The Ecology of the Timber Wolf (*Canis lupus* Linn.) in Southern Manitoba - Wilderness, Recreational and Agricultural Aspects.

by

Edward Leslie Hill

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Department of Zoology
Winnipeg, Manitoba
R3T 2N2

THE ECOLOGY OF THE TIMBER WOLF (*Canis lupus* Linn.) IN SOUTHERN MANITOBA - WILDERNESS, RECREATIONAL AND AGRICULTURAL ASPECTS.

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ABSTRACT

The ecology and recreational value of timber wolves (Canis lupus) in the Wallace Lake area and the extent of wolf predation on cattle in agricultural regions of Manitoba were examined during 1973-1975 in an effort to evaluate the ecological, recreational and economic status of wolves in Southern Manitoba.

A population of approximately eleven wolves occupied the 563 km^2 Wallace Lake study area resulting in a density of one wolf per 51 km^2. Examination of 203 wolf scats from the study area showed that moose, white-tailed deer and beaver comprised 89.5% of the wolves' diet. Beaver was the primary prey species during summer while moose and deer were utilized heavily during the winter. There was no shift in the wolves' diet to young ungulates during the summer.

Post-mortem examinations of 21 wolf carcasses collected by trappers from scattered locations throughout Southern Manitoba revealed the majority were in good nutritional condition with light parasite loads and few pathologic abnormalities. Sixteen of 20 wolves aged were less than one year old.

A questionnaire survey of 126 summer visitors to the Wallace Lake study area indicated a large majority was interested in hearing and seeing wolves, and 73.6% would have been willing to participate in organized programmes on wolf biology had these been available.

A questionnaire mailed to 1,059 cattle owners yielded a 49.2% return. Of those, 19% had lost livestock to predators of all species during the last five years. Only 1.8% had lost a total of 19 calves and one sheep, attributable to wolf predation during 1973-74. It was concluded that livestock losses to timber wolves in Manitoba were minimal.

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INTRODUCTION

The timber or grey wolf (Canis lupus Linn.) at one time had a circumpolar distribution in the Northern Hemisphere. It was found in all Northern Hemisphere habitat types with the exception of certain desert areas in the western and south-western regions of the United States and tropical rain forests (Goldman, 1944). In North America the wolf's range extended from the High Arctic Islands to the southern end of the Mexican Plateau (Goldman, ibid.). Wolves now occupy approximately half of their former range in North America (Theberge, 1973). The remnant populations outside Canada and Alaska are very small and geographically limited.

Men and wolves have seldom co-existed peacefully. The wolf is a predator of large mammals and this has led to conflicts, either real or imagined, with man's utilization of game animals and husbandry of domestic livestock. The belief that wolves prey on humans has also contributed to the fear and hatred that man has felt for the wolf. As a result, wolves have been exterminated in much of their former range.

As in other areas of North America, the wolf in Manitoba has been subjected to bounty and poison campaigns in an attempt to lower the population and hence the presumed conflict with man. In Manitoba wolves have been restricted primarily to the boreal forest "wilderness area" of the province with

small outlying populations existing in Riding Mountain National Park and Spruce Woods Provincial Park. Wolves are occasionally seen in agricultural Manitoba. Although there is no longer a provincial bounty on the wolf, it is still classified as a predator and is therefore unprotected throughout the year except in wildlife refuges and Riding Mountain National Park.

In recent years the public attitude toward predators has changed. Increases in both the sport-hunting value and the commercial value of predators have resulted in increased hunting and trapping pressures. At the same time, the aesthetic and intrinsic values of predators have been recognized and the wolf has become a symbol of "wilderness". Because of their increased aesthetic and commercial values, there is now a greater need for "management" of wolves and other predators than for control. Management of predators requires information on the biology of the species, on their effects on agricultural operations and on their effects on other wildlife species.

Few data have been collected on wolves in Manitoba except in Riding Mountain National Park where a detailed study of wolf ecology is presently being conducted as part of a large mammal systems study (Carbyn, pers. comm.). Records of track occurrences, rough population estimates and some reports of predation on livestock have been presented in regional reports by the Manitoba Department of Renewable Resources and Transportation Services (R.R.T.S.). This,

however, is not an adequate basis for making management decisions of potential biological and economic impact on wolf populations.

I undertook this study to provide some basic data on the ecology of timber wolves in Manitoba. The primary objective of my study was to examine the ecology of timber wolves in the Wallace Lake area. The secondary objective was to examine some aspects of the relationship between man and wolves. This involved evaluating: 1) the effects of wolves on cattle-rearing operations in agro-Manitoba and 2) the attitudes of tourists in a wilderness area (Wallace Lake) to wolves. The data collected in this study were used to formulate recommendations for a wolf management policy for Manitoba.

LITERATURE REVIEW

Timber wolves evolved as pack-hunting predators of large animals. They possess physical and behavioral characteristics which have adapted them to this niche. The adaptations which enable them to capture large ungulates render them inefficient as hunters of small animals. Studies in North America have shown that timber wolves depend on large ungulates for their primary food source. Although wolves consume a wide variety of small mammals, birds, fish, invertebrates and vegetation, beaver (Castor canadensis) is the smallest species they prey on regularly. There is a large recent body of literature concerning the interaction of wolves with moose (Alces alces), deer (Odocoileus sp.) and beaver.

Pimlott et al. (1969) observed that wolf food habits studies in North America have shown that there is an "optimum prey species" in every area. That is, one species provides the majority of the wolves' diet. They suggested that a combination of prey characteristics such as density, escape and defence capabilities and habitat physiography determine the "optimum prey species" of an area.

Wolves concentrate on the smallest or easiest prey to catch when two or more species of large prey inhabit the same area (Mech, 1970). Peterson (1955) found that wolves preyed more heavily on white-tailed deer (Odocoileus virginianus) than on moose in the St. Ignace Island area of

Ontario. Despite the fact that moose were much more abundant, he found that their remains occurred in only 36% of the scats collected while deer remains were found in 57%. Cowan (1947) reported that mule deer (Odocoileus hemionus) contributed more to the diet of wolves in Jasper and Banff National Parks than the deer population size would suggest. He found that deer kills were approximately half as numerous as elk (Cervus canadensis) kills although only about one third as many deer as elk were seen. Pimlott et al. (1969) also found that deer were the preferred food of wolves in Algonquin Park, Ontario.

The feeding habits of timber wolves shift with changes in prey populations (Murie, 1944; Voigt et al. 1976) and also with the seasonal availability of prey. When one prey species becomes scarce or unavailable, such as beaver do during the winter, they concentrate on other species. An important seasonal change in the diet of wolves is the shift from adult to infant ungulates during the summer.

FOOD HABITS OF WOLVES

MOOSE

The wide distribution of moose in North America has made them the primary ungulate prey of wolves in many areas. Moose is also an important game species, a situation which has led to real and imagined conflicts between humans and wolves over the utilization of moose.

The importance of moose to the diet of wolves depends upon the availability of alternate food sources. Murie (1944) found that barren-ground caribou (Rangifer tarándus) was the major food source of wolves in Mount McKinley National Park and moose remains were identified in only nine of 1,174 scats. Cowan (1947) noted that while moose were fifth in abundance in the total game population of Jasper and Banff National Parks, they were the third item in importance in the wolves' diet (7% of 420 scats). Pimlott et al. (1969) expected that moose would be the predominant food item following a decline in the deer population in the Marten River area of Ontario. However, the occurrence of moose remains in scats was only 17% while deer was 42%. Burkholder (1959) observed a pack of 10 wolves in Alaska for six weeks and found that, of 22 kills, 14 were caribou and eight were moose. Stephenson and Johnson (1972) and Stephenson (1975a) found that moose were the primary prey of wolves in south-central Alaska.

The wolves in Isle Royale National Park in Michigan rely on moose and beaver for their food supply. Moose are the only ungulates found on the island. Mech (1966) found moose remains in 75.9% of 438 summer scats and Shelton (1966) found that moose comprised 86% of summer food items occurrences. Beaver remains were found in approximately 11% of the summer scats collected during these studies. The summer predation pattern on Isle Royale changed in the early 1970's due to an increased beaver population and a decrease in moose productivity.

Beaver became the principal food source for the wolves during the summer, occurring in 76% of the scats examined in 1973 (Peterson, 1975). Moose have remained the major winter food source for the wolves.

Selection of Moose

Mech (1966) found that the predation efficiency (per cent of moose "tested" that were killed) of wolves on Isle Royale was 7.8%. Shelton (1966) found the total predation efficiency of wolves on Isle Royale over five years (his study and Mech's) was 8.1%. The low predation efficiency of wolves suggests that they must search out moose which are more vulnerable to predation than the majority of the population. A number of factors including age, sex, debilitating conditions, winter severity and range conditions have been found to influence the suceptibility of moose to predation by wolves.

Predation by wolves is usually concentrated on calves and relatively old moose. Studies of the summer food habits of wolves have shown that calves often comprise the majority of moose eaten during that season. Mech (1966) found that 75% of identifiable occurrences of moose remains were calves. Pimlott et al. (1969) found that calves comprised 88% of the occurrences of moose remains. Frenzel (1974) also found a very high proportion of calf remains in summer wolf scats.

Moose, especially calves, were a major item in the summer diet of wolves in south-central Alaska (Stephenson, 1975a).

Because it is impossible to discern whether food items found in scats are obtained through predation or scavenging, it is difficult to determine the significance of this high occurrence of calf remains. If the wolves are feeding on dead calves or calves that would have died of other causes they would not affect the population significantly. However, if they were preying on young animals which would otherwise survive, they could be a significant limiting factor.

LeResche (1968) found that in one area in Alaska the greatest mortality among moose calves occurred during the first five months after birth. During that time, 56% of the calf crop was lost. The greatest mortality, approximately 26%, occurred within two weeks of parturition. Causes of mortality included drowning, entrapment by vegetation, abandonment, injuries inflicted by the mother and predation. Gasaway et al. (1977) estimated calf mortality in another area of Alaska to be 40 - 50% from parturition to six weeks and 60 - 70% by six months of age. They believed wolf predation to be the most probable cause of this high mortality rate.

Moose between the ages of one and seven years are usually not affected by wolf predation (Mech 1966). Winter studies have shown that calves and older animals (eight years and older) bear the brunt of wolf predation. Burkholder (1959)

determined the ages of seven moose killed by wolves and found that six were calves and one was a yearling. He did not notice any selection for age among 14 caribou killed by the same pack during the observation period. Mech (1966) found that calves composed 15% of the moose population on Isle Royale during his three year study. However, calves comprised 36% of 50 observed winter kills and approximately 47% of 36 kills made by the large pack of 15 wolves. No wolf-killed moose between the ages of one and seven years were found. Moose eight years and older comprised 46% of the winter kills. Shelton (1966) in a later study, examined 28 kills made by the large pack and found that 79% were eight years or older. Fourteen per cent of these kills were calves despite the fact that he estimated that calves made up approximately 17% of the late winter population. This low representation of calves may be explained by the fact that in 1962 he missed at least three kills (probably calves) by the big pack. Wolfe and Allen (1973) found that 32% of the 44 wolf-killed moose they examined, also on Isle Royale, were calves.

Mech (op. cit.) and Shelton (op. cit.) found a strong selection for female moose on Isle Royale during February and March (67% and 65% respectively), assuming the sex ratio was even. Shelton (ibid.) reported that the sex ratio of all adult moose killed or eaten by wolves, including those found in spring, summer and fall, was 18 males: 19 females.

Furthermore, the sex ratio of all remains, young and adult, for which sex could be determined, was 23 males: 25 females. On the basis of this information, Mech (1970) suggested that wolf predation on bull moose was concentrated during some period other than February and March. Wolfe and Allen (1973) however, did not find this selection for cows in later studies on Isle Royale. Stephenson and Johnson (1972) found that five of nine wolf-killed moose they examined in Alaska were adult females but that adult females were the most abundant group in their study area.

Debilitating factors such as malnutrition, parasites and pathological conditions may increase the vulnerability of moose. It is difficult to find evidence of physical disabilities in wolf-killed animals because the carcass is usually completely consumed or nearly so by the time it is discovered. As Mech (1970) pointed out, it is also difficult to determine the effect of various debilitating factors on vulnerability when the incidence of these factors in the population is unknown.

Moose are subject to a wide range of diseases and parasites, many of which seem to have been acquired in North America from contact with livestock and native deer of the genus Odocoileus (Anderson and Lankester, 1974). Sylvatic echinococcosis is common in Canada and the northern United States wherever moose and wolves co-exist. Anderson and Lankester (ibid.) briefly reviewed the literature on

Echinococcus granulosus and found general agreement that increasing numbers of pulmonary hydatid cysts increase an animal's vulnerability to predators and other stresses. Mech (1970) found a much higher rate of infection in a small sample of wolf-killed moose than in animals that died of other natural causes.

Mech (ibid.) reported that 21% of 61 wolf-killed moose on Isle Royale had moderate or severe granulomatous lesions in the manibular region which may have been the result of actinomycosis or food impaction. Although the effect of such infection in moose is unknown, Murie (1944) found that it was an important factor in predation in Dall sheep (Ovis dalli) between two and eight years of age.

Peek et al. (1976) found that all mortality appeared to be concentrated on calves, yearlings and the oldest animals in a Minnesota moose population. Cerebrospinal nematodiasis (Parelaphostrongylus tenuis) was found to be the cause of death in 23 of 34 moose which died of natural causes. Moose which died of nematodiasis were under five years of age. Peek et al. (ibid.) suggested that the presence of this parasite in the population might alter the age structure of wolf-kills by predisposing relatively young moose to predation.

Mech (1970) suggested that malnutrition, as evidenced by fat-depleted femur marrow, may increase the vulnerability of moose to wolf predation. The marrow of eight of 54 wolf-killed adult moose on Isle Royale was fat-depleted. Studies

in Alaska have not shown a strong selection for malnourished moose. Stephenson and Johnson (1972) and Stephenson (1957b) found that the majority of moose taken by wolves were in relatively good nutritional condition. Franzmann and Arneson (1976) found that the marrow fat content of moose killed accidentally and by wolves during the winter was very similar. The marrow fat content of these groups was significantly greater than that of moose which starved to death during the same period. Their data suggested that wolves selected moose from the entire population and did not rely on moose under nutritional stress.

Effect of Winter on Predation

Moose have physical and behavioral adaptations to snow cover. Their long legs assist in their browsing habit and are an obvious advantage in thick snow cover. Coady (1974) concluded that adult moose are relatively unimpeded by snow thicknesses up to 70 cm. Snow thicknesses greater than 90 cm severely restrict movement and can be critical. Calves are less able to cope with thick snow cover because of their shorter legs.

During the winter, moose are in a negative energy balance due to the low quality of browse available during that season (Gasaway and Coady, 1974). Thick and/or hard snow can add to this stress by reducing the availability of low-growing browse species and restricting movement so that

more energy is expended moving to feeding areas than is derived from the ingested food (Coady, op. cit.).

Several authors have recorded the effect of severe winters on moose populations. MacLennan (1975) reported heavy mortality in Saskatchewan following the severe winter of 1970-71. Gasaway et al. (1977) reported a general and precipitous decline in the Alaskan moose population during the winter of 1965-66 which had near-record snow accumulation.

The pattern of wolf predation on moose changes during severe winters with more than 70 cm of snow. Moose of all age classes become more vulnerable but most noticeable are calves and young adults from one to six years of age. Peterson and Allen (1974) found that unusually thick snow cover resulted in an increased rate of predation and less complete utilization of kills. Of 193 wolf-killed moose, 31% were calves when snow thicknesses were less than 76 cm. However, when the snow thickness was greater than 76 cm the proportion of calves rose to 49% of 76 kills (Peterson and Allen, ibid.). They found that during the severe winters of 1969, 1971 and 1972, 38% of 42 adult moose killed by wolves were from one+ to three+ years of age while in other years on Isle Royale (with less snow) this age class represented only 12% of 113 kills. Stephenson (1975b) reported that during the severe winter of 1971-72, calves comprised 56.1% of the wolf-killed moose located but had made up only 15.8% of the autumn 1971 population. This suggests that calf mortality increases

significantly only during very severe winters.

Peterson and Allen (1974) suggested several possible explanations for increased calf vulnerability under these conditions. Both moose and wolves use shorelines extensively because travelling is easier there than inland, resulting in more contacts between the two species. Cows and calves are separated occasionally when the cow goes inland to feed while the calf remains near the shore. When a cow-calf pair is tested by wolves, the cow guards the rear and the calf is forced to break trail thereby expending a great deal of energy. The ability of cows to protect their calves may also be reduced by winter stress. Calves are the first age group to be affected by malnutrition which reduces their vigor and increases their vulnerability. Stephenson (1975b) reported that the marrow fat content of eight adult wolf-killed moose averaged 75.8% while that of 14 calves averaged 21.8%.

Stephenson (1975b) found that the average age of adult moose taken by wolves during two average winters was 10.6 years while hunter-killed moose averaged about six years which suggested that the wolves selected moose which were slightly older than the population average. During the severe winter of 1971-72 however, the mean age of adult wolf-killed cows and bulls was 8.6 and 3.0 years respectively. Hunter-killed adult cows and bulls in 1971 averaged 6.7 and 3.2 years respectively. This suggested that younger animals were more vulnerable during that severe winter.

Wolves and moose differ greatly in their abilities to travel in specific snow conditions. The static weight-load of moose has been found to vary from 420 g / cm^2 to over 1000 g / cm^2 (Nasimovich, 1955; Kelsall and Telfer, 1971). Coady (1974) found that the foot load decreased from fall to spring due to seasonal loss of body weight. Peterson and Allen (1974) conducted compaction tests to determine the weight-load that best simulated the track depth of moose and found that the average value was 230 g / cm^2. Wolves have a much lower weight-load. Nasimovich (op. cit.) found standing weight-loads of 89 to 114 g / cm^2 and Peterson and Allen (1974) found that a weight-load of approximately 100 g / cm^2 best simulated track depths of wolves. The long legs of moose give them an advantage in thick snow cover of low density but wolves are supported by crusts through which moose break.

Pruitt (1959) described a "snow shadow effect" caused by vegetation along shorelines which results in a band of relatively thick soft snow extending up to 90 meters out from the shore. As this snow is thicker and softer than the snow farther out on the lake it may give the wolves an advantage over their prey when contact occurs there. Pruitt (ibid.) also noted that a "snowfence effect" caused by shoreline vegetation results in thicker softer snow cover for a variable distance inland than is found under normal forest cover. This might also give the wolves an advantage if the prey attempted

to move inland after contact occurred.

The increased vulnerability of moose during severe winters appears to be due to a combination of the effect of weather on their health and vigor and a restriction of their escape and defense capabilities by thick snow. Although studies by Stephenson (1975b), Stephenson and Johnson (1972) and Franzmann and Arneson (1976) showed that wolf-killed moose were usually in better condition nutritionally than moose that were winter-killed, severe winters reduce the nutritional level and hence increase the vulnerability of the entire population. In extremely thick snow cover (over 70 cm), the fact that the weight-load of wolves is less than half that of moose could become a critical factor. Furthermore, until the snow becomes dense enough to support a moose, each increase in density is to the wolf's advantage. Mech (1966) noted that when pursuing a moose, most of the wolves followed single file in the trail of the moose. This enables the wolves to conserve energy while the moose is forced to exert valuable energy breaking the trail. These factors plus the increased contact along shorelines probably account for increased predation rates during severe winters.

Malnutrition due to thick snow and restricted browse intake can have a long term effect on moose susceptibility to wolf predation. Gasaway and Coady (1974) noted that pregnant cows undergo a period of greatly increased energy

demands from early March until parturition. Malnutrition during this fetal period results in calves which are of subnormal size at birth and suffer long-term retardation in growth and development (Peterson, 1975).

Peterson (ibid.) found that on Isle Royale the percentage of one to six year old wolf-killed moose rose from 5% to 22% from the early 1960's to the late 1960's and increased to 53% in the early 1970's. This mortality pattern continued even in winters of below average snow thicknesses. Most of these moose were in average physical condition. Since most of these moose were born after winters in which nutritional hardship was apparent, Peterson suggested that malnutrition during the fetal period affected their later development so that they were susceptible to wolf predation during age classes when Mech (1966) found that most moose were "invulnerable" to wolves.

Effects of Wolf Predation on Moose Populations

The question whether or not wolves can control or limit populations of moose or other "big game" species is the core of much conflict between man and wolves. Various studies have shown that wolf predation can be a major mortality factor and under certain conditions may be the primary factor limiting moose populations.

Pimlott (1967a) postulated that predators may have effectively controlled ungulate populations before humans

altered the environment. He suggested that deer and moose did not evolve intrinsic mechanisms of population control to prevent their exceeding their food supply because they had very efficient predators. Pimlott (ibid.) considered that the forest ungulates and their predators evolved in relatively stable environments that could not support high density prey populations.

Cowan (1947) reported that survival rates of elk, deer, moose and sheep were nearly identical in wolf-inhabited and wolf-free areas. He believed that range condition was the critical limiting factor. The prey: predator ratio in Cowan's study area was very high - approximately 300 to 400 head of "big game animals" per wolf. He noted that the wolves were not able to remove the injured and diseased animals from the population let alone prevent populations from increasing.

Mech (1966) and Shelton (1966) concluded that the wolves on Isle Royale were controlling the moose population below the level at which the food supply would become the limiting factor. The wolf: moose ratio in these studies was approximately 1:30. Both authors noted that continuing forest maturation would eventually reduce the amount of available browse and hence cause a reduction in both moose and wolf populations.

The beneficial effects of intensive wolf predation on Isle Royale were evidence by high productivity and the absence

of starvation in the moose population. The twinning rate is a sensitive indicator of a moose population's productivity. Data presented by Mech (1966) and Shelton (1966) indicated an extremely high twinning rate of approximately 32%. Since wolves arrived on Isle Royale the moose population has remained relatively stable and has not exhibited the extreme increases and decreases found in the 1930's and 1940's which were due to depletion of the food supply (Mech op. cit.).

Pimlott et al. (1969) noted the beneficial influences of wolf predation on the Isle Royale moose population but criticised the conclusion reached by Mech (1966) and Shelton (1966) that wolves were controlling the moose population. The criticisms of Pimlott et al. (op. cit.) were based on three weaknesses in the facts. Firstly, the moose population may have been underestimated. Secondly, Mech and Shelton obtained their estimates of annual adult mortality by projecting the rate of kill of adults during their winter study period. Pimlott et al. (ibid.) suggested that fewer adults were killed in the summer when calves were most vulnerable. Thirdly, the conclusion that the population was stable was based primarily on the observation of calves in late winter.

Peterson (1975) reported that the wolves on Isle Royale have not imposed a limit on moose density independent of the food supply and other environmental factors. Browse production in the most recent burn (1936) has declined, forcing

the moose to increase their use of areas of more mature forest which are marginal habitats. However, despite the decreasing carrying capacity, the moose population increased during the 1960's. A series of severe winters beginning in 1969 has increased the stress on the moose populations. As a result of these conditions, the productivity of the moose has declined and there is more evidence of malnutrition. Peterson (ibid.) noted a twinning rate of only 14% from 1966 through 1973, a significant decline from that reported by Mech (1966) and Shelton (1966). Peterson (op. cit.) also reported several deaths due to malnutrition in 1971, 1972 and 1974.

As mentioned previously, the pattern of wolf predation on Isle Royale has shifted during the 1970's so that a greater proportion of young adult moose were taken. The wolves responded to the increased vulnerability of moose functionally by an immediate increase in kill rate and numerically by an increase in wolf density (Peterson, 1975). Peterson (ibid.) stated that although the mid-winter moose population has not declined significantly since 1969, the low calf production and survival and high winter mortality due to predation suggest that a decline in the moose population is very possible. In addition to an increased predation rate, the wolves were killing young moose before they could contribute to the population. Peterson (ibid.) noted that the degree of control exerted by wolves depends ultimately

upon the browse supply and winter severity which affect the vulnerability of moose to predation as well as their productivity.

Workers in Alaska have found that wolves can have a controlling effect on moose populations when moose survival and productivity are reduced by severe winter conditions and/or declining habitat conditions. Rausch (1969) noted that the best correlation of moose population fluctuations appeared to be with winter range and climatic extremes rather than with hunting or wolf predation. Rausch et al. (1974) suggested that when severe winters result in population decreases, wolves may accelerate the decrease by preying intensively on the younger age classes as shown by Peterson (1975). Bishop and Rausch (1974) stated that a combination of wolf predation and hunting have probably prevented the recovery of the Nelchina Basin moose population following a decline due to severe winters.

Gasaway et al. (1977) studied the effects of wolf predation on a moose population in interior Alaska. The moose population in the Tanana Valley increased from the 1940's until the mid-1960's due to a combination of factors - an increased food supply resulting from fires, cessation of market hunting, initiation of a predator control program and a long series of mild winters. The population declined during the severe winters of 1965-1966 and 1966-1967, recovered slightly and then crashed during the winter of

1970-1971 when up to 50% of the population may have died. The population continued to decline through 1975.

The wolf population in the area increased following the cessation of the predator control program and remained high while the moose population declined. This resulted in a wolf : moose ratio of approximately 1 : 15 in 1975. A ratio of approximately 1 wolf : 43 ungulates existed when Dall sheep and caribou were included but these species were limited to the mountainous southern half of the area. Therefore moose was the only ungulate prey available in half the area.

Gasaway et al. (ibid.) found that high rates of calf and adult mortality precluded population growth. Hunting, range conditions and disease were not limiting the population. They found that low reproductive rates and neonate mortality were not responsible for the low population. Surveys showed that summer and winter calf mortality increased during the 1970's. The greatest increase in calf mortality occurred between June and November. Calf mortality in a group of 48 collared cows was estimated to be 68% by five months of age in 1975. This information suggested that predation was the most significant factor influencing calf survival and hence population growth.

Following much political controversy, the wolf population in the study area was reduced by approximately 60% during the winter of 1975-76. This resulted in very low wolf densities

in the Tanana Flats where moose were the only available ungulate prey.

Calf survival was much higher through November, 1976 and similar to the rates observed during the early 1960's when the population was increasing. The increased rate of calf survival was presumed due to reduced wolf predation.

Gasaway et al. (ibid.) concluded that the moose population had reached a critically low point due to severe winters. This decline was hastened by sport hunting which took an estimated 15-20 percent of adult moose in 1973. Once the moose population reached that critical low point, wolves were able to regulate it and cause further declines.

WHITE-TAILED DEER

White-tailed deer is the major prey species of timber wolves in most areas of North America where the two species co-exist. Thompson (1952) and Stenlund (1955) found that deer were the staple food of wolves in Wisconsin and Minnesota. Later studies by Mech et. al. (1971b), Frenzel (1974) and Van Ballenberghe et al. (1975) showed that deer was the primary prey of wolves in northeastern Minnesota. Pimlott et al. (1969) found that deer was the principal prey of wolves in the Algonquin Park area of Ontario. Deer remains were found in 80% of 1435 summer scats and in 90% of 50 winter scats collected in Algonquin Park. Deer comprised 42% and 59% of summer scats collected in the

Marten River and Pakesley areas respectively near Algonquin Park. Despite the importance of beaver in their summer diet, wolves could not exist in these areas if moose and especially deer were not available to them (Pimlott et al. ibid.).

Voigt et al. (1976) found that due to a decline in deer population, beaver became the principal summer food of wolves in the three areas studies by Pimlott et al. (op. cit.). The occurrence of deer remains dropped from 76% in 1963 to 33% in 1972 in Algonquin Park while in the Pakesley area it was only 11% from 1964 through 1967. In 1969 the occurrence of deer hair in 220 summer scats in the Marten River area as 1%. This change in the feeding habits of wolves resulted from a decreased availability of deer while the beaver population remained fairly high or increased. Because beaver are not available during the winter, Voigt et al. (op. cit.) suggested that a continued decline in the deer population would result in lower wolf densitites in the Algonquin Park area.

Selection of Deer

As with moose, wolf predation on deer is selective. Mech and Frenzel (1971) noted that wolves had a low success rate in capturing deer during the winter. Only one chase of 14 which were observed was successful (6.7%). This was similar to the kill rate of moose found on Isle Royale (7.8%)

by Mech (1966). The low success rate suggests that most deer are relatively invulnerable to wolf predation or conditions of the hunts are usually not favorable to the wolves. Vulnerability to wolf predation depends on age, physical disabilities, snow conditions and habitat condition.

Fawns usually comprise a major proportion of the deer fed upon by wolves during the summer. Thompson (1952) found fawn remains in approximately 45% of the summer scats which contained deer hair. Fawn hair comprised 71% of deer occurrences between 1 July and 30 September in the Algonquin Park area (Pimlott et al. 1969). Voigt et al. (1976) found that fawn hair comprised 81% of the occurrences of deer hair after 31 May in the same area.

Van Ballenberghe et al. (1975) documented the seasonal importance of fawns to wolves and the changes in the wolves' diet over the summer. Prior to the fawning period, adult deer comprised 77% of the food item occurrences. From mid-June until mid-July, deer remains were found in 81% of the scats and of those, 48% were fawns. The occurrence of deer declined after mid-July to less than 50% and only approximately 33% of the deer occurrences in scats were fawns. Van Ballenberghe et al. (ibid.) suggested that the abrupt decrease in deer and fawn consumption was due to decreased numbers or vulnerability of fawns and increased utilization of other food sources.

It is difficult to determine the effect on deer populations of heavy utilization of fawns during the summer by wolves because the proportion of fawns consumed as carrion is unknown as is the proportion of fawns which would have died of other causes even if wolves had not taken them. Pimlott et al. (1969) suggested that if much of the predation on fawns is non-compensatory it could have a substantial limiting effect on deer populations.

Cook et al. (1971) studied fawn mortality in a wildlife refuge in Texas, Of 81 radio-collared fawns, 58 died during the study and 93% of this mortality occurred within 32 days of parturition. Coyote (Canis latrans) predation accounted for 50% of the fawn deaths. Cook et al. (ibid.) suggested that predation by coyotes on fawns was the major factor stabilizing this deer population. They also noted that disease could be an important regulating factor both as an independent mortality factor and as a predisposing factor in predation. White et al. (1972) stated that: "Heavy predation on newborn ungulates apparently represents one of the most important loss factors and evolutionary forces in many populations."

Wolf predation during the winter is concentrated on deer older than five years. Pimlott et al. (1969) aged 331 wolf-killed deer and found that 17% of them were fawns, 25% were one to four years old and 58% were five years or older. This age distribution differed significantly from that of

275 deer killed by cars or collected for research purposes in Algonquin Park of which 20% were fawns, 67% were one to four years old and only 13% were five years or older. The age distribution of the latter group was similar to that of hunter-killed deer inside Algonquin Park. Mech and Frenzel (1971) found an abnormal age distribution among wolf-killed deer in northeastern Minnesota. Wolf-killed deer were significantly older (average of 4.7 years) than hunter-killed deer with an average age of 2.6 years. The age distribution of 433 hunter-killed deer was: fawns 26%, one to four years 64% and five years and older 10%. Both authors noted that fawns may be under-represented in these studies since their small carcasses may be consumed more completely making them difficult to locate.

Mech and Frenzel (ibid.) offered two possible explanations for the increased vulnerability of deer over five years of age. Firstly, the deer are in the final half of their life span and their alertness and fitness may be expected to decline. Secondly, Kelsall (1969) found that the weight-load on track increased in deer, at least up to 4.5 years. Therefore older deer would probably sink deeper into snow than young animals and their escape would be impeded.

Wolf predation appears to be selective for female fawns and adult male deer. Mech and Frenzel (1971) found a higher proportion of females (59%) in fawn wolf-kills than in

adults (46%) while the sex ratio of hunter-killed fawns was even. Pimlott et al. (1969) did not separate fawns from adults but found that males comprised 57% of 257 sexable wolf-kills in Algonquin Park. This differed significantly from the expected 50 : 50 sex ratio. Mech and Frenzel (op. cit.) found that in a wilderness area wolves preyed more heavily on adult males (71%) than on adult females (39%). Hunter-killed deer also contained a higher percentage of males (66%) presumably due to their greater movement during the rutting season which overlapped the hunting season. In the hunted area wolves killed a significantly higher percentage of adult does (56%) than in the wilderness area. This was due presumably to the effect of hunters on the sex ratio of the deer population. Kolenosky (1972) found that the sex ratio of wolf-killed deer (250 males : 100 females) was significantly different from that of hunter killed deer (92 males : 100 females) during the same period. He suggested that this was the result of bucks wintering on the fringe of the areas used by does and fawns. Since predation was disproportionately heavy along this edge, more bucks were taken by wolves.

Mech and Frenzel (1971) suggested that does may normally be less susceptible to predation than bucks. Kelsall (1969) found that does had lower weight-load-on-track than bucks at all ages due to lower body weight and similar track area. Bucks may also be more susceptible to

predation because of their poorer condition following the rut.

Mech and Frenzel (op. cit.) found that the incidence of dental and jaw abnormalities and pathological conditions of the lower limbs was significantly higher in wolf-killed than in hunter-killed deer. A high percentage of fawns (13%) and yearlings (84%) killed by wolves during mid and late winter exhibited delayed tooth replacement. This suggested that either they were born later than usual or were suffering from some nutritional deficiency. The incidence of pathological abnormalities increases with age and probably increases the vulnerability of deer over five years old.

Effects of Winter on Predation

The vulnerability of deer to predation is increased by thick snow cover conditions (Mech et al. 1971a). Kolenosky (1972) noted that the hunting success rate of wolves (based on track interpretation) rose from 25% during a winter when the maximum snow thickness was approximately 36 cm to 63% the following winter when the snow thickness was approximately 51 cm in January. These authors and Pimlott et al. (1969) also noted that deer carcasses were not completely consumed initially as they were during average winters. Pimlott et al. (ibid.) suggested that the palatability of individual deer might affect the degree of consumption. Although Kolenosky (op. cit.) found that wolves periodically returned to their kills and ultimately consumed them, Mech et al. (op. cit.) found that many were abandoned. It appears, therefore, that

when prey animals are relatively easily obtained the degree of utilization decreases.

Deer are restricted in movement by snow thicknesses of 40 cm or more. Wolves are better supported in snow than deer because of a lighter "weight-load-on-track". Peterson and Allen (1974) found that a weight-load of approximately 100 g / cm^2 best simulated the track depth of wolves. Verme (1968) found that a weight-load of approximately 211 g / cm^2 best simulated the track depth of deer. This difference in track load may become a critical factor in thick snow cover. Mech et al. (1971a) suggested that a general decline in fitness of the deer population and a tendency for deer to congregate on lakes where wolves have the advantage, along with the relatively lighter track-load of wolves, may explain the increased vulnerability of deer during winters with thick snow cover.

Effects of Wolf Predation on Deer Populations

The question whether or not wolves can control or reduce deer populations is a very old one - often tinged with intense emotionalism. Young (1944) recorded several gory accounts of the slaughter of deer by wolves, especially in winter "yards". Criddle (1925) described the destructive effect of wolves on deer during severe winters in Manitoba. This question has still not been fully answered, but recent studies have shown that wolves can reduce deer populations

especially during winters with thick snow conditions.

A number of studies have shown conclusively that wolves prey heavily on fawns. Pimlott (1967a) suggested that if much of this fawn mortality were non-compensatory, that is, if most of the fawns would survive if there were no wolf predation, then a dense wolf population may constitute a potent limiting factor.

The white-tailed deer is at the northern edge of its range in most of Canada and winter stress is a definite limiting factor. The northward extension of the deer's range followed land-clearing and logging operations which created suitable habitat. Changing land-use practices, fire prevention and forest maturation have reduced the extent and quality of deer habitat in many areas.

The limiting effect of severe winters on deer populations is increased by the fact that deer become more vulnerable to wolf predation during periods of thick snow. Mech et al. (1971a) and Kolenosky (1972) found that during winters with "normal" snow cover, the estimated kill rate of wolves was approximately one deer per wolf per 18 days. However, during periods of thick snow cover, Mech et al. (op. cit.) found that this kill rate almost doubled. Kolenosky (op. cit.) found that the success rate of wolves killing deer was approximately 250% greater during a winter with thick snow.

Pimlott (1967a) suggested that, on the basis of studies done in Algonquin Park, wolves may not be capable of

controlling deer at a ratio exceeding 100 deer per wolf. Furthermore, "predation by wolves may cease to be an important limiting factor when densities of deer exceed 20 per square mile." Pimlott et al. (1969) stated that while their data suggested that wolf predation was a major mortality factor affecting deer in Algonquin Park they were not detailed enough to determine whether wolves were the "primary mortality factor that is limiting the deer population." Pimlott (1967a) did note that wolf predation may have prevented major eruptions in the deer population in the park.

Thompson (1952) found that wolves with a density of one per 40 - 50 square miles did not prevent an over-population of deer from developing in one county in Wisconsin. The rate of increase may have been slower than in wolf-free areas but the magnitude was similar.

Mech (1970) stated that "the single, unqualified question of whether or not predators control the numbers of their prey cannot, in my opinion be covered by any broad generality." Mech (ibid.) reached a tentative conclusion that "wolf predation is the major controlling mortality factor where prey-predator ratios are 24,000 pounds of prey per wolf or less, but that at higher ratios wolf predation cannot keep up with annual reproduction: it then becomes only one of several other contributing mortality factors and cannot be considered a primary controlling influence." Mech (ibid.) used the ratio of "pounds of prey per wolf" to integrate data from wolf studies dealing with such prey species as deer,

moose and caribou.

BEAVER

Beaver is an important secondary food source for wolves over much of its range. Beaver, which usually weigh between 15 and 35 kg when full grown (Banfield, 1974) is the smallest animal that is important in the wolf's diet.

The significance of beaver seems to depend upon their abundance and the availability of the wolf's primary prey - the large ungulates. Murie (1944) found that beaver, which were widely distributed but not abundant in Mount McKinley National Park, occurred in only .15% of the wolf scats he collected. Rausch (1967) stated that beaver form an important part of the wolf's diet in southeastern, southcentral and interior Alaska.

Cowan (1947), working in the Rocky Mountain Parks of British Columbia and Alberta, found that beaver comprised an important part of the wolves' diet in certain areas. Overall, beaver remains occurred in 7% of the scats he collected (1.5% in the winter and 17% in the summer), but at one den, 42% of 60 pup scats were composed entirely of beaver. This exceeded the importance of deer and elk combined. That den was located in an area where the beavers had killed most of the aspen and were forced to travel far from their ponds in search of food, making them easy prey for predators.

Van Ballenberghe et al. (1975) found that beaver was of

secondary importance to wolves in northeastern Minnesota, occurring in 9.4% of 637 scats. Beaver was found in 9.7% of the summer scats. This figure approximates Peterson's (1955) findings of 10.5% occurrence in 76 scats in Ontario. Van Ballenberghe et al. (op. cit.) reported that locally beaver was very important to wolves as it occurred in 45.4% of 60 scats found at one rendezvous site.

Detailed quantitative studies in central North America have provided the best insight into wolf-beaver relationships. Work in the Algonquin Park area of Ontario and on Isle Royale has shown that beaver comprises a major portion of the wolf's diet.

Pimlott et al. (1969) found that white-tailed deer, moose and beaver were the principal items in 1,435 wolf scats collected in Algonquin Park from 1958 to 1962. Their percent frequencies of occurrence were 80.5, 8.5 and 7.1 respectively. Of fifty scats collected during the winter of 1962-63, 45 (90%) contained deer hair, three (6%) contained moose hair and two (4%) beaver hair.

Voigt et al. (1976) reported on further summer wolf food habits studies in these three areas. The frequency of occurrence of beaver hair in Algonquin Park increased from approximately 7% in the summer of 1963 to 55% in the summer of 1972. This was accompanied by a decrease in the occurrence of deer hair from 76% to 33%. Similarly in the Marten River area, the occurrence of beaver increased from 37% to 74% in

1969. Beaver hair was the predominant item (75%) in scats collected in the Pakesley area from 1964 to 1967.

The deer population in the Algonquin Park area has declined since the severe winters of 1958-59 and 1959-60, while the beaver population has fluctuated but remained at a relatively high level. Beaver were found to be three to four times more abundant in the Pakesley area than in Algonquin Park. Beaver has become the primary summer food of wolves in these three areas, presumably because of the decreased availability of deer (Voigt et al, ibid.).

The beaver population reached a peak on Isle Royale about 1948 and then declined rapidly in the early 1950's (Shelton, 1966). He believed that this decline was caused mainly by epizootic tularemia (Francisella tularensis) which affected all areas adjacent to Lake Superior at that time. By 1966, the population had partially recovered from its low point (Shelton, ibid.).

The importance of beaver to wolves on Isle Royale has increased dramatically since the early 1960's. Mech (1966) found beaver remains in 10.8% of the 438 scats he collected and Shelton (op. cit.) found beaver in 11% of 475 scats. (16% of summer scats). Moose was the primary food item occurring in 75.9% and 86% of the scats respectively. Peterson (1975) reported that the beaver population on Isle Royale had approximately doubled from 1962 to 1973. Beaver remains were found in 76% of the scats collected in 1973 and

accounted for 50% of the prey occurrences in 554 summer scats. Beaver had therefore become a principal food source during the open water season. Peterson (ibid.) attributed the increased wolf density on Isle Royale partially to the dense beaver population especially as moose calf production was generally low. The availability of beaver is a major factor influencing pup survival (Mech, 1977).

The effect of wolf predation on beaver populations is not well understood. Cowan (1947) believed that predators could not prevent a beaver population from increasing as long as an adequate food supply was "safely available." The wolf population on Isle Royale which had increased from approximately 28 in 1966 to at least 41 in 1975 did not prevent the beaver population from doubling between 1962 and 1973 (Peterson, 1975). Factors such as low water levels or a food shortage which adversely affect beavers would predispose them to predation. Under such conditions, predation might be the immediate cause of a population decline.

MATERIALS AND METHODS

STUDY AREA

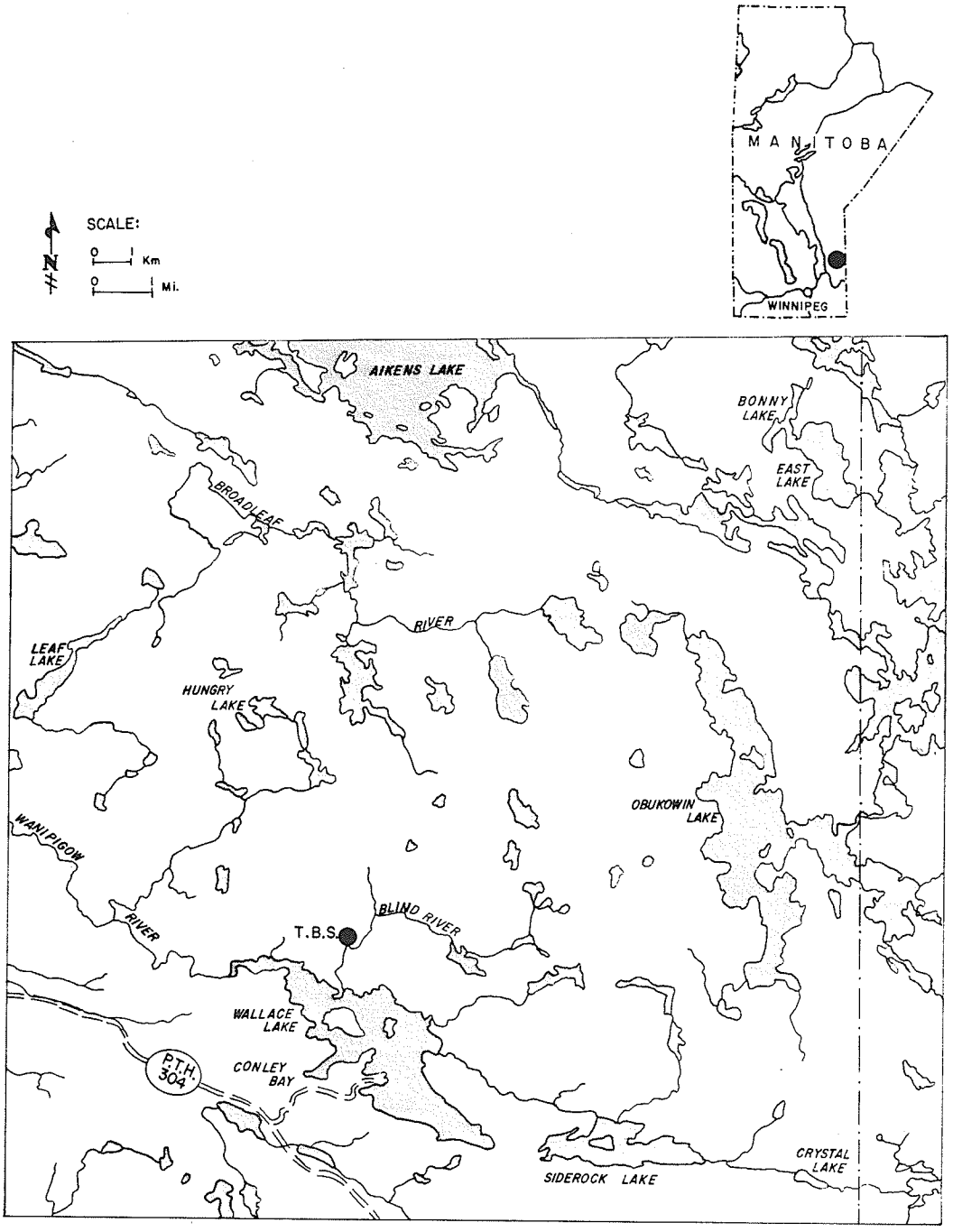
The study area is in southeastern Manitoba, east and north of the town of Bissett (Fig.1). It lies between Wallace Lake to the south and Aikens Lake to the north, the Broadleaf River to the west and the Ontario Border to the east (50^{o} 59'N to 51^{o} 11'N and 95^{o} 9' 15"W to 95^{o} 30'W), an area of approximately 563 km^{2}. Is is part of the Nelson River Drainage Basin. All the field work was done in this area. The base of operations for the study was the Taiga Biological Station (TBS).

Weir (1960) stated that the study area is in the Precambrian Drift Plain area of the Precambrian Shield. The Precambrian Drift Plain lies along the Ontario border east of Lake Winnipeg. The terrain is rolling to hilly and the surface deposits consist of varying amounts and thicknesses of glacial drift with abundant rock outcrops. These glacial drift deposits are predominantly of granitic materials. Bogs and lakes cover 40% to 60% of the surface area. The altitude in this area varies between 304 and 395 metres above sea level.

The geology of the study area was examined by Russell (1948). His study indicated that the bedrock structure of the area consists of Precambrian grey biotite granite.

The dominant soil types of this area are Podzol and Grey Wooded soils. Both soil types are derived from coarse-grained

Figure 1. Map of study area showing its location in Manitoba


MANITOBA
WINNIPEG
SCALE:
0 Km
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N
AIKENS LAKE
BONNY LAKE
EAST LAKE
BROADLEAF
RIVER
LEAF LAKE
HUNGRY LAKE
OBUKOWIN LAKE
WANIPIGOW
RIVER
BLIND RIVER
T.B.S.
WALLACE LAKE
P.T.H. 304
CONLEY BAY
SIDEROCK LAKE
CRYSTAL LAKE

crystalline rocks. Podzol soils form under a cover of coniferous forest and are typically found in jackpine-covered areas. Grey Wooded soils develop in areas predominantly covered by deciduous forest. Podzol and Grey Wooded soils are found in association over large areas of the Precambrian Shield.

The climate of Manitoba can be described as continental. Summer temperatures in the Wallace Lake area are warm (average July temperature is 18.3 to 18.9 degrees C.) and winter temperatures are cold (average January temperature is -33.7 to -34.2 degrees C.). Annual precipitation averages between 508 mm and 533 mm. Annual snowfall averages from 1397 mm to 1524 mm and the snow cover usually remains from November to April.

According to Rowe (1972), Wallace Lake is in the ecotone between the Northern Coniferous and the Lower English River sections of the Boreal Forest Region of Canada. Black Spruce (Picea mariana) is the dominant species in the Northern Coniferous section. It is associated with jack pine (Pinus banksiana) on the poorly-drained lowlands. The spread of jack pine has been favoured by frequent fires which are probably responsible for the scattered representation of white birch (Betula papyrifera). White Spruce (Picea glauca) balsam fir (Abies balsamea), trembling aspen (Populus tremuloides) and balsam poplar (Populus balsamifera) form mixed stands in river valleys, around some lakes and on south-

facing slopes. The Lower English River section of the Boreal Forest is characterized by mixed stands of trembling aspen, balsam poplar and white spruce which provide the chief forest cover on well-drained sites. Balsam fir, white birch and jack pine are also present. Jack pine is common on the sandier sites but also extends to clay and silt soils after fire. Black spruce and larch (Larix laricina) occupy shallow bogs. Green ash (Fraxinus pennsylvanica), American elm (Ulmus americana) and bur oak (Quercus macrocarpa) are found on riverine sites. Mixed stands of conifers and hardwood with early seral stages of plant succession, which are the most productive ungulate habitat, were found mainly along water bodies on the periphery of the study area.

Human activity in the study area was limited to light trapping, prospecting and tourism. Most of the tourist activity is concentrated around the campground on Wallace Lake although parties of canoeists or snowmobilers may be encountered along the major travel routes.

METHODS

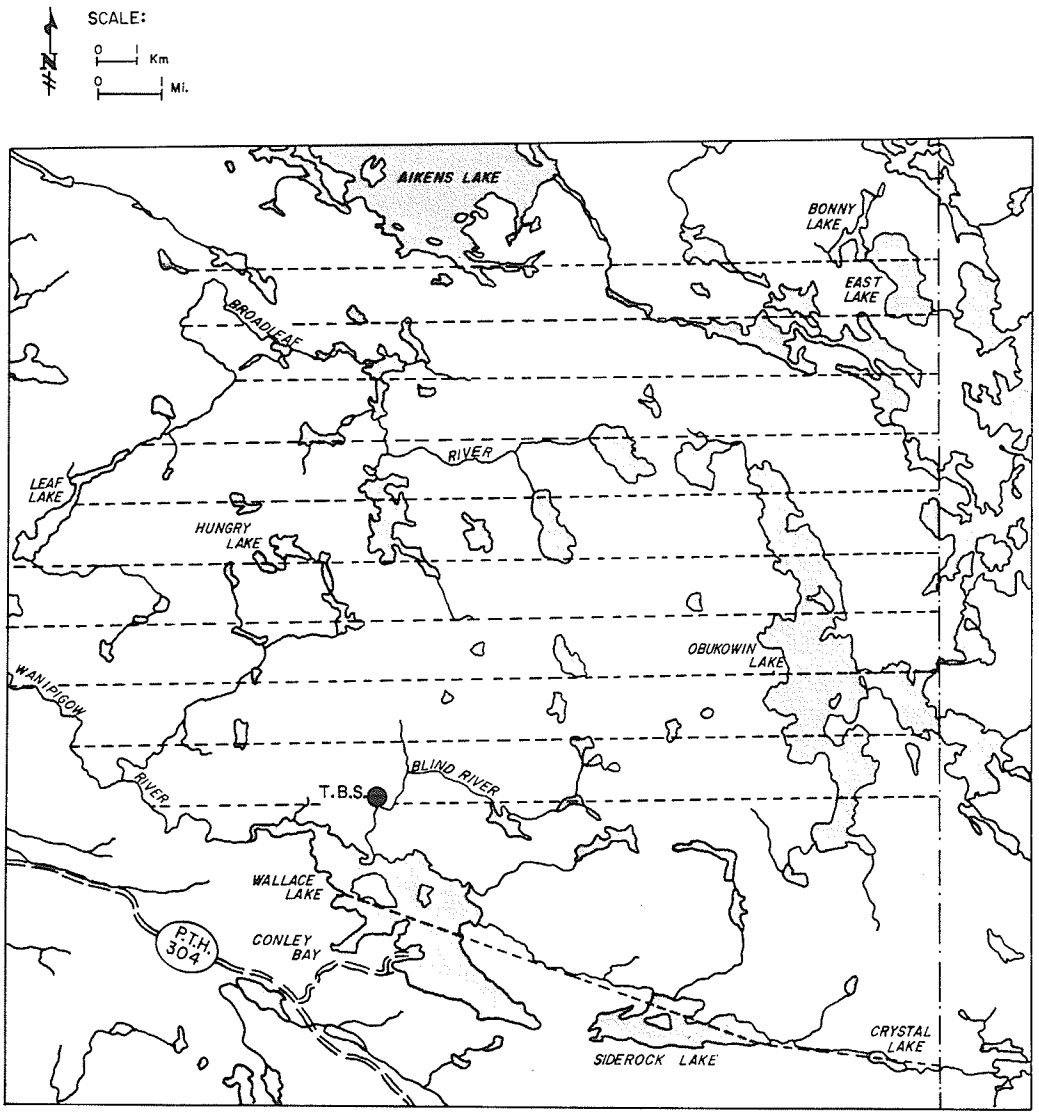
The study period extended from May, 1973 to June, 1975. It was subdivided into four "biological" seasons: Break-up (April), Summer (May to October), Freeze-up (November) and Winter (December to March) in order to clarify the food habits of the wolves which varied according to the season.

Populations

Aerial surveys and ground observation were used in an attempt to determine the size of the wolf and ungulate populations within the study area. The aerial surveys were carried out during the winter when observation conditions were optimal. Survey flights were flown east to west at 1.6 km intervals over the study area (Fig.2). These flights took place at the pleasure of the weather and when an aircraft could be obtained. Because of these factors, they could not be made at the regular intervals I would have preferred. There were six flights during the winter of 1973-74. They were on 17 and 18 December, 1973 and 13, 14 18 and 26 February 1974. In the second winter the first flight was not made until 10 February 1975. I then flew on 12, 20, 24, 26 February and 3 March. A total of 18.8 hours were flown in 1973-74 and 12.5 hours in 1975.

The survey flights were all flown at approximately 131 kilometers per hour at an altitude of 242 to 303 metres. They were done between 1000 hours and 1500 hours so that the sun would be high enough to reduce shadows to a minimum. Particular attention was paid to frozen water bodies and open areas where timber wolves were most visible. I made note of all timber wolves and other animals as well as tracks seen on these flights. The occurrence of black or light-coloured wolves was noted along with pack size to assist in differentiating between packs. Whenever a carcass

Figure 2. Map of study area showing aerial survey lines.



was sighted, we attempted to land in order to inspect it. This was seldom possible however, due to slush and snow conditions. During the first winter, a PA-18 Piper Super Cub was used. All but one of the flights in the second winter were flown in a PA-12 Piper Cub. A Cessna 180 flew one survey when the PA-12 was unavailable. On this flight my wife acted as a second observer.

I also used "howling" as a technique to locate packs and determine pack size. Pimlott (1960) and Joslin (1966, 1967) used this technique with great success in Ontario. I howled three or four times at approximately 30 second intervals and waited for a response. Then after three or four minutes this was repeated. I did this at various times and locations throughout the study whenever low wind velocities and/or foreknowledge that wolves were nearby made success possible.

I conducted a search for wolf dens in the spring of 1974 and again in 1975. The area between Siderock Lake and the Ontario border was selected for this search because the rough terrain and close proximity to water matched criteria described by Mech (1970) for den sites.

Food Habits

The feeding habits of timber wolves were determined by analyzing scats (faeces) collected throughout the year. I also analyzed the stomach contents of trapped wolves to

provide additional information on feeding habits.

Scats were collected on the roads, trails and portages in the Wallace Lake area. I travelled these routes as often as possible in the summer and winter, both to be able to date the scats and to keep track of the wolves' movements. A total of 231 wolf scats were collected during the study: 127 in 1973, 67 in 1974 and 37 in 1975. Of these 34.6% were found on Provincial Road 304 while the remaining 65.4% were found in the bush or on frozen water bodies. The scats were collected in paper bags with the following information recorded: location, date, vegetation, probable age of scat, and collector.

I usually found scats deposited singly. However, on three occasion I collected groups which were deposited in an area where the wolves had rested while consuming deer or moose carcasses. These 28 scats were composed entirely of deer or moose hair. Because my sample sizes were relatively small, these clumped samples biased the results. Therefore, I omitted these samples from my calculations leaving a sample size of n = 203.

Few scats were collected in November of both years because I was isolated at the Taiga Biological Station during freeze-up. I was absent from the area during break-up in 1974 and 1975 so few scats were collected in April and May of these years. With the exception of nine days in June, I concluded my field work in April, 1975. Therefore, the scat sample for summer 1975 was incomplete and the results

can only be used to indicate the continuing importance of beaver as a food source for wolves during that season.

Before analysis, the scats were autoclaved at 8.6 - 9.1 kg steam pressure and a temperature of 117° C. for one hour to reduce the possibility of contracting parasites, primarily Echinococcus sp. (Lubinsky, pers. comm.). Frenzel (1974) also recommended autoclaving wolf scats before laboratory analysis. At the time of autoclaving, the data from the bags were transferred to cards upon which the results of the analysis were recorded.

The method used in scat analysis followed that of Fichter et al. (1955) and Pastuck (1974). After autoclaving, the scats were soaked overnight in water to soften and then washed with tap water in two strainers (7.1 and 23.6 mesh per cm^2) to remove extraneous material. I then placed the material from both strainers on a numbered paper towel and allowed it to dry. The samples were examined individually by segregating them into their components. Because of the possibility that viable Echinococcus sp. might still be present, the samples were dampened with alcohol and a surgical mask and gloves were worn during the examination.

I assembled a reference collection of potential food items to facilitate identification of the ingested materials. Samples of hair from potential prey species in the Wallace Lake area were obtained. Museum study skins and skeletons were available and literature was referred to as needed. The manual by Adorjan and Kolenosky (1969) was used for comarison of hair scale impressions.

Scat contents were identified by comparing teeth, claws and hairs with the reference collection. Hairs were identified by the following criteria: general morphology, colour banding and cuticular scales. The cuticular scales were examined by preparing hair impressions as described by Van Zyll de Jong (1966). These impressions were then compared with reference material and the literature for identification.

The percent volume of each food item was estimated visually after it was identified and segregated. Using a method similar to that of Knowlton (1964), each occurrence was classified as either a major item (M.I.) or not a major item. This was done to show the relative importance of each item to the wolves' diet. For example small bits of vegetation were found in almost all the scats. If these were discussed on the basis of their frequency of occurrence, their importance would be greatly exaggerated since they occupied only a very small volume in the samples.

I used the following definitions to indicate the relative importance of food items which were ingested:

Frequency of occurrence (F.O.):

> The number of food samples (scat or stomach) in which a particular food item appeared.

Percent frequency of occurrence:

$$\frac{\text{Frequency of occurrence}}{\text{number of food samples}} \times 100$$

Major Item (M.I.):

A food item which comprised 40% or more by volume of a food sample on the basis of visual estimate.

Frequency of occurence as a major item:

The number of food samples in which a particular food item appears as a major item.

Percent frequency of occurrence as a major item:

$$\frac{\text{Frequency of occurrence as a major item}}{\text{number of food samples}} \times 100$$

When two items in one food sample occurred as a major item, each was tabulated as one-half of an occurrence to maintain the integrity of the sampling unit and to limit the sum of the percentage frequencies of occurrence as a major item to 100%.

The stomach contents of all the wolf carcasses I collected were examined. Thirteen carcasses had identifiable material remaining in the stomach. Analysis of the stomach contents presented some problems not encountered in scat analysis. Most of the wolves examined were trapped, and because of the varying lengths of time spent in the trap before death, digestion had progressed to varying degrees. Also, some of the material was probably bait. Therefore it was unrealistic to attempt to determine precisely the volumes or weights of food items present in the stomach.

The stomach contents were removed at the time of post-mortem examination. They were washed and dried in a manner

similar to the scats, but not autoclaved. I made a visual estimate of the percent volume of each component after identification and segregation. Food items were identified and classified as either a major item or not by the same method described for scat analysis.

Post-Mortem Examinations

A total of 22 timber wolf carcasses were collected, seven males and 15 females. Trappers in the Bissett area were paid $10.00 for each carcass they brought to me. Two carcasses were obtained in the winter of 1973-74 from the Bissett-Manigotogan area. In 1974-75, one carcass was collected in Lac du Bonnet, three in Pine Falls, three in the Bissett - Manigotogan area, one in my study area and 12 were donated by the Research Branch, Manitoba Department of Renewable Resources and Transportation Services (R.R.T.S.) from the Porcupine Mountains and the north end of Lake Winnipegosis. The carcass which I picked up in my study area (Cat. No. 44) had been shot illegally by aircraft hunters. Because of scavenging by ravens (Corvus corax), this specimen was unfit for post-mortem examination and only the stomach contents were examined. These specimens were weighed and standard measurements were taken where possible.

Dr. L. E. Lillie, of the Veterinary Services Branch, Manitoba Department of Agriculture, performed the post-mortem examination of the carcasses. As part of the examination,

the general nutritional condition, reproductive status, presence of parasites, and any gross pathologic abnormalities were noted. The advanced state of autolysis of many of the carcasses, caused by repeated freezing and thawing, prevented a more detailed examination of the specimens. Dr. T. Dick of the Zoology Department examined the diaphragms of these wolves for Trichinella sp. I attempted to determine the reproductive state of one male wolf (Cat. No. 38) using sperm smears from the sectioned testes (Heubner, pers. comm.). Following the examination, skeletons were prepared from most carcasses using the enzyme technique (Dubois, pers. comm.). Details of the post-mortem examinations are presented in Appendix I.

Aging

Twenty of the wolf carcasses collected were aged using a technique similar to the one described for coyotes by Linhart and Knowlton (1967). This involved the counting of cementum layers in the sectioned and stained roots of the upper canines. The upper canines were used because they have less lateral curvature than the lower canines resulting in a better section (Johnston, pers. comm.).

The remains of one moose and three white-tailed deer presumably killed by wolves were also examined. Dr. Lillie and I performed a post-mortem examination of a female white-tailed deer killed on Wallace Lake. This deer and the moose

found on Bonny Lake were aged using the methods described by Gilbert (1966) and Sergeant and Pimlott (1959) which involved counting cementum layers in the sectioned and stained roots of the first incisor. The fat content of the marrow of these animals was determined using the standard ether extraction method which complies with the official method of the Association of Official Agricultural Chemists (Horwitz, 1965). Both femora were collected from the deer killed on Wallace Lake but only portions of the moose tibiae could be located. The marrow in portions of the tibiae of the two deer found on Wanipigow Lake, approxmately 29 km west of the study area, was analyzed.

Questionnaires

Tourist Questionnaire

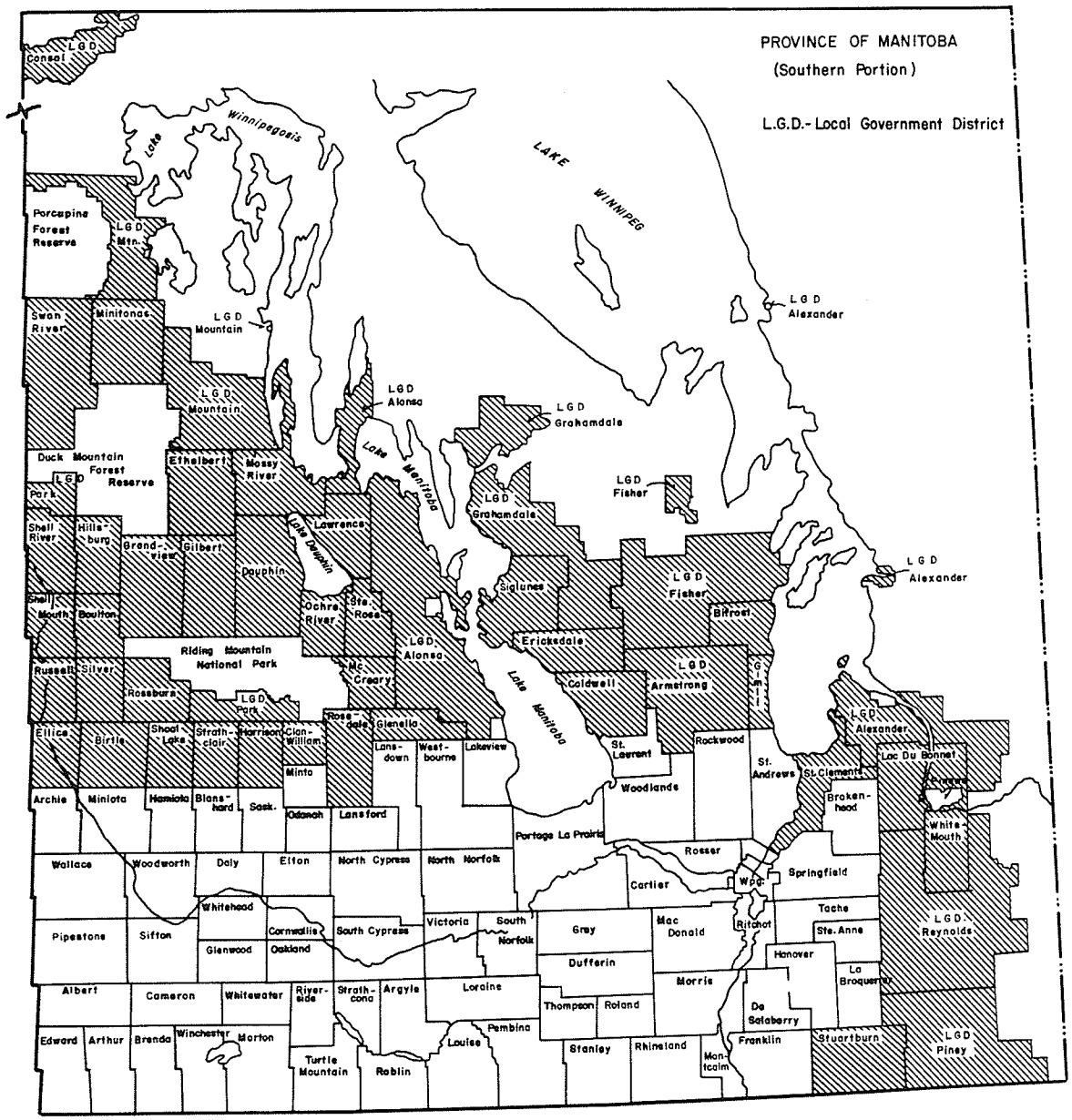
I used two questionnaires in the study. One questionnaire was designed to examine the attitudes of tourists at Wallace Lake toward timber wolves (see Appendix II). This was a fairly short questionnaire, consisting of 15 questions, which was completed by personal interview with the form being filled in by the interviewer. Both transient campers and cottage users were sampled. In order to get as large a sample as possible, the interviewing was done on weekends in July and August, 1974 when the campground was most crowded.

Farmer-Rancher Questionnaire

The second questionnaire was designed to examine the extent of timber wolf predation on livestock, particularly cattle, in Manitoba (see Appendix II). The Statistics and Sociology Departments of the University of Manitoba and the Manitoba Department of R.R.T.S. assisted in designing this questionnaire. The Provincial Department of Agriculture provided a list of cattle owners in Manitoba. The Statistical Program for the Social Sciences (S.P.S.S.) was used in an I.B.M. 168 computer to analyze the data.

For sampling purposes, the province was divided into three regions. These were: Eastern (east of Lake Winnipeg), Interlake and Western (west of Lakes Manitoba and Winnipegosis). I selected those municipalities and Local Government Districts within these regions where timber wolves might present a problem (Fig.3). The following municipalities and Local Government Districts were sampled: Eastern Region: Alexander, St. Clements, Lac du Bonnet, Whitemouth, Reynolds, Piney and Stuartburn; Interlake Region: Grahamdale, Siglunes, Eriksdale, Coldwell, Fisher, Bifrost, Armstrong and Gimli; Western Region: Consol, Mountain, Swan River, Park, Shell River, Hillsburg, Shellmouth, Boulton, Russel, Silver Creek, Rossburn, Ellice, Birtle, Shoal Lake, Strathclair, Harrison, Clanwilliam, Rosedale, Glenella, McCreary, Alonsa, Ste. Rose, Ochre River, Lawrence, Dauphin, Mossey River, Gilbert Plains, Grandview, Ethelbert and Minitonas.

Figure 3. Map of southern Manitoba showing area sampled by Farmer-Rancher Questionnaire.


PROVINCE OF MANITOBA
(Southern Portion)
L.G.D.- Local Government District
LAKE WINNIPEG
Lake Winnipegosis
Lake Manitoba
Lake Dauphin
L G D Consol
Porcupine Forest Reserve
L G D Mtn.
Swan River
Minitonas
L G D Mountain
Duck Mountain Forest Reserve
L G D Park
Ethelbert
Mossy River
Shell River
Hillsburg
Grandview
Gilbert Plains
Dauphin
Lawrence
Shell Mouth
Boulton
Ochre River
Ste. Rose
Riding Mountain National Park
Russell
Silver
Rossburn
L G D Alonsa
Mc Creary
L G D Park
Rose dale
Glenella
Ellice
Birtle
Shoal Lake
Strath-clair
Harrison
Clan-William
Lans-downe
West-bourne
Lakeview
Minto
Archie
Miniota
Hamiota
Blans-hard
Sask.
Odanah
Lansford
Wallace
Woodworth
Daly
Elton
North Cypress
North Norfolk
Whitehead
Cornwallis
Oakland
Glenwood
South Cypress
Victoria
South Norfolk
Pipestone
Sifton
Albert
Cameron
Whitewater
River-side
Strath-cona
Argyle
Loraine
Edward
Arthur
Brenda
Winchester
Morton
Turtle Mountain
Roblin
Pembina
Louise
L G D Grahamdale
L G D Fisher
L G D Alexander
Siglunes
Eriksdale
Bifrost
Coldwell
L G D Armstrong
L G D Lin II
St. Laurent
Rockwood
Woodlands
St. Andrews
St. Clements
L G D Alexander
Lac Du Bonnet
Brokenhead
White-mouth
Portage La Prairie
Rosser
Cartier
Springfield
Wpg.
Tache
Ste. Anne
Ritchot
Mac Donald
Grey
Dufferin
Morris
Thompson
Roland
Stanley
Rhineland
Montcalm
Franklin
De Salaberry
Hanover
La Broquerie
L G D Reynolds
Stuartburn
L G D Piney

A 10% systematic random sample of cattle owners in the municipalties and Local Government Districts noted above was selected from a list of cattle owners in the provincial tuberculosis-brucellosis testing program. The starting name was chosen using a random numbers table and then every tenth name was selected. A total of 1059 questionnaires were mailed. The sample sizes were as follows: Eastern Region n = 161, Interlake n = 222, Western region n = 676. Three successive mailings were used to ensure as high a return as possible. The questionnaires were mailed in February, March and April, 1974.

After the third mailing, a small systematic random sample of the non-respondents was selected and contacted in person and interviewed to determine if or how they differed from those who had returned a questionnaire. The starting point among the non-respondents was chosen using a random numbers table and then every tenth one was selected. Contacting non-respondents was limited by time and finances. However, with the assistance of the Research Branch (R.R.T.S.) I was able to obtain completed questionnaires from 14 non-respondents.

RESULTS

WOLF POPULATIONS

The locations and numbers of wolves sighted and the locations of suspected wolf-kills are shown in Fig. 4. Wolves were observed in the study area during three of the six survey flights in 1973-74 and during two of the six flights in 1975. A single wolf was observed 7.2 km east of Bissett on 13 May, 1973 feeding on a road-killed moose, and a pack of three wolves was observed feeding on a deer carcass on Wanipigow Lake approximately 29 km west of the study area on 17 December, 1973.

Five packs were observed during the two years of observation and the maximum wolf population in the study area was approximately 20. The estimates of pack composition and range were based on aerial and ground observations of wolves and tracks. The Hungry Lake pack was seen on Hungry Lake on 18 December, 1973. It consisted of four wolves: one black wolf, one very light tan (almost white) wolf and two brown wolves with black backs. No wolves were seen in the Hungry Lake area during the 1975 flights but tracks on neighboring lakes indicated that a pack was still in the area. The Obukowin Lake pack, which consisted of two brown wolves with black backs, was observed at a moose carcass on Obukowin Lake on 13 February, 1974. This pack was observed once more on 14 February, 1974 again feeding on the moose carcass. Tracks on the lake indicated that these wolves had attacked

Figure 4. Map of study area showing sightings of timber wolves and suspected wolf kills.

Number of wolves sighted indicated by number inside symbol.

Sightings:

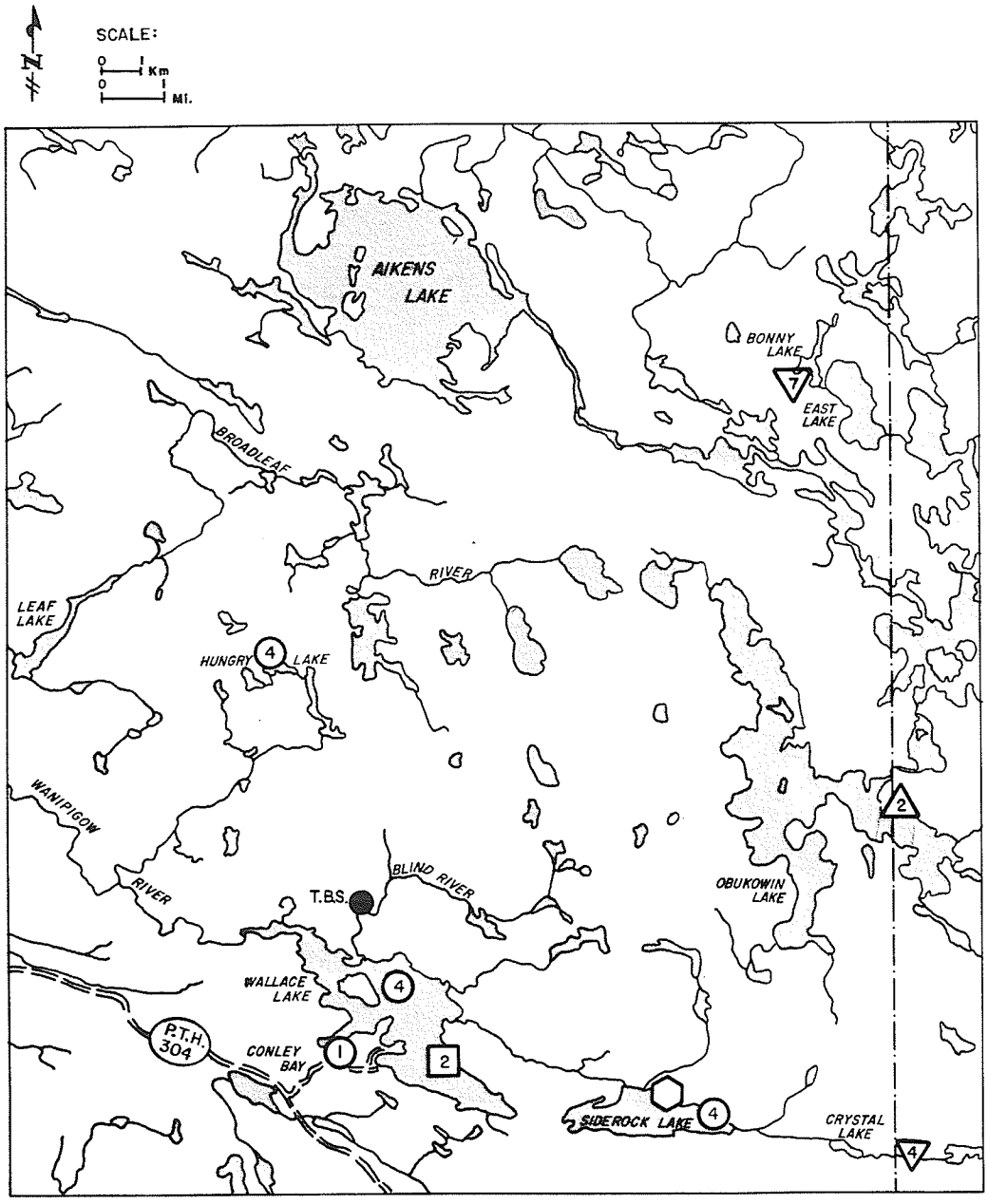
Wolves

Moose carcass and wolves winter of 1973-74

Moose carcasses and wolves winter of 1974-75

Deer carcass and wolves winter of 1974-75

Moose carcass


N
SCALE:
Km
Mi.
AIKENS LAKE
BONNY LAKE
EAST LAKE
BROADLEAF
RIVER
LEAF LAKE
HUNGRY LAKE
WANIPIGOW
RIVER
BLIND RIVER
T.B.S.
OBUKOWIN LAKE
WALLACE LAKE
P.T.H. 304
CONLEY BAY
SIDEROCK LAKE
CRYSTAL LAKE

and killed the moose they were eating. The Siderock Lake pack was observed on Siderock Lake on 14 February, 1974. Two of these wolves were black, one was light tan and one was brown with a black back. This last wolf may have been a pup since it had a gangling appearance and its movements were not as smooth as the others in the pack. This is probably the pack which I observed on Wallace Lake on 3 February 1974 although I was unable to distinguish their colours on that occasion. The Siderock Lake pack consisted of five wolves in the winter of 1974-75. On 6 December, 1974 a group of hunters reported hearing howling and saw the tracks of five wolves at the east end of Siderock Lake. Five days later, I just missed seeing a pack of five wolves at the east end of Wallace Lake near the portage to Siderock Lake. Subsequent following of tracks showed that these wolves had travelled along the Wanipigow River from Siderock to Wallace and then returned to Siderock via the portage trail.

The Siderock pack may have been observed again on 26 February 1975 feeding on a moose carcass approximately one km east of Crystal Lake. However, these wolves appeared to be gray-brown in colour and only four were seen. It is possible that another wolf was in the bush nearby but was not observed.

The Bonny Lake pack was observed feeding on a moose carcass on 24 February, 1975. It consisted of seven wolves, all a typical gray-brown (Mech, 1970) in colour. Two wolves which occasionally travelled as a pack also utilized the

Wallace Lake area.

Bill Conley, a resident trapper, saw one gray-brown wolf near his garage at Conley Bay on Wallace Lake on 3 October, 1974. Drillers working for the Midwest Drilling Company saw two wolves which had killed a white-tailed deer near their drill site on Wallace Lake on 15 February, 1975. The tracks of these two wolves were frequently seen on Wallace Lake and in the surrounding bush.

I had very limited success using howling to locate wolves. On 16 May, 1973, three or four wolves responded when I howled near the moose carcass 7.2 km east of Bissett. Two or three responded on 21 May, 1973 at the same location. I heard wolves howling on two occasions near the Taiga Biological Station. On 6 October 1974 three wolves were heard howling within two km of the Station from a north-westerly direction. When I howled back they seemed to respond. On 28 October, 1974 I heard four or five wolves howling within one km of the Station. This time the howling came from the north-east. On both occasions there was little or no wind and the howling occurred between 0500 and 0900 hours.

I was unable to locate any wolf dens in the study area.

UNGULATE POPULATIONS

During the aerial surveys I paid particular attention to frozen bodies of water and open areas where timber wolves

were most visible. This is not an effective technique to use when searching for large ungulates. Therefore, the numbers of moose and woodland caribou which I observed cannot be used to estimate their populations accurately.

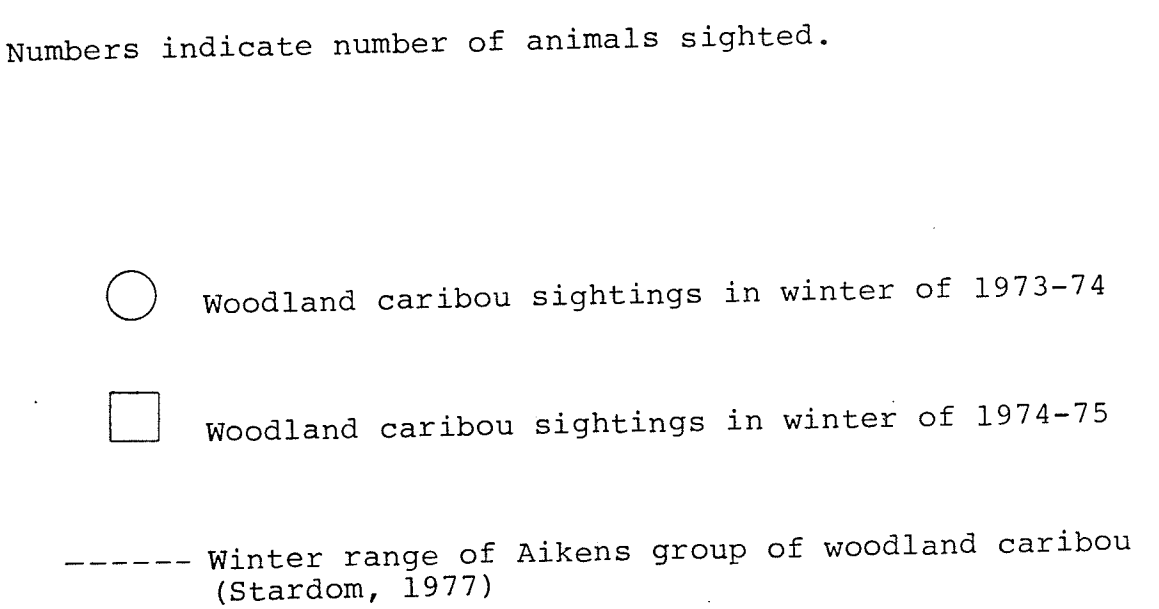
I observed approximately 17 different moose, including two calves, during the winter of 1973-74. Eight to 12 moose were observed in the winter of 1974-75, but no calves were seen.

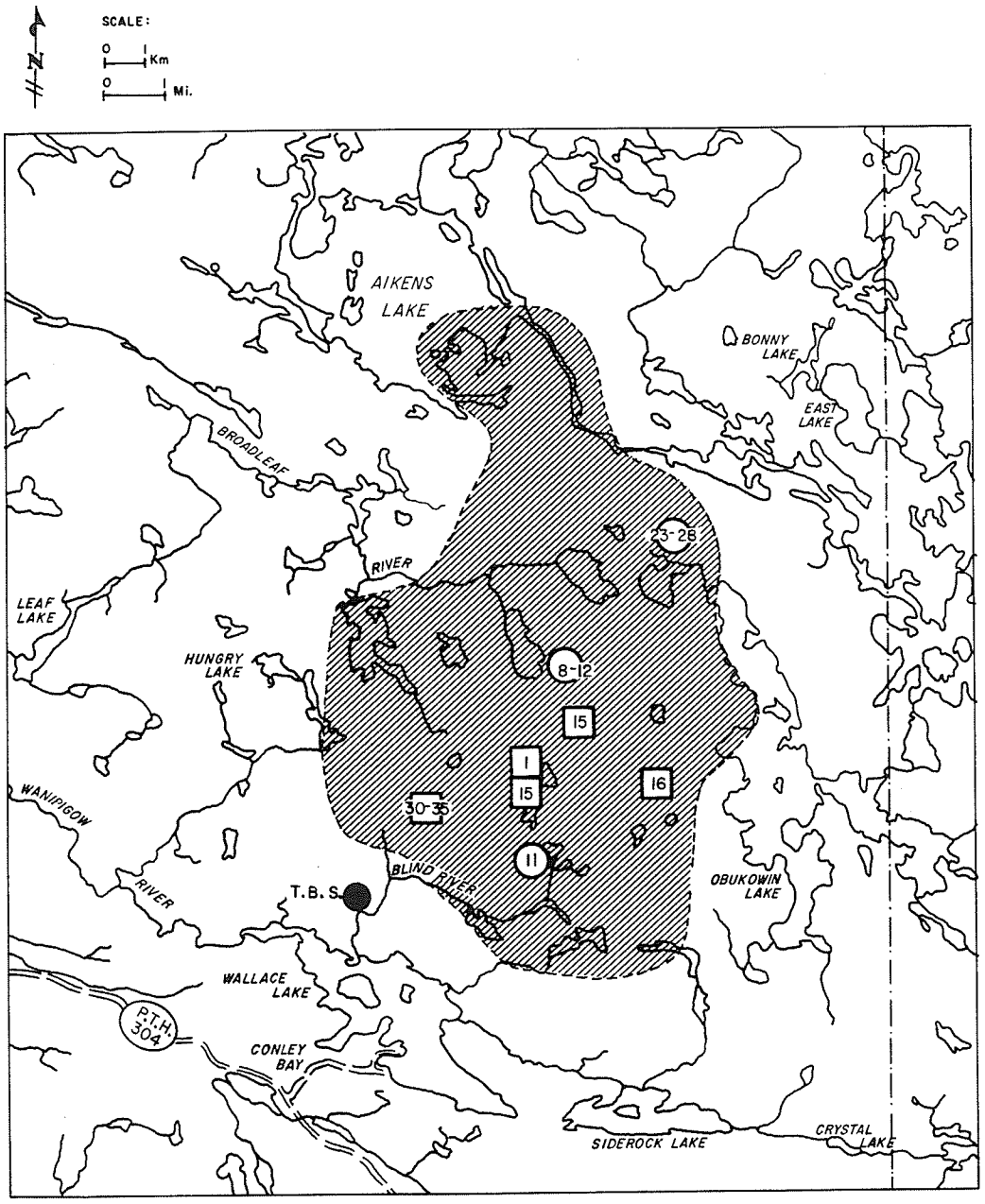
I did not observe any white-tailed deer during the survey flights over the study area. Pilots picking up water on Wallace Lake for fire fighting reported seeing six deer approximately one km south-west of the Taiga Biological Station on 3 July, 1974. This figure may be exaggerated but it does confirm the presence of deer in this area. Deer tracks were observed infrequently.

The locations of the bands of woodland caribou which I observed are shown in Figure 5. In 1973-74 three bands were seen. In 1975 caribou, including a group of 30-35, were observed on four separate flights. All the caribou sightings were within the area described by Stardom (1977) as the winter range of the Aikens group of woodland caribou. Although wolf and caribou tracks were frequently sighted in the same area, I saw no evidence of interaction between the two species.

The remains of one white-tailed deer and four moose which had been fed on by wolves were found in the study area

Figure 5. Map of study area showing woodland caribou sightings.




SCALE:
0 Km
0 Mi.
N
AIKENS LAKE
BONNY LAKE
EAST LAKE
BROADLEAF
RIVER
LEAF LAKE
HUNGRY LAKE
WANIPIGOW
RIVER
T.B.S.
BLIND RIVER
WALLACE LAKE
P.T.H. 304
CONLEY BAY
OBUKOWIN LAKE
SIDEROCK LAKE
CRYSTAL LAKE
23-28
8-12
15
1
15
16
30-35
11

(Fig.4). The remains of two white-tailed deer consumed by wolves were found on Wanipigow Lake. With the exception of the deer on Wallace Lake, the carcasses were consumed except for rumen contents and bone fragments.

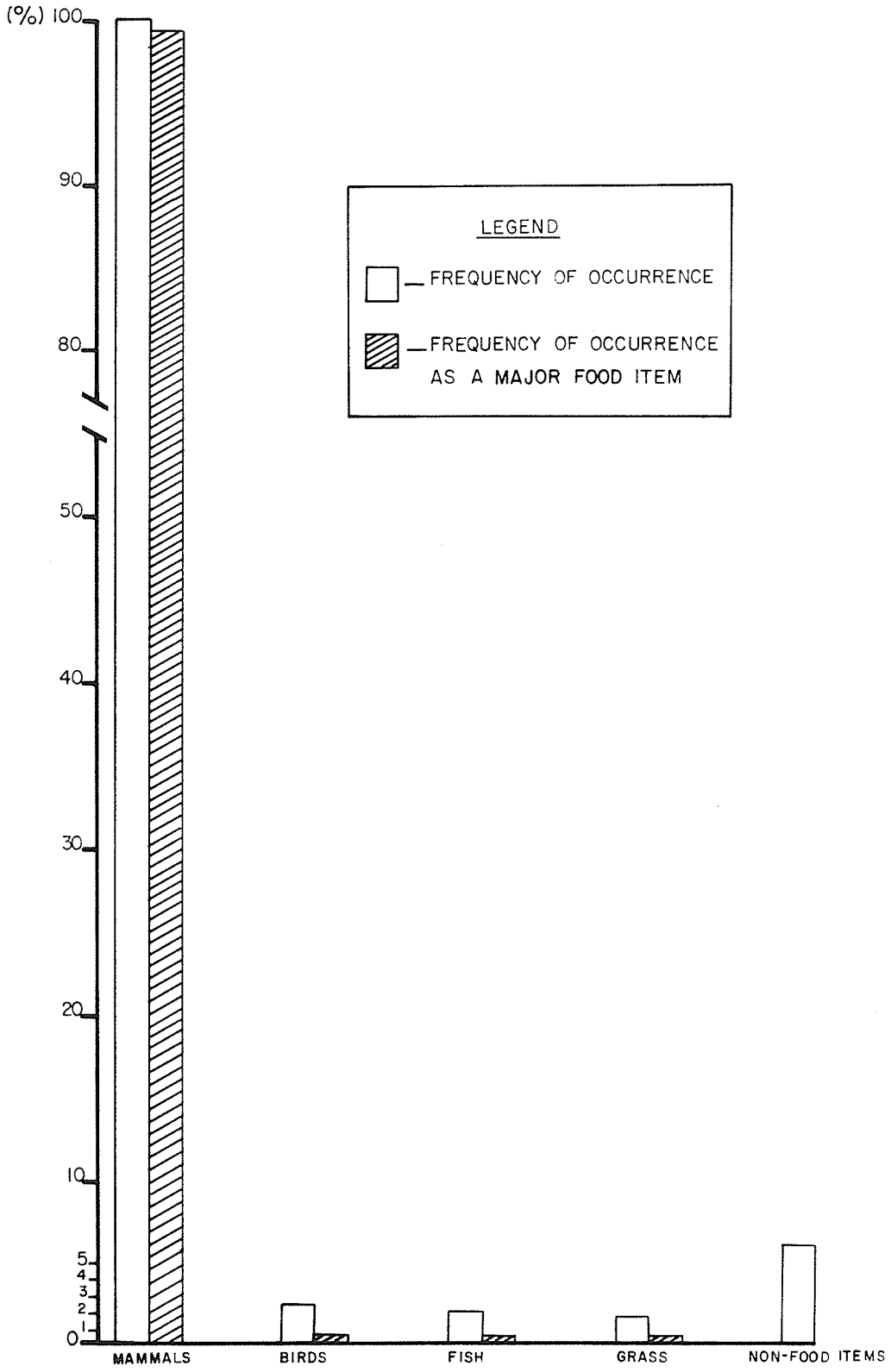
SCAT ANALYSIS

General Food Habits

Mammals comprised the major part of the wolves' diet throughout the study, occurring in 100% of the scats (99.4% M.I.). Birds occurred in only 2.5% (0.2% M.I.) of the scats and fish in 2.0% (0.2% M.I.). The only invertebrates found in the scats were three ticks (Dermacentor variablis). Traces of vegetation, probably either ingested accidentally or collected with the scat, were found in nearly all scats examined. However, I found vegetation, grasses, in larger than trace amounts in 1.0% (0.2% M.I.) of the scats. Debris or non-food items were found in 6% of the scats but never as a major item. I found no trace of cold-blooded terrestrial vertebrate animals.

Figure 6 shows the general food habits of the wolves in my study area in terms of major food groups - mammals, birds, fish and vegetation. The general food habits of wolves did not vary significantly over the two years of the study with respect to these major groups.

Figure 6. Percent Frequency of occurrence and percent frequency of occurrence (M.I.) of the major food groups in 203 scats collected between April, 1973 and June, 1975.


(%) 100
90
80
50
40
30
20
10
5
4
3
2
1
0
LEGEND
FREQUENCY OF OCCURRENCE
FREQUENCY OF OCCURRENCE AS A MAJOR FOOD ITEM
MAMMALS
BIRDS
FISH
GRASS
NON-FOOD ITEMS

Specific Food Habits

The contribution of the species which constituted the wolves' diet during the study period is presented in Table I. Moose, white-tailed deer and beaver comprised 89.5% (M.I.) of the diet of wolves in the study area as indicated by scat analysis. Figure 7 illustrates the seasonal importance of these species over the two years of the study. Beaver were the principal prey during the ice-free season while deer and moose were most important during the winter. A chi-square test indicated that there was no significant different in the proportions of beaver, moose and deer between years ($\chi^2 = 5.4042$). Also, the proportions of deer and moose found in the scats in 1973-74 and in 1974-75 were not significantly different ($\chi^2 = 0.5641$).

STAPLE FOOD ITEMS

Alces alces

Moose were an important item in the wolves' diet in both summer and winter. In the summer of 1973 they comprised 12.8% (M.I.) of the diet and 25.0% (M.I.) in the summer of 1974 (Table I). In the winter of 1973-74 they comprised 56.7% (M.I.) of the diet and 35.3% (M.I.) in the winter of 1973-74

Moose calf hair was present in scats in both summers. Calves comprised 15.8% of the moose remains found in summer scats.

Table 1: Percent frequency of occurrence and percent frequency of occurrence as a major item (M.I.) of specific food items found in 203 scats collected from April, 1973 to June, 1975.

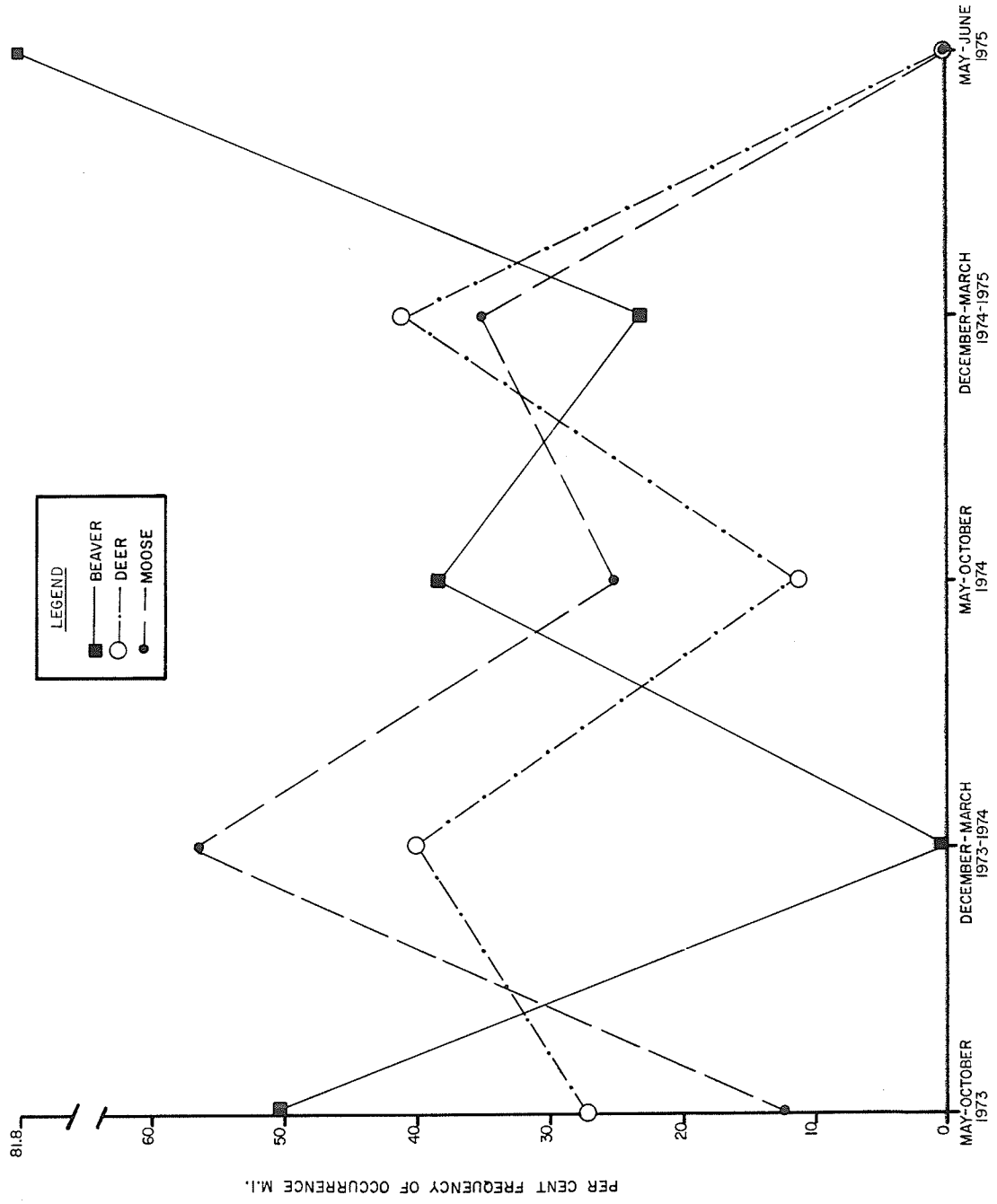
* M.I. seasonal percents are calculated using the number of scats at the top of the column rather than the total sample of 203.

Percent Frequency of occurrence of food items in scats	1973-1974 Apr.	May-Oct.	Nov.	Dec-Mar.	Total	1974-1975 Apr.	May-Oct.	Nov.	Dec-Mar.	Total	1975 Apr.	May-June	Total	GRAND TOTAL
Number of scats collected	16	86	2	30	134	7	26	0	17	50	8	11	19	203
MAMMALIA														
Artiodactyla														
Alces alces														
Total sample	1.5	5.4		8.4	15.3	3.4	3.9		3.5	10.8	2.0		2.0	28.1
M.I. Total sample	1.5	5.4		8.4	15.3	3.4	3.2		3.0	9.6	2.0		2.0	26.9
M.I. Seasonal*	18.8	12.8		56.7		100.0	25.0		35.3		50.0			
Odocoileus virginianus														
Total sample	1.5	14.8	1.0	5.9	23.2		1.5		3.4	4.9	1.0		1.0	29.1
M.I. Total sample	1.5	11.6	1.0	5.9	20.0		1.5		3.4	4.9	0.5		0.5	25.4
M.I. Seasonal	18.8	27.3	100.0	40.0			11.5		41.2		12.5			
Rangifer tarandus caribou														
Total sample				0.5	0.5		1.0			1.0				1.5
M.I. Total sample				0.5	0.5		1.0			1.0				1.5
M.I. Seasonal				3.3			7.7							
RODENTIA														
Castor canadensis														
Total sample	3.9	23.2			27.1		4.9		2.0	6.9	1.0	4.4	5.4	39.4
M.I. Total sample	3.5	21.4			24.9		4.9		2.0	6.9	1.0	4.4	5.4	37.2
M.I. Seasonal	43.8	50.6					38.5		23.5		25.0	81.8		
Ondatra zibethicus														
Total sample		1.0	0.5		1.5		0.5			0.5		0.5	0.5	2.5
M.I. Total sample		1.0			1.0		0.2			0.2		0.5	0.5	1.7
M.I. Seasonal		2.3					1.9					9.1		

	1973-1974					1974-1975					1975			GRAND TOTAL
	Apr.	May-Oct.	Nov.	Dec-Mar.	Total	Apr.	May-Oct.	Nov.	Dec-Mar.	Total	Apr.	May-June	Total	
Tamiasciurus hudsonicus														
Total sample				0.5	0.5									0.5
M.I. Total sample														
M.I. Seasonal														
Marmota monax														
Total sample		1.0			1.0									1.0
M.I. Total sample		1.0			1.0									1.0
M.I. Seasonal		2.3												
LAGOMORPHA														
Lepus americanus														
Total sample	1.5	1.0			2.5		1.0			1.0	0.5		0.5	4.0
M.I. Total sample	1.5	1.0			2.5		0.7			0.7	0.5		0.5	3.7
M.I. Seasonal	18.8	2.3					5.8				12.5			
CARNIVORA														
Ursus americanus														
Total sample							1.0			1.0		0.5	0.5	1.5
M.I. Total sample							1.0			1.0		0.5	0.5	1.5
M.I. Seasonal							7.7					9.1		
Canis familiaris														
Total sample		0.5			0.5									0.5
M.I. Total sample		0.5			0.5									0.5
M.I. Seasonal		1.2												
UNIDENTIFIED LARGE MAMMAL														
Total sample												0.5	0.5	0.5
M.I. Total sample														
M.I. Seasonal														

	1973-1974					1974-1975					1975			
	Apr.	May-Oct.	Nov.	Dec-Mar.	Total	Apr.	May-Oct.	Nov.	Dec-Mar.	Total	Apr.	May-June	Total	GRAND TOTAL
AVES														
Anseriformes														
Anas platyrhynchos														
Total sample							1.0			1.0				1.0
M.I. Total sample							0.2			0.2				0.2
M.I. Seasonal							1.9							
UNIDENTIFIED BIRD														
Total sample	0.5	1.0			1.5									1.5
M.I. Total sample														
M.I. Seasonal														
OSTEICHTHYES														
Total sample		2.0			2.0									2.0
M.I. Total sample		0.2			0.2									0.2
M.I. Seasonal		0.6												
INVERTEBRATA														
Dermacentor variabilis														
Total sample	0.5	0.5			1.0									1.0
M.I. Total sample														
M.I. Seasonal														
VEGETATION														
Grass sp.														
Total sample		1.0			1.0									1.0
M.I. Total sample		0.2			0.2									0.2
M.I. Seasonal		0.6												
NON-FOOD ITEMS														
Total sample														6.0
M.I. Total sample														
M.I. Seasonal														

Figure 7. Seasonal and annual percent frequency of occurrence (M.I.) of beaver, moose and white-tailed deer.


LEGEND
BEAVER
DEER
MOOSE
81.8
60
50
40
30
20
10
0
PER CENT FREQUENCY OF OCCURRENCE M.I.
MAY-OCTOBER 1973
DECEMBER-MARCH 1973-1974
MAY-OCTOBER 1974
DECEMBER-MARCH 1974-1975
MAY-JUNE 1975

I was able to examine the remains of only one presumably wolf-killed moose. It was approximately 21 months old. The fat content of its tibial marrow was 73.5%.

Odocoileus virginianus

The remains of white-tailed deer were found in both summer and winter scats. As shown in Table I, deer comprised 27.3% (M.I.) of the scats found in the summer of 1973 and 11.5% (M.I.) of those found in the summer of 1974. During the winters of 1973-74 and 1974-75, they comprised 40.0% and 41.2% (M.I.) respectively of the scats found.

Fawn remains comprised 16.7% (M.I.) of the scats which contained deer hair in the summer of 1973. No fawn remains were found in scats collected in the summer of 1974.

Although actual predation was not observed, I located the remains of two deer which were probably killed by wolves and one which definitely was. A post-mortem examination of the female white-tailed deer killed by wolves on Wallace Lake during the night of 14 - 15 February, 1975 revealed that it weighed 43 kg and had adequate fat deposits in its body. The fat content of the femur marrow was 86.7%.

I did not find any parasites in the nervous system, heart or lungs. The abdominal organs had been consumed by the wolves. This deer was 5 3/4 years old. The fat content of the tibial marrow of the two deer found on Wanipigow Lake was also high 87.8% and 81.2%.

Castor canadensis

Beaver were an important summer food item for wolves over the entire study period (Table 1). Beaver remains were frequently found in summer scats, but seldom occurred in winter scats.

Incidental Food Items

The remaining species listed in Table I were found infrequently in scats and did not constitute a major part of the wolves' diet during the study. They were probably captured opportunistically or consumed as carrion.

Non-Food Items

Various materials, including undigestible human refuse, acorn shells and pieces of wood were found occasionally in scats throughout the study. They contributed very little to the volumes of the samples.

STOMACH ANALYSIS

The results of stomach analyses are presented in Table 2. These results are presented separately from the scat analyses because of the small number of stomachs which contained food remains and also because most of the carcasses were obtained outside the study area. Few of the stomachs were full and

TABLE 2.

Percent frequency of occurrence and percent frequency of occurrence as a major item (M.I.) of food items found in 13 stomachs.

Food Item	Percent frequency of occurrence	Percent frequency of occurrence as a Major Item
MAMMALIA		
Artiodactyla		
Odocoileus virginianus	38.5	30.7
Alces alces	7.7	7.7
Domestic Animals		
Bos taurus	7.7	7.7
Equus caballus	7.7	7.7
RODENTIA		
Microtus pennsylvanicus	7.7	0.0
CARNIVORA		
Canis lupus (trap debris resulting from self mutilation)	30.8	15.4
Canis familiaris	7.7	7.7
Unidentified Large Mammal	15.4	0.0
Fish	23.1	15.4
Vegetation (trace)	76.9	0.0
Non-food Items		
Rope	7.7	0.0
Paper	15.4	0.0
Parka	7.7	7.7
Matchstick	7.7	0.0
Tinfoil	7.7	0.0

most were less than one-quarter full. Therefore, the importance of such items as the traces of wolf fur and claws which were the result of self-mutilation while in the trap were exaggerated.

Mammal remains constituted most of the food items (76.9% M.I.) found in the stomachs. White-tailed deer remains occurred in four stomachs. One meadow vole (Microtus pennsylvanicus) was found in a stomach. Remains of domestic cattle, horses and dogs occurred in the stomach of one individual in each case. The stomach of the wolf collected on East Lake contained moose hair. Fish remains were found in three stomachs. The traces of vegetation were probably ingested while the wolves were trapped.

POST-MORTEM EXAMINATIONS

The median age of the wolves examined was between eight and nine months. If the two oldest animals (a male 9 3/4 years and a female 8 2/3 years) are excluded, the average age was 9.3 months. The average age of the six males was 7.5 months and that of 12 females was 11 months. I assumed that the pups were born in May (Mech, 1970).

The males were heavier (average weight 26.9 kg) than the females (average weight 22.2 kg). Of the 21 animals examined, 20 were in a nutritionally satisfactory condition with adequate body fat deposits and one male (No.26) was emaciated.

According to Rausch (1967), female timber wolves first breed at approximately 22 months. Only three of the females I examined were this age or older. Animal No.41 (8 2/3 years old) had previously been pregnant, but was not at the time of examination. The reproductive tracts of the other females appeared to be quiescent and in a virginal condition.

Smears prepared from the testes of a male wolf (No. 38) did not reveal the presence of any sperm cells. This was expected as male wolves do not usually become sexually mature until they are 22 months old (Rausch, 1967; Rabb et al. 1967) and No. 38 was only six months old.

The parasite load of these animals was light and few pathologic abnormalities were found. Animal No. 32 had irregular hemorrhagic mucosal ulcers in the stomach. Unidentified cestode segments were found in the small intestines of animals No's 26 and 32. Several Toxocara eggs were present in the faeces of animal No. 33. Organisms resembling Isopora bigemina were found in the faeces of animal No. 46. One giant kidney worm (Dioctophyma renale) was found in each of animals No. 39 and No. 46. The worm in No. 39 was found within the capsule of the right kidney and had destroyed all the parenchymatous tissue of that kidney. A mature kidney worm (104 cm in length) was found free in the peritoneal cavity of No. 46. Dr. Dick did not find any evidence of Trichinella sp. in the diaphragms. There was no evidence of Echinococcus granulosus infection in any of the wolves. The

level of parasitic infection in the examined wolves (27%) was low compared with that found by Holmes and Podesta (1968) in Alberta. They found that 98% of 98 wolves examined harbored one or more species of helminths with a mean of 2.6 species perwolf.

Three of the wolves (Nos. 40, 41 and 42) had evidence of trauma. Nielsen (1977) reported evidence of traumatic injury in 50.9% of 110 Alaskan wolves examined. These injuries were probably associated with hunting large ungulate prey, intraspecific fighting and trapping.

QUESTIONNAIRES

Tourist Questionnaire

The campground at Wallace Lake contained 69 permanent cottages and 60 unserviced camping sites. In the summers of 1973 and 1974, 757 and 639 camping permits were issued respectively. The owners or users of 38 cottages were interviewed along with 88 "transient" campers for a total sample of 126.

Three quarters of the people who visited Wallace Lake (74.6%) were from Winnipeg. Most of the campers (80.7%) visited Wallace during the summer while many cottage owners used the area on a year-round basis. Cottage owners spent more time at the lake annually and also spent more time away from the campground than campers.

The three most popular outdoor activities of the two groups were fishing, swimming and powerboating. The groups were approximately equal in the amount of travelling done to see wildlife. Cottage owners had seen much more wildlife in the Wallace Lake area than the campers. When asked what wildlife they would like to see, campers expressed more interest in moose and "big game" than cottage users. Both groups wanted to see white-tailed deer.

Twenty-nine percent of the cottage users had heard wolves howling in the Wallace area while only 14.8% of the campers had. Similarly 21.1% of the cottage users had seen a wolf while only 6.8% of the campers had. While a large majority of both groups said they would like to hear and/or see a wild timber wolf, a larger percentage of the campers expressed this desire than the cottage users. A majority of both groups said they would be willing to make an effort to hear timber wolves howl.

To test the hypothesis that the campers and cottage users were homogeneous in their interest in wolves, 2 x 2 contingency tables were prepared for questions 12, 13 and 15. Chi-square tests indicated that campers were significantly more interested in hearing and seeing wild wolves than cottage users ($\chi^2 = 4.3905$ and $\chi^2 = 6.1358$ respectively). However, there was no significant difference ($\chi^2 = 2.0136$) in the effort the two groups would make to attend an organized "wolf-howl".

Questionnaire respondents were also grouped according to sex or type of family group encountered in order to determine whether they was any sex-related reaction to timber wolves. The groups tested were male, female, husband and wife and "other". Because of the small sample size, the responses from families, children and the non-recorded group were grouped together to form an "other" category. Questions 12, 13 and 15 were correlated with these groups.

To test whether these groups were homogeneous in their responses, 2 x 4 contingency tables were prepared for questions 12, 13 and 15. Chi-square tests indicated that these groups were homogeneous in their desire to see wolves ($\chi^2 = 4.8771$) and the effort they would make to attend an organized "wolf-howl" ($\chi^2 = 4.3367$). Women, however, were significantly less interested in hearing wolves howl ($\chi^2 = 9.7871$) than the other groups tested.

Farmer-Rancher Questionnaire

The questionnaire used to examine the extent of timber wolf predation on domestic livestock was sent only to cattle owners because very few operators in Manitoba raise sheep as a primary source of income. Because of this sampling bias, the incidental data collected regarding losses of sheep, swine, and poulty were not examined in detail.

Of the 1059 questionnaires mailed out, 455 were completed and returned. A further 66 were returned unanswered or

unusable since the farmers had retired, moved, died or mutilated the form so that their region could not be identified. This gave a total return of 521 or 49.2% of the number mailed originally.

A large majority of the respondents did not have any predator problems. Eighty-one percent had not lost any livestock to predators within the last five years and 76.1% did not think there was a predator problem in their area. One hundred respondents (23.9%) said there was a problem in their area and 84 (19.0%) had lost livestock to predators over the last five years. These losses included poultry, swine, sheep and cattle.

Three hundred and nine respondents had free ranging cattle, while 211 used a feed lot system. Approximately 65 farmers used both systems, putting their cattle out to pasture in the spring. Fifty-eight percent of those with free ranging cattle had 25 - 100 head. Fifteen respondents with free ranging cattle stated they had wolf problems while only seven feed lot operators did so. Twenty-seven of the respondents kept sheep as well as cattle. Ten of these kept their sheep in a feed lot while 17 allowed them to pasture away from their buildings.

Reported losses of cattle and sheep during the five year period between 1969 and 1973 are presented in Table 3. The total number of farmers who suffered losses during that period is exaggerated in Table 3 as some lost both calves and

TABLE 3.

Reported livestock losses to predators between 1969 and 1973.

Region	Calves	Cattle	Lambs	Sheep
Eastern	39 (12)*	10 (3)	0	0
Interlake	14 (11)	4 (2)	18 (3)	3 (2)
Western	213 (65)	64 (18)	115 (13)	27 (5)
Total	266 (88)	78 (23)	133 (16)	30 (7)

* Number in parentheses indicates number of farmers who reported losses.

cattle or both sheep and lambs to predators. Seventy-four respondents (16.3%) lost 266 calves and 78 cattle and nine respondents (2.9%) lost 133 lambs and 30 sheep. The actual losses may have been higher since 15 respondents (3.3%) stated they had suffered losses but did not quantify them. The annual losses of livestock were fairly constant over that period and averaged 52.3 calves and 15.8 cattle per year. The respondents who reported losses to predators lost an average of 4.7 cattle each. The average loss per farmer reporting losses was highest in the Eastern region at 5.4 cattle each. The Western region was second with 5.0 cattle each and the Interlake region was lowest with 1.9 cattle each. The number of respondents reporting losses was highest in the first mailing (47) and declined in the second (28) and third (8) mailings. Most losses occurred during the summer according to 40.6% of 288 respondents followed by spring (30.9%), fall (25.4%) and winter (3.1%).

Losses to predators within the 12 month period prior to receiving the questionnaire (approximately 31 March 1973 to 31 March 1974) are presented in Table 4. Assuming average values of $150.00 for calves, $325.00 for cattle and $30.00 for lambs and sheep, these losses totalled $25,000.00. These losses were incurred by 67 respondents (14.7%). Of the 68 respondents who indicated how certain they were of predators actually killing livestock rather than scavenging on carcasses 58.8% were positive, 20.6% were fairly certain, and 20.6% were not certain.

TABLE 4.

Livestock losses to predators between 31 March 1973 and 31 March 1974.

	Calves	Cattle	Lambs	Sheep
Coyotes	47	12	32	4
Black Bear	34	4	5	3
Timber Wolf	19			1
Domestic Dog	11			
Magpie	2			
Unknown	10			
Total	123	16	37	8

Eight respondents (1.8%) lost livestock valued at $2,880.00 to wolves within that 12 month period. Four lost one calf each, one lost two calves, one lost four calves, one lost nine calves and one lost one sheep. Seven of these respondents had free-ranging cattle while the farmer who lost nine calves had a feed lot operation. All were very certain that wolves caused these losses. Five of these farmers were in the Western region, two in the Interlake and one in the Eastern region. Two men (Western region) lost stock only to wolves while the others had also lost stock to bears and/or coyotes. All the farmers with losses to wolves indicated that both wolves and coyotes were present in their areas and four had losses to coyotes which exceeded their losses to wolves. Losses to wolves occurred in the spring, summer and fall.

Canids were blamed for most of the predator problems. Twenty-one respondents (4.6%) stated that dogs did kill livestock in their areas while 326 (71.6%) said there was no problem with them. Seventy-six and one half percent of the respondents stated that coyotes were present in their area. When asked about timber wolves, 148 (32.5%) respondents replied that they were present, 97 (21.3%) said they were not and 210 (46.2%) did not reply. The large proportion of non-respondents to this question may indicate that wolves were not present in many areas or that some respondents had difficulty in identifying them. Ninety-six farmers reported seeing lone wolves, while 51 reported seeing packs. The majority of wolf

packs seen (55.6%) consisted of two or three animals. Packs of four to six animals were reported by 25.9% of the respondents and packs of seven or more were seen by 11.1% while 7.4% of these men were unable to say how large the packs were. Six respondents reported that single wolves killed calves and four stated that packs were responsible for stock losses.

I also asked which predator caused most of the problems in their area. Coyotes were the worst offenders according to 26.6% of the farmers sampled. They were followed by red fox (Vulpes vulpes) (16.3%), black bear (15.4%), domestic dog (7.0%), timber wolf (6.2%) and lynx (Lynx lynx) (2.2%). Other predators mentioned were skunks (Mephitis mephitis) (3.7%), raccoon (Procyon lotor) (1.5%), magpie (Pica pica) (1.1%), grey foxes (Urocyon cinereoargenteus) (0.2%), badgers (Taxidea taxus) (0.2%) and mink (Mustela vison) (0.2%). Problems caused by species other than bears, wolves, coyotes and magpies were related to livestock other than cattle and sheep.

Eighty-six farmers replied to a question asking what action they took when losses occurred. The results were as follows: shooting predators (29.1%), nothing (24.4%), asked for a control program by conservation officers (20.9%), trapping (9.3%), different handling of stock (8.1%) and "Other" (8.1%). "Different handling of stock" included keeping calves in the farm yard, checking stock more often, putting stock out to pasture later in the summer, and moving stock to a different area. "Other" included selling sheep and buying cattle,

informing police, skidoo and aircraft hunting, and informing the local council of the problem.

I also asked the farmers what, in their opinion, is the best way to deal with a predator problem. This elicited 403 replies. A bounty system was suggested by 28.3% of the respondents. Other responses were: hunting (22.1%), trapping (21.6%), removal of individual problem animals by specialists (13.1%), an annual government poison bait control program (9.2%), modification of livestock handling methods (2.2%) and "other" (3.5%). "Other" included aircraft and skidoo hunting, loss compensation and shooting predators "on the spot."

The only non-respondent I contacted in the Eastern region had sold all his cattle and therefore had not responded to the questionnaire. Twelve non-respondents were contacted in the Interlake. Two of these completed questionnaires. Only one mentioned that he had suffered a loss, possibly one calf to a black bear, but he was not certain that the bear had actually killed the calf. Of the remaining non-respondents, two had died, one had moved, four had sold their cattle, and three had no predator problems. Twelve non-respondents were contacted in the Western region and completed questionnaires. Of these, ten had no problems with predators, one had sold his livestock, and one had lost a calf to coyotes within the last twelve months.

The following data were taken from the questionnaires completed by the 14 non-respondents from all areas. Four of

these farmers kept cattle in a feed lot and 12 allowed them to free-range (at least in the summer). None of them kept sheep.

Two of them thought there was a predator problem in their area while eleven did not. Two had lost one calf each within the last five years. Coyotes and a black bear were blamed for the losses, but only in the case of the coyotes was the farmer very certain of the cause of death. The loss of the calves occurred in the summer. One farmer reported there was a problem with dogs killing sheep in his area.

Eleven stated there were coyotes in their area while two said there were none. Seven farmers said wolves were present while six said they were not present. Coyotes were seen more frequently than timber wolves. Of the men who said wolves were present in their areas two said they were usually alone while three said they were in packs of two or three animals. When asked which predators cause most of the problems in their area, two replied black bears and coyotes, one said red foxes, and three said skunks. The foxes and skunks caused poultry losses.

Neither of the farmers who suffered losses from predators took any action. However, all the farmers contacted had opinions on how to deal with a predator problem. Their suggestions were: a bounty system (50%), hunting (21.4%), an annual poison bait program (14.3%), the removal of problem animals by specialists (14.3%) and trapping (7.1%).

DISCUSSION

POPULATIONS

Aerial surveys and ground track observations in the study area suggested that it was utilized by eleven wolves - the Hungry Lake pack, the Siderock Lake pack and a pair which frequented Wallace Lake. The ranges of these packs included portions of the study area but were not wholly encompassed by it. This yields a density of one wolf per 51 km^2 (1/19.7 sq. miles).

During the winter of 1976-77, after I had ceased field studies, I received reports of a pack of ten to 20 wolves in the study area (Conley and Darby, pers. comm.). If Rausch's (1967) hypothesis that the frequency of larger packs is higher in populations of higher density is correct, then the large pack may indicate an increasing population in the study area.

A number of authors, Pimlott (1967a) Pimlott et al. (1969), Mech (1970), Van Ballenberghe et al. (1975), and Stephenson (1975a) have reviewed the literature on wolf population densities. They found a wide variation in densities across North America. The highest recorded density was on Isle Royale in 1975 (Peterson and Allen, 1974) with one wolf per 13.3 km^2. Kuyt (1972) found one wolf per 17.9 km^2 near Abitau Lake in the Northwest Territories in an area of caribou concentration. Parker (1973) also

reported very high densities of wolves (up to one wolf per 20.2 km^2) in wintering areas of barren-ground caribou in Manitoba and Saskatchewan. Very low densities have also been reported. Pimlott (1967a) stated that in 25,900 km^2 of moose range in Ontario, the wolf density was between one wolf per 259 km^2 and 518 km^2. Riewe (1975) observed 12 wolves in the area of approximately 22,000 km^2 in the Jones Sound region of the eastern High Arctic. This would be a density of less than one wolf per 1800 km^2.

As Pimlott (1967a) pointed out, obtaining accurate data on wolf and prey densities has proven to be the major problem in understanding the influence of wolves on prey populations. Cowan (1947) estimated that the summer density of wolves in Jasper National Park was between 225 and 287 km^2 per wolf. In the winter, because of range compression into lower altitudes the density increased to approximately one wolf per 26 km^2. This density remained constant over a five year period. Cowan's population figures are based on reports received from park wardens while Pimlott's figures were based on extensive aerial surveys.

More recent work has been carried out in Ontario and Minnesota using radio-collared wolves. Kolenosky (1972) found that a pack of eight wolves in Ontario utilized a winter range of 224 km^2 (a density of one wolf per 28 km^2). Van Ballenberghe *et al*. (1975) studied five packs in Minnesota and estimated their density at one wolf per 24 km^2.

The exact number of large ungulates in the study area was unknown. It was estimated that there were approximately 66 moose and 37 woodland caribou (Stardom, 1977). White-tailed deer were very scarce and were probably concentrated along the north shores of Wallace and Siderock Lakes. The population estimates for deer and moose are probably low.

GENERAL FOOD HABITS

On the basis of their frequency of occurrence in scats (Table 1), deer, moose and beaver can be considered staple items in the diet of wolves in the study area. The importance of these three species is in agreement with the findings of other studies although the relative importance of these species varies between studies (Mech, 1970).

I did not find a dramatic shift to moose calves or deer fawns in the summer as other authors have reported (Mech, 1966; Pimlott et al. 1969; Van Ballenberghe et al. 1975). I had difficulty distinguishing between adult and juvenile hair in some cases and this may have resulted in a slight under-estimation of the importance of young ungulates in the summer diet of the wolves.

There is some disagreement as to how accurately remains found in scats reflect the proportion of adult and juvenile deer and moose consumed by wolves. Mech (1970) contended that juveniles are over represented in scat collections

because the ratio of surface area to body mass is greater in juveniles and more hair may be consumed because the skin can be more readily torn apart and ingested. Also juveniles may be consumed more quickly allowing the wolves to move on leaving a higher proportion of scats containing juvenile remains scattered along trails where they are collected rather than concentrated in one area. Pimlott et al. (1969) assumed that the proportion of juveniles and adults indicated by scat analysis approaches the proportion that are killed. I followed Pimlott's assumption but omitted three groups of scats, each found in a small area associated with a kill.

As Knowlton (1964) observed, scat analysis is a crude tool for determining the food habits of carnivores, but it does allow the collection of relatively large samples from discrete areas without endangering future collections. Also scats can be accurately dated when collections are made regularly.

Pimlott (1967a) discussed some problems associated with determining food habits by scat analysis. The material found in scats does not provide any information concerning the physical condition of the prey which made it susceptible to predation. Furthermore, one cannot distinguish between food items obtained by predation and scavenging. These problems also apply to the analysis of stomach contents. Because of selective predation, a prey species can show higher importance as a food item without occurring in higher densities in the

area (Frenzel, 1974). It is also often difficult to determine the cause of death of a carcass upon which wolves have fed. Unless one has actually observed the act of predation, the cause of death is usually an assumption.

STAPLE FOOD ITEMS

Moose were the most abundant large ungulates found in the study area. Stardom (1977) estimated the population to be 66; a density of one moose per 8.5 km^2. They were concentrated in suitable habitat along the lake and river systems on the periphery of the study area and were seldom seen in the central area. Low productivity was indicated by the fact that I saw only one calf and later found the tracks of another. The low occurrence of calf remains in scats may also indicate relatively low productivity. The population and productivity estimates were probably conservative as no intensive surveys for moose were conducted.

There was a hunting season for moose in the study area during the two years of the study. Native hunters also took an unknown number of moose along Highway 304 during both winters. Traces of hunter-killed moose undoubtedly occurred in scats I collected because wolves fed on gut piles and wounded animals which escaped the hunters.

A number of authors, Peterson (1955), Pimlott et al. (1969) and Mech (1970), have observed that the importance of

moose as a food source of wolves depends on the availability of alternate food sources. Wolves concentrate on the easiest prey to catch. Data from my study support this hypothesis. When beaver or deer were readily available, the wolves utilized them in preference to moose. During the spring and summer of 1973 beaver and deer were relatively abundant and moose remains were found in only 12.8% (M.I.) of the summer scats. However, the following summer when deer were less abundant and beaver were not as accessible due to a later spring break-up, the occurrence of moose in summer scats rose to 25.0% (M.I.). During the summer, wolves also preyed on a wide variety of small mammals, birds and fish.

Insufficient quantitative data precluded any conclusions regarding the condition of moose killed by wolves or the effects of wolf predation on this moose population. The high marrow fat content of the moose and deer tested may not accurately describe the nutritional state of these animals as the samples were not taken from the femur. Fat reserves are utilized earlier in the femur than in the tibia and tarsus. Thomas et al. (1976) found that fat is often present in the marrow of the tarsus of caribou when it is nearly depleted in the femur and the tibia.

White-tailed deer were common in the Bissett area from the 1920's to the 1940's as habitat was created by logging and land clearing operations (Stardom, 1977). Changes in land use practices, increased hunting pressure and severe winters

reduced the population to its present low level. The deer population in the study area has remained low due to a lack of suitable habitat and severe winter conditions. Deer tracks were found occasionally in the study area and near a landing strip approximately 1.3 km west of Wallace Lake. Conley (pers. comm.) stated that a small group of deer usually wintered along the north shore of Siderock Lake. Seven deer were observed during the study - six from the air by a pilot and one killed by wolves on Wallace Lake. There was no sport hunting season for deer in Manitoba in 1973 or 1974 and few, if any, deer were taken by poachers in the study area. Therefore, unlike moose, it is not likely that the wolves fed on the remains of hunter-killed deer.

The frequency of occurrence of fawn remains in summer scats was very low. This was probably due to a low deer population with low productivity. Fawn production was probably higher in 1973 than 1974 due to winter weather conditions. The winter of 1972-73 was relatively mild with a snowfall of 121.2 cm which was approximately 27 cm less than the 30 year average for the region. The following winter (1973-74) was relatively severe with 232.7 cm of snow recorded at Bissett. This may account for the absence of fawn remains in the summer of 1974.

Wolves in the study area were forced to rely on moose and deer for most of their diet during the winter. However, while the frequency of occurrence of deer in their diet

remained relatively constant (40.0% M.I. and 41.2% M.I. respectively), the occurrence of moose declined from 56.7% (M.I.) in the winter of 1973-74 to 35.3% (M.I.) in the winter of 1974-75. Although a chi-square test indicated that there was no significant difference in the proportions of deer and moose in their diet, it does seem to suggest that deer is their optimum prey during the winter and that if other food sources (such as beaver) become available wolves will utilize them rather than moose. Selective predation by wolves may be a secondary factor, following habitat and winter conditions, in maintaining the deer population in the area at a low level.

Beaver were found throughout my study area. Although no house counts were carried out, the population was estimated to be high. Beaver comprised the major portion of at least one trapper's annual fur harvest (Conley, pers. comm.).

I identified beaver remains in 39.4% (37.2% M.I.) of the scats I collected. The wolves preyed on beaver most heavily during the ice-free season (Table 1). However, beaver remains were also found in scats collected during the winter of 1974-75. When beaver run out of food or their food supply becomes frozen in, they are forced to leave their ponds to search for food. At such times they are very vulnerable to predation. Mech (1966) reported two sightings of beaver killed in this way in early March, 1961. I observed a pond in February, 1974 which beaver were leaving, presumably daily, in order to cut aspen.

As shown in Table 1, the heaviest occurrence of beaver was found in April and early summer of 1973. Of the 44 scats collected during the summer of 1973 which contained beaver remains as a major item, 28 were deposited in May. This heavy occurrence in April and May was probably due to a very early breakup on 21 April of that year (Conley, pers. comm.). In 1974 and 1975, breakup occurred on 11 May and 6 May respectively (Conley, pers. comm.) and beaver were not preyed on intensively until after those dates. The seasonal occurrence of beaver in the wolf scats correlates well with Mech's (1966) statement that beaver are most vulnerable in the early spring and autumn when they are most active on land. Shelton (1966) found that beaver were most vulnerable in the fall when they were cutting trees for their winter food supply.

The relatively great importance of beaver to the wolves in my study area is comparable to that found by Voigt et al. (1976) in Ontario and Peterson (1975) on Isle Royale. This is probably due to the relatively low availability of deer and moose and the high density of beaver in the area.

INCIDENTAL FOOD ITEMS

Timber wolves rely on large ungulates for their primary food source. However, they also prey opportunistically on smaller mammals, birds and fish and occasionally these other groups comprise a significant supplement to the wolf's diet.

In addition to the staple food items (moose, deer and beaver), the wolves in the study area consumed a variety of incidental food items as shown in Table 1. Although these incidental items comprised only 10.5% (M.I.) of the wolves diet in the study area, they have been found occasionally to assume greater importance in other areas.

Rangifer tarandus caribou

There is very little information in the literature concerning the relationship between wolves and woodland caribou. I found the remains of caribou in only three of the scats collected. This may be due partly to the fact that few of the scats were collected within the range of the caribou band as described by Stardom (1977). Although the tracks of wolves and caribou were frequently seen in the same area during my surveys, I did not observe any interaction between the two species or any evidence of dead caribou, wolf-killed or otherwise.

The low utilization of woodland caribou by wolves is in sharp contrast to the importance of barren-ground caribou to wolves. Murie (1944), Kuyt (1972) and Parker (1972) found that barren-ground caribou comprised a major portion of the wolves' diets. Barren-ground caribou are preyed upon more heavily than woodland caribou probably because of their greater numbers, their concentration on calving and wintering areas and a lack of suitable alternate prey.

Ondatra zibithecus

Muskrats are relatively unimportant to wolves as a food source. Like beaver, they are available only during the ice-free season. Because of their low importance, other authors (Pimlott et al. 1969, Van Ballenberge et al. 1975 and Voigt et al. 1976) lumped muskrats with other small mammals whose total frequency of occurrence averaged less than seven percent.

Muskrats were abundant throughout the study area but were seldom fed on by the wolves. They occurred in 2.5% of the scats I collected but were a major item in only 1.7% (Table 1). Muskrats were taken only in the summer and did not comprise an important part of that season's diet.

Marmota monax

Woodchucks were common along the roads in the study area. Their burrows were often in rocky areas where they would be difficult to excavate. Wolves probably captured them opportunistically or consumed them as carrion. They were found only in scats collected during the summer of 1973. Woodchuck remains were found infrequently in scats collected in Ontario and Minnesota (Pimlott et al. 1969 and Van Ballenberghe et al. 1975).

Murie (1944) and Stephenson and Johnson (1972) found that wolves in Alaska occasionally preyed on marmots (Marmota caligata), especially when caribou were scarce. Murie (op. cit.) noted that because of their size - average weight

5.9 kg (Banfield, 1974) - marmots could provide a considerable amount of food for wolves.

Tamiasciurus hudsonicus

Red squirrels were abundant throughout the study area but occurred in only one scat. Because of their small size and arboreal habits, they are not an important food source for wolves. Mech (1966) and Van Ballenberge et al. (1975) also found a very low frequency of occurrence of squirrel remains in wolf scats.

Although Tamias sp. (Pimlott et al. 1969 and Van Ballenberghe et al. 1975) and Glaucomys sp. (Voigt et al. 1976) have been found in wolf scats, I did not find them in my study.

Microtus pennsylvanicus

Mice and voles are not an important food item for wolves in the forested areas of North America. The following species have been found occasionally in wolf scats: Clethrionomys gapperi, Microtus pennsylvanicus, Synaptomys cooperi, Peromyscus maniculatus and Napaeozapus insignis (Van Ballenberghe et al. 1975 and Voigt et al. 1976). Mice and voles contributed only small fractions of the total occurrences of food items. The only occurrence of voles in the wolves' diet which I found was one Microtus pennsylvanicus in the stomach of a wolf from the Pine Falls area.

Cowan (1947) noted that coyote scats in Banff and Jasper National Parks contained "appreciable numbers" of microtine remains even though the mouse population was low during his study period. On the other hand, only 2% of the wolf scats he collected contained mouse remains. Murie (1944) found mouse remains in 5.5% of the 1,174 scats he collected in Mount McKinley National Park in Alaska. He found several scats composed entirely of mouse remains (as many as six mice in a scat). Murie (ibid.) observed both adults and pups hunting mice and suggested they might be an important supplement to the wolves' diet especially when large prey animals are scarce and mouse populations are high.

There is evidence that small mammals supplement the summer diet of arctic wolves. Kuyt (1972) found that wolves in the Thelon Game Sanctuary, Northwest Territories fed on Arctic ground squirrels (Spermophilus sp.) and microtine rodents were eaten by pups and adults to the same extent (approximately 12.6% of prey items) whether caribou were present or not. Microtines and Arctic ground squirrels also augmented the summer diet of wolves in the north central Brooks Range in Alaska (Stephenson and Johnson, 1972). Stephenson and Johnson (ibid.) found one den site at which microtine rodents and ground squirrels apparently comprised the bulk of the diet. Both studies found that wolves depended primarily on ungulates for their summer food supply.

Lepus americanus

The snowshoe hare population in most of southern Manitoba "crashed" in the spring of 1972 (Pastuck, 1974). I assumed this decline occurred in the study area at approximately the same time because the hare population was low during the entire study. Hare remains were found in only 3.9% of the scats collected and only in spring and summer scats. The frequency of occurrence of hare remains in my study was similar to that reported by Cowan (1947), Pimlott et al. (1969) and Van Ballenberghe et al. (1975).

It has often been suggested that snowshoe hares may be an important food source for wolves. However, most authors have reported a very low frequency of occurrence of hare remains in wolf scats. The largest occurrence of hares in the wolf's diet was reported by Stebler (1944) in Michigan, who found that they accounted for 28.5% of the food items in eight wolf stomachs and 37.5% in eight wolf scats. Stephenson (1975b) found snowshoe hare remains were the predominant item (35.7%) in 1,157 scats collected at a wolf den in southeastern Alaska. He stated that hares constituted an important supplement to the diet but ungulates comprised the major portion of the diet. Mech (1977) suggested that high densities of beaver and snowshoe hares may enhance pup survival during summer in years when ungulate populations are low.

Ursus americanus

Black bears were common in the study area, especially near the garbage dump at Wallace Lake. Nuisance bears were occasionally shot near the campground and the carcasses were usually taken to the dump.

Remains of bears were found in three scats. This was probably the result of wolves scavenging upon bear carcasses at the garbage dump. Pimlott et al. (1969) and Van Ballenberghe et al. (1975) reported occasional traces of black bear in wolf scats. Wolves probably kill bears occasionally but such bears would likely be in a weakend condition (Mech, 1970).

Canis familiaris

I found the remains of domestic dogs in one scat and in the stomach of a wolf from the Waterhen Lake area of Manitoba. Several authors (Young, 1944; Cowan, 1947; Pulliainen, 1975) have reported wolf predation on dogs throughout the range of the wolf in North America and in Northern Europe.

Canis lupus

I found no wolf remains in scats during my study, however, wolf remains were found in the stomachs of four trapped animals. These remains consisted of hair and in two cases pieces of pads and claws. This was probably the result

of self mutilation while the wolves were in a trap. Wolf hair has been found in a small number of scats by Van Ballenberghe et al. (1975) and by Voigt et al. (1976). Traces of hair may be ingested while grooming, as Pastuck (1974) suggested for coyotes.

Cannibalism by wolves has been reported by several authors. Rausch (1967) reported finding injuries during autopsies which were probably inflicted by other wolves. He also mentioned six instances in which trapped wolves were consumed by other wolves. Marhenke (1971) observed four wolves kill another wolf which appeared to be a "loner". Van Ballenberghe and Erickson (1973) presented evidence that a pack of three to five wolves killed and consumed another wolf in northeastern Minnesota.

Intraspecific aggression which appeared to be manifestations of territorial tendencies has been observed on Isle Royale by a number of authors. Mech (1966) reported that the large pack (15 - 16 wolves) pursued alien wolves on a number of occasions but no contact was observed. Jordan et al. (1967) also observed members of the large pack pursuing other wolves. They found evidence that the aged alpha male of the large pack was killed and devoured by other members of the pack.

Mortality due to intraspecific strife contributed significantly to the decline of wolves in the core study area of the Superior National Forest in northeastern

Minnesota (Mech, 1977). The ultimate cause of the decrease in the wolf population was a decline in the deer population due to a series of severe winters from 1968 to 1969 and 1973 to 1974. Malnutrition, especially in pups, was the initial response to a lack of prey. Mortality due to malnutrition, which had not been observed previously, constituted 30% of the wolf mortality from 1971 to 1973. Productivity also decreased dramatically. Despite the population reduction, the remaining wolves were forced to trespass in other packs' territories in order to obtain sufficient food. This resulted in mortality due to intraspecific strife and usually affected alpha animals which are the established breeders. Intraspecific strife accounted for 100% of the wolf mortality found in the core study area in 1974 and 1975 (Mech, ibid.).

AVES

Birds and their eggs are a relatively unimportant supplement to the summer diet of wolves. Several authors (Kuyt, 1972; Stephenson and Johnson, 1972; Van Ballenberghe et al. 1975) have found bird and bird egg remains, representing passeriforms, anseriforms and galliforms in wolf scats. In my study, mallard duck remains were found in 1% of the scats (0.2% M.I.). Timm et al. (1975) reported that wolves killed and ate at least two mallards which had been caught in banding traps in Alaska. Wolves have also been found to

search systematically for flightless ducks around small ponds in the James Bay Region (Hagar, in Mech, 1970).

OSTEICHTHYES

Fish are also a supplement to the summer diet of wolves. Young (1944) recorded several instances of wolves catching spawning salmon (Oncorhynchus sp.) in British Columbia and Alaska. Kuyt (1972) found that fish were important in areas where caribou were absent during most of the denning season. Bromley (1973) observed a female wolf catching whitefish (Coregonus sp.) during a spawning run in the Northwest Territories. Stephenson and Johnson (1972) found the remains of Arctic grayling (Thymallus arcticus) in scats collected at a den in Alaska. They thought the grayling were taken in a spawning creek approximately one mile from the den. Mech (1970) did not consider fish to be an important food item for wolves.

I found the remains of fish in 2% (0.2% M.I.) of the scats I collected and in 23.1 % (15.4% M.I.) of the stomachs I examined. The wolves in my study area may have caught fish or more probably scavenged dead fish along the shores of Wallace Lake or at the garbage dump. Fish found in the stomachs may be trap bait or have been taken while scavenging around commercial fishing operations.

INVERTEBRATA

Invertebrates are not as important to wolves as they are to smaller canids such as fox and coyote. Stephenson and Johnson (1972) found traces of insect remains in wolf scats. Beetles (Coleoptera) and bees or wasps (Hymenoptera) were found in wolf scats by Kuyt (1972). He found more beetle remains in areas temporarily devoid of caribou which suggests that wolves eat them only when other prey is unavailable.

The only invertebrates I found were three dog ticks (Dermacentor variablis). These were probably ingested while grooming.

VEGETATION

Vegetation is not an important food item for wolves and is usually found in only trace amounts. Van Ballenberghe et al. (1975) however, found that vegetation, mainly fruit remains, constituted a significant percentage (up to 31.4%) of the food items collected at four rendezvous sites in Minnesota. Identified species included Rubus spp., Vaccinium spp. Amelanchier spp., and Prunus virginiana. I collected one scat (later lost) that appeared to consist entirely of blueberries (Vaccinium sp.).

Most of the scats I collected contained bits of conifer needles and grass. I ignored these trace amounts as they were probably ingested accidentally or adhered to the scat after deposition.

Grass (Graminae) occurred in two of the scats in larger than trace amounts and was a major item in one scat. Murie (1944) found grass and sedges in 1.5% of 1,174 scats and postulated that grasses acted as a parasite scour. Kuyt (1972) found a scat, composed entirely of grass, which contained several tapeworms (Taenia sp.). Mech (1966) suggested that wolves may eat blood-spattered grass around kills.

NON-FOOD ITEMS

Like bears, wolves frequent garbage dumps which were probably the source of many of the non-food items I found in the scats and stomachs. Scavenging garbage has been noted by Murie (1944) and by Voigt et al. (1976).

WOLF-HUMAN INTERACTIONS

Recreational (Tourist Questionnaire)

The two groups of tourists sampled at Wallace Lake, campers and cottage users, were very similar with respect to place of origin, number of children and recreational activities. Cottage users spent more time in the Wallace Lake area annually and also more time away from the campground. They did more hunting, boating, hiking and snowmobiling in the area than campers. This probably accounts for the fact that they had seen more wildlife, including wolves, than campers.

Many visitors came to Wallace Lake with the hope of seeing wildlife. Most people wanted to see white-tailed deer and moose. Some of the campers were not aware of the variety of species of wildlife present in the area. Many also expressed dissatisfaction with the difficulty of observing large mammals. It was apparent that most visitors regarded the opportunity to see wildlife as an essential part of "wilderness" camping and this helped to draw them to Wallace Lake.

The visitors interviewed at Wallace Lake generally had a very favorable attitude toward wolves. The majority of Wallace Lake users would like to hear and/or see wild wolves and the few who have the experience enjoyed it. Furthermore, a majority would be willing to make a concerted effort to hear or see wolves in an outing similar to the organized "wolf howls" conducted in Algonquin Park in Ontario. Many people were interested in this as an educational experience for their children.

Several women indicated that they thought hearing wolves howl was a rather frightening experience as it usually occurred at night when they were alone or "defenseless" in a tent. However, women did not differ significantly from the other groups tested in their willingness to attend an organized "wolf howl".

Timber wolves are popular subjects for Interpretive Programs in both provincial and national parks. Most people are fascinated by wolves, regardless of their personal

positive or negative attitude toward them. The identification of wolves with "wilderness" and recent publications and films have created a great deal of interest in the species. The vocalizations of wolves make them particularly interesting as they will respond to human "howling".

The great success enjoyed by public "wolf howls" in Algonquin Provincial Park and Riding Mountain and Prince Albert National Parks and the interest expressed in such activities by tourists at Wallace Lake suggest that wolves have a great potential as a non-consumptive recreational resource which is just beginning to be exploited. Pimlott (1976b) suggested that there is great potential for commercial guiding services and nature tours to conduct people through areas where there is a possibility of hearing and even seeing wolves.

Economic (Farmer-Rancher Questionnaire)

The destructive effect of wolf predation on domestic livestock has been well documented in the literature (Young, 1944). The usual approach to wolf problems has been attempted or complete extermination of the species using a broad range of methods.

Attempts to control wolves in Manitoba began in 1878 when an act establishing a bounty of $1.00 on "large wolves" and $0.50 on "small wolves" was passed (Emberley, 1968). The

provincial bounty on wolves existed in one form or another until 1965 when bounties paid by the provincial government were discontinued and the present Predator Control Act was enacted. The bounty system was as ineffective in controlling predators in Manitoba as it was elsewhere.

The Predator Control Act of 1965 declared timber wolves, coyotes, foxes and bears to be predators and not protected in Predator Control Areas. In 1967, Local Government Districts (L.G.D.'s) south of the 53rd parallel were declared Predator Control Areas along with all municipalities. A Predator Control Area was defined in the Act as all territory within a municipality or L.G.D. excepting public shooting grounds, wildlife management areas, refuges, provincial forests, provincial parks and provincial recreational areas. Predators and their young can be killed at any time in these areas. Timber wolves may be shot or trapped anywhere in Manitoba with the exception of Riding Mountain National Park and the Provincial wildlife refuges.

The Predator Control Act permitted municipalities to pay bounties if they assumed responsibility for payment. Less than five municipalities did this and bounties of $5.00 and $2.00 were paid on one wolf in 1972-73 and one in 1973-74. This program was discontinued in 1974.

The Act provided four general cost-sharing agreements with the municipalities: (1) 1080 (sodium monofluoracetate) Poison Bait Program for controlling coyotes and foxes.

(2) The Individual or $10.00 agreement whereby participating municipalities are assessed $10.00 for each complaint investigated by provincial government staff. (3) Special Trapper Programs to deal with special problems within a municipality. (4) Special Predator Permits enabling the holder to hunt predators in specific areas using an aircraft or snowmobile (McKay, 1975). These agreements are still in effect. However, poison baits have been used infrequently since 1968 and no Special Predator Permits have been issued since 1973-74. High fur prices in recent years have encouraged trapping and hunting and thus kept predator populations at a low level in most settled areas. The predator control program in fringe agricultural areas is aimed at removing problem animals rather than reducing populations over wide areas.

It is very difficult to determine the effects of predation on the livestock industry. As Balser (1974) stated: "The problems of livestock losses to predators in the western United States are compounded today by confusion caused by too many participants, misinformation from non-authoritative sources, human emotion which polarizes opinions, and most important of all, a lack of data on livestock losses and effects of predator control." These problems are also found in Manitoba - especially a lack of accurate data on livestock losses and costs and effects of predator control. The difficulty in gathering such data has aggravated the predator-livestock problem.

Results of the questionnaire survey indicated that losses to timber wolves in Manitoba were and probably will continue to be minimal. The majority of respondents who had losses to predators reported them in the first mailing. The information received from non-respondents who were contacted in person indicated that most of the farmers who did not reply to the questionnaire either had no predator problems or were no longer raising livestock. There is therefore, a bias toward overestimation of the importance of wolf predation in respondents to the first mailing and toward underestimation in the personal contacts with non-respondents. Even if the highest figure is used, wolves were responsible for only 19 of a total of 139 cattle lost to predators during the year preceeding mailing of the questionnaire.

Comments by respondents to the questionnaire ran the gamut from those who noted the value of predators in the environment (intrinsic and of benefit to man) to those who would like to see them all exterminated. Their opinions undoubtedly influenced their responses concerning the effects of predators on livestock.

There have been few studies done on the effects of timber wolves on livestock operations in North America because wolves have been eradicated in most agricultural areas. In Manitoba, there have been occasional complaints of wolf-livestock problems which resulted in local control programs. Most of these complaints have come from the marginal agricultural

areas bordering the boreal forest. Farming in these areas usually consists of cattle operation in which the stock is pastured on large tracts of uncleared Crown Land which provide excellent habitat for predators. Furthermore, the cattle are usually unattended for long periods of time. There are geographical limitations involving soils, topography and climate which restrict the encroachment of agriculture on the boreal forest and hence on existing wolf habitat. Livestock management practices have a direct influence on the extent of losses to predators. Free-ranging unattended stock is most prone to predation. Twice as many respondents with free-ranging cattle had wolf problems compared to those with feed lot operations.

Those respondents who lost stock to wolves indicated that they were very certain that wolves actually killed that stock. If this was the case, then wolves were responsible for only a small percentage (14%) of the cattle lost to predators. However, it must be noted that these losses occurred during the summer and most were in areas not easily observed by the farmer. Therefore, a possibility exists that a least some of these reports of predation were actually scavenging. There is also a possibility that coyotes or dogs were responsible as they are often difficult to distinguish from wolves at a distance or under conditions of poor visibility. Tracking conditions are also poor during the summer. It is recognized that although losses to wolves were insignificant on a

provincial basis, they may result in substantial financial loss at the individual level.

CONCLUSIONS

1. A population of approximately eleven wolves occupied the study area which resulted in a density of one wolf per 51 km^2.

2. Post-mortem examination of 21 wolf carcasses revealed that the majority were in good nutritional condition with light parasite loads and few pathologic abnormalities.

3. Of the 20 wolves aged, 16 (80%) were less than one year old.

4. The wolves in the study area depended upon beaver, moose and deer for 89.5% of their diet. No other single prey species comprised a significant proportion of the remainder.

5. The food habits of the wolves changed seasonally. Beaver was the primary prey species during the ice-free season. Moose and deer were utilized heavily during the winter.

6. There was not a major shift in the wolves' diet to young ungulates during the summer. This may have been the result of low productivity of the moose and deer populations, a low deer population and a high beaver population in the study area.

7. The tourists at Wallace Lake generally had a very favorable attitude toward wolves. A large majority of the people interviewed were interested in hearing and seeing wolves and would make a special effort to do so.

8. The non-consumptive recreational potential of wolves is underexploited in Manitoba at present.

9. The Farmer-Rancher Questionnaire indicated that livestock losses to timber wolves in Manitoba were minimal and greatly influenced by livestock management practices. However, it should be noted that such losses may be substantial at the individual producer level.

MANAGEMENT RECOMMENDATIONS

Predators have positive and negative socio-economic values. In the past, emphasis on their negative values has resulted in widespread bounty and control programs. In recent years the public has become more aware of the positive values of predators and other types of wildlife. As a result, our concepts and utilization of wildlife have changed.

Timber wolves in particular have benefited from this change in attitude. Many people have come to regard the wolf as a symbol of "wilderness" and to appreciate its role in the environment. At the same time due to a high demand for long haired fur, the value of wolf pelts in Manitoba has risen dramatically from an average price of $23.00 in 1970-71 to $146.38 in 1977-78 (Stardom, pers. comm.) thereby increasing their importance to trapping revenue. An average of 373 wolf pelts were taken annually in Manitoba between 1971-72 and 1977-78 (Stardom, pers. comm.). The negative value of wolves is propounded by some farmers and ranchers who lose livestock to wolves and by some hunters who believe wolves are killing game that "belongs" to them. Certain groups in society favour total protection for wolves while others would prefer extermination. Neither of these extremes is desireable. The most reasonable approach is sound management which minimizes conflicts.

In order to avoid or minimize the emotional and political

ramifications which are often associated with wolves, it is necessary to develop an objective wolf management policy in Manitoba. A management policy should ensure that wolves are controlled only when and where it is biologically and economically justified, not when and where such control is wanted. Furthermore, wolves should be protected to varying degrees when and where such protection is justified. Both the biological and human aspects of this study provide information useful for producing a wolf management policy for Manitoba

The following recommendations should be incorporated in a wolf management policy:

1. Status:

At present the wolf is defined as a predator under the Predator Control Act. As such, residents of Manitoba may hunt or trap wolves without restriction of a licence, season or bag limit in areas to which they have right of access for hunting purposes throughout the province. Furthermore, non-residents of Manitoba may hunt or trap wolves without restriction of a licence, season or bag limit north of the 53rd parallel. Clearly, the increase in the economic value of the wolf as a fur-bearer alone justifies a change in this status. It is only logical that wolves be given the same protection as other economically valuable fur-bearers in the province.

If one extrapolates the value of reported wolf-killed livestock in 1973-74 obtained from the 10% sample of cattle owners in the questionnaire to 100%, an estimate of $28,800.00 wolf-caused damages results. The revenue derived from the sale of wolf pelts in 1973-74 was $22,238.48 (Manitoba Department of Renewable Resources and Transportation Services, Research Branch, n.d.). It is very likely that the revenue derived from wolves equalled or exceeded the losses they caused that year. Furthermore, in 1977-78, 363 wolf pelts were sold in Manitoba for a total return of $53,135.94 (Stardom, pers. comm.). It is improbable that losses to wolves exceeded this amount. Therefore, it would appear that wolves are an economic asset rather than a liability to the province. I recommend that the status of the wolf be redefined as a fur-bearer.

2. Wolf Management in Wilderness Areas

Under normal circumstances there should be no wolf control in wilderness areas. Studies by Mech and Frenzel (1971) and by Gasaway et al. (1977) have shown that under certain conditions wolf predation can accelerate the decline and limit the population growth of deer and moose in an area. If this should occur in an area heavily utilized by sport hunters it would be necessary to stop hunting and perhaps institute a wolf control program to allow the ungulate

population to recover. Reduction of the wolf population should be achieved by sustained trapping pressure rather than by poison programs or aerial hunting, if possible. Once the ungulate population has recovered, the control program should be reduced or eliminated. Range management techniques should also be utilized to increase or maintain ungulate populations.

3. Wolf Management in Agro-Manitoba

My study indicated that livestock losses to timber wolves were minimal on a provincial basis. However individual situations requiring action to prevent further losses do arise.

Emphasis should be given to removing individual animals which are causing stock losses rather than attempting to reduce wolf populations over large areas. Henderson and Boggess (1977) stated that most coyote-related damage is caused by one or a few individuals. Furthermore, the livestock producer is in the best position to remove that problem individual promptly and prevent further losses.

One method of solving individual problems is the "Trapper Training Program" (Cockle, 1974). Under this program landowners with predator problems were instructed in the use of trapping and snaring methods by a trapper. This is basically a "self-help" program. Farmers should be encouraged to remove problem wolves when they are prime in order to realize a maximum return on the pelts.

If landowners are unable to solve their predator problems themselves, assistance from professional trappers or predator control officers should be available. Poison programs should not be used except as a last resort.

Emphasis should also be placed on improving livestock management procedures to reduce or prevent losses to timber wolves. Increased surveilance of stock and pasturing stock in areas away from predator habitat would reduce losses. Land clearing should be done in a fashion which would minimize contact between livestock and predator habitat. Landowners with chronic predator problems should be able to obtain advice from agricultural and wildlife specialists on how to alleviate the problem.

Wolf control should be based upon economic as well as biological facts. McKay (1975) assumed that control costs exceeded the value of livestock lost to predators in most years. Perhaps an "acceptable loss level" should be established in the fringe areas of agro-Manitoba where some losses are unavoidable due to the practise of pasturing livestock in predator habitat. Control programs would then not be initiated until losses to predators exceeded the acceptable level.

4. The Wolf as a Recreational Resource

At present the wolf's potential as a recreation resource is greatly underexploited. The Interpretive Programs in

provincial parks should be expanded and more literature concerning the distribution and habits of wolves should be made available to the public. People are interested in wolves and they should be made aware of areas within the province where they may see or hear timber wolves.

5. Research

Wolf research is of necessity long term because wolves are found in relatively low densities in inaccessible areas where observation is difficult. Government agencies should be primarily responsible for wolf research because it is expensive in terms of time, manpower and funds. Expenses and uncertainty of results make wolf research generally unsuitable for graduate projects. As a long term study develops, however, certain areas which are suitable for investigation by graduate students may become evident.

In Manitoba, a long term project involving the recording of track sightings and observations and scat collection by field personnel would yield valuable information on populations, general distribution and food habits. An autopsy program using carcasses collected from trappers would provide data on age and sex ratios and the general physical condition of trapped wolves. Reports of predation on livestock by wolves along with the costs of such losses and control operations should be collected in a central data bank. Such projects would not be cost-intensive and would provide much

valuable information on wolves in the province.

More detailed information is also needed on wolf densities and distribution and their effects on deer and moose populations. Cost-intensive studies would be needed to provide this data. The best approach would be an intensive study involving fitting wolves with radio transmitters and tracking them with an aircraft. Such a study should be co-ordinated with ungulate studies in the same area.

A detailed study is also needed to evaluate objectively the effects of predators (including wolves) on the livestock industry in Manitoba and to devise management techniques to minimize any adverse effects. This should be a co-operative project involving the Departments of Agriculture and Renewable Resources and Transportation Services.

LITERATURE CITED

Adorjan, A.S. and G.B. Kolenosky. 1969. A manual for the identification of hairs of selected Ontario mammals. Research Branch, Ontario Dept. of Lands and Forests. 64 pp.

Anderson, R.C. and M.W. Lankester, 1974. Infectious and parasitic diseases and arthropod pests of moose in North America. Naturaliste can., 101 : 23-50.

Balser, D.S. 1974. An overview of predator-livestock problems with emphasis on livestock losses. Thirty-ninth North American Wildlife Conference. pp.292-300.

Banfield, A.W.F. 1974. The mammals of Canada. University of Toronto Press, Toronto. 438 pp.

Bishop, R.H. and R.A. Rausch. 1974. Moose population fluctuations in Alaska, 1950-1972. Naturaliste can., 101 : 559-593.

Bromely, R.G. 1973. Fishing behaviour of a wolf on the Taltson River, Northwest Territories. Can. Field - Nat., 87 (3) : 301-303.

Burkholder, B.L. 1959. Movements and behaviour of a wolf pack in Alaska. J. Wildl. Manage., 23 (1) : 1-11.

Coady, J.W. 1974. Influence of snow on behaviour of moose. Naturaliste can., 101 : 417-436.

Cockle, G. 1974. Predation and control in the Western Region. Manitoba Department of Mines, Resources and Environmental Management. Unpublished Report, 5 pp.

Cook, R.S., M. White., D.O. Trainer and W.C. Glazener. 1971. Mortality of young white-tailed deer fawns in South Texas. J. Wildl. Manage., 35 (1) : 47-56.

Cowan, I. McT. 1947. The timber wolf in the Rocky Mountain National Parks of Canada. Can. J. Res., 25 : 139-174.

Criddle, N. 1925. The habits and economic important of wolves in Canada. Dom. of Canada Dept. of Agr. Bull. (n.s.) No. 13. 24 pp.

Emberley, G. C. 1968. Summary of Manitoba's bounty system 1978-1965. Statistical summary bounty payments 1944-1965. Manitoba Department of Mines, Resources and Environmental Management. Unpublished Report, 115 pp.

Fichter, E.,G. Schildman and J. H. Sather. 1955. Some feeding patterns of coyotes in Nebraska. Ecol. Monogr., 25 (1) : 1 - 37.

Franzmann, A. W. and P. D. Arneson. 1976. Marrow fat in Alaskan moose femurs in relation to mortality factors. J. Wildl. Manage., 40 (2) : 336-339.

Frenzel, L. D. 1974. Occurrence of moose in food of wolves as revealed by scat analyses: a review of North American studies. Naturaliste can., 101 : 467-479.

Gasaway, W.C. and J. W. Coady. 1974. Review of energy requirements and rumen fermentation in moose and other ruminants. Naturaliste can., 101 : 227-262.

Gasaway, W. C., D. Haggstrom and O. E. Burris. 1977. Preliminary observations on the timing and causes of calf mortality in an interior Alaskan moose population. Trans. 13th N. Am. Moose Conf. and Workshop. Jasper, Alberta. 14 pp.

Gilbert, F. F. 1966. Aging white-tailed deer by annuli in the cementum of the first incisor. J. Wildl. Manage., 30 (1) : 200-202.

Goldman, E. A. 1944. The wolves of North America, Part II. Classification of wolves. Amer. Wildl. Inst. Washington, D. C. pp.389-636. (Reprinted 1964. General Publishing Co. Ltd., Toronto, Canada. pp.389-636).

Hagar, J. A. 1970. In Mech, L.D. 1970. The wolf: the ecology and behavior of an endangered species. The Natural History Press. Garden City, New York. XX + 384 pp.

Henderson, F. R. and E. K. Boggess. 1977. A public education program of predator damage control. Trans. 42nd N. Am. Wildl. and Nat. Res. Conf. pp. 323-328.

Holmes, J. C. and R. Podesta. 1968. The helminths of wolves and coyotes from the forested regions of Alberta. Can. J. Zool., 46 (6) : 1193-1204.

Horwitz, W., ed. 1965. Official methods of analysis of the association of official agricultural chemists. 10th ed. The Association of Official Agricultural Chemists. Washington, D. C. 957 pp.

Jordan, P. A., P. C. Shelton and D. L. Allen. 1967. Numbers, turnover and social structure of the Isle Royale wolf population. Am. Zool., 7 (2) : 233-252.

Joslin, P. W. B. 1966. Summer activities of two timber wolf (Canis lupus) packs in Algonquin Park. Unpubl. M. Sc. thesis, University of Toronto. 98 pp.

Joslin, P. W. B. 1967. Movements and home sites of timber wolves in Algonquin Park. Am. Zool., 7 (2) : 279-288.

Kelsall, J. P. 1969. Structural adaptations of moose and deer for snow. J. Mamm., 50 (2) : 302-310.

Kelsall, J. P. and E. S. Telfer. 1971. Studies of the physical adaptation of big game for snow. pp. 134-146. In : A. O. Haugen (ed.) Proc. snow and ice in relation to wildlife and recreation symp. Iowa Coop. Wildl. Res. Unit, Iowa State Univ. Press. Ames, Iowa. 280 pp.

Knowlton, F. F. 1964. Aspects of coyote predation in South Texas with special reference to white-tailed deer. Unpubl. Ph.D. thesis, Purdue Univ. 209 pp.

Kolenosky, G. B. 1972. Wolf predation on wintering deer in east-central Ontario. J. Wildl. Manage., 36 (2) : 357-368.

Kuyt, E. 1972. Food habits of wolves on barren-ground caribou range. Can. Wildl. Serv. Rpt. Ser. No. 21. Information Canada. 36 pp.

LeResche, R. E. 1968. Spring-fall calf mortality in an Alaska moose population. J. Wildl. Manage., 32 (4) : 953-956.

Linhart, S. B. and F. F. Knowlton. 1967. Determining age of coyotes by tooth cementum layers. J. Wildl. Manage., 31 (2) : 362-365.

MacLennan, R. R. 1975. An analysis of fluctuating moose populations in Saskatchewan. Sask. Dept. of Tourism and Renewable Resources. Tech. Bull. No. 2. 16 pp.

Manitoba Department of Renewable Resources and Transportation Services, Research Branch. n. d. "Manitoba fur fact book. A collection of primary fur industry statistics since 1920." no pagination.

Marhenke, P. 1971. An observation of four wolves killing another wolf. J. Mamm., 52 (3) : 630-631.

McKay, D. I. 1975. Coyote-livestock interaction in Manitoba. Manitoba Department of Mines, Resources and Environmental Management, Research Branch MS. Rep. No. 75-11, 39 pp.

Mech, L. D. 1966. The wolves of Isle Royale. U.S. Nat. Park Serv. Fauna Ser. No. 7. 210 pp.

Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. The Natural History Press. Garden City, New York.XX + 384 pp.

Mech, L. D. 1977. Productivity, mortality and population trends of wolves in northeastern Minnesota. J. Mamm., 58 (4) : 559-574.

Mech L. D. and L. D. Frenzel, Jr. 1971. An analysis of the age, sex and condition of deer killed by wolves in northeastern Minnesota. pp. 35-51. In: L. D. Mech and L. D. Frenzel Jr. (ed.) Ecological studies of the timber wolf in northeastern Minnesota. U.S.D.A. For. Serv. Res. Paper NC - 52. 62 pp.

Mech, L. D., L. D. Frenzel, Jr. and P. D. Karns. 1971a. The effect of snow conditions on the vulnerability of white-tailed deer to wolf predation. pp. 51-59. In: L. D. Mech and L. D. Frenzel Jr. (ed.) Ecological studies of the timber wolf in northeastern Minnesota. U.S.D.A. For. Serv. Res. Paper NC-52. 62 pp.

Mech, L. D., L. D. Frenzel, Jr., R. R. Ream and J. W. Winship. 1971b. Movements, behavior and ecology of timber wolves in northeastern Minnesota. pp. 1-35. In: L. D. Mech and L. D. Frenzel Jr. (ed.) Ecological studies of the timber wolf in northeastern Minnesota. U.S.D.A. For. Serv. Res. Paper NC-52. 62 pp.

Murie, A. 1944. The wolves of Mount McKinley. U.S. Nat. Park Serv. Fauna Ser. No. 5. 238 pp.

Nasimovich, A. A. 1955. The role of the regime of snow cover in the life of ungulates in the U.S.S.R. Moscow, Institute of Geography of the Academy of Science Press. 402 pp. (In Russian).

Nielsen, C. A. 1977. Wolf necropsy report: preliminary pathological observations. Alaska Fed. Aid in Wildl. Rest. Special Rept. Proj. W - 17 - 8 and W - 17 - 9. 129 pp.

Parker, G. R. 1972. Biology of the Kaminuriak population of barren-ground caribou. Part I. Can. Wildl. Serv. Report Series No. 20. Information Canada. 93 pp.

Parker, G. R. 1973. Distribution and densities of wolves within barren-ground caribou range in northern mainland Canada. J. Mamm., 54 (2) : 341-348.

Pastuck, R. D. 1974. Some aspects of the ecology of the coyote (Canis latrans Say) in southwestern Manitoba. Unpubl. M.Sc. thesis, University of Manitoba. 159 pp.

Peek, J. M., D. L. Urich and R. J. Mackie. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildlife Monographs No. 48. 65 pp.

Peterson, R. L. 1955. North American moose. University of Toronto Press. Toronto, Ontario. 280 pp.

Peterson R. O. 1975. Wolf response to increased moose vulnerability on Isle Royale. Trans. 11th N. Am. Moose Conf. and Workshop. Winnipeg, Manitoba. pp. 344-369.

Peterson, R. O. and D. L. Allen. 1974. Snow conditions as a parameter in moose-wolf relationships. Naturaliste can., 101: 481-492.

Pimlott, D. H. 1960. The use of tape recorded wolf howls to locate timber wolves. 22nd Midwest Wildl. Conf. 15 pp. (mimeo.).

Pimlott, D. H. 1967a. Wolf predation and ungulate populations. Am. Zool., 7 (2) : 267-278.

Pimlott, D. H. 1967b. Wolves and men in North America. Defenders of Wildlife News. Jan.-Feb.-March 1967. 11 pp.

Pimlott, D. H., J. A. Shannon and G. B. Kolenosky. 1969. The ecology of the timber wolf in Algonquin Provincial Park. Ont. Dept. of Lands and Forests Res. Br. Res. Rept. (Wildl.) No. 87. 92 pp.

Pruitt, W. O. 1959. Snow as a factor in the winter ecology of barren-ground caribou. (Rangifer arcticus). Arctic 12 (3) : 158-179.

Pulliainen, E. 1975. Wolf ecology in northern Europe. In: M. W. Fox (ed.) The wild canids. Their systematics, behavioral ecology and evolution. Van Nostrand Reinhold Co. Toronto, Ontario. 508 pp.

Rabb, G. B., J. H. Woolpy and B. E. Ginsburg. 1967. Social relationships in a group of captive wolves. Am. Zool., 7 (2) : 305-311.

Rausch, R. A. 1967. Some aspects of the population ecology of wolves, Alaska. Am. Zool., 7 (2) : 253-265.

Rausch, R. A. 1969. A summary of wolf studies in south-central Alaska. 1957-1968. Trans. 34th N. Am. Wildl. Conf. pp. 117-131.

Rausch, R. A., R. J. Somerville and R. H. Bishop. 1974. Moose management in Alaska. Naturaliste can., 101 : 705-721.

Riewe, R. R. 1975. The High Arctic wolf in the Jones Sound Region of the Canadian High Arctic. Arctic 28 (3) : 209-212.

Rowe, J. S. 1972. Forest Regions of Canada. Dept. of the Environment, Can. For. Serv. Pub. No. 1300. 172 pp.

Russell, G. A. 1948. Geology of the Wallace Lake area - Rice Lake division. Man. Dept. of Mines and Nat. Res., Mines Br. Prelim. Rept. 47-1. 15 pp.

Sergeant, D. E. and D. H. Pimlott. 1959. Age determination in moose from sectioned incisor teeth. J. Wildl. Manage., 23 (3) : 315-321.

Shelton, P. 1966. Ecological studies of beavers, wolves and moose in Isle Royale National Park, Michigan. Unpubl. Ph.D. thesis, Purdue Univ., 307 pp.

Stardom, R. R. P. 1977. Winter ecology of woodland caribou, Rangifer tarandus caribou, and some aspects of the winter ecology of moose, Alces alces andersoni, and whitetail deer, Odocoileus virginianus dacotensis (Mammalia : Cervidae) in southeastern Manitoba. Unpubl. M.Sc. thesis, University of Manitoba. 157 pp.

Stebler, A. M. 1944. The status of the wolf in Michigan. J. Mamm., 25 (1) : 37-43.

Stenlund, M.H. 1955. A field study of the timber wolf (Canis lupus) on the Superior National Forest, Minnesota. Minn. Dept. of Cons. Tech. Bull. No. 4. 55 pp.

Stephenson, R. O. 1975a. Wolf report. Alaska Fed. Aid in Wildl. Rest. Prog. Rept. Project.W-17-6 and W-17-7. 11 pp.

Stephenson, R. O. 1975b. Wolf report. Alaska Fed. Aid in Wildl. Rest. Final Rept. Proj. W.-17-3 through W-17-7. 6 pp.

Stephenson, R. O. and L. Johnson. 1972. Wolf report. Alaska Fed. Aid in Wildl. Rest. Proj. Rept. Proj. W-17-3. 52 pp.

Theberge, J. B. 1973. Wolf management in Canada through a decade of change. Nature Canada 2 (1) : 3-10.

Thomas, D. C., R. H. Russell, E. Broughton and P.L. Madore. 1976. Investigations of Peary caribou populations on Canadian Arctic Islands, March-April 1975. Can. Wildl. Serv. Prog. Notes No. 64. 13 pp.

Thompson, D. Q. 1952. Travel, range and food habits of timber wolves in Wisconsin. J. Mamm., 33 (4) : 429-442.

Timm, D. E., S. O. Morgan and R. E. Wood. 1975. Wolf as predator on mallards in a bait trap. Can. Field - Nat., 89 (3) : 322.

Van Ballenberghe, V. and A. W. Erickson. 1973. A wolf pack kills another wolf. Am. Mildl. Nat., 90 (2) : 490-493.

Van Ballenberghe, V., A. W. Erickson and D. Byman. 1975. Ecology of the timber wolf in northeastern Minnesota. Wildlife Monographs No. 43. 43 pp.

Van Zyll de Jong, C. G. 1966. Food habits of the lynx in Alberta and the Mackenzie District, N.W.T. Can. Field - Nat., 80 (1) : 18-23.

Verme, L. J. 1968. An index of winter weather severity for northern deer. J. Wildl. Manage., 32 (3) : 566-574.

Voigt, D. R., G. B. Kolenosky and D. H. Pimlott. 1976. Changes in summer foods of wolves in central Ontario. J. Wildl. Manage., 40 (4) : 663-668.

Weir, T. R., ed. 1960. Economic atlas of Manitoba. Dept. of Industry and Commerce. Prov. of Manitoba. 81 pp.

White, M., F. F.Knowlton and W. C. Glasener. 1972. Effects of dam-newborn fawn behavior on capture and mortality. J. Wildl. Manage., 36 (3) : 897-906.

Wolfe. M. L. and D. L. Allen. 1973. Continued studies of the status, socialization and relationships of Isle Royale wolves, 1967-70. J. Mamm., 54 (3) : 611-635.

Young, S. P. 1944. The Wolves of North America, Part 1. Their history, habits, economic status and control. Amer. Wildl. Inst. Washington, D. C. 385 pp. (Reprinted 1964 General Publishing Co. Ltd., Toronto, Canada. 385 pp).

APPENDIX I

RESULTS OF GROSS PATHOLOGIC EXAMINATION OF 22 TIMBER WOLF CARCASSES

Catalogue No.25

Date Collected: Winter 1974-75

Location: Pelican Bay (Lake Winnipegosis.)

Sex:	Female
Age:	Not available
Measurements:	None available Weight - 25.0 Kg
Nutritional condition:	Good with adequate body fat depots.
Reproductive condition:	Undetermined
Pathologic abnormalities:	Stomach dilated but empty. No other pathologic lesions noted.
Comments:	Animal was in advanced autoysis and head was missing.

Catalogue No.26

Date Collected: December, 1974

Location: 4 miles west and 2 miles south of Birch River.

Sex:	Male
Age:	7 months
Measurements:	Total length - 1725 mm Tail Length - 500 mm Hind foot - 273 mm Left testis - 36 mm Right testis - 37 mm Weight - 20.4 Kg
Nutritional condition:	Emaciated. All body fat depots completely exhausted.
Reproductive condition:	Inactive
Pathologic abnormalities:	A single span of decomposed and unidentified Cestode segments was present in the jejunal region of

the small intestine. No other specific lesions were observed.

Comments: Stomach contents examined.

Catalogue No.27

Date Collected: February 1975

Location: Graves Point, Dawson Bay (Lake Winnipegosis)

Sex: Female

Age: 9 months

Measurements:
Total length - 1517 mm
Tail length - 373 mm
Hind feet missing
Weight - 23.0 Kg

Nutritional condition: Moderately good nutritional condition.

Reproductive condition: Inactive

Pathologic abnormalites: The lungs were mottled. No other specific gross lesions noted.

Catalogue No.28

Date Collected: February 1975

Location: Mallard Lake

Sex: Female

Age: 9 months

Measurements:
Total length - 1416 mm
Tail length - 398 mm
Hind foot - 260 mm
Weight - 13.6 Kg

Nutritional condition: Moderately good nutritional condition.

Reproductive condition: Inactive

Pathologic abnormalities: None

Catalogue No.29

Date Collected: February 1975

Location: Mire Lake

Sex:	Female
Age:	9 months
Measurements:	Total length - 1440 mm Tail length - 397 mm Hind foot - 252 mm Weight - 16.1 Kg
Nutritional condition:	Moderately good
Pathologic abnormalities:	None
Comments:	Stomach contents examined

Catalogue No.30

Date Collected: Winter 1974-75

Location: Pelican Rapids area (Lake Winnipegosis)

Sex:	Female
Age:	8 - 9 months
Measurements:	Total length - 1379 mm Tail length - N. A. Hind foot - 275 mm Weight - 30.4 Kg
Nutritional condition:	Moderately good
Pathologic abnormalities:	None noted
Comments:	Animal was in advanced autolysis and complete examination was not possible. Stomach contents examined.

Catalogue No.31

Date Collected: December 1974
Location: 4 miles west and 2 miles south of Birch River

Sex: Female

Age: 7 months

Measurements

Total length - 1599 mm
Tail length - 481 mm
Hind foot - 276 mm
Weight - 25.4 Kg

Nutritional condition: Moderately good

Pathologic abnormalities: None

Comments: Animal was markedly autolyzed and detailed examination was not possible. Twig lodged between upper molars - trap debris. Stomach contents examined

Catalogue No.32

Date Collected: December 1974

Location: 4 miles west and 2 miles south of Birch River.

Sex: Male

Age: 7 months

Measurements:

Total length - 1745 mm
Tail length - 436 mm
Hind foot - 310 mm
Weight - 34.5 Kg
Left testis - 52 mm
Right testis - 45 mm

Nutritional condition: Moderately good.

Pathologic condition: The stomach contained a small quantity of frozen bloody fluid. Irregular shallow hemorrhagic mucosal ulcers were present in the stomach. Several masses of Cestode

segments were found in the intestinal lumen. No evidence of blood was present in the lumen of the small intestine, however, the colon was filled with a dense tonacious mass of fecal material mixed with a large quantity of partially digested blood.

Catalogue No.33

Date Collected: December 1974

Location: 4 miles west and 2 miles south of Birch River

Sex: Male

Age: 7 months

Measurements:

Total length	- 1673 mm
Tail length	- 444 mm
Hind foot	- 285 mm
Left testis	- 32 mm
Right testis	- 35 mm
Weight	- 30.7 Kg.

Nutritional condition: Moderately good

Pathologic condition: None noted

Comments: Stomach contents examined.

Catalogue No.34

Date Collected: February 1975

Location: Cameron Bay (Lake Winnipegosis)

Sex: Male

Age: 9-3/4 years

Measurements:

Total length	- 1550 mm
Tail length	- N.A.
Hind foot	- 260 mm
Weight	- 40.0 Kg

No testes present

Nutritional condition: Moderately good

Pathologic condition: Animal in extreme state of autolysis

Comments: Stomach contents examined

Catalogue No.35

Date Collected: February 1975

Location: Waterhen Lake

Sex: Male

Age: 9 months

Measurements:

Total length	-	1200 mm
Tail length	-	N.A.
Hind foot	-	297 mm
Left testis	-	32 mm
Right testis	-	35 mm
Weight	-	20.4 Kg.

Nutritional condition: Moderately good

Pathologic abnormalities: None

Comments: Stomach contents examined.

Catalogue No.36

Date Collected: February 1975

Location: Mallard Lake

Sex: Female

Age: 1-3/4 years

Measurements:

Total length	-	1548 mm
Tail length	-	412 mm
Hind foot	-	266 mm
Weight	-	23.4 Kg

Nutritional condition: Good

Reproductive condition: Inactive

Pathological Abnormalities: None

Comments: Stomach contents examined

Catalogue No.37

Date Collected: February 4, 1975

Location: Wendigo Area (Approx. 8 miles N.E. of Lac du Bonnet)

Sex:	Male
Age:	9 months
Measurements:	Total length - 1588 mm Tail length - 460 mm Hind foot - 279 mm Testes missing Weight - 25.2 Kg
Nutritional condition:	Moderately good
Pathologic abnormalities:	A quantity of blood stained material was present in the lower bowel. No specific gross pathologic lesions were observed.
Comments:	Stomach contents examined

Catalogue No.38

Date Collected: November 15, 1974

Location: Sandy River

Sex:	Male
Age:	6 months
Measurements:	Total length - 1352 mm Tail length - 368 mm Hind foot - 254 mm Left testis - 37 mm Right testis missing Weight - 17.0 Kg
Nutritional condition:	Good
Reproductive condition:	Sperm test negative
Pathologic abnormalities:	None

Catalogue No.39

Date Collected: January 11, 1975
Location: Caribou Lake

Sex:	Female
Age:	2-2/3 years
Measurements:	Total length - 1632 mm Tail length - 400 mm Hind foot - 279 mm Weight - 25.2 Kg
Nutritional condition:	Moderately good
Pathologic condition:	A giant kidney worm (Dioctophyma renale) was present within the capsule of the right kidney and had completely destroyed all parenchymatous tissue of that kidney.
Comments:	Stomach contents examined.

Catalogue No.40

Date Collected:Dec. or Jan.1974-75
Location: Pine Falls

Sex:	Female
Age:	7 - 8 months
Measurements:	Total length - 1416 mm Tail length - 387 mm Hind foot - 244 mm Weight - 17.8 Kg
Nutritional condition:	Moderately good
Pathologic condition:	Some minimal evidence of ante mortem trauma was present in the soft tissue ventral to the pelvis and in the adductor muscles of the hind legs.
Reproductive condition:	Inactive.

Catalogue No. 41

Date Collected: Dec. or Jan. 1974-75

Location: Pine Falls

Sex: Female

Age: Approximately 8-2/3 years

Measurements:

Total length	-	1537 mm
Tail length	-	400 mm
Hind foot	-	241 mm
Weight	-	27.3 Kg

Nutritional condition: Moderately good

Reproductive condition: Quiescent but had obviously been previously active.

Pathologic abnormalities: Extensive traumatic damage was present to the right anterior thoracic cage of this animal. The stomach had herniated anteriorly through the diaphragm and had ruptured with release of a large volume of gastic contents into the thoracic cavity. It was not definitely possible to decide that this was an ante mortem lesion, however, it would be unlikely for this type of lesion to be produced even by rough handling of the carcass after death.

Comments: Stomach contents examined

Catalogue No.42

Date Collected: December 29, 1974

Location: 8-22-16E

Sex: Female

Age: 7 months

Measurements:

Total length	-	1588 mm
Tail length	-	464 mm
Hind foot	-	286 mm
Weight	-	25.7 Kg

Nutritional condition: Moderately good

Reproductive condition: Inactive

Pathologic abnormalities: Evidence of bruising and excess fluid accumulation was present in the thoracic cavity.

Catalogue No.43

Date Collected: Dec. or Jan. 1974-75

Location: Pine Falls

Sex: Female

Age: 7 - 8 months

Measurements:

Total length	-	1352 mm
Tail length	-	375 mm
Hind foot	-	248 mm
Weight	-	13.2 Kg

Nutritional condition: Moderately good

Pathologic condition: No significant pathologic lesions were noted.

Comments: Stomach contents examined

Catalogue No.44

Date Collected: February 26, 1974

Location: East Lake

This carcass was unfit for examination.

Catalogue No.45

Date Collected: January 1974

Location: 10 miles west of Bissett along Hwy. No.304.

Sex: Female

Age: 8 months

Measurements:	Not available
Nutritional condition:	Moderately good. Body fat depots and subcutaneous fat were moderate.
Reproductive condition:	Small and inactive
Pathologic abnormalities:	An extensive quantity of blood fluid was present in the peritoneal cavity. No specific lesions were noted in the esophagus. A small quantity of degenerate, bloody fluid was present in the trachea and small bronchi. The lungs were markedly mottled, with large primarily antero-ventral areas of dark discoloration contrasting against a grey colour for the more dorsal diaphragmatic portions. The right ventricle of the heart appeared to be moderately dilated and thin walled in comparison with that of the left ventricle. The stomach contained a very small quantity of sero mucous fluid which was dark brownish-black in colour. The intestinal tract contained a small quantity of almost completely digested content. Large numbers of very coarse hairs were present in this material. The liver, kidney and spleen appeared essentially normal.
Histopathology:	Severe freezing artifact was present in all tissues. The tubular reproductive tract appeared to be in a quiescent state. All mucosa had been sloughed. The ovary was small and consisted principally of collagenous connective tissue. Three identifiable ova were present in this section. A large quantity of hemosiderin-like pigment was present in the renal tubules. It is not known whether or not this represents freezing artifact or not.

Comments: Parasites were not seen in the fecal floatation.

Catalogue No.46

Date Collected: November 27, 1973

Location: Quartz Lake

Sex: Female

Age: 6 months

Measurements: Not available

Nutritional condition: Good. Body fat depots were good.

Reproductive condition: Small and inactive

Pathologic abnormalities: No specific esophageal or tracheal abnormalities were observed. The lungs were uniformly dark and discoloured but the consistency appeared to be uniform and not too abnormal. The heart was essentially normal. A single mature specimen of Dioctophyma renale measuring 104 cm in length was found free in the peritoneal cavity. The stomach contained a very small quantity of solid debris consisting of remnants of hair, feathers and plant or woody material. Admixed with this and found also in several locations in the small intestine were small bits of crumpled aluminum foil. The small intestine contained a relatively small quantity of partially digested ingesta. Several small clumps of cestode segments were present in the small intestine. The liver, spleen and kidneys were essentially normal. No specific skeletal abnormalities were noted.

Histopathology: Freezing artifact is prominent in all tissues. The reproductive tract is inactive. The ovary consists largely of collagenous

connective tissue. No developing ova were found.

Comments: Organisms resembling Isospora bigemina were moderately prominent in the fecal floatation.

APPENDIX II

QUESTIONNAIRES

WALLACE LAKE QUESTIONNAIRE

1. Where are you from?
   ( ) Winnipeg
   ( ) Town
   ( ) Farm
   ( ) U.S. Town

2. How many children do you have?
   ( ) 0
   ( ) 1
   ( ) 2
   ( ) 3 or more

3. Do you own:
   ( ) Cabin
   ( ) Tent
   ( ) Trailer
   ( ) Truck-camper
   ( ) Combination of the above

4. What seasons are you here?
   ( ) Spring
   ( ) Summer
   ( ) Fall
   ( ) Winter

5. How much time do you spend at Wallace Lake each year?
   ( ) Less than 1 week
   ( ) 1 - 2 weeks
   ( ) 3 or more

6. Of this time, how much is spent away from the campground?
   ( ) 1 day
   ( ) 2 - 4 days
   ( ) 5 - 10 days
   ( ) more

7. In what outdoor recreational activities do you take part at Wallace?
   Number in order of importance.

( ) Fishing	( ) X-C skiing
( ) Hunting	( ) Snowmobiling
( ) Swimming	( ) Picnicing
( ) Canoeing	( ) Painting, photography
( ) Powerboating	( ) Driving looking for wildlife
( ) Hiking	( ) Other

8. Do you do any travelling with the express purpose of seeing wildlife?
   ( ) Yes
   ( ) No.

9. What wildlife have you seen around Wallace?

( ) White-tailed deer	( ) Muskrat
( ) Black bear	( ) Lynx
( ) Moose	( ) Woodland Caribou
( ) Woodchuck	( ) Timber wolf
( ) Fisher	( ) Fox
( ) Mink	( ) Coyote
( ) Beaver	( ) Other

10. Have you heard timber wolves around Wallace?
    ( ) Yes
    ( ) No

11. Have you seen wolves around Wallace?
    ( ) Yes
    ( ) No

12. Would you like to hear wolves howl?
    ( ) Yes
    ( ) No

13. Would you like to see a wild timber wolf?
    ( ) Yes
    ( ) No

14. What wildlife would you like most to see around Wallace Lake?

15. What effort would you be willing to make in order to hear timber wolves howl?
    ( ) Drive 5 miles
    ( ) Travel 5 miles in a powerboat
    ( ) Paddle a mile
    ( ) Walk a mile
    ( ) Combination of the above

UNIVERSITY OF MANITOBA
DEPARTMENT OF ZOOLOGY

FARMER - RANCHER QUESTIONNAIRE

Name:
Address:
Telephone No:
(If you do not wish to give your name, record only your municipality here)

Section A:

1. How many head of livestock did you have in the last 12 months?

Cattle

	Feed Lot	Free Ranging
Less than 25	☐	☐
25-100	☐	☐
More than 100	☐	☐

Sheep

	Feed Lot	Free Ranging
Less than 25	☐	☐
25-100	☐	☐
More than 100	☐	☐

2. Do you think there is a predator problem in your area?
   yes ☐
   no ☐

3. Have you lost any livestock to predators in the last 5 years?
   yes ☐
   no ☐

   If your answer is yes to (3) please complete the entire questionnaire.
   If it is no, please do only section B.

4. (a) What kind of livestock and how many have you lost in the last 12 months?

Cattle		Sheep	
less than 1 year old	☐	Lambs	☐
1 year or older	☐	Adults	☐

(b) Losses in the last 5 years:

	Cattle		Sheep	
1969	less than 1 year old	☐	Lambs	☐
	1 year or older	☐	Adults	☐
1970	less than 1 year old	☐	Lambs	☐
	1 year or older	☐	Adults	☐
1971	less than 1 year old	☐	Lambs	☐
	1 year or older	☐	Adults	☐
1972	less than 1 year old	☐	Lambs	☐
	1 year or older	☐	Adults	☐
1973	less than 1 year old	☐	Lambs	☐
	1 year or older	☐	Adults	☐

5. Which of the following kinds of predators do you think caused your losses within the last 12 months?

- ☐ Red Fox
- ☐ Black Bear
- ☐ Domestic Dog
- ☐ Timber Wolf
- ☐ Coyote ("Brush Wolf")
- ☐ Lynx
- ☐ Other (Please indicate)
- ☐ Unknown

6. Please indicate how much livestock was lost to each kind of predator (where appropriate) within the last 12 months.

Predators	Cattle less than 1 year old	Cattle 1 year or older
Red Fox	.....	.....
Black Bear	.....	.....
Domestic Dog	.....	.....
Timber Wolf	.....	.....
Coyote ("Brush Wolf")	.....	.....
Lynx	.....	.....
Other (Please indicate)	.....	.....
Unknown	.....	.....

Predators	Sheep - Lambs	Sheep - Adults
Red Fox	.....	.....
Black Bear	.....	.....
Domestic Dog	.....	.....
Timber Wolf	.....	.....
Coyote ("Brush Wolf")	.....	.....
Lynx	.....	.....
Other (Please indicate)	.....	.....
Unknown	.....	.....

7. How certain are you that predators did the actual killing or did they feed on carcasses which died from other causes?

- ☐ Very certain
- ☐ Quite certain
- ☐ Not certain

8. Please indicate to the best of your ability the number of times such feeding on already dead carcasses may have occurred by the following predators.

Predators	Cattle less than 1 year old	Cattle 1 year or older
Red Fox	.....	.....
Black Bear	.....	.....
Domestic Dog	.....	.....
Timber Wolf	.....	.....
Coyote ("Brush Wolf")	.....	.....
Lynx	.....	.....
Other (Please indicate)	.....	.....
Unknown	.....	.....

Predators	Sheep - Lambs	Sheep - Adults
Red Fox	.....	.....
Black Bear	.....	.....
Domestic Dog	.....	.....
Timber Wolf	.....	.....
Coyote ("Brush Wolf")	.....	.....
Lynx	.....	.....
Other (Please indicate)	.....	.....
Unknown	.....	.....

9. At what time of the year did most losses to predators occur in 1973?

Spring ☐ Fall ☐
Summer ☐ Winter ☐

At what time of the year did most losses to predators occur in 1972?

Spring ☐ Fall ☐
Summer ☐ Winter ☐

At what time of the year did most losses to predators occur in 1971?

Spring ☐ Fall ☐
Summer ☐ Winter ☐

At what time of the year did most losses to predators occur in 1970?

Spring ☐ Fall ☐
Summer ☐ Winter ☐

At what time of the year did most losses to predators occur in 1969?

Spring ☐ Fall ☐
Summer ☐ Winter ☐

10. What action did you take when losses occurred?

Different handling of stock (Please explain) ☐
Trapping ☐
Shooting ☐
Ask for control program by conservation officers (Game Wardens) ☐
Nothing ☐
Other (Please explain) ☐

Section B:

1. (a) Is there a problem with domestic dogs killing livestock in your area?

yes ☐
no ☐

(b) If so, how often has this occurred to your livestock within the last 5 years?

Cattle	less than 1 year old	1 year or older
1 - 2 times	.....	.....
3 - 5 times	.....	.....
More than 5 times	.....	.....

Sheep	Lambs	Adults
1 - 2 times	.....	.....
3 - 5 times	.....	.....
More than 5 times	.....	.....

2. (a) In your area are there:

Coyotes ("Brush Wolf") - yes ☐ no ☐

Timber Wolves yes ☐ no ☐

(b) If so, approximately how many times have you seen them in the last 12 months?

Coyotes ("Brush Wolf") .....

Timber Wolves .....

3. If Timber Wolves are present, are they alone or in packs?

Alone ☐

Packs ☐

If in packs, approximately how large are the packs?

2 - 3 animals ☐

4 - 6 animals ☐

7 or more (please specify) ☐

Don't know ☐

4. Which one of the following predators causes most of the problems in your area?

☐ Red Fox

☐ Black Bear

☐ Domestic Dog

☐ Timber Wolf

☐ Coyote ("Brush Wolf")

☐ Lynx

☐ Other (Please specify)

5. In your opinion, what is the best way to deal with a predator problem?

☐ Hunting

☐ Trapping

☐ Modification of livestock handling methods

☐ An annual government control program using poison baits to reduce the predator problem to a minimum

☐ The removal of individual problem animals by specialists

☐ Bounty

☐ Other

☐ Please continue your answer on back of this sheet if desired

Return all pages of the questionnaire in the enclosed stamped return envelope

Thank you!