in 1968.

Herd	Serological Reaction		
	Negative	Positive*	
	Number	Number	Percent
Arctic	162	9	5.3
Nelchina	16	---	---
Delta	29	---	---
Adak	2	---	---

* Titres of 1:20 or greater

B. Calving Ground Aerial Surveys:

The results of the Arctic calving groung surveys for 1966-68 are summarized for comparative purposes in Table 2. Again I am not inclined to view the somewhat higher percentage of animals showing placental retention in 1968 as being significantly different from the preceding years. The most significant feature of last year's observations is not summarized in Table 2. Because of the unusual distribution of animals on the calving grounds, it was possible to determine whether or not an affected cow had lost its calf. Thirty of the 52 cows (i.e. 58 percent) showing placental retention and/or hemorrhagic perineum had lost their calves a few days *post partum*. At the same time only 32 of the 1958 normal cows (i.e. 1.7 percent) observed were seen standing by dead calves. One cannot help but conclude that a highly significant calf mortality may be associated with the condition leading to placental retention, etc. No doubt the calf loss was aggravated by the relatively severe weather and comparatively extensive snow cover experienced in 1968.

There did not appear to be any significant change in the number of limpers (principally those animals affected by foot rot) in the Arctic in 1968. However, late in October, guides operating near Chignik on the Alaska Peninsula reported seeing severely crippled caribou more or less commonly since early in the hunting season. One severely affected bull was collected in the area by personnel doing moose surveys. Although the animal was in excellent condition otherwise, an infected hoof evidently resulted in a severe toxification and the animal displayed very lethargic behavior. Material from the affected hoof was put into field culture and Dr. Lawrence Miller, Arctic Health Research Center, eventually identified the causative organism as *Spherophorus necrophorus*, the common foot-rot organism. It seems probable that the small scale epizootic (about 1 percent affected animals) on the Alaska Peninsula may have involved a particularly virulent strain of the necrobacillus. This would account for the severe affect on an animal in otherwise excellent condition.

Table 2. Prevalence of various abnormal animals in the Arctic calving herd, 1966-68.

Year	Condition	Sample Size	Number	Percent
1966	Placental retention and/or hemorrhagic perineum	20581	34	1.6
1967	" "	28321	16	0.45
1968	" "	20101	52	2.6
1966	Limpers	2058 plus2	14	0.7
1967	"	2832 plus	14	0.5
1968	"	2010 plus	7	0.3

1 Includes only animals with calves or showing the condition.

2 Includes all animals examined for placental retention plus hundreds(?) of others.

C. Studies on Migratory Concentrations: Anaktuvuk Pass.

During the spring movement north through Anaktuvuk Pass we had an opportunity to closely examine 36 caribou. Only the usual, common parasites (i.e. warbles, nose bots, cysticerci, etc.) were seen. Unlike the previous fall when about 10,000 animals went by the village, only occasional scattered bands moved through the pass while I was there. This was the first time I failed to have any opportunity to do any autopsies.

D. Bibliographic Studies and Publications:

Work on the bibliography of the "Diseases, Parasites and Disorders" of caribou and reindeer was continued. Through the diligence of my current assistant, Miss Clarice Dukeminier, the bibliography now includes between 600-700 entries. Most of the additions to the "first compilation" prepared in 1967 involved older Eurasian material. No other potential publications involving Rangifer spp. were prepared in 1968. A paper, "The Diseases and Parasites of Alaskan Wildlife Populations, Part I. Some Observations on Brucellosis in Caribou," was published in "The Bulletin of the Wildlife Disease Association," April 1968, Vol. 4, pp. 27-36.

A joint publication with Dr. Ronald O. Skoog on the parasites of caribou is in preparation.

Job No. 2: Sheep

PROCEDURES

Studies on the diseases and parasites of sheep will be carried out and published jointly with members of the sheep work plan. The procedures we will employ may be summarized as follows:

1. The primary emphasis of our studies will be focused on several study areas now being selected.

2. All animals collected for studies on reproduction, population dynamics, nutrition, etc. will be routinely autopsied in the field. Some organ systems or other selected materials will be brought into the laboratory for closer inspection in those instances where an adequate examination cannot be accomplished under field conditions.

3. Specimens from hunter-killed sheep will be handled as they come in on a volunteer basis or solicited from the public whenever situations arise which require large numbers of samples (e.g. jaws).

4. Fresh fecal pellet samples will be collected on the study areas at intervals in order to follow changes in intensities of parasitic infections. These will also be collected in other areas as time allows.

5. Routine bacteriological, parasitological, etc. methods will be employed in the laboratory to evaluate specimens that come to hand. Selected material will be referred to specialists for histo-pathology.

6. A definitive bibliography on the parasites, diseases and disorders of wild sheep will be prepared and kept up to date.

7. Significant research accomplishments will be published at irregular intervals.

FINDINGS

Only a very limited amount of work on sheep diseases and parasites was accomplished during the preceding year. Arrangements were made with members of the sheep study group to collect and autopsy several sheep during late November. However, because of bad weather only one animal was collected. This specimen, an adult ram, upon gross examination appeared to harbor only a light infestation of lungworm. Analysis of fecal pellets from this animal revealed, however, that trichostrongylid nematode parasites were also present, but undetected in the digestive tract. Fecal pellets from four hunter-killed rams from Rainy Pass, Alaska Range, also contained the same elongately, oval eggs of a trichostrongylid nematode.

Through the diligence of my current temporary assistant a bibliography of the "Diseases, Parasites, and Disorders of Wild Sheep" doubled in size. This bibliography, initiated at the request of the members of the first meeting of the Northern Sheep Research Council, will be presented to the Council at the second meeting in March 1969.

Job No. 3: Alternate Host Species

PROCEDURES

Field collections of host species will be conducted largely in conjunction with other investigations. Members of all divisions of the Department, as well as the public and other state or federal organizations, have been requested to send in suspected pathological specimens or in certain instances to obtain material of special interest. Such material will be handled in our laboratory, or in some cases referred to other specialists for diagnosis. At the present time special emphasis is being placed on the following host species:

1. Moose

The success of the long-term, penned-moose nutritional studies on the Kenai Peninsula will, in part, depend on an adequate knowledge of the levels of parasitism in the experimental animals. Because preliminary state-wide studies already clearly demonstrate several differences in kinds and/or numbers of parasites in moose in different areas, one can only conclude that the moose pen area may also exhibit its own peculiarities in this regard.

Because moose are probably the most sought-after species and are of great importance to all subsistence hunters, we will continue to get a variety of material from hunters and during specific life history studies by our moose work plan biologists.

2. Bison

The frequent close association between bison and domestic animals in the Big Delta farming area is one of the few instances in Alaska in which wildlife may be a potential source of diseases for domestic animals. Accordingly, it is important that whenever bison are available for examination (e.g. controlled hunts, road kills, transplants, etc.) that appropriate studies (e.g. autopsy, collection of blood samples, etc.) be made.

3. Blacktail Deer

In the Southeast Alaska and Prince William Sound areas blacktail deer are an important big game species for both sporting and subsistance purposes. For this reason we are continuing our studies on this species, in progress since 1960, but only on a limited basis. We still know relatively little about the parasites and diseases of the blacktail in many areas of the state (e.g. Kodiak, the extreme southern or western parts of Southeast Alaska).

4. Carnivores

At present we are soliciting carcasses of wolves, coyotes and wolverine taken in Southeast Alaska. There is no published data on the parasites of these predatory species in that area. However, they (wolves and coyotes?) are involved in the transmission of parasites to blacktail deer and in one instance (i.e. Echinococcus) also a human parasite. These studies were initiated in 1960 and will be continued until adequate sampling has been accomplished.

In conjunction with the lynx life history study we have undertaken to study the levels of parasitism in this species in central Alaska from one population high to another. Relatively little is known about the parasites of lynx anywhere. We have an unusual opportunity to get quantitative as well as qualitative information.

Sled dogs, though not a wild species, nevertheless in many cases exist under semi-wild conditions. For example, in many places they commonly are fed uncooked parts of game animals which are the normal prey of wolves. Accordingly, it is possible to obtain some insight into the question of whether wolves suffer infectious diseases transmitted to them from their prey species by studying the diseases of sled dogs which are fed uncooked game. There is added interest when such diseases are also transmissable to man.

5. Marine Mammals

Many native Alaskans subsist to a large extent on marine mammals. Some marine species are also important furbearers or trophy animals. Since 1960 we have engaged in casual investigations on the parasites of a variety of marine mammals from Alaskan waters. We have also cooperated with other agencies engaged in biological studies on these species in Alaskan or other waters.

6. Miscellaneous host species

All species of fish and game which are prey species for various predators harbor parasites peculiar to themselves, but also the intermediate stages of parasites which mature in the predators which feed on them. In some instances these intermediate (larval) stages are of greater importance to man or beast than are those parasites peculiar only to prey species. For example, the larval stages of various tapeworms which mature in fish-eating birds or fish, may render desirable food species of fish unfit for human consumption. Some of these may occasionally infect man when partly cooked fish are eaten as is the habit of some native or non-native groups. Most, if not all, of our small game or sportsfish species may be involved in these detracting host-parasite relationships. Many of the inquiries we get from the public regarding the palatability of presumably infected wildlife involve these host species. We will continue to deal with this kind of material on a casual, time-available basis.

Much of the material to be covered in a pamphlet on the "Common Diseases and Parasites of Fish and Game" now being prepared for general distribution will involve parasites of various sportsfish and small game commonly encountered by sportsmen.

FINDINGS

During the past year data were obtained on parasites and suspected disease conditions in 393 miscellaneous specimens of mammals, birds and fishes. Much of the material was derived from organized studies (e.g. lynx, moose, deer, Southeast carnivore studies) while many of the specimens were brought in by hunters or came to hand unexpectedly.

Individual species or groups of species of special interest are discussed above in the procedural section of this job report. Observations of particular interest for these species (groups) are individually discussed below.

1. Moose

A. Hydatid Cysts. A particularly heavy infection of hydatid cysts (i.e. larvae of *Echinococcus granulosus*) was seen in a bull taken last fall near Mt. Fairplay on the Fortymile highway. Both lungs were parasitized by cysts about the size of large walnuts. There appeared to be about as much parasite tissue as host tissue. In spite of the obvious intensity of the infection, the animal was in prime condition. A similar case of hydatidosis was seen in a cow with calf taken during the first antlerless hunt in the Matanuska Valley. In this instance both the cow and calf were judged to be in fine condition. This lends further support to the hypothesis that uncomplicated infection of the lungs by hydatid cysts does not represent a pathological condition in moose of any appreciable influence on the animal's condition or apparent well-being under normal conditions. Perhaps a heavily parasitized animal, such as those described, would be less able to perform strenuously for a prolonged period of time due to impairment of expansion and restricted ventilation of the lungs. This would make the animal more susceptible to predation and less able to successfully engage in rutting strife with other bulls or other stressful situations. It seems very unlikely that the light hydatid infections seen in most instances (98 percent) in moose, caribou, or other ungulate hosts are of any real significance to their well-being.

B. Brucellosis testing. Over 100 moose serum samples were referred this year to the U. S. Department of Agriculture Laboratory at Palmer for brucellosis testing, all with negative results. Antlerless hunts and tagging operations in the Anchorage-Matanuska Valley area yielded 85 specimens. Eighteen additional specimens were obtained from kills on the Kenai Peninsula and two from kills in the Nelchina Basin.

Only one bonafide brucellosis infection has ever been encountered in Alaskan moose in over 300 sera tested to date. This was in a road-killed animal found several years ago along the Seward Highway only a few miles from the pen in which experimental brucellosis infections in reindeer were being carried out by the Arctic Health Research Center (Neiland et al. Bull. Wildl. Dis. Ass., Vol. 4, pp. 27-36). Since the closest known wild source of infection was the Nelchina caribou herd located over one hundred air-miles from the kill site, it seems unlikely that the infection was naturally acquired. While accidentally-lost infective material from the reindeer pen is probably the most likely source of infection, one cannot rule out infected domestic animals as a potential source of infection. The Matanuska Valley, where much dairy farming goes on, is well within the range moose may be expected to occasionally wander. This has been demonstrated by departmental moose tagging studies. Even though the dairy animals are subject to continual brucellosis testing by state and federal veterinarians, the procedures they use do not always reveal all infected animals. In the "south 48" they are repeatedly confronted by so-called "problem herds" in which individual reservoirs of infection are finally detected only by more sophisticated testing procedures unsuitable for routine use on a large scale. Infected dairy cows have been unexpectedly found in Alaska in the past decade. Just prior to the first antlerless moose hunt in the Matanuska Valley in 1960, the Department was contacted by the state veterinarian regarding collecting moose blood samples for brucellosis testing. This was prompted by the detection of a brucellosis test reactor in a local dairy herd. All moose tested, then and now, were negative.

More recently I helped the federal veterinarian test a family milk cow in the Delta-Clearwater area. This animal had been classified a year or two earlier by the previous federal veterinarian as a "test-suspect." On the later occasion the animal gave a strong, positive reaction indicative of a currently active infection. The animal was sent to slaughter. Tests on about one hundred blood samples from the bison herd which wander through the Delta-Clearwater farm area have not yet yielded any evidence of brucellosis in this herd, and there have been no suspicious gross symptoms.

These two test reactors are examples of cases of the disease very likely either imported into the State or acquired from other domestic stock.

All of the available evidence indicates that you cannot necessarily expect to detect 100 percent of the brucellosis infections present in domestic animals by using only the routine agglutination testing procedure employed throughout much of the world. How this procedural fact may affect the control of the disease in Alaskan reindeer and the management of Alaskan caribou remains to be seen. We are at present engaged in a comparative study of different brucellosis testing procedures as applied to caribou. This is being carried out in cooperation with Dr. Lois M. Jones, Department of Veterinary Science, University of Wisconsin, a leader in brucellosis technology.

2. Bison

Ten bison were taken during a controlled hunt this past fall. The lungs from each animal were brought into the laboratory for examination. None proved to be infected with lungworms or showed any signs of other disease. Lungworms have been found in up to two-thirds of the animals taken in previous hunts.

A cow with a severe limp first observed last summer was again as she crossed the highway with a herd. She appeared to still be in otherwise good condition.

3. Blacktail Deer

Examination of blacktail deer from the islands of Prince William Sound by Mr. Loyal Johnson of our Cordova office reveals that a small trichostrongylid roundworm is a common parasite of deer in that area. None of the infections have appeared to be heavy enough to result in significant harm to the animal. Quite recently we have found the same, though yet unidentified, worm in two deer taken on Whale Island near Kodiak.

During the past several years we have had occasion to see or to receive reports from hunters about a pneumonic condition in deer. Thus far, cases have come to our attention only in the Petersburg area. This past fall several examples were reported while I was in that area on vacation. I had a chance to examine two, otherwise normal bucks in good condition both of which showed massive abscesses in the thoracic cavity involving principally the lungs. In both instances the abscesses were heavily encapsulated suggesting that the infections were of comparatively long duration. A similar, though less advanced, case was reported from a yearling doe from the Petersburg area in our report for 1967. In all instances the comparatively good condition and reportedly normal behavior of the animals was in sharp contrast with the seemingly severe appearance of the lesions. Because of the apparent long-term character of the lesions, one is led to speculate that the infections were acquired during the period of late winter-early spring when the animals are likely in poorest condition. In this respect it will not prove surprising if we eventually find this condition to be most common in bucks. Bucks normally pass through the winter in poorer condition than does and are therefore more vulnerable during the period when heavy snowpacks may severely restrict the useable range. At that time transmission of disease from one animal to another is favored by the crowding imposed by the range-restricting snow depths.

The true extent and affect of the disease on the deer population is at present unknown. However, it appears that the infection may have been more common this past year than the previous one. In the event that transmission of the disease is particularly sensitive to the nutritional condition of the potential host, it may have a natural predilection for bucks in the spring. In this event overall population density might not be too adversely affected, although "buck hunters" might be less successful. We will attempt to isolate and identify the causative organism during the coming hunting season.

4. Carnivores

Seventy-five sets of lynx digestive tracts were examined during the past year as part of our continuing study of the parasites of this host species from one population high to another. We continue to find two species of tapeworms and three species of roundworms more or less commonly. The results will be published in detail at the end of the study.

Thirty-three sets of organs from wolves taken in southeastern Alaska were examined during the past year. Wolves are commonly infected with three species of tapeworms in mainland Alaska and those from Southeastern are no exception. One species, Echinococcus granulosus, is a minor potential medical problem in that dogs may become infected by eating deer lungs in which the infective larval stage is found. The adult stage which then develops in the dog's gut produces eggs which will infect deer or other ungulates, and also man, with another generation of the larval stage. The two other species of canine tapeworms found in wolves do not directly affect man other than rendering the infected edible parts (i.e. meat, liver) less aesthetically pleasing. Many livers are no doubt discarded each year.

5. Marine Mammals

During the past year the only work done on marine mammals was the final preparation of a paper on five new species of air-sinus flukes from delphinid porpoises. Of particular interest is the fact that none of this material from hosts from the eastern Pacific is conspecific with the four other known species of Nasitrema all from oriental delphinids. The paper is first in a series dealing with flukes and Acanthocephala to be prepared in cooperation with Mr. Dale Rice, Marine Mammal Biologist U. S. Fish and Wildlife Service, who collected much of the material.

Job No. 4: Radiological Survey

PROCEDURES

Samples of muscle and rumen contents from five adult caribou are taken twice a year from each of three Alaskan caribou herds. About March 15 and October 15 collections are made from the Arctic, Nelchina, and Alaska Peninsula caribou herds. Samples of lichen and sedge are gathered at established collecting stations in each area when the fall caribou samples are taken. These are all forwarded to the Environmental Radiation Section, U. S. Public Health Service, Las Vegas, Nevada, for quantitative analyses of radioactive fallout contaminants and interpretation of the resultant data.

FINDINGS

The most recent report from the U. S. Public Health Service, summarizing data on Alaskan caribou and reindeer, is included below in toto. The overall results of the surveillance project indicates that at the present time, radioactive contamination of caribou flesh is slowly declining.

Radioactivity in Alaskan Caribou and Reindeer Samples

This report transmits a summary of data collected from the Bureau of Radiological Health (formerly National Center for Radiological Health) environmental surveillance program in Alaska. Most of the samples were collected by or in cooperation with the State of Alaska Department of Fish and Game, and the Bureau of Indian Affairs, Department of the Interior.

Annual reports have been submitted in recent years which present all data collected since the beginning of the program. This report presents the data collected since the last report issued on October 10, 1967. Included in this report are the following:

A. Table summarizing cesium-137 and strontium-90 concentrations in caribou and reindeer muscle, rumen, and bone samples from fall 1967 through spring 1968. One exception is a bone sample collected from the Kotzebue reindeer herd (R-1) in August 1965. This sample was inadvertently omitted in previous reports.

B. Tables providing detailed information concerning concentrations of radioactivity in individual samples of muscle, bone, and rumen content from the caribou and reindeer herds. Special samples of lichen and sedge collected in 1966 and 1967 are included in a separate table.

C. A map of Alaska which shows the approximate grazing locations of the caribou and reindeer herds which are currently being sampled. The codes correspond to those in the tables.

D. Graphs of the average concentration of cesium-137 in muscle samples from three caribou and three reindeer herds as a function of time. All data collected since the beginning of the program are included for these selected herds. Points on the graphs are connected by lines, but these lines may not reflect the true concentrations of cesium-137 during the periods between sampling times.

For the present program, samples are taken in the spring and fall from selected caribou and reindeer herds. Samples of muscle and rumen contents of five animals from each herd are collected during the sampling period. Hock joint bones from five animals are collected only from the Nome herd during the fall collection period. Muscle samples are analyzed individually and rumen content samples from each herd are composited before analysis for cesium-137 by gamma-ray spectroscopy. Muscle and bone samples from the individual herds are composited before analysis of strontium-89 and strontium-90. All samples are analyzed at the Public Health Service's Southwestern Radiological Health Laboratory in Las Vegas, Nevada.

The detection limit for cesium-137 varies with the sample size, the concentration of other radionuclides present in the sample, and other factors. No single detection limit can be given for this radionuclide. The minimum detectable limits for strontium-89 and strontium-90 are 5 pCi/kg and 2 pCi/kg respectively.

The reported concentrations are not directly related to daily radionuclide intake since it is necessary to obtain ancillary information on the amount of meat consumed in the diet and the relative role of other foods in the diet. Caribou and reindeer samples were selected since this type of food seems to constitute a large percentage of the diet of certain natives in isolated villages of Alaska.

In FRC Report No. 7, Section 4.9, the Federal Radiation Council states the following on the Alaskan situation:

> "Although the Federal Radiation Council did not set a specific RPG for cesium-137, in either Report No. 1 or No. 2, it did state in the Memorandum for the President (Federal Register, September 26, 1961): 'The characteristics of cesium-137 lead to direct comparisons with whole body exposure for which recommendations by the Council have already been made.' This implies that the RPG would be 0.5 rem in a year to the whole body of individuals in the general population when the doses can be measured directly, or an average of 0.17 rem to a suitable sample of the population group, when direct measurement is not practicable. Therefore, an annual average body burden in adults of 3,000 nanocuries and 1,000 nanocuries would be estimated to result in these respective doses. The body burdens of cesium-137 in the groups of interest are being measured directly. If a comparison with the guidance provided by the FRC is to be made, the applicable RPG is 0.5 rad per year and the corresponding annual average body burden is 3,000 nanocuries of cesium-137 in adults."

Assuming a steady state condition and the assumptions made by the Advisory Committee from the Division of Medical Sciences, National Academy of Sciencel, a continuous daily intake level of 21,000 picocuries of cesium -137 corresponds to a body burden of 3,000 nanocuries of cesium-137. The average consumption of caribou meat by natives who depend on this meat as a main portion of their diet is approximately 0.8 kilograms/day [2, 3]. Consequently continuous consumption of meat with a cesium-137 concentration of approximately 26,000 picocuries per kilogram would be expected to lead to an average body burden of 3,000 nanocuries of cesium-137 in adults. As shown in the attached graphs, the cesium-137 concentrations of caribou and reindeer meat vary seasonally, reaching a maximum in the spring. The highest average cesium-137 concentration in the individual herds during this period (fall 1967 and spring 1968) was 18,200 pCi/kg wet weight. This value corresponds to 70% of the concentration in meat which if consumed at a rate of 0.8 kg/day over a year is estimated to result in an average cesium-137 body burden of 3,000 nCi. The latest reported study of body burdens in Alaska[4] indicates no individual exceeded the FRC guide of 3,000 nanocuries.

The results reported here will continue to be published in Radiological Health Data and Reports, a monthly publication of the Department of Health, Education and Welfare.

In general, the average cesium-137 concentrations in caribou and reindeer have followed previous seasonal variations. Although the range of values for each herd is too great to make a meaningful analysis, these data do indicate a general trend downward during the period covered by this report.

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Summary Table of Radionuclide Concentrations
in Caribou and Reindeer Muscle Samples

Sampling dates	Number of samples	^{89}Sr[a,b]	^{90}Sr[a]	Concentrations in pCi/kg wet weight ^{137}Cs		
				Average	Minimum	Maximum
Caribou						
Arctic Herd (C-1)						
October 1967	5	0	33	5,900	4,800	8,100
April 1968	5	0	32	14,600	5,400	21,000
Nelchina Herd (C-2)						
September 1967	5	0	10	5,800	2,900	9,900
May 1968	4	0	26	9,900	8,300	12,000
Peninsula Herd (C-3)						
October 1967	5	35	66	11,200	6,600	14,600
March 1968	5	0	13	18,000	9,100	25,000
Reindeer						
Shishmaref Herd (R-4)						
October 1967	5	0	53	10,600	8,500	13,500
April 1968	5	0	5	15,400	13,000	17,000
Nunivak I. Herd (R-8)						
August 1967	5	16	18	3,500	3,000	3,900
April 1968	5	0	9	18,200	13,000	22,000
Nome Herd (R-10)						
September 1967	6	93	177	14,200	9,000	25,800
May 1968	5	25	820	16,000	10,000	20,000

[a] Samples composited before analysis.

[b] All results $\leq$ 5 pCi/kg wet weight are reported as 0.

Summary Table of Radionuclide Concentrations

in Caribou and Reindeer Rumen Content Samples

Herd and sampling locations	Collection Date	Number of Samples	Rumen (pCi/kg wet wt. ^{137}Cs[a]
Arctic caribou herd	October		
Anaktuvak Pass, C-1	October 67	5	4,800
	April 68	5	5,900
Nelchina caribou herd			
Dickey Lake, C-2	September 67	5	6,200
	May 68	4	5,100
Peninsula caribou herd			
King Salmon, C-3	October 67	5	8,100
	March 68	5	1,100
Shishmaref reindeer herd			
Seward Peninsula, R-4	October 67	5	4,600
	April 68	5	3,100
Nunivak Island reindeer			
herd, R-8	August 67	5	1,700
	April 68	5	7,100
Nome reindeer herd, R-10			
	September 67	6	9,400
	May 68	5	11,000

[a]Samples composited bevore analysis.

Summary Table of Radionuclide Concentrations

in Caribou and Reindeer Bone Samples

Herd and sampling locations	Collection date	Number of samples	Bone (pCi/g ash)	
			^{89}Sr[ab]	^{90}Sr[a]
Kotzebue reindeer herd R-1	August 1965	5	0[b]	211
Nunivak Island reindeer R-8	April 1968	5	10 (1000)[c]	150 (24,000)[c]
Nome reindeer herd R-10	September 1967	6	48 (17,000)[c]	110 (40,000)[c]
	May 1968	5	35 (10,000)[c]	150 (42,000)[c]

[a] Samples composited before analysis.

[b] All results $\leq$ 5 pCi/g ash are reported as 0.

[c] Values in parentheses are reported as pCi/kg wet weight.

Department of Health, Education, and Welfare
Environmental Control Administration - National Center for Radiological Health

Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Caribou Muscle

Herd: Arctic (C-1)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides ^{137}Cs (pCi/kg)	^{89}Sr [ab] (pCi/kg)	^{90}Sr [a] (pCi/kg)
.80	10/14/67	Anaktuvak Pass	F	5	5,000		
.81	10/16/67	" "	M	9	6,500		
.82	10/16/67	" "	M	2	8,100	0	33
.83	10/16/67	" "	F	9	4,900		
.84	10/16/67	" "	F	4	4,800		
erage					5,860	0	33
191	4/25/68	Anaktuvak Pass	F	9	21,000		
192	4/25/68	" "	F	10	9,500		
193	4/25/68	" "	F	Calf	18,000	0	32
194	4/25/68	" "	F	9	5,400		
195	4/25/68	" "	M	2	19,000		
erage					14,520	0	32

[a]Samples composited before analysis.

[b]All results $\leq$ 5 pCi/kg wet weight are reported as 0.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Caribou Muscle

Herd: Nelchina (C-2)

mple mber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					^{137}Cs (pCi/kg)	^{89}Sr[ab] (pCi/kg)	^{90}Sr[a] (pCi/kg)
170	9/16/67		F	Calf	9,900		
171	9/16/67		F	3	2,900		
172	9/16/67		F	4	3,400	0	10
173	9/20/67		F	9	5,300		
174	9/20/67		F	Calf	7,400		
erage					5,780	0	10
195	5/9/68		M	5	11,000		
196	5/9/68		M	9	12,000	0	26
197	5/9/68		F	5	8,300		
198	5/9/68		M	4	8,300		
erage					9,900	0	26

[a]Samples composited before analysis.

[b]All results ≤ 5 pCi/kg wet weight are reported as 0.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Caribou Muscle

Herd: Peninsula (C-3)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					^{137}Cs (pCi/kg)	$^{89}Sr^{ab}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
175	10/4/67		F	2	10,200		
176	10/4/67		F	2	14,600		
177	10/4/67		M	4	11,700	35	66
178	10/4/67		M	3	6,600		
179	10/4/67		F	Calf	13,000		
erage					11,220	35	66
185	3/16/68		F	3	22,000		
186	3/16/68		F	4	17,000		
187	3/16/68		F	9	9,100	0	13
188	3/16/68		F	Calf	25,000		
189	3/16/68		F	5	17,000		
verage					18,020	0	13

[a] Samples composited before analysis.

[b] All results $\leq$ 5 pCi/kg wet weight are reported as 0.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Muscle

Herd: Shishmaref (R-4)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					^{137}Cs (pCi/kg)	$^{89}Sr^{ab}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
-001	10/31/67	Cape Espenberg	M	5	11,000		
-002	10/31/67	" "	M	4	13,500		
-003	10/31/67	" "	M	4	11,000	0	53
-004	10/31/67	" "	M	4	8,900		
-005	10/31/67	" "	M	4	8,500		
verage					10,580	0	53
-001	4/20/68	Cape Espenberg	M	5	17,000		
-002	4/20/68	" "	M	4	17,000		
-003	4/20/68	" "	M	4	13,000	0	5
-C04	4/20/68	" "	M	3	17,000		
-005	4/20/68	" "	M	3	13,000		
verage					15,400	0	5

[a] Samples composited before analysis.

[b] All results ≤ 5 pCi/kg wet weight are reported as 0.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Muscle

Herd: Nunivak Island (R-8)

le er	Collection Date	Location	Sex	Age (yrs.)	Radionuclides ^{137}Cs (pCi/kg)	^{89}Sr[ab] (pCi/kg)	^{90}Sr[a] (pCi/kg)
-001	8/24/67	Nunivak Island	F	3	3,700		
-002	8/24/67	" "	M	2	3,000		
-003	8/24/67	" "	F	2	3,900	16	18
-004	8/24/67	" "	F	3	3,000		
-005	8/24/67	" "	F	2	3,900		
verage					3,500	16	18
-001	4/5/68	Nunivak Island	F	2	17,000		
-002	4/5/68	" "	M	5	13,000		
-003	4/5/68	" "	F	5	22,000	0	9
-004	4/5/68	" "	M	4	20,000		
-005	4/5/68	" "	F	5	19,000		
verage					18,200	0	9

[a]Samples composited before analysis.

[b]All results ≤ 5 pCi/kg wet weight are reported as 0.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Muscle

Herd: Nome (R-10)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides ^{137}Cs (pCi/kg)	$^{89}Sr^{a}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
579	8/31/67	Nome	F	---	13,900		
729	9/1/67	"	F	---	13,500		
314	9/1/67	"	F	2	11,700	93	177
359	9/1/67	"	F	---	25,800		
291	8/31/67	"	F	---	9,000		
463	8/31/67	"	F	---	11,000		
erage					14,150	93	177
507	5/1/68	Nome	M	5	19,000		
1470	5/4/68	"	M	2	10,000		
1396	5/5/68	"	M	2	20,000	25	820
---	5/5/68	"	M	5	14,000		
---	5/4/68	"	F	4	17,000		
rerage					16,000	25	820

Dash - indicates not reported.

[a]Samples composited before analysis.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Caribou Rumen Content

Herd: Arctic (C-1)

ple nber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					$^{137}Cs^{a}$ (pCi/kg)	$^{89}Sr^{a}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
R-180	10/14/67	Anaktuvak Pass	F	5			
R-181	10/16/67	" "	M	9			
R-182	10/16/67	" "	M	2	4,800	NA	NA
R-183	10/16/67	" "	F	9			
R-184	10/16/67	" "	F	4			
R-190	4/25/68	Anaktuvak Pass	F	9			
R-191	4/25/68	" "	F	10			
R-192	4/25/68	" "	F	Calf	5,900	NA	NA
R-193	4/25/68	" "	F	9			
R-194	4/25/68	" "	M	2			

[a]Samples composited before analysis.

NA - no analysis

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Caribou Rumen Content

Herd: Nelchina (C-2)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					$^{137}Cs^{a}$ (pCi/kg)	$^{89}Sr^{a}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
-170	9/16/67	Nelchina	F	Calf			
-171	9/16/67	"	F	3			
-172	9/16/67	"	F	4	6,200	NA	NA
-173	9/20/67	"	F	9			
-174	9/20/67	"	F	Calf			
-195	5/9/68	Nelchina	M	5			
-196	5/9/68	"	M	9	5,100	NA	NA
-197	5/9/68	"	F	5			
-198	5/9/68	"	M	4			

[a] Samples composited before analysis.

NA - no analysis

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Caribou Rumen Content

Herd: Peninsula (C-3)

mple mber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					$^{137}Cs^{a}$ (pCi/kg)	$^{89}Sr^{a}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
-175	10/4/67		F	2			
-176	10/4/67		F	2			
-177	10/4/67		M	4	8,100	NA	NA
-178	10/4/67		M	3			
-179	10/4/67		F	Calf			
-185	3/16/68		F	3			
-186	3/16/68		F	4			
-187	3/16/68		F	9	1,100	NA	NA
-188	3/16/68		F	Calf			
-189	3/16/68		F	5			

[a]Samples composited before analysis.

NA - no analysis

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Rumen Content

Herd: Shishmaref (R-4)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides $^{137}Cs^{a}$ (pCi/kg)	$^{89}Sr^{a}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
1	10/31/67	Cape Espenberg	M	5			
2	10/31/67	" "	M	4			
3	10/31/67	" "	M	4	4,600	NA	NA
4	10/31/67	" "	M	4			
5	10/31/67	" "	M	4			
1	4/20/68	Cape Espenberg	M	5			
2	4/20/68	" "	M	4			
3	4/20/68	" "	M	4	3,100	NA	NA
4	4/20/68	" "	M	3			
5	4/20/68	" "	M	3			

[a] Samples composited before analysis.
NA - no analysis

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Rumen Content

Herd: Nunivak Island (R-3)

mple mber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides $^{137}Cs^{a}$ (pCi/kg)	Radionuclides $^{89}Sr^{a}$ (pCi/kg)	Radionuclides $^{90}Sr^{a}$ (pCi/kg)
R-1	8/24/67	Nunivak Island	F	3			
R-2	8/24/67	" "	M	2			
R-3	8/24/67	" "	F	2	1,700	NA	NA
R-4	8/24/67	" "	F	3			
R-5	8/24/67	" "	F	2			
R-1	4/5/68	Nunivak Island	F	2			
R-2	4/5/68	" "	M	5			
R-3	4/5/68	" "	F	5	7,100	NA	NA
R-4	4/5/68	" "	M	4			
R-5	4/5/68	" "	F	5			

[a] Samples composited before analysis.

NA - no analysis

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Rumen Content

Herd: Nome (R-10)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					$^{137}Cs^{a}$ (pCi/kg)	$^{89}Sr^{a}$ (pCi/kg)	$^{90}Sr^{a}$ (pCi/kg)
579	8/31/67	Nome	F	---			
729	9/1/67	"	F	---			
314	9/1/67	"	F	---	9,400	850	1,400
359	9/1/67	"	F	2			
291	8/31/67	"	F	---			
463	8/31/67	"	F	---			
507	5/1/68	Nome	M	5			
1470	5/4/68	"	M	2			
1396	5/5/68	"	M	2	11,000	170	7,800
	5/5/68	"	M	5			
	5/4/68	"	F	4			

Dash - indicates not reported.

[a]Samples composited before analysis.

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Bone

Herd: Kotzebue (R-1)

Sample Number	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					^{137}Cs (pCi/kg)	^{89}Sr[a] (pCi/kg)	^{90}Sr (pCi/kg)
-------	8/31/65	Kotzebue	--	--		0	229
-------	8/31/65	"	--	--		0	246
-------	8/31/65	"	--	--	NA	0	254
-------	8/31/65	"	--	--		0	160
-------	8/26/65	"	--	--		0	165
					NA	0	211

NA - no analysis

Dash - indicates no data reported.

[a]All results _ 5 pCi/g ash reported as 0.

Table 1. Femur marrow fat content of caribou taken at Anaktuvuk Pass, April, 1968

Sample #	Sex	Age	Hind Foot Length (cm)	Heart Girth (cm)	Visual Index	Whole Weight (Kg)	Moisture, %	Fat, %	Non-fat Residue, %
A-53124	M	3	57.0	109.0	81	1	71.9	23.7	4.4
A-53128	M	3	56.0	117.0	83	1	75.9	17.4	6.7
A-53130	M	4-5	57.0	124.0	--	1	80.4	13.7	5.9
A-53137	M	3	54.0	118.0	--	1	87.8	5.6	6.6
A-53138	M	4	57.0	118.0	85	1	88.4	6.4	5.2
A-53113	M	6-9	57.0	128.0	89	2	59.0	36.8	4.2
A-53117	M	6-9	57.0	126.0	100	2	52.5	45.6	2.0
A-53121	M	2	55.0	119.0	88	2	51.2	44.3	4.5
A-53123	M	2	56.0	112.0	73	2	66.0	28.8	5.2
A-53140	M	2	58.0	108.0	79	2	47.1	49.7	3.2
A-53106	M	2	56.0	114.5	79	3	22.8	74.4	2.8
A-53122	M	1	55.0	101.0	59	3	42.2	53.8	4.0
A-53125	M	4	55.0	127.0	87	3	42.2	54.9	2.9

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Bone

Herd: Nunivak Island (R-8)

mple mber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides		
					^{137}Cs (pCi/kg)	^{89}Sr[a] (pCi/kg)	^{90}Sr[a] (pCi/kg)
-001	4/5/68	Nunivak Island	F	2			
-002	4/5/68	" "	M	5			
-003	4/5/68	" "	F	5	NA	10 (1,000)[b]	150 (24,000)[b]
-004	4/5/68	" "	M	4			
-005	4/5/68	" "	F	5			

[a]Samples composited before analysis.

[b]Values in parentheses are reported as pCi/kg wet weight.

Table 1. Femur marrow fat content of caribou taken at Anaktuvuk Pass, April, 1968

Sample #	Sex	Age	Hind Foot Length (cm)	Heart Girth (cm)	Visual Index	Whole Weight (Kg)	Moisture, %	Fat, %	Non-fat Residue, %
A-53136	F	3-4	52.0	110.5	---	1-	88.2	3.1	8.7
A-53135	F	4	54.0	113.0	---	1	74.7	20.5	4.8
A-53126	F	6-9	52.5	107.0	70	1	90.8	3.6	5.6
A-53127	F	6-9	49.5	107.0	64	2	70.8	24.3	4.9
A-53132	F	4	54.0	115.0	---	2	46.7	48.8	4.5
A-53139	F	3	52.0	107.0	70	2	51.0	44.5	4.5
A-53111	F	6-9	53.5	117.0	76	2	47.8	51.0	1.2
A-53102	F	6-9	53.5	117.0	80	3	38.4	58.9	3.7
A-53105	F	6-9	54.5	117.0	73	3	76.6	19.5	3.9
A-53114	F	5	56.0	114.5	75	3	41.7	54.6	3.7
A-53131	F	6-9	53.0	110.0	---	3	43.0	53.7	3.3
A-53107	F	4	54.5	117.0	---	4	10.5	87.6	1.9
A-53108	F	3	56.0	119.5	80	4	23.1	73.4	3.5
A-53109	F	3	53.5	109.0	65	4	18.3	79.3	2.4
A-53110	F	3	53.5	112.0	78	4	21.8	76.0	2.3
A-53129	F	5	55.0	109.0	---	4	27.7	69.4	2.9
A-53118	F	4	53.5	133.0	85	4+	21.2	76.6	2.3
A-53115	M	3	52.0	127.0	77	1	82.8	11.5	5.7
A-53116	M	4	54.5	114.5	75	1	86.1	7.4	6.5
A-53119	M	4	56.6	120.0	82	1	87.7	7.3	5.0
A-53120	M	2-3	56.0	117.0	85	1	88.3	5.9	5.8

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Table of Laboratory Analytical Results
Alaskan Caribou and Reindeer Sampling Program

Sample Type: Reindeer Bone

Herd: Nome (R-10)

ple ber	Collection Date	Location	Sex	Age (yrs.)	Radionuclides ^{137}Cs (pCi/kg)	^{89}Sr[a] (pCi/kg)	^{90}Sr[a] (pCi/kg)
859	9/1/67	Nome	F	2			
814	9/1/67	"	F	---			
729	9/1/67	"	F	---	NA	48 (17,000)[b]	110 (40,000)[b]
579	8/31/67	"	F	---			
291	8/31/67	"	F	---			
463	8/31/67	"	F	---			
507	5/1/68	Nome	M	5			
---	5/1/68	"	M	5			
1396	5/1/68	"	M	2	NA	35 (10,000)[b]	150 (42,000)[b]
---	5/1/68	"	M	4			
1470	5/1/68	"	M	2			

[a]Samples composited before analysis.

[b]Values in parenthesis are reported as pCi/kg wet weight.

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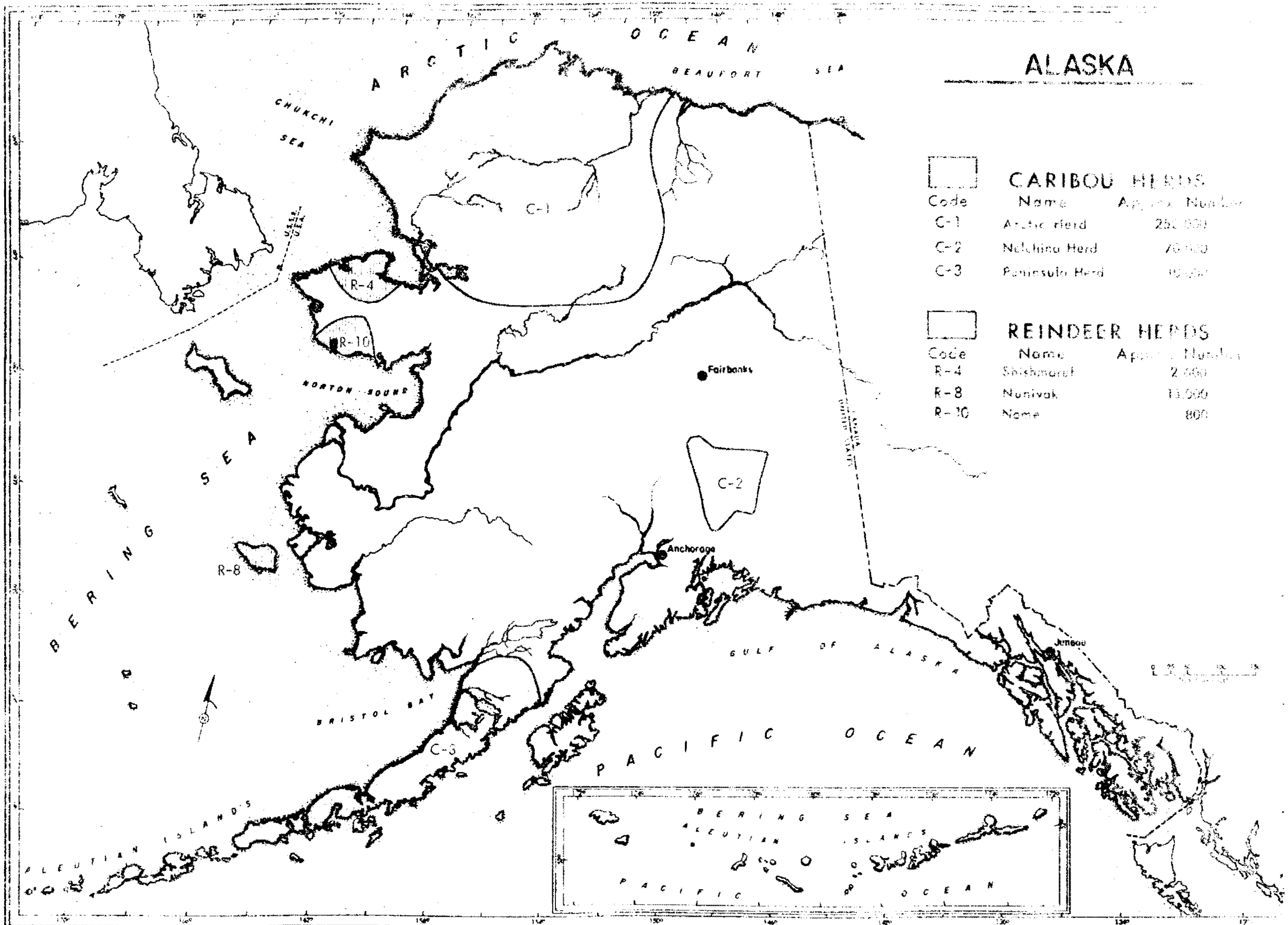
Table of Laboratory Analytical Results
Alaska Caribou and Reindeer Sampling Program
Special Samples

Sample Number	Sample Type	Location	Collection Date	Radionuclides (pCi/kg wet weight)		
				^{137}Cs	^{89}Sr[a]	^{90}Sr
GV-7	Lichen	Nelchina	9/28/66	11,000	9,200	3,200
GV-8	Sedge	Nelchina	9/28/66	7,300	4,800	2,200
GV-9	Lichen	Peninsula	11/1/66	7,700	0	2,500
GV-10	Lichen	Anaktuvuk Pass	10/12/66	14,000	0	4,500
GV-11	Sedge	Anaktuvuk Pass	10/12/66	3,000	770	2,900
0-12	Lichen	Nelchina	9/18/67	12,000	517	3,300
0-13	Sedge	Nelchina	9/18/67	1,400	1,100	4,700
0-14	Lichen	Peninsula	10/ 7/67	6,500	730	3,200
0-15	Sedge	Peninsula	10/ 7/67	1,200	430	1,300
0-16	Sedge	Anaktuvuk Pass	10/27/67	2,800	0	3,400
0-17	Sedge	Anaktuvuk Pass	10/27/67	1,300	70	580

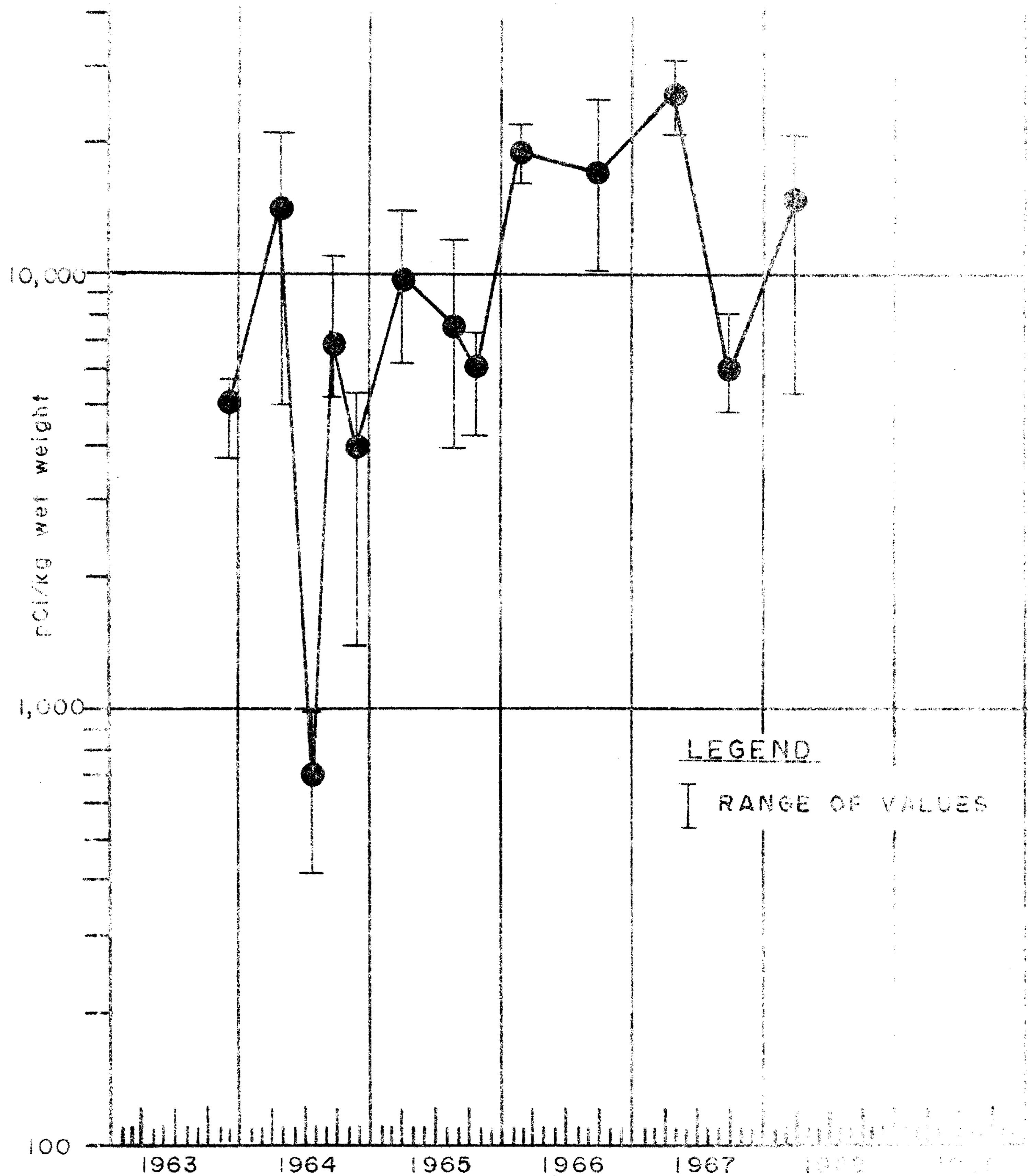
[a] All results $\leq$ 5 pCi/kg wet weight as reported as 0.

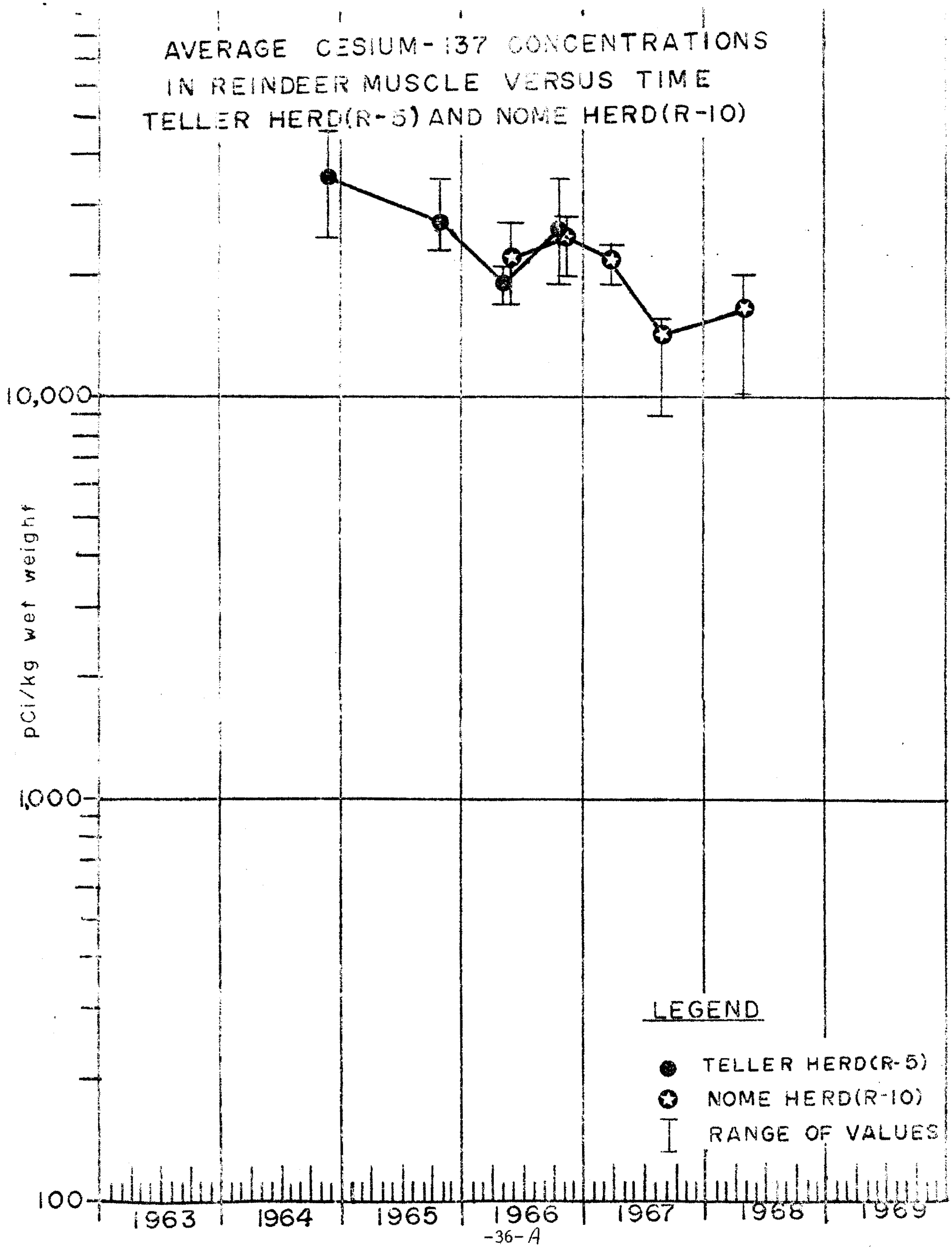


Locations of caribou and reindeer herds sampled in Alaska

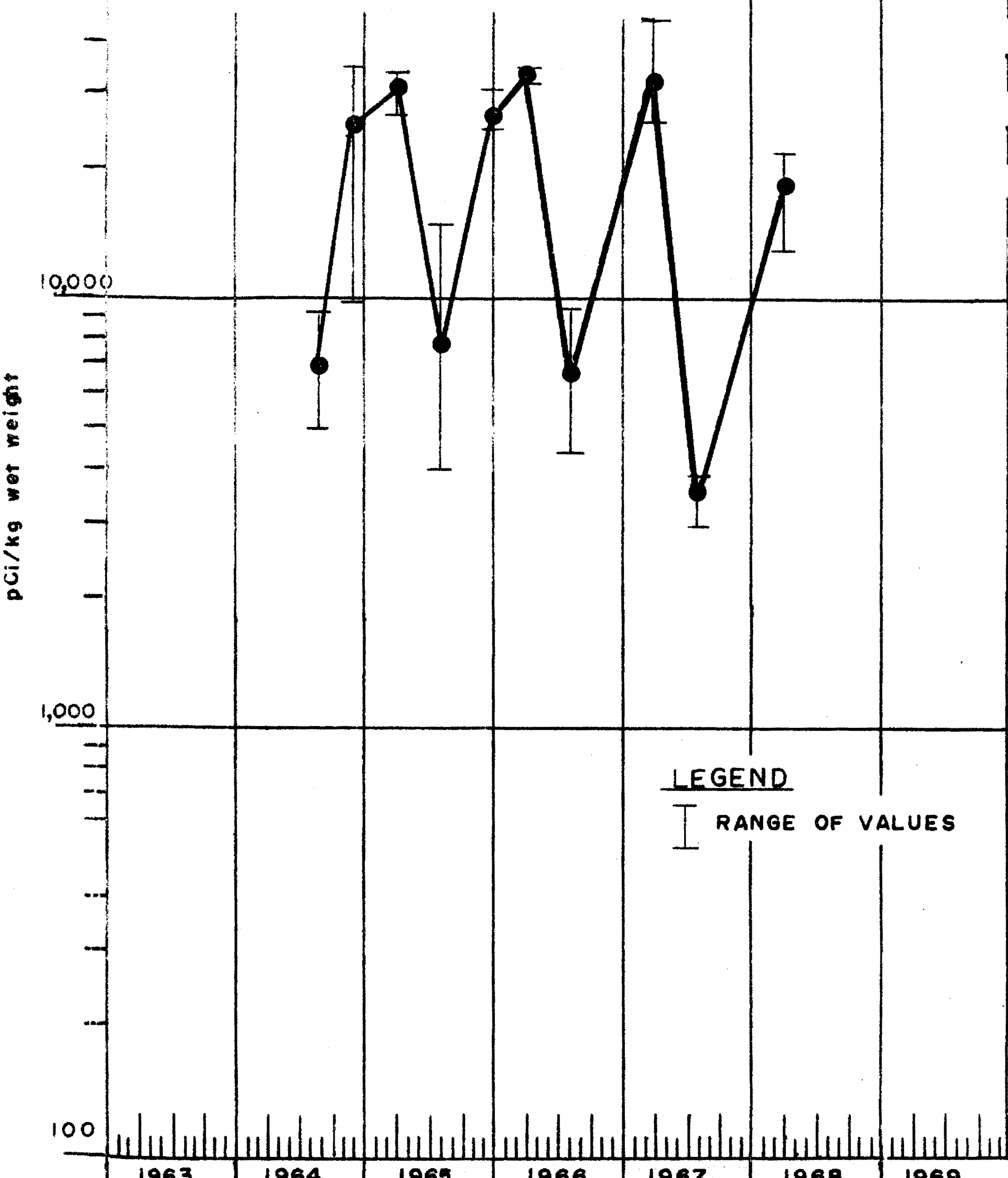
AVERAGE CESIUM-137 CONCENTRATIONS IN CARIBOU MUSCLE VERSUS TIME

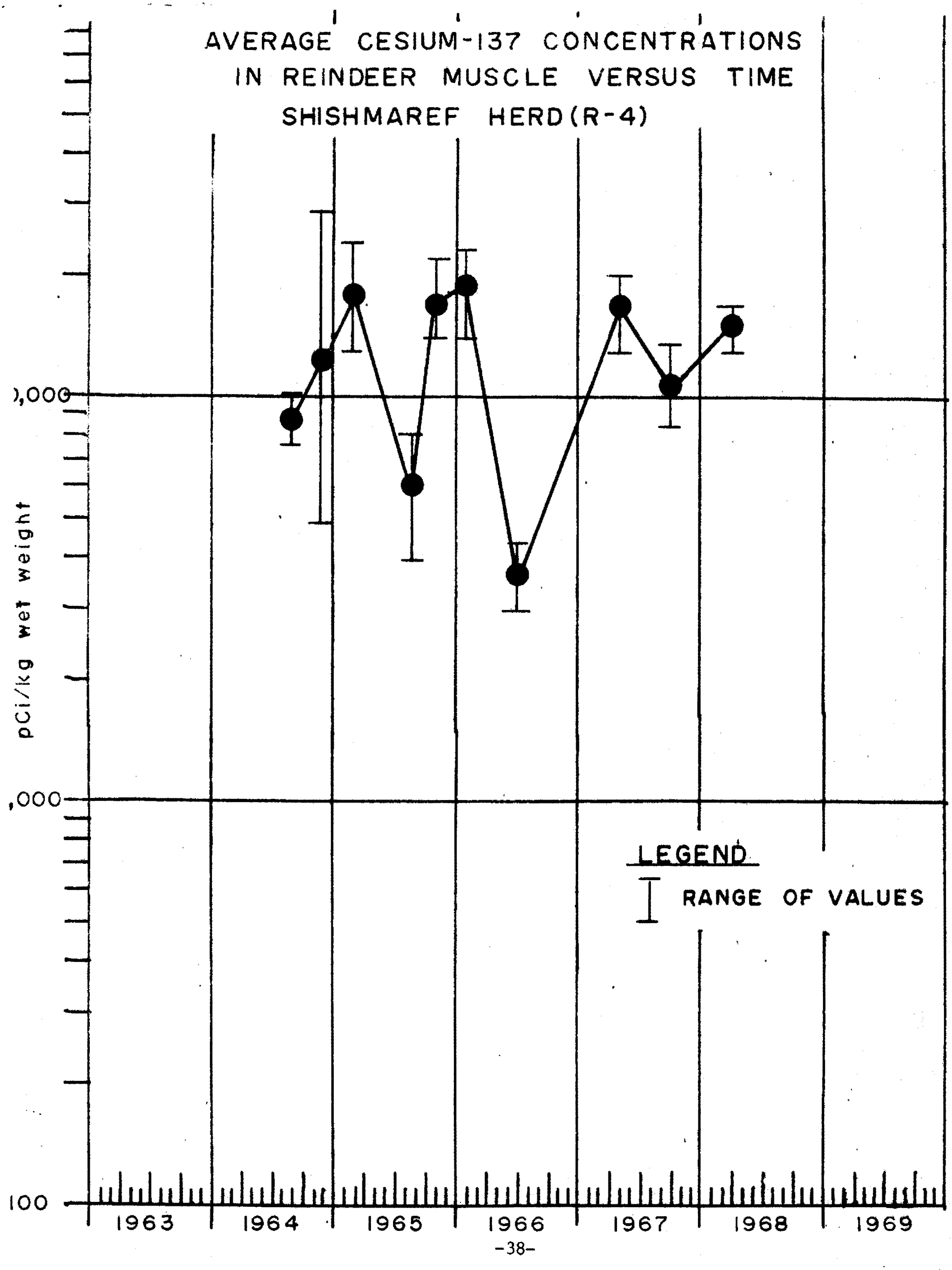
ARCTIC HERD (C-1)

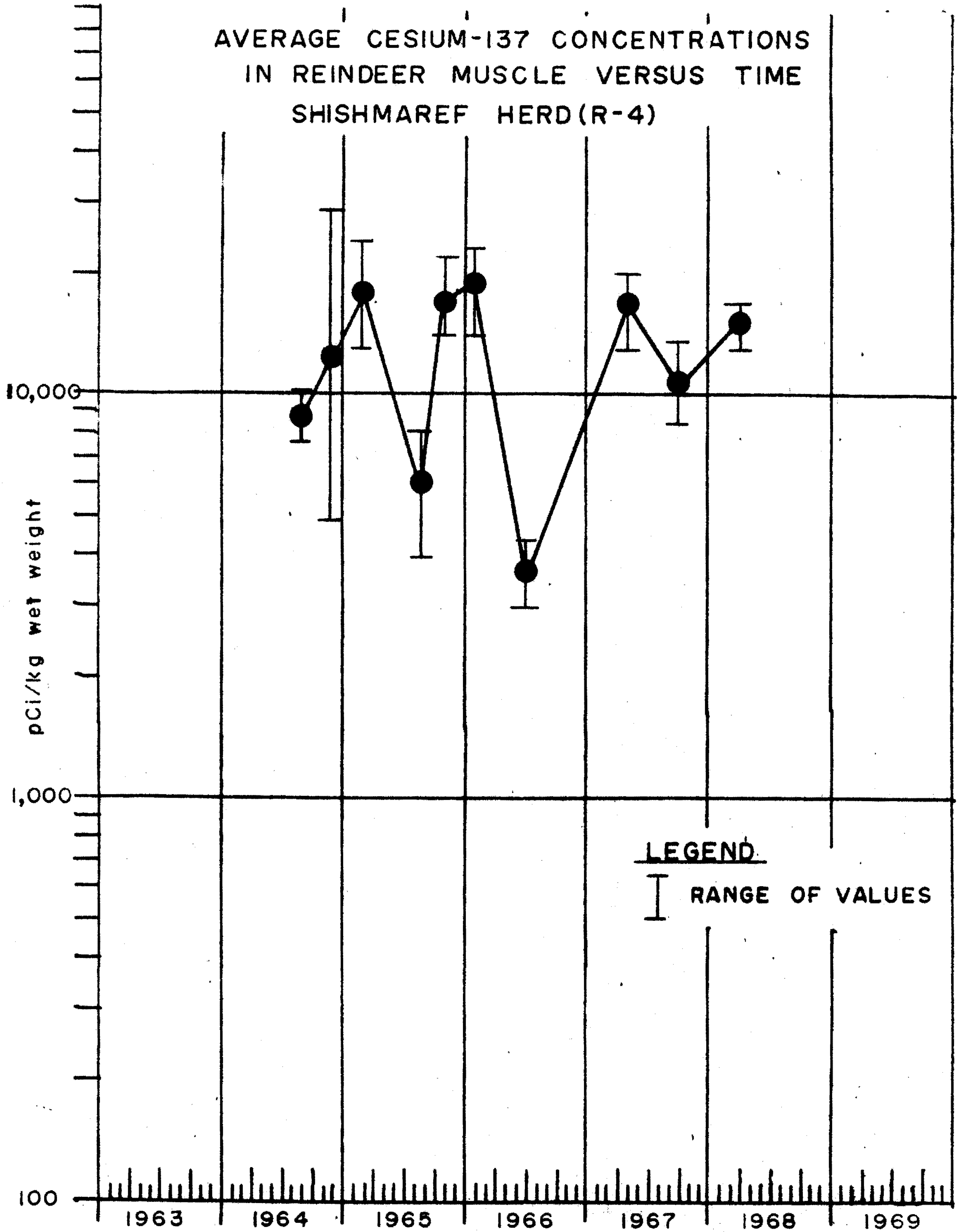


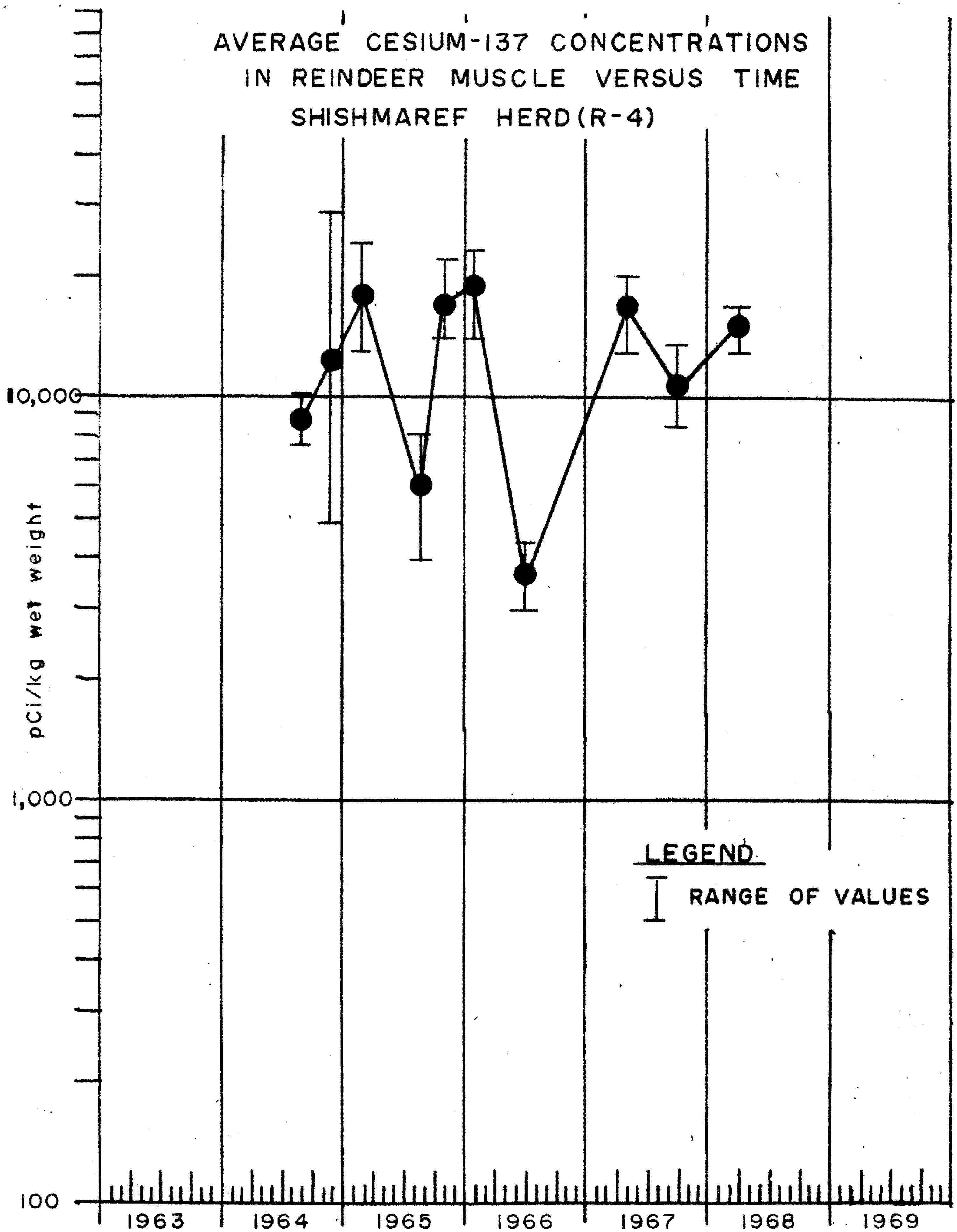

AVERAGE CESIUM-137 CONCENTRATIONS
IN REINDEER MUSCLE VERSUS TIME
TELLER HERD(R-5) AND NOME HERD(R-10)
pCi/kg wet weight
10,000
1,000
100
1963
1964
1965
1966
1967
1968
1969
LEGEND
TELLER HERD(R-5)
NOME HERD(R-10)
RANGE OF VALUES

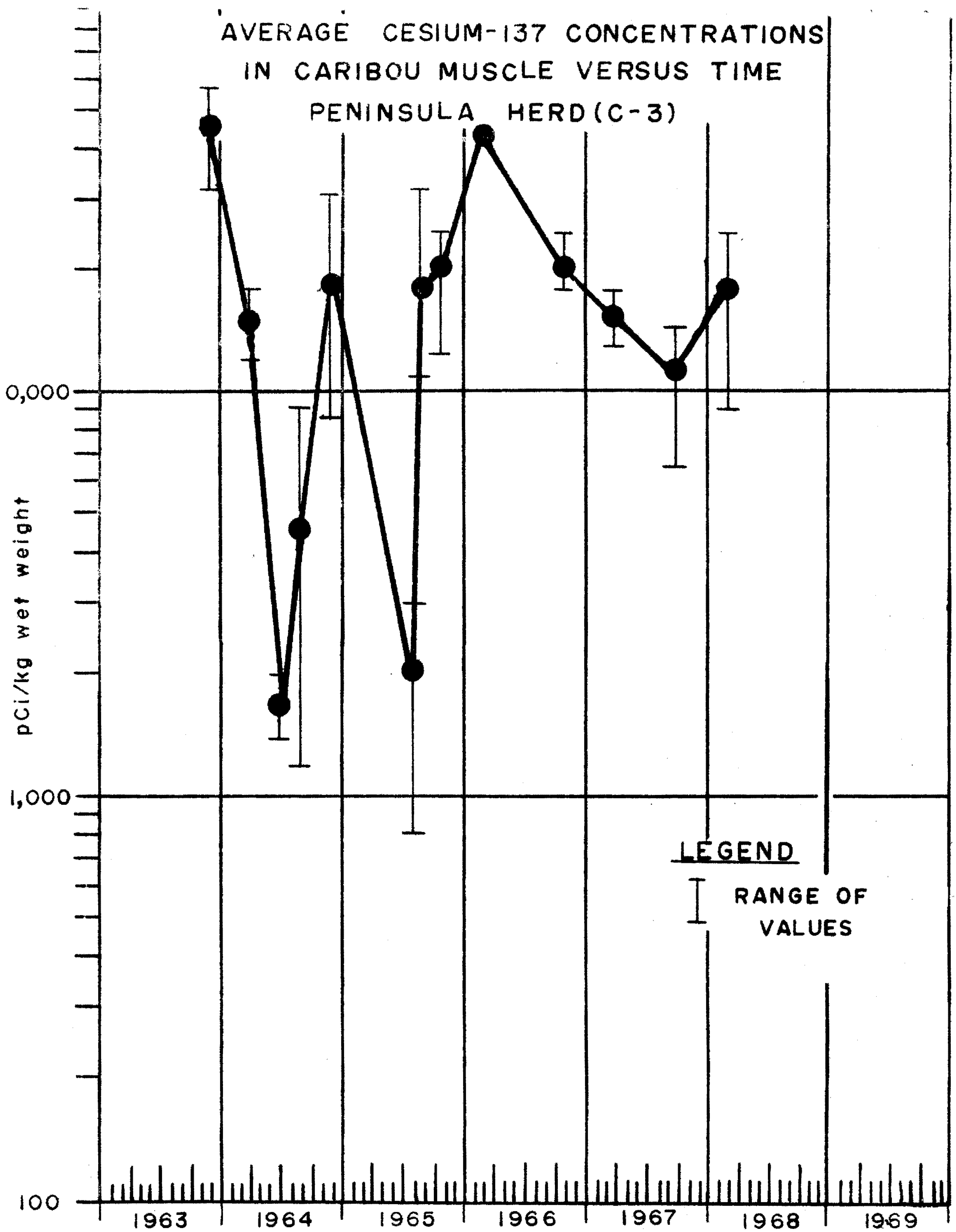
AVERAGE CESIUM-137 CONCENTRATIONS
IN REINDEER MUSCLE VERSUS TIME
NUNIVAK ISLAND HERD(R-8)



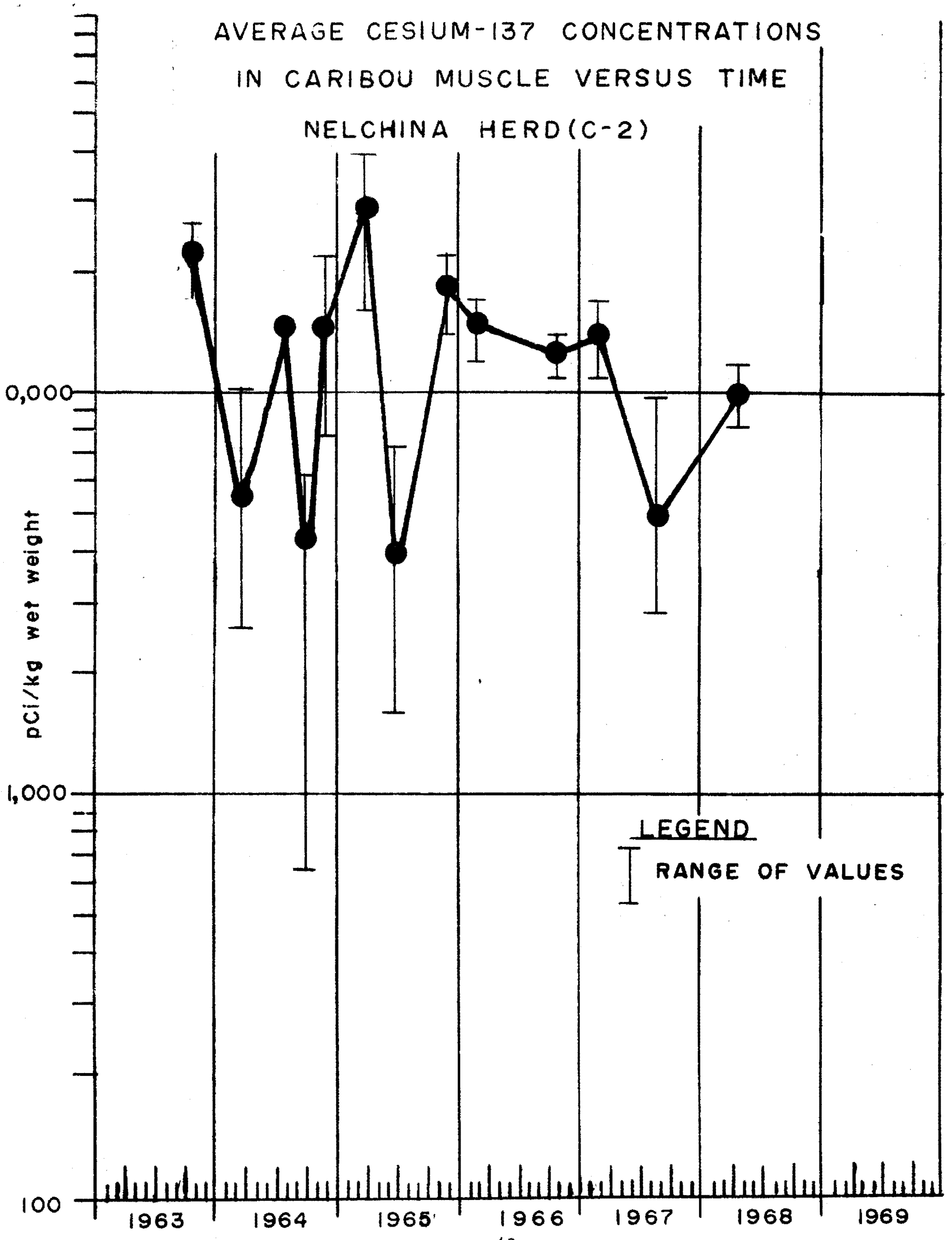

AVERAGE CESIUM-137 CONCENTRATIONS
IN REINDEER MUSCLE VERSUS TIME
SHISHMAREF HERD (R-4)
pCi/kg wet weight
,000
,000
100
1963
1964
1965
1966
1967
1968
1969
LEGEND
RANGE OF VALUES


AVERAGE CESIUM-137 CONCENTRATIONS
IN REINDEER MUSCLE VERSUS TIME
SHISHMAREF HERD (R-4)
10,000
1,000
100
pCi/kg wet weight
LEGEND
RANGE OF VALUES
1963
1964
1965
1966
1967
1968
1969


AVERAGE CESIUM-137 CONCENTRATIONS
IN REINDEER MUSCLE VERSUS TIME
SHISHMAREF HERD (R-4)
10,000
1,000
100
pCi/kg wet weight
LEGEND
RANGE OF VALUES
1963
1964
1965
1966
1967
1968
1969



AVERAGE CESIUM-137 CONCENTRATIONS
IN CARIBOU MUSCLE VERSUS TIME
PENINSULA HERD (C-3)
0,000
1,000
100
pCi/kg wet weight
1963
1964
1965
1966
1967
1968
1969
LEGEND
RANGE OF VALUES


AVERAGE CESIUM-137 CONCENTRATIONS
IN CARIBOU MUSCLE VERSUS TIME
NELCHINA HERD (C-2)
pCi/kg wet weight
0,000
1,000
100
LEGEND
RANGE OF VALUES
1963
1964
1965
1966
1967
1968
1969

Job No. 5: Nutritional Physiology of Caribou and Moose

PROCEDURES

The present efforts are being devoted to developing suitable techniques based upon methods which have been applied to domestic animals, and, in one or two instances, to wild ruminants. In general the procedures being used are as described below.

1. Development and testing of a "dry-weight" method of evaluating the fat content of marrow fat depots.

2. Development and testing of a "field-fermentation" method for assessing the quality of herbivore forage in terms of the *in vitro* production of volatile fatty acids and gaseous byproducts.

3. Review of the literature for pertinent information on rumen metabolism and other related aspects of the nutritional physiology of domestic and wild ruminants.

FINDINGS

A. Marrow Fat Studies.

The relative, apparent fattiness of long-bone marrow has been used for many years as an indicator of nutritional condition of wild ruminants. Attempts to quantify this observation have employed tedious fat-extraction techniques or comparatively inaccurate "shrinkage" measurements and are thus not conveniently and/or suitably applicable to large series of samples. However, marrow-fat depots are much better defined and easier to isolate than others, eg. subcutaneous or visceral depots, and large numbers of marrow samples (femur) can be obtained from some herds (eg. Arctic caribou). Accordingly, it was hypothesized that, if marrow fat content is directly proportional to general body condition, and if a simple procedure for quantitatively determining marrow fat could be devised, then it would be possible to obtain a meaningful estimate of herd condition. For example, we can obtain hundreds of femurs from subsistence-kills each year but it is not practical to attempt to get weights each year from hundreds of animals. Furthermore, in evaluating nutritional condition during field necropsies, it is comparatively difficult to accurately estimate or quantitatively measure the extent of the various fat depots.

1. Marrow fat estimation

It has been known for many years that fat content and water content of animal tissues or carcasses are inversely correlated. The biochemical basis for this in part involves the fact that fat mobilization or storage involves hydrolytic processes which release or consume water. Further, fat depots are comprised of little more than fat, water, and a diffuse connective tissue stroma. This being the case, it is evident that dried marrow is principally comprised of fat plus a small weight of connective tissue components. Thus for purposes such as ours in which an error of about 5% is deemed acceptable, it is practical to equate fat content with dry weight. If a reduced level of error is desired, a correction for the fat-insoluble residue can be easily applied.

The techniques employed are briefly as follows.

a. Dry Weight Determination

Samples of femur marrow weighing 50 grams, more or less, were weighed wet and then dried to near constant weight in a drying oven at about 60-65°C. Drying to a daily weight variation of no more than about 1 part per 1000 was obtained for 27 of 32 samples in 12 days. Since an error of 1 part in 20 (i.e. 5%) is deemed permissable the routine drying time can no doubt be considerably reduced.

b. Non-fat-soluble Residue

The non-fat-soluble residue (N.F.S.R.) was determined by extracting the dried marrow with a 1.1, methanol-chloroform solvent system using a Sozhlet extraction apparatus with electric mantle heater. Most of the fat is extracted in 2-3 hours, but in the present study the extractions were continued for 10-12 hours.

The basic data on 35 caribou taken at Anaktuvuk Pass from April 25-30, 1968, are shown in Table 1 and summarized in Figures 1 and 2. The individual marrow samples and related data were ranked according to a four-point visual index (V.I.) system in which the apparent moistness and color (white through red) were used to score individual samples. A visual index (V.I.) score of 1 indicated low-fat, "poor-condition" marrows while a V.I. score of 4 indicates high-fat, "best-condition" marrows.

DISCUSSION

Inspection of the data in Table 1 reveal that the non-fat-soluble residues of 34 marrow samples were 1.2-8.7 (4.3 mean) percent of the wet weight of the marrow. It is evident that "higher-fat" marrows tend to have somewhat less N.F.S.R.'s than "lower-fat" marrows. For example, the six female marrow samples given a V.I. score of 4 had a mean N.S.F.R. value of 2.6% and fat content of 77% while seven female marrows assigned V.I. scores of 1 or 2 had a mean N.S.F.R. value of 5.0% and fat value of 28%. In the event that less error was required in the fat determination, the N.S.F.R. data could be plotted against the fat data and a correction for any fat value could be determined from the resulting curve. In this way the error ascribable to the N.F.S.R. could be reduced to the 1% level or less. Correction tables would probably have to be determined for each species.

The considerable variation in fat content of samples assigned class I or II visual index values, illustrates the comparative lack of sensitivity of this visual method of grading lower class marrows. While the visual method may be satisfactory for many purposes when applied to better quality (higher fat content) marrows, it is too inaccurate, except for very gross purposes, for grading poor quality marrows.

The relationship between femur marrow fat content and general body condition is illustrated in Figures 1 and 2. In both instances it appears clear that there is a direct, though more or less variable relationship between the amount of fat in marrow tissue and the general bodily condition of adult (4 year and older) male or pregnant female caribou. Admittedly, more data is needed to statistically confirm the apparent relationship. It should also be noted that using dressed weight rather than whole weight would probably have resulted in less spread of the points shown in Figure 2. Unfortunately, dressed weights were not recorded for all of the individuals included in the samples used. It can only be concluded that femur marrow fat may be a good, quantitative indicator of general bodily condition (i.e. caloric stores) which can be comparatively easily measured by the "Dry Weight" method.

Adequate data is not yet available to accurately assess seasonal variation of femur marrow fat depots.

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