Table 6 — Wolf Observations During Five Winters, 1948-49 through 1952-53

Winter	Number of Animals in Pack												Total Wolves	Total Observations	Average Pack Size
	1	2	3	4	5	6	7	8	9	10	11	12			
1948-49	19	7	3	3	2	2	4	3	2	..	..	1	158	46	3.4
1949-50	16	6	2	1	1	2	..	..	1	..	..	..	64	29	2.2
1950-51	8	4	2	2	3	3	..	..	..	..	..	..	63	22	2.9
1951-52	3	5	..	..	2	..	..	..	..	..	..	..	23	10	2.3
1952-53	2	2	..	1	..	..	..	..	..	..	..	..	10	5	2.0
TOTALS	48	24	7	7	8	7	4	3	3	..	..	1	318	112	..
AVERAGE															2.8

Since most observations from the air were made of animals crossing frozen lakes, it is believed that the counts accurately portray the number of animals actually composing the packs.

Travel and Hunting Habits

One of the most commonly accepted beliefs concerning the habits of the wolf is that it uses a circular route when traveling. Early wolf stories would have one believe that wolves traveled predetermined routes as regularly as a night watchman. Studies in recent years tend to disqualify some of this information in certain areas.

On the Sibley Peninsula, Ontario, de Vos (1950) found no conclusive evidence of definite circuits. Wolves tended toward moving circuitously because of home ranges. He concluded that the wolves moved more or less at random over these ranges.

Murie (1944) found wolves traveling in both directions on the same route. Banfield (1951a) established five different circuits used by wolves in Prince Albert Park, Canada. These routes varied little from year to year and ranged from 27 to 87 miles in length. Young and Goldman (1944) wrote that the shape of a wolf runway was generally an irregular circle and its length depended upon the amount of food available.

In Wisconsin, Thompson (1952) found no consistent evidence of the use of a circular route by wolves. There was only consistent use of regular trails.

In the Superior National Forest, Olson (1938) ascertained routes used by wolves based on information received from trappers and on personal observations. He states that they "have a beat which they cover every two or three weeks and a trapper who knows the route of a pack can bank on the possibility of its appearance in a certain locality regularly."

During the course of this study, no complete circuitous route was established for any one pack. This does not necessarily mean that wolves do not travel in circles. It means, rather, that circumstances prevented following the wolves long enough to establish a circuitous travel route, if it existed. Tracks of certain packs followed from the air were lost when they entered thick, extensive cover. Wolf tracks followed on the ground became confusing because eventually they mingled with those of other wolves. Also an animal while hunting might just move at random for a time.

Certainly the only way to establish definite proof that wolves travel circular routes in the Forest would be to actually follow trails or backtrack on trails using airplanes and snowshoes. This procedure was only partially carried out. It failed due to the difficulties mentioned above and also to fresh snowfalls which obliterated trails.

In one instance, a pack traveled a distance of 35 miles overnight. Travel was confined almost entirely to the lake ice and the pack did little or no hunting. The route ran from Knife Lake south to Thomas Lake and Lake Insula, thence west and north through Fire Lake forming a fishhook, which, presumably, could have ended at Knife Lake again to complete a circle since the area between Fire and Knife Lakes is used commonly by wolves.

In another route, wolves traveled north during one night from Heritage Lake to near Range Line Lake, thence south to Hustler and Oyster Lakes to form a rough semicircle of ten miles.

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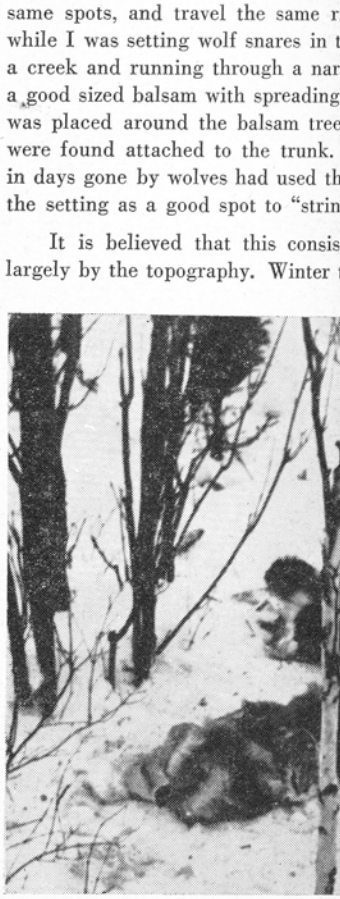

FIG. 6. *Remains of ma*

Dice (1952) defines home range as the area over which an individual animal habitually travels while engaged in its usual daily activities.

In instances where the home ranges of certain wolf packs were established, no definite routes were traced which were followed consistently. Since other wolves often encroached upon home ranges, tracks and trails were confused.

Movements in the Forest, although largely restricted to certain home ranges, are more or less at random covering each pack's home range. At times certain parts of the range are visited regularly. Other parts are hunted only once or twice during the winter. Still other sections of the range are hunted during only part of the winter. Refuge Supervisor Morris Paterson observed that wolves hunted the Moose River area only during March for a three-year period. Wolves frequented the Lake Insula area early in the winter, and sign decreased steadily as the season progressed.

Although definite proof of circular routes used by wolves is lacking, abundant evidence was gathered to show that wolves use the same trails, cross lakes and rivers in the same spots, and travel the same ridges year after year. During the winter of 1936-37 while I was setting wolf snares in the Star Lake area, I found a wolf trail passing along a creek and running through a narrow gorge—an excellent spot for snares. In addition, a good sized balsam with spreading branches was growing along the trail. When a snare was placed around the balsam tree, the rusted remains of an old homemade wolf snare were found attached to the trunk. The bark was growing over the wire—evidence that in days gone by wolves had used the same gorge and that another trapper had visualized the setting as a good spot to "string wire."

It is believed that this consistent use of the same avenues of travel is governed largely by the topography. Winter travel routes of wolves often follow the summer travel

FIG. 6. *Remains of male fawn killed by wolves, February, 1953.*

routes and portages of canoe parties. Lakes, streams, narrows between bodies of water, and the lowest valleys between lakes and rivers are used by wolves and canoeists. At times, wolves strike directly across country over some of the steepest hills to hunt or to satisfy some whim, but generally the easiest routes are followed between hunting grounds.

The desire to travel appears to be an inherent trait in wolves. They can cover 30 to 60 miles in a night and during this time never stop to hunt. In one instance, a single wolf came down Lake One, passed through the Fernberg Lookout deer concentration area and continued to Snowbank Lake without stopping to investigate any of the dozen or more fresh deer trails which it crossed. Either the wolf had fed recently, or his intentions were to reach an area other than the Fernberg before beginning to hunt.

When a pack reaches an area to be hunted, it separates and drives through much like a party of human deer hunters. It is during these drives that wolves are likely to pick up an occasional grouse or hare which is flushed and driven into the reach of another wolf. That there is method to their hunting is evidenced by two observations made by Warden Pilots Rodney Brevig and Robert Hodge. In the first case, a pack of five or six wolves approached an island over the ice. Two wolves separated from the pack and ran around the island on the ice while the remaining three or four hunted across the island. A deer which was flushed by the hunting wolves left the island on the far side but was killed by the two wolves which had run around quickly on the ice to intercept it. The deer was knocked down three times before it was killed.

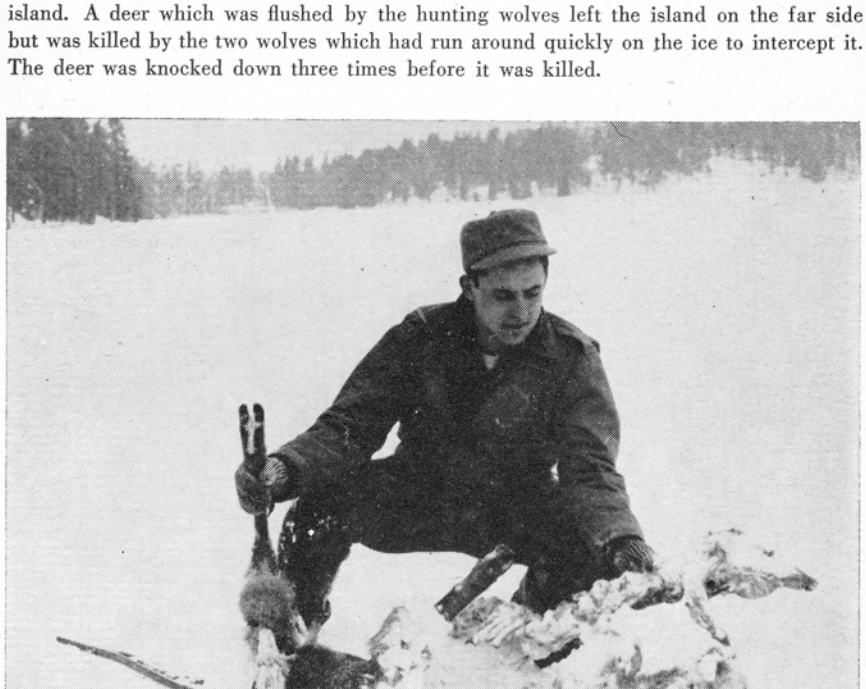

FIG. 7. *Remains of adult doe killed by wolves, Nels Lake, March, 1947.*

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In the second case, observed by Pilot Robert Hodge, a pack of wolves drove the point separating Round and Seven Beavers Lakes while a part of the pack ran alongside on the ice. Again, a deer driven off the point onto Seven Beavers Lake was intercepted by the wolves which had run ahead.

A single wolf is capable of killing a deer and apparently does so with little difficulty. Hugo Sandstrom reported that a wolf chased an adult doe across the ice of North Arm Burntside Lake during the winter of 1946. It bit at the hind flanks and the deer fell three times before it stayed down. Hide and hair flew in all directions as the wolf fed, and by the time Sandstrom reached the scene ten minutes later most of one ham was gone. Earlier, a pack of three had killed an adult buck, again knocking it down three times.

In some instances, wolves actually give up chasing certain deer, and continue on their hunt. Generally, however, they have little trouble bagging their game once they have set after it.

Wolves occasionally swim and will actually pursue their quarry in water. Frank Hubachek reported a wolf killed while swimming across Basswood Lake during the summer of 1951. Johnson (1921) recorded an instance in which a wolf actually had to tread water while feeding on a carrion moose. In an observation described previously a wolf swam across a pothole near Northern Light Lake in pursuit of a wounded moose.

It is widely believed that wolves do not outrun deer while hunting, but outlast them due to greater endurance. Young and Goldman (1944) reported wolves running at speeds of 28 and 40 miles per hour. They were of the opinion that an average speed of 22 to 24 miles per hour was likely for a mile or two. During the winter of 1932, Warden Supervisor F. W. Johnson and Warden John Peil encountered a large wolf while they were driving across the ice of Lake Vermilion. They gave chase and clocked the animal at 35 to 40 miles per hour for a distance of four miles. Since wolves appear to catch deer with comparative ease on lakes in the Forest, it is possible that they are capable of greater speeds than originally believed.

Wolves evidently travel lakes, rivers, and open areas more during the night than during the day. During midday or after feeding they bed down on hillsides or ridges. No dense cover appears to be necessary and the advantage of being able to see some distance from the bedding area outweighs the disadvantage of being exposed—an indication that the wolf fears no other animal. Wolves, after feeding heavily, defecate frequently in the area and may remain to feed again if there is a sufficient amount of the carcass left. If not, they bed down to rest and then continue with their travels. Occasionally a wolf picks up a bone or piece of hide and carries it for miles while traveling. This often explains the single bone found on a lake with no deer carcass in sight.

No evidence of hamstringing of deer was found on freshly killed carcasses although the possibility does exist. Usually deer are run down from behind, the wolf or wolves biting at the hind flanks and abdomen, or at the hind flanks and head region simultaneously. Often the deer is knocked to the ground two or three times before it is killed. It is possible that some deer might even die from a combination of shock, fright, and exhaustion rather than from actual wounds since in some cases it did not appear that animals were wounded badly enough to cause death.

When deer were more plentiful in the region, wolves often ate only the internal organs or a single ham and then traveled on. During recent years, with deer less numer-

ous, carcasses are cleaned up so that only pieces of hide, head, large leg bones and paunch are left. What little the wolves leave is quickly eaten by bobcats, foxes, fisher, ravens, eagles, Canada jays, and chickadees.

On December 28, 1953, Warden Pilot Robert Hodge and Patrolman Lloyd Nelson had the unusual experience of seeing a wolf sight a deer, pursue it, and knock it down with a second deer as an uninterested bystander. While flying over Little Indian Sioux River near the Chad Creek junction, Hodge and Nelson observed a large wolf trotting up the river on the ice. About 100 yards away stood a doe and fawn in a willow thicket. The fawn ran across the river and into the thicker lowlands on the other side. The wolf gave chase and passed within 50 feet of the doe which remained standing in the same spot. Within a hundred yards the wolf had caught up to the fawn and knocked it down. It grabbed the fawn near the right hip and shook it vigorously. The fawn got up on four feet and the wolf immediately knocked it down again. This time the fawn's hind feet were stretched out behind and the wolf grabbed at the front shoulder and neck. The plane now roared over the two struggling animals, and the wolf ran into the thicker woods and disappeared. The fawn remained on the ground a short while, then got up and walked across a small opening in the thicket. It left no blood trail and did not appear to be hurt. Hodge and Nelson flew over the area again a half-hour later. The fawn now lay under a balsam tree within 100 feet of the site of the skirmish.

Decimating and Welfare Factors Affecting Wolf Populations

Predator control program. To all appearances, the only important decimating factor on wolves is the effort of man. In the Forest, local trappers, airplane operators and Department personnel are actively engaged in the control of wolves. For years the trap and snare have been used extensively. Poison was used until prohibited by state law.

A bounty of $35 is now paid on all adult timber wolves. Prior to 1950, no differentiation was made between coyotes and timber wolves; therefore, a breakdown of bounty figures as to species is impossible before that date. According to the Bureau of Law Enforcement records, bounty was paid on 290 timber wolves in 1950, 295 in 1951, and 201 in 1952. Cook, Lake and St. Louis counties paid bounty on 434 or 55 per cent of these 786 wolves. The Superior Na
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The total take of wolves by m
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AIRPLANE HUNTING—Consi
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FIG. 8. *Some of the 38 wolves ta*

Table 7 — Wolf Take During Three-Year Period, 1950-1952

County	Area in Square Miles	Average Annual Bounty Take	Average Department Personnel Take	Total Average Take	Square Miles per Wolf
St. Louis.....	2,988*	70**	20	90	33
Lake	2,232	34	8	42	53
Cook	1,764	32	7	39	45
TOTALS.....	6,984	136	35	171	..
AVERAGE					41

*Major wolf range in county only.
**Excludes estimated 8 taken outside major range.

these 786 wolves. The Superior National Forest lies in these counties. In addition to the wolves turned in for bounty, about 35 have been taken from the Forest by Conservation Department personnel each year during the period 1949-1952.

The total take of wolves by man in the Superior National Forest approximates one animal per 41 square miles (Table 7). This is based on the total areas of Cook and Lake counties plus the major wolf range of St. Louis County, a total of 6,984 square miles.

With an estimated population of one wolf per 17 square miles in the Forest, the take by man is about 41 per cent of the population annually. Since the number of wolves apparently has remained relatively stable during the past five winters, it would appear that the predator control program is harvesting the surplus wolves. Likewise, it can be said that as long as there is no apparent increase in wolf numbers, the population is being controlled. The question for which there is no direct answer is how many wolves would there be if no control program had been in existence? Would they increase rapidly or would they be controlled through natural factors as theory would suggest? Comparison of populations in the cutover area and the uncut regions of the Border Study Area provides one important clue to the cause of high wolf populations. As stated previously, wolves have been scarce in the uncut areas for the past 25 years and common in the cutover areas. In neither area has an organized intensive predator control program been in effect. The major biological difference between the areas is that more deer are found in the cutover area. It appears, then, that natural controls such as the scarcity of deer are limiting wolf numbers in the uncut areas and that a predator control program is unnecessary.

AIRPLANE HUNTING—Considerable numbers of wolves were taken for bounty with the aid of airplanes during the winters of 1946-47 and 1947-48. One operator in Ely

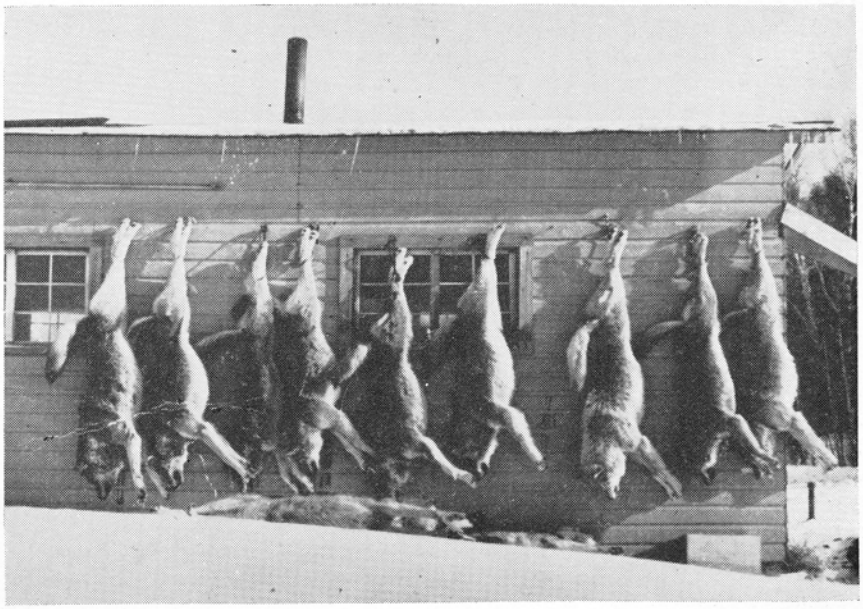

FIG. 8. *Some of the 38 wolves taken by Elwyn West during the winter of 1946-47.*

took 38 during that first year. Wolves were shot on the lakes from the air or from the ice after the taxiing plane had driven them into an open area.

The airplane take dropped drastically the third winter, 1948-49. The wolves had learned to avoid open lakes when they heard airplanes approaching and also a large number had already been removed during the previous two winters. In two instances wolves were actually seen to turn and run for the shore before observers heard the plane in the distance. They reappeared and continued in their travels on the ice after the plane had passed. At the present time a Presidential Air Space Reservation over the "Roadless Area" of the Forest prevents private planes from hunting wolves.

THE BOUNTY SYSTEM — "Bounties, even when excessively high, have proven ineffective in keeping down the wolves, and the more intelligent ranchmen are questioning whether the bounty system pays." Does this sound like modern thinking? It might, but it was also modern 46 years ago when Vernon Bailey (1907) wrote it! At that time, Bailey found Minnesota had paid bounty on an average of 3,260 wolves (coyotes and timber wolves) annually during the nine-year period, 1896-1904. During the eight-year period, 1944-1951, some 45 years later, Minnesota still paid annual bounties on an average of 2,760 coyotes and wolves! The intent of this paper is not to delve into the intricacies of the wolf bounty system as it exists today. It might be well, however, to summarize the opinions of others regarding this complex problem.

In Wisconsin, Thompson (1952) found that wolf hunting as a sport did not diminish during a two-year period, 1943-1945, when bounties were not in effect. Data even suggested that the wolf kill increased.

In Ontario, de Vos (1949a) found little change in the number of wolves taken over a ten-year period, 1937-1947. He was of the opinion that the bounty system apparently had no effect in reducing the wolf population.

Again in Ontario, after an extensive study of the bounty system, Omand (1950) concluded that the expenditure of bounty money on wolves has had practically no effect on the population in the Province.

Young and Goldman (1944) were of the opinion that the "extirpation of this predator (wolf) from many parts of North America was mainly due to the modification of the habitat through human settlement, and the consequent reduction of its natural food supply." They further concluded that the bounty system has so many undesirable features that it should never be substituted for the more orderly and scientific control that can be applied through the employment of trained hunters and trappers. In contrast, Taylor (1942) reported that Ontario attempted to control the wolf with a bounty because the animal takes a toll of big game which is "out of proportion to any semblance of the bounds of nature."

The average annual bounty take of 136 wolves in the three counties costs about $4,700. If, in actuality, the wolf population of Cook, Lake, and St. Louis counties is being controlled for this amount it is reasonable enough since it is difficult to see how trained personnel could be hired to cover the same area for this amount in salary and expenses. A study to find out whether natural controls alone could maintain a stable wolf population would necessitate intensive census work during at least a two-year period in which no bounties would be paid.

A more detailed study of the present bounty system would be difficult because data are not available to indicate how many timber wolves were taken on which bounty was paid during the years prior to 1950.

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Dioctophyma renale, 5.5 per cent;
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An apparent disadvantage of the system is that no control is exercised over the locality where trappers can take wolves. Also, there is a ten-dollar differential between Ontario and Minnesota bounties on wolves. The temptation to seek bounty on Canadian wolves in Minnesota may be great.

Disease and parasites. Specific information on diseases and parasites of timber wolves is meager. Most observers are of the opinion that natural controls are exceedingly important in holding down wolf numbers, but most information to back these claims is only general. Since wolves inhabit the wildest part of our country, it would be difficult to find the carcasses of animals that may have died from disease or natural causes unless the die-off was on a major scale.

Rabies, mange, tularemia, cancer, smallpox, arthritis, and encephalitis are all reported to occur in wolves, according to Young (1942).

Two wolves examined in Ontario by Cross (1940) exhibited advanced bone deposition on an elbow joint on one, and on hind feet of the other, symptoms of arthritis.

Sarcoptic mange was the only positively identified disease in the wolves of Jasper and Banff Parks, Canada, and it was not widespread (Cowan, 1947).

A great epizootic disease accurred among wolves in Canada in 1868 according to Clark (1940). After listing dog disease, rabies, and mange, he concluded that diseases in wolves constituted the real check on wolf numbers and that trappers do not take enough to be significant as a population control.

Murie (1944) lists mange, distemper, and rabies as diseases affecting wolves on Mt. McKinley and quotes Warburton Pike in describing a wolf epizootic which occurred during the winter of 1889-90 in which numerous dead, "mangy" wolves were found.

During this study, little evidence of the effects of disease has been found in wolves. Only two wolf carcasses were found in the woods. Both were in a state of advanced decomposition and the cause of death could not be determined. There was, however, no indication that the animals had been trapped or snared. Game wardens in Grand Marais reported two dead wolves found in the woods. In one case, decomposition was well advanced; in the other the wolf was in good condition and the fur was still attached firmly to the hide. It appeared that the animal dropped dead in its tracks. Cause of death could not be determined.

W. P. Ballard, taxidermist in Nevis, Minnesota, reported a wolf taken near Park Rapids, "seemed to be mangy, with large bare spots and scabby." This wolf measured 69½ inches, total length, and was described as being in poor condition.

Facts concerning internal parasites of timber wolves are more specific. In examining 27 Minnesota wolves, of which nine were represented by stomachs only, Erickson (1944) listed five tapeworms and four roundworms. Tapeworms and their percentage of occurrence were as follows: *Taenia hydatigena,* 44.4 per cent; *Echinococcus granulosus,* 27.7 per cent; *Taenia pisiformis,* 27.7 per cent; *Multiceps packii,* 5.5 per cent; and *Taenia* sp., 5.5 per cent. Roundworms were: *Uncinaria stenocephala,* 27.7 per cent; *Dioctophyma renale,* 5.5 per cent; *Filaroides osleri,* 5.5 per cent; and *Physaloptera* sp., 3.7 per cent. In addition, Erickson listed one fluke, and four other roundworms as having been reported in North American wolves.

Of five wolves examined for parasites by Cowan (1947), four contained the tapeworm *Taenia hydatigena*, one carried *Toxocara canis*, and one *Echinococcus granulosus*.

In discussing the hydatid tapeworm, *Echinococcus granulosus*, Riley (1939a) found cysts in 11 of 21 moose examined, adult worms in three out of eight wolves, and nothing in 19 coyotes. These were all Minnesota specimens.

Young (Young and Goldman, 1944) noted that the fish tapeworm (*Diphyllobothrium latum*) had also been found in wolves in the western Great Lakes region. This worm is found as an adult in man and carnivorous animals. Although it is endemic in northeastern Minnesota (Riley, 1939b) it did not appear in wolves examined. This may indicate the relative unimportance of fish in the diet of the wolves in the area.

Intestines taken from 18 wolves examined for food habits studies were sent to the University of Minnesota and were examined for parasites by Reino Freeman and Thorkil Jensen. Sixteen of the 18 specimens contained parasites in the small intestine (Table 8).

Table 8 — Parasites Recovered from 18 Timber Wolf Intestines

Species	Number Times Occurring	Per Cent Occurrence	Greatest Number in One Intestine
Cestodes (Tapeworms)			
Taenia hydatigena	15	83.3	14
Echinococcus granulosus	4	22.2	32
Taenia sp.	5	27.8	3
Nematodes (Roundworms)			
Uncinaria stenocephala	3	16.7	7

The fact that the rabbit tapeworm, *Taenia pisiformis*, was not found in a single wolf is further evidence that hares are unimportant as food for wolves in the Forest. The larval stage of this parasite is commonly found in snowshoe hares.

Unbalanced sex ratios. Substantial data concerning vital statistics in wolf populations are lacking. There are indications that males may outnumber females and this has been offered as a factor which tends to hold wolf numbers down naturally. However, Young and Goldman (1944) list 68 wolves taken in New Mexico in February, 1916, as being made up equally of males and females. In a smaller sample of 25 wolves taken in the Canadian Rockies, Cowan (1947) found 15 males and suggested that, " . . . anything that upsets the 50:50 ratio in a monogamous species such as the wolf will exert profound influence upon the reproductive potential of the population." He further concluded that this unbalanced sex ratio along with mange and old age were to a large measure holding down wolf numbers in the Rocky Mountain Park.

Of 156 wolves taken in northeastern Minnesota, 100, or 64 per cent, were males and 56, or 36 per cent, were females (Table 9). Of 103 in which the method of the take was known, 58 were shot from airplanes and 45 were snared. In each case, 60 per cent were males. This exact correlation was probably a coincidence, but the figures definitely show a preponderance of males taken both in snares and from planes. These methods of take are so different that one might believe the resulting sex ratios portray the ratios as they actually exist in the wild.

Table 9 — Sex

Method of Take	Total Number	Number
Shot.....	58	35
Snared.....	45	27
Trapped....	11	5
Unknown...	42	33
TOTALS.... AVERAGES	156	100

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In the Forest, trapper Joel Ma
years consecutively, indicating a fen

Table 9 — Sex Ratios of Minnesota Wolves

Method of Take	Total Number	Males Number	Males Per Cent	Females Number	Females Per Cent	Number Males to 100 Females
Shot.....	58	35	60	23	40	154
Snared.....	45	27	60	18	40	149
Trapped....	11	5	45	6	55	84
Unknown...	42	33	79	9	21	366
TOTALS....	156	100	..	56	..	...
AVERAGES			64		36	179

Home territory. The theory that territorialism or the defense of home territory to the exclusion of other animals of the same species has been offered as a possible explanation for natural control in populations. Elton (1950) refers to territory systems found among hawks, warblers, kingfishers, tigers, badgers and insects. Furthermore, he states that, "Animals which have no natural enemies, or which are comparatively immune from them tend to adopt systems of limitations of numbers."

Murie (1944) found packs having rather definite home ranges which sometimes overlapped. Wolves within these ranges drove off strange wolves on occasion. If this action were normal, it would tend to limit the number of wolves on a range.

Banfield (1951a) also found that home ranges were a reality although one or more groups may use the same range or even single wolves could travel its routes.

No evidence of intraspecific strife was found in Minnesota. Travel routes suggested established home ranges with poorly defined borders overlapped somewhat by ranges of other packs. Home ranges from which the main pack had been removed remained barren of sign for two or three weeks after which other wolves reoccupied the range. Since these vacated home ranges remained free of wolves for a period of time, it is probable that wolves and wolf packs on the periphery respected the established territory of the home pack. The respect of another pack's range would limit the number of wolves living in the area and would act as a natural control on total numbers.

Nonproductive animals. Another unknown to be added to the long list of mysteries in the lives of wolves is the number of sterile, nonbreeding, or senile animals in a population.

Females do not breed until during their second year (Murie, 1944), but data are lacking as to whether all wolves breed every year. If not, the nonbreeding females could influence the population greatly within the area.

Murie (1944) found a family of wolves using the same dens two years in succession and producing litters. However, Cowan (1947) found four or five adults using the same small range for a period of three years without apparently producing any pups. He was of the opinion that there were many nonbreeding individuals among the population.

In the Forest, trapper Joel Mattinen took litters of pups from the same den two years consecutively, indicating a female was breeding each year.

THE WHITE-TAILED DEER

History

Prior to 1884 when the first railroad was built through what is now part of the Superior National Forest, deer were scarce and moose and caribou were the important big game mammals. Large deer populations were located in the hardwoods areas of central and southern Minnesota and along the edge of the prairies. With the creation of ideal deer habitat in the Forest by the logger's ax and accompanying fires, the populations of white-tailed deer increased rapidly and those of caribou and moose declined. The major logging operations in the Forest occurred during the thirty years from 1885 to 1915. With the development of a second growth forest, the deer population built up to a peak in the 1930's and then gradually declined.

Rise of the deer herd. The build up of deer numbers from a low in 1885 to an overpopulation by 1935, a period of 50 years, was due to three conditions. First was the transformation of a virgin evergreen forest devoid of good deer habitats into a second growth hardwoods forest capable of supporting many deer. According to Grange (1949), deer populations reach a peak and begin to decline 18 to 33 years following denudation of areas similar to those found in the Forest. Taking the year 1900 as the midpoint of the major cutting period, the peak and decline should have, theoretically, occurred from 1918 to 1933. This is strikingly close to what actually happened.

The second condition which favored the tremendous build up of the deer herd was the presence of thousands of cedar swamps never before utilized by any large number of deer. They provided ideal wintering areas, and optimum conditions of food and cover. The formation of browse lines in these swamps by 1930 was the first indication that deer numbers were exceeding the carrying capacity of the cedar yards (Fredine, 1940).

The third condition which caused the deer population to mushroom was restrictions on deer hunting. Large refuges were maintained, hunting seasons were limited to alternate years only, and seasons were not longer than 11 days after 1922. During the period 1930-1940 the largest number of licenses sold in Minnesota in any one year was 71,000 and the highest estimated deer take was 56,000. Hunters attained a phenomenal 84 per cent success in 1932 and 81 per cent success in 1940. It is apparent now that the take could easily have been doubled or tripled without detriment to the herd. Actually a larger take during the "Roaring 30's" would have benefited today's deer population since good range and winter feeding conditions would have been extended over a longer period of time.

Decline of the deer herd. By 1945, indications were that deer numbers were declining and 1946 was the last of the "golden years" of the Forest's deer herd. Most hunters were of the opinion that reduced deer numbers were due to wolves and overhunting. Overshooting certainly could have been an important factor in certain local areas as the number of licensed deer hunters in Minnesota jumped from 70,000 in 1940 to 179,000 in 1946. However, deer numbers in Minnesota also declined in refuge areas where there was no hunting and in closed areas where there were no timber wolves. The most important single factor which reduced the deer population from its peak in the 1930's was range deterioration accompanied by starvation and lower production (Fredine, 1940).

Starvation occurred in wintering areas in 1933, 1937, and 1939. Census drives by Civilian Conservation Corps showed a decline in deer numbers from 17 per section in

1935-36 to 13 per section in 1938
the spring of 1937 showed that a
square mile of the entire Forest a

During the winter of 1938-39 a
died of starvation (Stenlund, 1949

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1935-36 to 13 per section in 1938 (Morse, 1941). Mortality checks in wintering areas in the spring of 1937 showed that an average of 1.1 deer had died of starvation on each square mile of the entire Forest area.

During the winter of 1938-39 an estimated 6,500 deer perished, of which 55 per cent died of starvation (Stenlund, 1949).

Starvation caused general depletion of deer numbers again in 1943, 1948, and 1950. The 1950 starvation loss occurred despite the fact that hunting seasons on both sexes had been held annually since 1942 and an estimated half-million deer had been harvested by hunters in the state. During the spring of 1950, a starved deer was found for each two acres in the Brule River deer yard near Grand Marais. Twenty-four starved deer were found dead along a nine-mile stretch of road leading into Lake Vermilion. This story was much the same over northern Minnesota.

These spring losses were due to general range deterioration resulting from four conditions. First was the almost complete elimination of cedar as food for deer. Cedar is a slow growing tree in the northern lowlands. Reproduction was eliminated by an overpopulation of deer and an abundance of snowshoe hares in 1935 and 1945. Cedar swamps which harbored hundreds of deer in the 1930's were abandoned almost completely by 1945.

The second condition which contributed to the decline in deer numbers was overbrowsing of hardwood food species by the top-heavy deer herd. Mountain maple, red maple, red osier dogwood, mountain ash, elderberry and sumac are hardwoods preferred by deer. A general check of the Jonvik deer yard near Lutsen in 1951 showed one-third of the stems in mountain maple clumps were dead. Detailed surveys of five wintering yards revealed a decrease of 50 per cent in the amount of available food during the nine-year period 1940-1949. The surveys also showed that the quantity of good food had declined and poorer foods such as hazel and thimbleberry were making up an important part of the deer diet (Krefting and Stenlund, 1951). Of 28 deer wintering areas checked by general surveys from 1949 through 1952, food conditions in three were classed as good, six as medium, and nineteen as poor. Starvation would have occurred in those nineteen areas during a severe winter.

The third factor which hastened the decrease of deer in the Forest was that the second growth timber which had occupied the cutover areas was reaching maturity or overmaturity. Heavy shade by a full canopy of crown leaves discouraged the growth of new shrubs to provide food. Grange (1949) indicates that deer are still found in a closed forest but that the numbers decline.

Finally, size of the present and future deer herd in the Forest is being influenced by a change or succession in the dominant trees. Evergreens are replacing deciduous species. The forest cover up to the disruption period 1885-1915 was a series of coniferous trees (Potzger, 1950). There is good reason to believe that the evergreen forest will again cover the land. Recent timber surveys indicate that the most important restocking species in many sample plots is balsam. With excellent fire protection and little cutting on a major scale, a balsam and spruce forest is likely to occupy sites formerly covered by second growth poplar and birch. Heinselman (1951) found 44 per cent of the understory of the present aspen-birch types is spruce and fir. According to the 1936 survey, two million acres of aspen-birch type in Minnesota were in the spruce-fir ecological type. Only 218,000 acres could convert to a hardwoods or a mixed hardwoods type suitable for

FIG. 9. *Fernberg Road area which reached optimum for deer during the 1930's. Birch occupied much of the burn of 1923. Balsam and spruce reproduction now becoming evident.*

deer. There is a strong tendency toward spruce-fir in secondary successions in northeastern Minnesota. Because the deer is primarily an animal of a mixed hardwoods forest, its numbers will gradually decline with the increasing evergreen forest.

Present status of the Forest deer herd. Since the decline in deer numbers which occurred during the 1940's, the Forest deer population curve has reached a plateau, above and below which it fluctuates depending on wintering conditions. During the abnormally mild winters of 1951-52 and 1952-53, deer prospered and fawn crops were large. Hunting success during 1952 did not come up to expectations due to the lack of snow and extremely poor visibility in the woods. The mild winters allowed deer to roam freely over much of their summer range and as a result, overbrowsed ranges received respite from heavy deer pressure.

Areas most heavily hunted during deer seasons are those lying near roads, trails, and lakes. Vast areas are hunted lightly or not at all because they are inaccessible. It is possible that closed deer seasons and strict predator control would increase deer numbers in the heavily hunted areas. If a severe winter followed a closed season, however, deer would be concentrated, shrubs would be overbrowsed again, and starvation would follow. Both deer and their range would suffer. Severe winters have occurred six times during the past twenty years, or once every three to four years.

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FIG. 10. *Adult doe, one of many*

Deer populations are low in the uncut wilderness area of the Border Study Area despite the facts that they are not hunted and wolf populations are lower than in neighboring cutover areas. Deer numbers have remained low for the past thirty years, and there is no reason to believe that they will increase in the future. Rocks, jack pine, and mature hardwoods which make up the habitat in these wilderness areas are not conducive to large deer production.

Deer are common in the cutover and burned over areas of the Border Study Area despite considerable wolf activity. These areas are hunted but little and were not hunted at all during the period 1909-1951. Even if these areas were never hunted and predators were completely eliminated, the deer population would decline because balsam fir is replacing the aspen-birch type with its accompanying food shrubs.

Decimating Factors

Hunting take. Although certain accessible areas sustain heavy hunting pressure, hunting pressure is generally light in the Superior National Forest. Some game refuges and large inaccessible areas are not touched by deer hunters. Hunter checks in the Gegoka Management Unit (ten townships) near Ely show a maximum pressure of 2.9 hunters per square mile, *if all hunters checked during the season were hunting at the same time.* Only 0.65 deer per section was removed annually by hunters during the three-year period 1947-1949 (Stenlund et al, 1952).

Exact numbers of deer taken by poaching is unknown but it is not believed to be high. Also, most poaching is done near settlements. The high wages and employment conditions which have existed the past thirteen years do not encourage poaching.

FIG. 10. *Adult doe, one of many deer which died from malnutrition during the severe spring of 1950.*