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SEROLOGIC SURVEY FOR MICROBIAL PATHOGENS

by
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SUMMARY

A serologic survey of selected wildlife species from Alaska was conducted. There was little or no evidence of most diseases in most host species. Some notable exceptions were apparent. Evidence of contagious ecthyma was common in Dall sheep (Ovis dalli) and rare in caribou (Rangifer tarandus). Evidence of parainfluenza III in the Delta Junction bison (Bison bison) herd increased from zero to nearly 100% over an 8-year period. Evidence of infectious bovine rhinotracheitis was high in arctic caribou herds, especially the Central Arctic Herd. Evidence of bovine viral diarrhea was low in bison, caribou, Dall sheep, moose (Alces alces), and muskox (Ovibos moschatus). Brucellosis was low to moderate in caribou and grizzly bear (Ursus arctos) on the North Slope. Evidence of leptospirosis was found in grizzly bear, black bear (Ursus americanus), bison, mountain goat (Oreamnos americanus), muskox, moose, and caribou. Prevalence of leptospirosis in grizzly bears was more common in the southern portions of the state. Specific serovarieties of Leptospira interrogans were more prevalent in certain host species and certain geographic areas. Evidence of Q fever was found in caribou, Dall sheep, mountain goat, muskox, arctic fox (Alopex lagopus), grizzly bear, and wolf (Canis lupus). Evidence of a virus similar to both bluetongue and epizootic hemorrhagic disease was found in moose, caribou, Dall sheep, and bison. Prevalence was low and there is conjecture over the identity of the agent. In addition to Q fever, evidence of brucellosis, leptospirosis, infectious canine hepatitis, canine distemper, canine parvovirus, tularemia, and rabies was found in wolves.

Key Words: Alaska, wildlife, disease, survey.

CONTENTS

BACKGROUND

Few instances of infectious diseases having had an observed impact on wildlife populations in Alaska have been documented. Brucellosis in caribou (Rangifer tarandus) and rabies in canids have been notable exceptions. In an effort to evaluate the disease status of various Alaskan wildlife populations, a serologic survey has been conducted throughout the state.

Disease surveys conducted by means of serologic tests have many advantages:

(1) Blood samples are easy to collect.

(2) It is not necessary to sacrifice animals to test for evidence of previous exposure to disease(s).

(3) Periodic samples can be collected from the same animal(s) over an extended time frame, thus providing information on the timing of exposure.

(4) Tests are relatively inexpensive to perform.

(5) A single sample can be tested for evidence of many different diseases, rather than requiring a specific tissue or organ for each disease of concern.

(6) Sera are stable for a long period of time (under adequate storage conditions), thus providing the basis for a functional archive system which can be tested in the future.

(7) If the sample size is adequate, it is possible to evaluate the status of an entire population in relation to a disease.

(8) If populations are monitored over a period of time, it is possible to determine changes in the disease status of the population.

(9) Early warning of such changes in disease status of a population allows for the consideration of human intervention into the disease process at the most opportune time and place.

Within a living animal, antibody molecules which are produced in response to some disease agents may decay to undetectably low levels over a relatively short period (ca. several months). The rate of degradation is an exponential decay function and is expressed as the "half-life." Antibody that is produced in response to other agents may be more long-lived and may remain at detectable levels for many years. Furthermore, reexposure of a previously infected host to the disease agent in question may cause an increase in the level of antibody in circulation. These factors all confound attempts to correlate the level of antibody in the serum to the date of exposure of the host to the agent.

Perhaps the most reasonable means of determining the time frame during which an animal has been exposed to an infectious disease agent is to periodically collect serum specimens from the specific animal involved. However, in most cases such periodic sampling schemes are not practical for free-ranging animals. Thus, determining the timing of exposure of either specific individuals or populations is difficult.

Test results for samples which have been collected during any particular year do not necessarily reflect the transmission pattern during that year. For example, animals with evidence of exposure may have been infected during previous years. However, analyzing such test results based upon the year in which the samples collected may reveal long-term trends in the frequency of disease transmission. Although this approach of grouping samples according to the year in which they were collected may not be infallible, it serves a practical purpose

and therefore has become an accepted technique for evaluating data. This sample grouping approach will be used throughout the discussion of the current study.

ADF&G has conducted serologic surveys since the early 1960's. During the early years, such surveys were limited in the scope of disease agents and host species which were investigated. Over the past decade, the survey has expanded to include 11 species of wild mammals and birds and 16 disease agents. Tests involving other disease agents and sera from other host species were conducted, but will not be reported here. Sample sizes were small; often just 1-5 specimens per host species. Presently, these data are too limited to allow meaningful analysis.

Results of disease surveys often have significant implications for wildlife management and human health. For example, understanding of the epizootiology of rabies (especially host range) has been expanded by surveys in Africa. In another example from the contiguous United States, results of surveys for duck virus enteritis in waterfowl allow management agencies to focus disease control efforts in areas most likely to be affected. Following an outbreak of contagious ecthyma involving captive Dall sheep (Ovis dalli) and muskoxen (Ovibos moschatus) near Fairbanks, eradication of the captive animals was proposed as a means of preventing spread of the disease to wildlife. Serologic surveys revealed that the disease was common in free-ranging Dall sheep and therefore precluded the need for such action.

OBJECTIVE

The objective of this survey has been to monitor Alaskan wildlife populations for the occurrence of microbial disease agents which may have a detrimental effect upon the health of both individual animals and entire populations.

METHODS

Most blood samples were collected by ADF&G biologists who captured animals to meet objectives of other studies. Hunters collected and contributed samples from bison (Bison bison), caribou, Dall sheep, Sitka black-tailed deer (Odocoileus hemionus sitkensis), and muskox. Arctic fox (Alopex lagopus) specimens were collected by a predator control agent near Prudhoe Bay. General collection areas are indicated in Figures 1 and 2.

Most blood samples were allowed to settle at ambient or refrigerated temperatures for 6-36 hours and then centrifuged; sera were then removed by aspiration. Sera were kept frozen until the time of testing. All serologic tests were performed by personnel of the National Veterinary Services Laboratories (USDA, Ames, Iowa). Serology is a suitable diagnostic tool for most viral and bacterial infections. Its applicability for fungal and parasitic exposures is much more limited. Disease agents were selected for inclusion in this survey based upon past or potential problems with wildlife species in Alaska or other parts of the world.

Sera were tested for evidence of antibodies to:

(1) Brucella spp., by the buffered acidified plate antigen test (Angus and Barton 1984),

(2) tularemia, by the tube agglutination test (Owen 1970),

(3) Q fever and contagious ecthyma, by the complement fixation test (Erickson et al. 1975),

(4) Leptospira spp., by the microscopic agglutination test (Cole et al. 1973),

(5) infectious bovine rhinotracheitis, bovine viral diarrhea, epizootic hemorrhagic disease, and bluetongue, by the serum neutralization test (Thorsen and Henderson 1971),

(6) epizootic hemorrhagic disease, bluetongue, ovine progressive pneumonia, and caprine arthritis encephalitis, by the immunodiffusion test (Pearson and Jochim 1979),

(7) parainfluenza III, by the hemagglutination-inhibition test (Thorsen and Henderson 1971),

(8) rabies, by the rapid fluorescent focus inhibition test (Smith et al. 1973),

(9) canine distemper and infectious canine hepatitis, by the microneutralization test (Appel and Robson 1973), and

(10) canine parvovirus, by the fluorescent neutralization test (King and Croghan, 1965).

Twelve Leptospira interrogans serovarieties were included in the tests: pomona, ballum, canicola, icterrohemorrhagiae, wolffi, grippotyphosa, hardjo, autumnalis, bataviae, tarassovi, australis, and pyrogenes. Minimum titers for all tests were established based upon natural or experimental infection of the species in question or of a domesticated

species. Sera which met or exceeded these titers (plus those designated "positive" in the immunodiffusion test and brucellosis plate test) were considered to contain evidence of past infection by the agent in question. Hereafter, these samples may be referred to as "positive." All other samples may be referred to as "negative." Differences in prevalence based upon sex and age were tested for significance by means of the Chi-square test (Johnson 1980).

Two types of potential qualitative errors should be considered in evaluating the significance of serologic survey results: (1) samples from animals which have in fact been infected by the disease agent in question may be incorrectly categorized as "negative," and (2) samples from animals which have never been exposed to an agent may be incorrectly deemed "positive." Explanations for the former include: (a) natural antibody decay over time, (b) antibody degradation due to improper handling of the specimen, (c) establishment of the threshold titer value at a level that is too high, (d) improper inspection or evaluation of the test, and (e) inaccuracies in recording of data. Explanations for the latter include: (a) presence of "non-specific" reacting substances in the sample, (b) improper inspection or evaluation of the test, and (c) inaccuracies in recording of data. With these disclaimers in mind, discussion of the test results may proceed.

RESULTS AND DISCUSSION

In most cases, test results provided no evidence of exposure to a particular disease in a particular host species (Tables 1-26). This discussion will focus on those situations where evidence of previous exposure was found.

Three viral diseases, infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), and parainfluenza III (PI3), are commonly referred to, collectively, as the "bovine respiratory group." As this generic term implies, the viruses often cause upper respiratory infections (Dieterich 1981a). Morbidity (rate of illness) may be high in an infected population, but mortality (rate of death) is usually low. Transmission usually occurs via aerosol droplet, but the venereal route may also play a role (Dieterich 1981a). Serologic evidence of exposure has been previously reported for various wildlife species (Thorsen and Henderson 1971; Parks and England 1974; Stauber et al. 1980).

Infectious bovine rhinotracheitis - (IBR)

Other than 1 bison at Delta (Table 1) and 1 Nelchina caribou (Table 2), the only evidence of IBR exposure was in the 3 arctic caribou herds (Tables 3-5). Low prevalence in the

Western Arctic Caribou Herd (3/41 - 7%) (Table 3) seems minor compared with the 23% prevalence (3/13) in the Porcupine Herd (Table 5) and especially the 28% prevalence (40/145) in the Central Arctic Herd (Table 4). Although the prevalences are similar between the Central Arctic Herd and the Porcupine Herd, I have more confidence in the long-term and larger sample size of the Central Arctic Herd results. The one-time sample from the Porcupine Herd is too small to base much of a judgment upon. Future collections should clarify this particular point. I originally believed that long-term high prevalence in the Central Arctic Herd was related to human activity along the Haul Road and Trans-Alaska Pipeline. I have not completely discarded this interpretation, but have altered it. It now appears that this disease is simply more common in arctic herds than elsewhere, and the situation may have been exacerbated in the Central Arctic Herd. The reason the virus should apparently be so limited to 1 species in 1 general area is a mystery. Antibody prevalence exhibits no sex- or age-specificity. If exposure commonly results in clinical overt disease, IBR could pose a significant health threat to the arctic caribou herds; especially the Central Arctic Herd, but no evidence to support this possibility has been found.

Bovine viral diarrhea - (BVD)

BVD has a broad range of possible hosts and a large geographic range. Evidence of exposure was found in bison (3/208 - 1%) (Table 1), moose (1/694 - ≅0%) (Tables 8-11), caribou (11/254 - 4%) (Tables 2-7), muskox (2/37 - 5%) (Table 12), and Dall sheep (2/132 - 1%) (Tables 13-16). These collections represent all general areas of the mainland except Game Management Unit 13 (GMU 13). Prevalence was low in all cases. There was no evidence of sex- or age-specificity. In the absence of clinical disease or other evidence to the contrary, I currently perceive little threat to wildlife populations as a result of BVD.

Parainfluenza III - (PI3)

Results of tests for PI3 in the Delta Junction Bison Herd (Table 1) have been discussed previously (Zarnke 1985). Prevalence increased from 0% prior to 1977 to 98% by 1983. No evidence of respiratory disease is present in this closely observed herd. We were unable to isolate virus from nasal swabs which were collected from 27 hunter-killed animals during the 1984-85 season. As stated in my earlier report, I believe the virus was introduced into this bison population by domestic cattle. The herd should be closely monitored for evidence of clinical disease. The only other animals which had evidence of PI3 were moose from the Kenai Peninsula (8/580 - 1%) (Table 10) and GMU 13 (1/175 - 1%) (Table 9).

Prevalence was low in large samples from both locations. I view this disease as little threat to moose, either in these locations or elsewhere in the state.

Leptospirosis

Leptospirosis is caused by 1 or more so-called "serovarieties" of a spirochete known as Leptospira interrogans (Busch 1970). Symptoms may include chronic kidney infections (Diesch et al. 1970), hepatitis (Bishop et al. 1979), and/or abortion. Transmission usually occurs via contamination of water by leptospires which are shed in urine (Busch 1970). Also, the disease may be passed along the food chain from prey to predators (Reilly et al. 1970). Exposure to more than 1 serovar is not uncommon.

Serum antibody prevalence for leptospirosis in grizzly bears (Ursus arctos) showed a progression from north to south. Prevalence was low on the North Slope (4/138 - 3%) (Tables 17-18), moderate in the Interior (5/51 - 10%) (Table 19) and GMU 13 (4/70 - 6%) (Table 20), and higher on Kodiak Island (13/80 - 15%) (Table 21). In addition, the frequency of serovars was different at these 3 locations. On Kodiak Island, serovar candida was most common (occurring in 13 of 13 positive grizzly bears), followed by serovars ballum (10/13) and pyrogenes (9/13). In the Interior and GMU 13, serovar grippotyphosa was the most common, representing 8/9 positive reactions. However, on the North Slope the 4 positive reactions were due to 4 different serovars. Chronologically, all of the positive specimens were collected during or after 1979, with 1983 collections having at least 1 positive sample in each area except GMU-13. The implications of any or all of these observations are unknown. I suspect the apparent geographic progression is reflective of more favorable conditions for the transmission of Leptospira spp. on Kodiak Island than at the other 2 major areas. I also suspect that the apparent predilection of specific serovars for specific localities is not an artifact. Perhaps environmental conditions or other factors allow a serovar to be more common at 1 location, whereas different serovars are more common elsewhere.

The apparent absence of leptospiral antibody in any grizzly bear sera prior to 1979 originally caused me to question the stability of such antibody during long-term storage. However, sera were collected prior to 1979 only from the Brooks Range locations, and sample sizes were small. In addition, prevalence in grizzly bears is lowest in these northern areas, regardless of year of collection. Therefore, it is not surprising that no positive samples were detected in these pre-1979 collections.

Serum antibody prevalence was high in mountain goats (Oreamnos americanus) near Ketchikan (15/20 - 75%) (Table 22), muskoxen on Nunivak Island (5/6 - 83%) (Table 12), and bison near Delta Junction (8/57 - 16%) (Table 1) during 1983. Adequate sample sizes were available for only 1 other year for both mountain goats and muskoxen, so the apparent discrepancy between years may be deceiving. However, regular testing of the bison herd over the previous 7 years failed to reveal any evidence of leptospirosis. As stated previously, 1983 was also a peak year for leptospirosis in most grizzly bear populations which were tested.

Serovar ballum was most common in muskoxen and mountain goats, accounting for 5 of 5 positives in the former and 14 of 15 in the latter. Ballum was isolated from a vole (Microtus oeconomus) collected on the Alaska Peninsula in 1974 (Woods 1974). This was the 1st leptospire isolated from an indigenous mammal in Alaska. The significance of this apparent predilection of ballum for coastal areas is unknown, but may be related to environmental factors. No single serovar dominated the scene among the positive bison specimens. Four samples were positive for hardjo, 2 for ballum, 2 for icterohemorrhagiae, and 2 for bataviae.

In moose from the Kenai Peninsula serum antibody prevalence for leptospirosis was low to moderate (37/606 - 6%) and spanned at least a 7-year period (Table 10). Prevalence was highest in 1973 and 1974 at 30/397 - 8%. Hardjo was the most common serovar (evident in 13 of 37 positive sera) followed by ballum (10 of 37). Once again, ballum was among the more common serovars in this coastal environment.

Prevalence was low (5/117 - 4%) in moose from GMU 13 and was found in only 2 of 4 years (Table 9). No single serovar predominated, with 2 of 5 positive sera showing evidence of bataviae, 2 of 5 hardjo, 1 of 5 australis, and 1 of 5 ballum. The predominant serovars in moose and bears (Tables 20, 24) from GMU 13 showed no correlation, suggesting bears did not become infected by means of preying on moose. This was the only area for which such predator/prey comparisons could be made.

No moose specimens were available for 1983 from either the Kenai Peninsula or GMU 13. Therefore, no comment can be made relative to the apparent peak of leptospirosis during 1983 which was so notable in other species. There was no evidence of leptospirosis in moose from the Interior (Table 8) or Seward Peninsula (Table 11) collection areas. Thus, leptospirosis was much more common in moose in the southern portion of the state, compared with more northerly areas, which is similar to the situation for grizzly bears. Presence of antibody in moose samples which were collected as early as

1971 provides further evidence against the instability of antibody, as discussed above, for grizzly bears. There was no evidence of sex- or age-specificity in any of the hosts.

Contagious ecthyma - (CE)

CE is a viral disease primarily found in sheep and goats, both wild (Samuel et al. 1975) and domestic (Beck and Taylor 1974). Infection causes crusty, proliferative lesions on exposed skin near the mouth, eyes, udder, anus, and/or hoof line (Beck and Taylor 1974; Dieterich et al. 1981b). Anorexia and ataxia are common symptoms (Beck and Taylor 1974). The virus is shed in scabs and remains infective for years (Beck and Taylor 1974). Direct contact transmission also plays a role (Beck and Taylor 1974). The epizootiology of CE in Alaska has been discussed previously (Dieterich et al. 1981b; Zarnke et al. 1983).

The host distribution of CE antibody in this survey both fulfilled expectations and provided a surprise. Antibody was commonly found in Dall sheep from all areas which were sampled (Tables 13-15), except in the small number of specimens from the White Mountains (Table 16). Antibody prevalence was highest in the Dry Creek population (54/153 - 35%) (Table 13).

The surprise portion of the CE picture involved evidence of infection in a small number of caribou from the Central Arctic (1/38) (Table 4), Western Arctic (3/23) (Table 3), and Fortymile (2/4) (Table 6) Herds. All 6 of these positive specimens were collected in 1980 or 1981, but I suspect that this observation is of little significance. No sex-specificity was evident. These specimens may represent actual infections, cross-reactions with another related virus, or errors in the test interpretation. Titers for 5 of these 6 specimens were high ($\geq$20). I believe that the results may, in fact, reflect actual infections. We have shown that caribou are indeed susceptible to experimental infection with CE (Zarnke et al. 1983). However, the likelihood for exposure under natural conditions seems small. Pending discovery of conflicting data, I will consider caribou to be an uncommon host of CE.

CE has been previously reported in mountain goats in western Canada, including coastal British Columbia (Hebert et al. 1977). Additional samples will be necessary before we can make any solid judgment regarding the status of mountain goats near Ketchikan relative to CE exposure.

Bluetongue - (BLU) and Epizootic hemorrhagic disease - (EHD)

BLU and EHD are viral diseases of wild and domestic ruminants. Symptoms may include anorexia, ataxia, dyspnea, and depression, but the 2 diseases are most often recognized post-mortem by acute subcutaneous and/or internal hemorrhaging

(Hoff and Trainer 1978). The oral route may be important for transmission during enzootic periods, but arthropod vectors play a big role during epizootics (Hoff and Trainer 1978).

The situation surrounding EHD and BLU in Alaskan wildlife is more confusing than for most other diseases. On occasions when positive samples were detected by means of immunodiffusion tests, USDA personnel attempted to determine which of the 2 viruses (EHD or BLU) was responsible. This was done by means of implementing the more specific serum neutralization test. In virtually all cases where this was done, test results were inconclusive and were accompanied by the following comment: "...significance of these results is difficult to evaluate in an area where no [overt disease] has ever been reported. The reaction may be due to exposure to an antigenically similar virus." Mention of antigenic variation and overlap are inherent in any discussion of these 2 viruses. Although discernible from each other, EHD and BLU are closely related antigenically. On the other hand, there are at least 19 distinct strains of BLU. It is not inconceivable that there is a distinct relative of EHD and BLU present in Alaskan wildlife. The proper means of addressing such a problem is to isolate and identify the disease agent in question. In the absence of clinical disease, the likelihood of isolating the agent is small.

There is some question regarding the transmission of either EHD or BLU in Alaska. In North America, a gnat (Culicoides variipennis) is the most common vector of these viruses. There is some debate as to whether this particular gnat species exists in Alaska. I recently attempted to collect gnats for identification but failed due to difficult trapping conditions during long summer evenings. Certainly, members of the genus Culicoides do occur in Alaska and experience in other parts of the world indicates that in the absence of the preferred vector species, other members of the genus will occupy this ecological niche and serve as vectors. In an attempt to answer several questions surrounding the significance of EHD/BLU in Alaska, I plan to continue attempts to collect Culicoides spp. both for vector identification and for virus isolation purposes.

The low antibody prevalence in moose (17 "suspect" samples) (Tables 8-11), Sitka black-tailed deer (2 "suspect") (Table 23), caribou (4 "suspect") (Tables 2-7), and bison (2 "suspect") (Tables 1) from various areas of the state leads me to believe that there is, indeed, some virus closely related to EHD and BLU present in the state. By this I mean that I accept the validity of the test results. I conclude this agent poses little threat to the health of the various host species. The single instance of high prevalence (8/29 - 28%, Dall sheep, Dry Creek, 1981) is an anomaly. Forty

samples representing 3 years (both before and after 1981) from the same location were all negative. In addition, no BLU positive samples were found at this location in any year. Pending additional data on this host, I must question the validity of these test results. Antibody prevalence exhibited no sex- or age-specificity for any of the host species.

Brucellosis

Brucella suis IV is the causative agent of the type of brucellosis found in Alaska. The most well-studied host species include caribou and their associated predators (Neiland et al. 1968; Neiland 1975). Infection usually localizes in joints or reproductive organs, causing arthritis and/or abortion (Neiland et al. 1968). Transmission occurs venereally (Neiland et al. 1968), or via the food chain (Neiland 1970, 1975).

Results of the brucellosis tests were substantially different from those of previous reports. For example, Neiland (1975) reported prevalences of around 90% for grizzly bears collected in the western Brooks Range and 30% for eastern Brooks Range bears for samples collected during the early 1970's. For the same general locations, current results indicated prevalences of 25/91 - 27% (Table 18) and 25/135 - 19% (Table 17), respectively. Differences may be partially explained by the fact that different test procedures were utilized and tests were performed in different laboratories. In addition, Neiland's threshold titers were established at lower values. This is not to say that one or the other of us was incorrect, rather just to point out different approaches and interpretations. Also, Brucella antibody prevalence in a host population does fluctuate over time, as demonstrated by Dieterich (pers. commun.). However, even with all of these possible explanations, I still find the vast discrepancy between the 2 data sets (especially for the western Brooks Range) difficult to understand. Prevalence in bears from the central Alaska Range, GMU 13, and Kodiak were between 2-4% (Tables 19-21, 24). I believe the higher prevalence in North Slope bears reflects the higher prevalence in North Slope caribou. There was no evidence of sex- or age-specificity.

Among the various caribou herds sampled, Brucella antibody prevalence was highest in the Western Arctic Herd (12/51 - 24%) (Table 3). In fact, 2 specimens from the Central Arctic Herd were the only other positive caribou samples (2/151 - 1%) (Table 4). Admittedly, sample sizes were small, but the absence of any positive animals in the other herds (Tables 2, 5-7) was surprising. Neiland et al. (1968) reported a similar situation with combined prevalence for the Central Arctic and Western Arctic Herds during the early 1960's ranging from 12-30%, whereas prevalence in the Nelchina Herd ranged from

1-8%. Different methods and interpretation at least partially account for the lower prevalences in the current study.

Brucellosis in moose is rare (Neiland et al. 1968). Current results (Tables 8-11) affirm this pattern. The 2 specimens from the Seward Peninsula which show evidence of previous exposure are somewhat surprising. This level of exposure represents an abnormally high prevalence for moose. Moose on the Seward Peninsula may simply have a greater opportunity for exposure because of the likelihood of indirect contact with infected caribou from the Western Arctic Herd and local reindeer herds. There may also have been difficulties with test interpretation.

Q fever

Q fever is caused by the rickettsium Coxiella burnetti (Randhawa et al. 1977). The organism usually localizes in the respiratory tract. Although the disease is usually mild in domestic species, abortions can occur in sheep and goats (Enright et al. 1963). Death is rare (Bell 1981). Coxiella burnetti is shed in milk, feces, birth fluids, and placental tissues (Enright et al. 1969).

The 2 host species in which we found evidence of Q fever are the wildlife counterparts of the 2 most common domestic host species of the disease; i.e., Dall sheep and mountain goats. Serum antibody prevalence was moderate in Dall sheep at the 2 Interior capture locations (13/133 - 10% and 4/39 - 10% at Dry Creek and Sheep Creek, respectively) (Tables 13-14) as well as on the Kenai Peninsula (2/21 - 10%) (Table 15). Prevalence was somewhat lower (2/32 - 6%) in mountain goats near Ketchikan (Table 22).

The most well-studied of the state's wildlife hosts for Q fever is the caribou. During a 10-year study, serologic prevalence in the Delta Herd averaged 10% (Hopla 1975). No evidence of infection was found in the Nelchina, Western Arctic, Central Arctic, or Fortymile Herds during the present study, but sample sizes were small (Tables 2-4, 6). The 17% (2/12) prevalence for the Porcupine Herd (Table 5) and 33% (4/12) for the Delta Herd (Table 7) fall within the range of Hopla's earlier investigations, especially considering the small sample sizes.

Prevalence in North Slope arctic foxes (9/34 - 26%) (Table 25), GMU 13 wolves (5/95 - 5%) (Table 26), and Kodiak grizzly bears (3/74 - 4%) (Table 21) was variable in magnitude. I suspect that these predators/scavengers are infected via the food chain. Neither sex- nor age-specificity played any apparent role in Q fever. Implications of these results for the health of the various host species are unknown.

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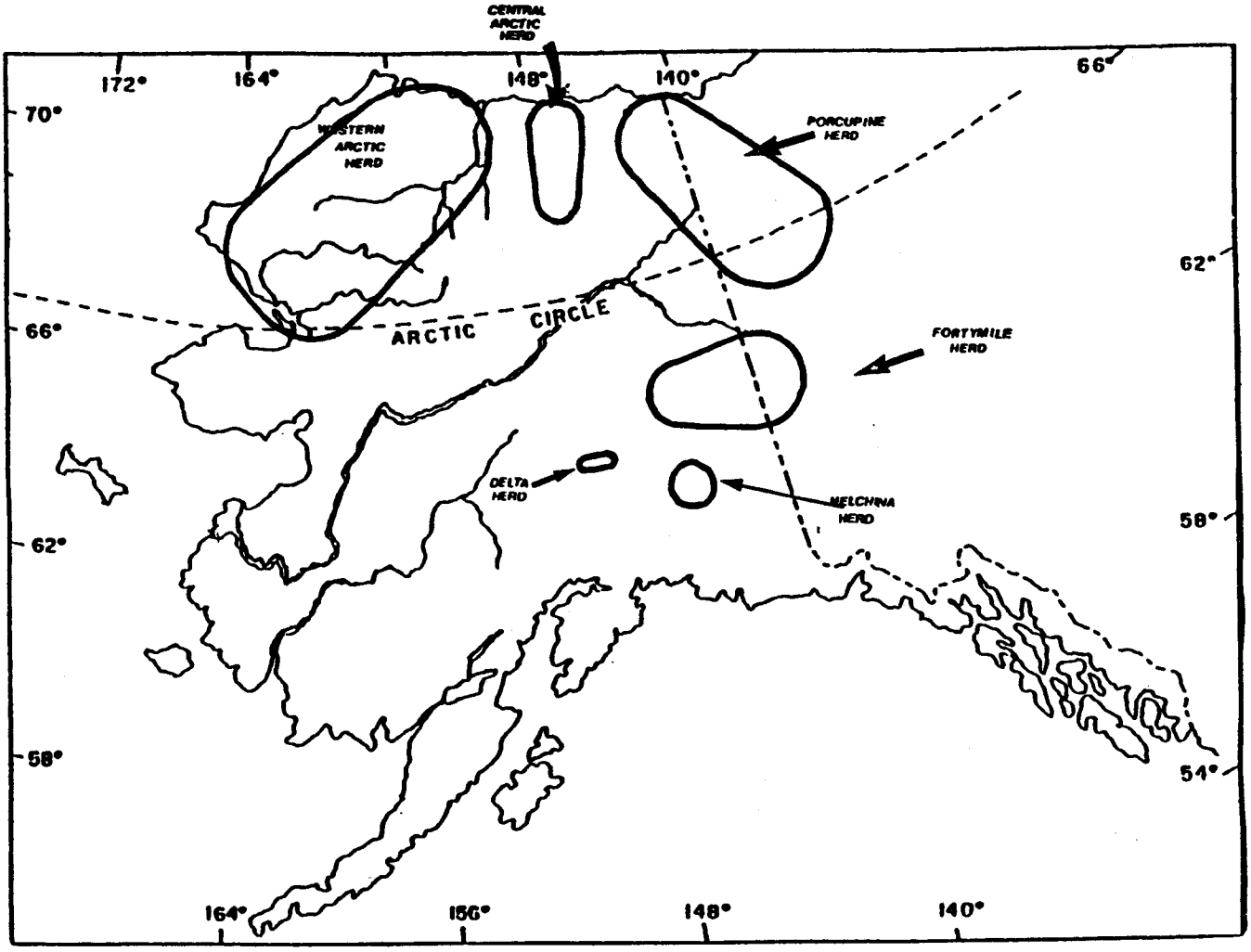

Fig. 1. Approximate home ranges of caribou herds from which blood specimens were collected for disease survey.

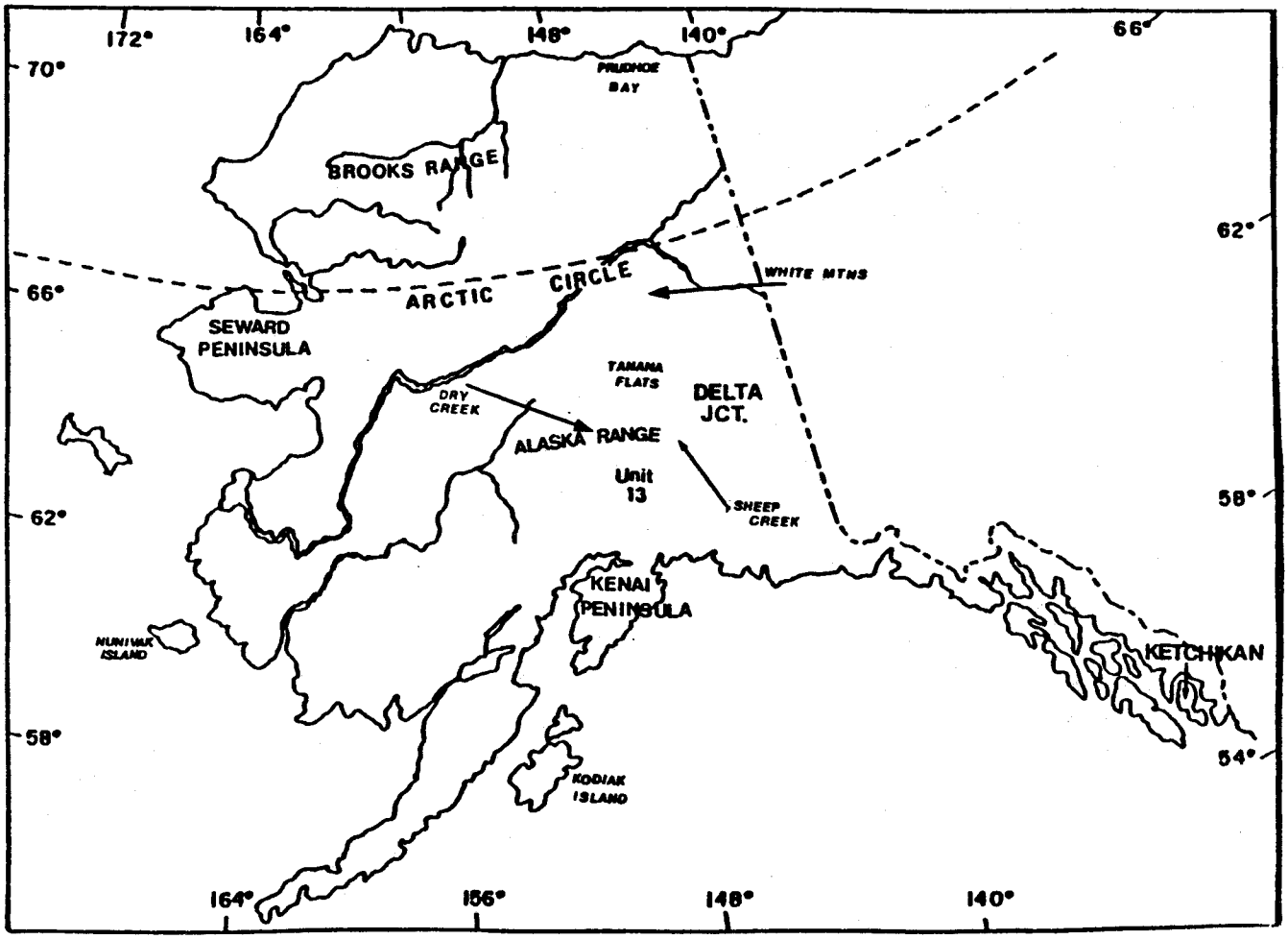

Fig. 2. Locations at which blood specimens were collected from listed species for disease survey.

Arctic fox	-	Prudhoe Bay
Bison	-	Delta Junction
Black Bear	-	Unit 13
Dall sheep	-	White Mountains, Sheep Creek, Dry Creek, Kenai Peninsula
Deer	-	Southeast Alaska
Grizzly bear	-	Brooks Range, Alaska Range, Unit 13, Kodiak Island
Moose	-	Tanana Flats, Unit 13, Kenai Peninsula, Seward Peninsula
Mountain goat	-	Ketchikan
Muskox	-	Nunivak Island
Wolf	-	Unit 13

Table 1. Serum antibody prevalence for 8 infectious diseases in bison near Delta Junction, Alaska, 1975-83.

Disease	1975	1976	1977	1978	1979	1980	1981	1982	1983
Infectious bovine rhinotracheitis SN 8[a]	0/11[b]	0/8	0/27	0/28	0/11	0/9	1/46	0/47	0/31
Bovine viral diarrhea SN 8	0/10	0/9	1/28	0/28	0/10	0/9	2/46	0/35	0/33
Parainfluenza 3 HI 8	0/10	0/13	1/28	13/30	8/11	5/9	23/45	17/53	44/45
Epizootic hemorrhagic disease ID (±)	0/11	0/13	1/35	0/36	0/11	0/9	1/47	0/55	ND[c]
Bluetongue ID (±)	0/11	0/13	0/36	0/36	0/11	0/9	0/47	0/55	ND
Q fever CF 20	0/11	0/7	0/28	0/33	ND	ND	0/40	0/30	ND
Brucellosis BAPA (±)	0/7	0/3	0/25	0/31	ND	ND	0/47	0/53	ND
Leptospirosis MAT 100	0/10	0/8	0/31	0/34	0/11	0/9	0/46	8/51	ND

Table 1. Continued.

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[a] Name of test: SN = serum neutralization test; HI = hemagglutination - inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number postive/number tested.

[c] ND = not done.

Table 2. Serum antibody prevalence for 9 infectious diseases in caribou collected from the Nelchina Herd, Alaska, 1978.

Disease	1978
Infectious bovine rhinotracheitis SN 8[a]	1/13[b]
Bovine viral diarrhea SN 8	0/13
Parainfluenza 3 HI 8	0/12
Epizootic hemorrhagic disease ID (±)	0/13
Bluetongue ID (±)	0/13
Contagious ecthyma CF 5	0/7
Q fever CF 20	0/1
Brucellosis BAPA (±)	0/12
Leptospirosis MAT 100	0/10

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 3. Serum antibody prevalence for 9 infectious diseases in caribou collected from the Western Arctic Herd, Alaska, 1975-1982

Disease	1975	1978	1980	1981	1982
Infectious bovine rhinotracheitis SN 8[a]	2/11[b]	0/6	1/4	0/20	ND[c]
Bovine viral diarrhea SN 8	2/11	0/6	0/4	0/19	0/4
Parainfluenza 3 HI 8	0/12	0/8	0/4	0/20	0/4
Epizootic hemorrhagic disease ID (±)	ND	0/8	0/4	0/20	0/4
Bluetongue ID (±)	ND	0/8	0/4	0/20	0/4
Contagious ecthyma CF 5	ND	0/2	0/2	3/17	0/2
Q fever CF 20	ND	ND	ND	ND	0/1
Brucellosis BAPA (±)	2/14	0/6	1/4	9/23	0/4
Leptospirosis MAT 100	0/9	0/4	0/4	0/19	0/4

Table 3. Continued.

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[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = Not done.

Table 4. Serum antibody prevalence for 9 infectious diseases in caribou collected from the Central Arctic Herd, Alaska, 1975-82

Disease	1975	1976	1977	1978	1980	1981	1982
Infectious bovine rhinotracheitis SN 8[a]	9/30[b]	14/34	2/21	8/23	2/11	1/7	4/19
Bovine viral diarrhea SN 8	1/27	2/35	3/20	3/23	0/11	0/7	0/18
Parainfluenza 3 0/28	0/31	0/13	0/21	0/9	0/7	0/18	HI 8
Epizootic hemorrhagic disease ID (±)	0/1	0/2	0/2	0/13	0/11	0/7	0/21
Bluetongue ID (±)	0/1	0/2	0/2	0/13	0/11	0/7	0/21
Contagious ecthyma CF 5	ND[c]	0/2	0/2	0/12	1/4	0/6	0/12
Q fever CF 20	0/1	0/1	0/2	0/1	0/1	ND	0/4
Brucellosis BAPA (±)	0/30	1/37	0/30	0/26	0/8	0/7	1/13
Leptospirosis MAT 100	0/28	0/26	0/20	0/23	0/6	0/7	0/16

Table 4. Continued.

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[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 5. Serum antibody prevalence for 9 infectious diseases in caribou collected from the Porcupine Herd, Alaska, 1979, 1981, and 1982.

Disease	1979	1981	1982
Infectious bovine rhinotracheitis SN 8[a]	0/4	3/9	ND[c]
Bovine viral diarrhea SN 8	0/4	0/9	ND
Parainfluenza 3 HI 8	0/4	0/8	ND
Epizootic hemorrhagic disease ID (±)	ND	1/7	0/7
Bluetongue ID (±)	ND	0/8	0/7
Contagious ecthyma CF 5	ND	0/6	0/2
Q fever CF 20	ND	2/6	0/6
Brucellosis BAPA (±)	ND	0/7	0/9
Leptospirosis MAT 100	ND	0/6	0/9

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic aggluntination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 6. Serum antibody prevalence for 9 infectious diseases in caribou collected from the Fortymile Herd, Alaska, 1980 and 1982.

Disease	1980	1982
Infectious bovine rhinotracheitis SN 8[a]	0/4[b]	0/6
Bovine viral diarrhea SN 8	0/4	0/6
Parainfluenza 3 HI 8	0/4	0/6
Epizootic hemorrhagic disease ID (±)	0/4	0/8
Bluetongue ID (±)	0/4	0/8
Contagious ecthyma CF 5	2/4	0
Q fever CF 20	ND[c]	0/2
Brucellosis BAPA (±)	0/4	0/8
Leptospirosis MAT 100	1/4	0/8

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 7. Serum antibody prevalence for 9 infectious diseases in caribou collected from the Delta Herd, Alaska, 1979, 1981, and 1982.

Disease	1979	1981	1982
Infectious bovine rhinotracheitis SN 8[a]	0/10[b]	0/9	0/14
Bovine viral diarrhea SN 8	0/10	0/9	0/14
Parainfluenza 3 HI 8	0/10	0/8	0/10
Epizootic hemorrhagic disease ID (±)	ND[c]	0/9[d]	0/17[e]
Bluetongue ID (±)	ND	0/9[d]	0/17[e]
Contagious ecthyma CF 5	ND	0/8	0/14
Q fever CF 20	ND	2/3	1/9
Brucellosis BAPA (±)	0/10	0/9	0/16
Leptospirosis MAT 100	0/15	0/9	0/16

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

[d] 2 positive for EHD and BLU by ID, but negative by SN.

[e] 1 positive for EHD by ID, negative by SN; also negative for BLU by both ID and SN.

Table 8. Serum antibody prevalence for 7 infectious diseases in moose collected from the Tanana Flats south of Fairbanks, Alaska, 1979-81.

Disease	1979	1980	1981
Infectious bovine rhinotracheitis SN 8[a]	0/15[b]	0/10	0/2
Bovine viral diarrhea SN 8	0/15	0/10	0/2
Parainfluenza 3 HI 8	0/15	0/9	0/2
Epizootic hemorrhagic disease ID (±)	1/19	0/10	0/2
Bluetongue ID (±)	2/19	0/10	0/2
Brucellosis BAPA (±)	0/16	0/10	0/2
Leptospirosis MAT 100	0/16	0/10	0/2

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 9. Serum antibody prevalence for 7 infectious diseases in moose collected from Game Management Unit 13, Alaska, 1974-76 and 1978.

Disease	1974	1975	1976	1978
Infectious bovine rhinotracheitis SN 8[a]	0/40[b]	0/53	0/12	0/5
Bovine viral diarrhea SN 8	0/40	0/53	0/13	0/5
Parainfluenza 3 HI 8	1/42	0/53	0/15	0/5
Epizootic hemorrhagic disease ID (±)	0/42	4/53	2/11	0/5
Bluetongue ID (±)	0/43	0/52	0/15	0/5
Brucellosis BAPA (±)	0/44	0/53	0/15	0/4
Leptospirosis MAT 100	3/44	0/53	2/15	0/5

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 10. Serum antibody prevalence for 7 infectious diseases in moose collected from the Kenai Peninsula, Alaska, 1968, 1971-74, and 1977.

Disease	1968	1971	1972	1973	1974	1977
Infectious bovine rhinotracheitis SN 8[a]	0/12[b]	0/2	0/92	0/202	0/159	0/69
Bovine viral diarrhea SN 8	1/12	0/2	0/92	0/203	0/158	0/43
Parainfluenza 3 HI 8	0/15	0/8	2/102	6/210	0/182	0/63
Epizootic hemorrhagic disease ID (±)	0/17	0/10	1/104	0/211	1/179	5/57
Bluetongue ID (±)	0/17	0/11	0/103	0/215	0/183	0/77
Brucellosis BAPA (±)	0/15	0/11	0/106	0/217	0/184	0/79
Leptospirosis MAT 100	0/16	1/11	4/103	16/212	14/185	2/79

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 11. Serum antibody prevalence for 7 infectious diseases in moose collected from the Seward Peninsula, Alaska, 1981-83.

Disease	1981	1982	1983
Infectious bovine rhinotracheitis SN 8[a]	0/28	0/9	0/9
Bovine viral diarrhea SN 8	0/28	0/9	0/9
Parainfluenza 3 HI 8	0/27	0/9	0/9
Epizootic hemorrhagic disease ID (±)	2/28	0/9	0/9
Bluetongue ID (±)	0/29	0/9	0/9
Brucellosis BAPA (±)	1/29	1/9	0/9
Leptospirosis MAT 100	0/28	0/9	ND[c]

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = Not done.

Table 12. Serum antibody prevalence for 9 infectious diseases in muskox collected from Nunivak Island, Alaska, 1982-83.

Disease	1982	1983
Brucellosis BAPA (±)[a]	0/21[b]	0/6
Contagious ecthyma CF 5	0/28	0/5
Leptospirosis MAT 100	0/26	5/6
Q fever CF 20	2/28	0/4
Epizootic hemorrhagic disease ID (±)	0/34	0/4
Bluetongue ID (±)	0/31	0/5
Infectious bovine rhinotracheitis SN 8	0/32	0/6
Bovine viral diarrhea SN 8	2/32	0/5
Parainfluenza 3 HI 8	0/29	0/6

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test; CF = complement fixation test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = Not done.

Table 13. Serum antibody prevalence for 10 infectious diseases in Dall sheep collected near Dry Creek, Alaska, 1971, 1978, 1981, 1982, and 1983.

Disease	1971	1978	1981	1982	1983
Contagious ecthyma CF 5[a]	0/75[b]	5/5	13/29	16/20	20/24
Infectious bovine rhinotracheitis SN 8	0/7	0/9	0/28	0/20	0/20
Bovine viral diarrhea SN 8	0/7	1/9	0/28	0/13	0/20
Parainfluenza 3 HI 8	0/2	0/9	0/28	0/21	0/24
Epizootic hemorrhagic disease ID (±)	ND[c]	0/11	8/29	0/21	0/8
Bluetongue ID (±)	ND	0/8	0/17	0/14	0/22
Ovine progressive pneumonia ID (±)	ND	ND	ND	0/21	0/24
Brucellosis BAPA (±)	0/1	0/7	0/28	0/21	0/24
Leptospirosis MAT 100	ND	0/2	0/15	0/19	0/24
Q fever CF 20	0/75	0/10	5/20	8/15	0/13

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 14. Serum antibody prevalence for 10 infectious diseases in Dall sheep collected near Sheep Creek, Alaska, 1978 and 1983.

Disease	1978	1983
Contagious ecthyma CF 5[a]	6/25[b]	9/21
Infectious bovine rhinotracheitis SN 8	0/15	0/18
Bovine viral diarrhea SN 8	0/15	0/16
Parainfluenza 3 HI 8	0/11	0/21
Epizootic hemorrhagic disease ID (±)	0/25	0/12
Bluetongue ID (±)	0/19	0/19
Ovine progressive pneumonia CF 5	ND[c]	0/21
Brucellosis BAPA (±)	0/7	0/21
Leptospirosis MAT 100	0/7	0/21
Q fever CF 20	1/25	3/14

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 15. Serum antibody prevalence for 10 infectious diseases in Dall sheep collected from the Kenai Peninsula, Alaska, 1971.

Disease	1971
Contagious ecthyma CF 5[a]	2/20[b]
Infectious bovine rhinotracheitis SN 8	0/19
Bovine viral diarrhea SN 8	1/19
Parainfluenza 3 HI 8	0/15
Epizootic hemorrhagic disease ID (±)	0/13
Bluetongue ID (±)	ND[c]
Ovine progressive pneumonia ID (±)	ND
Brucellosis BAPA (±)	0/10
Leptospirosis MAT 100	0/11
Q fever CF 20	2/21

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 16. Serum antibody for 10 infectious diseases in Dall sheep collected from the White Mountains, Alaska, 1983.

Disease	1983
Contagious ecthyma CF 5[a]	0/6[b]
Infectious bovine rhinotracheitis SN 8	0/6
Bovine viral diarrhea SN 8	0/5
Parainfluenza 3 HI 8	0/4
Epizootic hemorrhagic disease ID (±)	0/2
Bluetongue ID (±)	0/5
Ovine progressive pneumonia ID (±)	0/6
Brucellosis BAPA (±)	0/6
Leptospirosis MAT 100	0/5
Q fever CF 20	0/4

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 17. Serum antibody prevalence for 4 infectious diseases in grizzly bear collected from the eastern Brooks Range, Alaska, 1973-75, and 1982-83.

Disease	1973	1974	1975	1982	1983
Brucellosis					
BAPA (±)[a]	4/17[b]	6/27	0/1	7/45	8/40
Tularemia					
TAT 20	ND[c]	ND	ND	0/45	0/40
Q fever					
CF 20	ND	ND	ND	0/42	0/39
Leptospirosis					
MAT 100	0/1	0/10	0/1	1/45	1/40

[a] Name of test: BAPA = buffered antigen plate agglutination test; TAT = tube agglutination test; CF = complement fixation test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 18. Serum antibody prevalence for 4 infectious diseases in grizzly bear collected from the western Brooks Range, Alaska, 1977-80 and 1983.

Disease	1977	1978	1979	1980	1983
Brucellosis BAPA (±)[a]	10/36[b]	9/14	0/3	2/24	4/14
Tularemia TAT 20	ND[c]	ND	ND	ND	0/14
Q fever CF 20	ND	ND	ND	ND	0/13
Leptospirosis MAT 100	0/1	ND	1/3	0/24	1/13

[a] Name of test: BAPA = buffered antigen plate agglutination test; TAT = tube agglutination test; CF = complement fixation test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 19. Serum antibody prevalence for 4 infectious diseases in grizzly bear collected from the Alaska Range, Alaska, 1981-83.

Disease	1981	1982	1983
Brucellosis			
BAPA (±)[a]	0/3[b]	2/25	0/22
Tularemia			
TAT 20	ND[c]	0/25	0/22
Q fever			
CF 20	ND	0/25	0/21
Leptospirosis			
MAT 100	1/4	2/25	2/22

[a] Name of test: BAPA = buffered antigen plate agglutination test; TAT = tube agglutination test; CF = complement fixation test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 20. Serum antibody prevalence for 4 infectious diseases in grizzly bear collected from Game Management Unit 13, Alaska, 1979-80.

Disease	1979	1980
Brucellosis		
BAPA (±)[a]	1/43[b]	1/27
Tularemia		
TAT 20	ND[c]	ND
Q fever		
CF 20	ND	ND
Leptospirosis		
MAT 100	0/43	4/27

[a] Name of test: BAPA = buffered antigen plate agglutination test; TAT = tube agglutination test; CF = complement fixation test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 21. Serum antibody prevalence for 4 infectious diseases in grizzly bear collected from Kodiak Island, Alaska, 1980-83.

Disease	1980	1981	1982	1983
Brucellosis				
BAPA (±)[a]	0/4[b]	0/1	1/62	1/18
Tularemia				
TAT 20	ND[c]	ND	0/2	1/18
Q fever				
CF 20	ND	ND	1/61	2/17
Leptospirosis				
MAT 100	0/4	0/1	9/63	4/18

[a] Name of test: BAPA = buffered antigen plate agglutination test; TAT = tube agglutination test; CF = complement fixation test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = not done.

Table 22. Serum antibody prevalence for 11 infectious diseases in mountain goat collected near Ketchikan, Alaska, 1981 and 1982.

Disease	1981	1983
Contagious ecthyma CF 5[a]	0/18[b]	0/20
Infectious bovine rhinotracheitis SN 8	0/18	0/16
Bovine viral diarrhea SN 8	0/18	0/14
Parainfluenza 3 HI 8	0/18	0/18
Epizootic hemorrhagic disease ID (±)	0/18	0/18
Bluetongue ID (±)	0/18	0/19
Ovine progressive pneumonia ID (±)	ND[c]	0/20
Caprine arthritis encephalitis ID (±)	0/18	ND
Q fever CF 20	6/18	3/20
Brucellosis BAPA (±)	0/18	0/20
Leptospirosis MAT 100	0/18	15/20

Table 22. Continued.

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[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test; CF = complement fixation test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] ND = Not done.

Table 23. Serum antibody prevalence for 9 infectious diseases in Sitka black-tail deer collected in southeastern Alaska, 1981.

Disease	1981
Infectious bovine rhinotracheitis SN 8[a]	0/7[b]
Bovine viral diarrhea SN 8	0/7
Parainfluenza 3 HI 8	0/7
Epizootic hemorrhagic disease ID (±)	0/7[c]
Bluetongue ID (±)	0/7[c]
Contagious ecthyma CF 5	0/3
Q fever CF 20	0/4
Brucellosis BAPA (±)	0/7
Leptospirosis MAT 100	0/7

[a] Name of test: SN = serum neutralization test; HI = hemagglutination-inhibition test; ID = immunodiffusion test; CF = complement fixation test; BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

[c] 2 specimens positive for EHD by ID, negative by SN; both specimens negative for BLU by ID and SN.

Table 24. Serum antibody prevalence for 2 infectious diseases in black bear from Game Management Unit 13, Alaska, 1980.

Disease	1980
Brucellosis	
BAPA (±)[a]	0/28[b]
Leptospirosis	
MAT 100	1/29

[a] Name of test: BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 25. Serum antibody prevalence for 5 infectious diseases in arctic fox collected near Prudhoe Bay, Alaska, 1979 and 1982.

Disease	1979	1982
Brucellosis BAPA (±)[a]	0/10[b]	0/13
Tularemia TAT 20	0/11	0/13
Q fever CF 20	8/21	1/13
Leptospirosis MAT 100	0/21	0/12
Canine Parvovirus SN 16	0/25	1/13

[a] Name of test: BAPA = buffered antigen plate agglutination test; TAT = tube agglutination test; CF = complement fixation test; MAT = microscopic agglutination test; SN = serum neutralization test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that this test is simply read as either positive or negative.

[b] Number positive/number tested.

Table 26. Serum antibody prevalence for 8 infectious diseases in wolves collected from Game Management Unit 13, Alaska, 1975-82.

Disease	1975	1976	1977	1978	1979	1980	1981	1982
Brucellosis BAPA (±)[a]	0/1[b]	0/10	0/8	0/13	0/2	0/14	1/13	0/8
Leptospirosis MAT 100	0/2	0/11	0/12	0/23	0/2	0/14	1/14	0/7
Infectious canine hepatitis SN 20	2/2	9/13	13/13	18/25	2/2	11/14	10/13	7/7
Canine distemper SN 20	1/2	2/13	1/13	2/24	0/1	2/12	0/13	2/7
Tularemia TAT 20	0/1	1/10	4/8	4/13	0/2	2/14	6/13	0/8
Canine parvovirus SN 16	0/2	0/13	0/13	0/25	0/2	1/14	7/13	4/7
Q fever CF 20	0/2	0/11	1/16	3/30	0/10	1/9	0/9	0/8
Rabies RFFIT 30	0/2	0/13	0/13	1/25	0/2	0/14	0/11	0/8

Table 26. Continued.

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[a] Name of test: BAPA = buffered antigen plate agglutination test; MAT = microscopic agglutination test; SN = serum neutralization test; TAT = tube agglutination test; CF = complement fixation test; RFFIT = rapid fluorescent focus inhibition test. Numbers indicate minimum titers necessary to be considered as evidence of previous infection. The (±) indicates that test is simply read as either positive or negative.

[b] Number positive/number tested.

Appendix A. Serologic survey for selected microbial pathogens in Alaskan wolves, 1975-82. Zarnke, R. L. and W. B. Ballard. 1986. J. Wildl. Dis. In press.

Abstract: Blood samples were collected from 116 wolves that were captured in southcentral Alaska during the years 1975 through 1982. Antibodies to the following diseases were found: infectious canine hepatitis - 72 of 87 (81%), canine parvovirus - 0 of 55 (0%) through 1979 and 10 of 32 (31%) after 1979, tularemia - 16 of 67 (25%), canine distemper - 10 of 83 (12%), Q fever - 5 of 95 (5%), rabies - 1 of 88 (1%), brucellosis - 1 of 67 (1%), leptospirosis - 1 of 82 (1%). Apparently, rabies, brucellosis, and leptospirosis were rare enough that they had little or no effect on the wolf population. Conversely, the other five diseases were comparatively common and may have had negative impacts on the health of specific individual wolves, and thus on the health of the population. There were only very minor fluctuations in wolf population density in the study area during the period of this study. Thus, none of the diseases is perceived as a serious threat to wolf populations.

Appendix B. Serologic survey for selected microbial pathogens in Alaskan wildlife. Zarnke, R. L. 1983. J. Wildl. Dis. 19:324-329.

Abstract: Antibodies to Brucella spp. were detected in sera of seven of 67 (10%) caribou (Rangifer tarandus), one of 39 (3%) moose (Alces alces), and six of 122 (5%) grizzly bears (Ursus arctos). Antibodies to Leptospira spp. were found in sera of one of 61 (2%) of caribou, one of 37 (3%) moose, six of 122 (5%) grizzly bears, and one of 28 (4%) black bears (Ursus americanus). Antibodies to contagious ecthyma virus were detected in sera of seven of 17 (41%) Dall sheep (Ovis dalli) and five of 53 (10%) caribou. Antibodies to epizootic hemorrhagic disease virus were found in sera of eight of 17 (47%) Dall sheep and two of 39 (6%) moose. Infectious bovine rhinotracheitis virus antibodies were detected in sera of six of 67 (9%) caribou. Bovine viral diarrhea virus antibodies were found in sera of two of 67 (3%) caribou. Parainfluenza 3 virus antibodies were detected in sera of 14 of 21 (67%) bison (Bison bison). Antibodies to Q fever rickettsia were found in sera of 12 of 15 (80%) Dall sheep. No evidence of prior exposure to bluetongue virus was found in Dall sheep, caribou, moose, or bison sera.

Appendix C. Serologic and experimental investigations of contagious ecthyma in Alaska. Zarnke, R. L., R. A. Dieterich, K. A. Neiland, and G. Ranglack. 1983. J. Wildl. Dis. 19:170-174.

Abstract: Serologic evidence of contagious ecthyma (CE) was found in domestic sheep (Ovis aries), domestic goats (Capra hircus), Dall sheep (Ovis dalli), and muskox (Ovibos moschatus) in Alaska. A moose (Alces alces) calf and a caribou (Rangifer tarandus) fawn were susceptible to experimental infection and both developed antibody titers as a result. CE virus was isolated from lesions of Dall sheep which were involved in a natural outbreak of the disease.

Appendix D. Serologic evidence of arbovirus infections in humans and wild animals in Alaska. Zarnke, R. L., C. H. Calisher, and J. Kerschner. 1983. J. Wildl. Dis. 19:175-179.

Abstract: Blood samples were collected from humans and several species of free-ranging wild animals in Alaska. Sera were tested for antibody to Jamestown Canyon (JC), snowshoe hare (SSH), Northway (NOR), Klamath (KLA), Sakhalin (SAK), Great Island (GI), and Silverwater (SIL) virus. JC antibody was found in 54% of 121 human, 89% of 97 bison (Bison bison), 51% of 84 Dall sheep (Ovis dalli), 43% of 68 snowshoe hare (Lepus americanus), and 3% of 33 arctic fox (Alopex lagopus) sera. SSH antibody was found in 42% of 121 human, 89% of 97 bison, 41% of 84 Dall sheep, and 65% of 68 snowshoe hare sera. NOR antibody was found in 14% of 1221 human, 94% of 97 bison, 84% of 84 Dall sheep, 43% of 69 caribou (Rangifer tarandus), 3% of 68 snowshoe hare, 48% of 64 grizzly bear (Ursus arctos), 3% of 33 arctic fox, and 78% of 27 moose (Alces alces) sera. KLA antibody was found in 5% of 121 human and 40% of 97 bison sera. SAK antibody was found in 2% of 97 bison and 3% of 33 arctic fox sera. GI antibody was found in 1% of 97 bison sera. No SIL antibody was found in any sera tested. Thus the natural host ranges of JC, SSH, NOR, and KLA viruses have been extended by inference from the occurrence of antibody.